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C. K. OGDEN

1759



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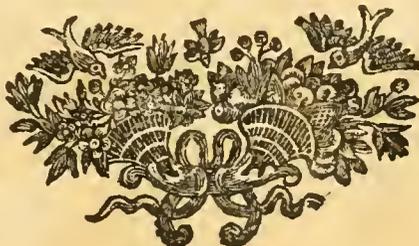


A NEW  
UNIVERSAL HISTORY  
OF  
ARTS and SCIENCES,  
SHEWING THEIR  
ORIGIN, PROGRESS, THEORY, USE and PRACTICE,  
AND EXHIBITING  
*The Invention, Structure, Improvement, and Uses,*  
Of the most considerable  
INSTRUMENTS, ENGINES, and MACHINES,  
WITH  
*Their Nature, Power, and Operation,*  
DECYPHERED IN  
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IN TWO VOLUMES.

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MDCCLIX.



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T H E  
  
I N T R O D U C T I O N  
  
C O N C E R N I N G  
  
A C A D E M I E S ,   a n d   A C A D E M I C A L   L E A R N I N G .

I T is a general Observation, that all Men retain a certain innate Affection for the Place of their Nativity. And shall it be said that a Genius can forget the Place of his Improvement in Knowledge? Are not the Endowments of the Mind as valuable, as the Gratifications of Sense in the Enjoyment of our natural Soil? Therefore it would be an unnatural Contempt of those *Nurseries of Learning*, should we enter upon a Work of this Kind, without paying due Tribute to ACADEMIES, to which we are greatly indebted for most of the useful Improvements in the several ARTS and SCIENCES.

ACADEMY in its simple and primitive Sense, was no other than the House of a certain Nobleman, named *Academos*, situate without the Walls of the famous University of *Athens*; to which he invited all Men of Learning: And it was honoured by *Plato* and others, who resorted thither to hold private Philosophical Conferences; which perhaps, were preparatory for, or not allowable to be disputed in, the *Areopagus*. — A Custom, which afterwards prevailed in other Countries near the Seats of Learning, as we are informed by History; till at last we have seen such Societies of learned Men regularly instituted, under the Protection of Princes, for the Cultivation and Improvement of Arts and Sciences, under the Name of *Academies*, in memory of their Founder *Academos* the *Athenian*.

*Cicero* likewise had his *Academy*, or Country-house for the Entertainment of his Philosophical Friends: to whose Conferences the World is indebted for his *Academical Questions*, and for his Books on the *Nature of the Gods*.

But the *Academies* in after Ages extended the Subjects of their Enquiry. For the Members of *that* instituted by *Charlemagne* at *Paris*, under the Direction of *Alcuin* (an *English* Monk) and composed of the first Wits of the Court, were employed in making judicious and learned Reflections upon some ancient and classical Author in every Branch of Literature.

We have since found this Name appropriated to Places set apart for the Improvement of some particular Sciences.

IN ENGLAND we have the *Royal Society*, whose Business is to make faithful Records of all the Works of *Nature* and *Art*, which come within their Reach. And how well they have executed this Plan is easily discovered by a Perusal of their *Philosophical Transactions*, containing a vast Collection of Experiments and Observations on most Parts of the Works of Nature; Histories of Arts, Manufactures, Engines, &c. and Improvements in civil, military and naval Architecture; Navigation, Trade and Agriculture. These Transactions, are in great Esteem, and, with a few Intermissions, have been regularly published since 1665.

This Society seems to owe its Origin to the Necessity of the Times; when Party Zeal and civil Discord obstructed the free Intercourse of the Learned in our Universities. For, it began, like that in the House of *Academy*, in *Wadham College, Oxford*, where Dr. *Wilkins* entertained the brightest Genius's of his Time for the Promotion of natural and experimental Philosophy, in his private Apartment; till the Jealousy of *Oliver's* Protectorate obliged them to discontinue their Meetings. However many of the Members taking up their Abode in *London*, we find them reviving at *Gresham College* in that Metropolis, about the Year 1658; where they acquired so much Reputation, that in the beginning of the Year 1663, King CHARLES II. incorporated this *Academical Society* by the Name and Stile of *The President, Council, and Fellows, for the promoting the Knowledge of natural Things and useful Experiments*.

This illustrious Body consists of Persons eminent for their Birth, and for their Knowledge in the Arts and Sciences they profess; amongst whom we find several Princes. Each of these Members at his Admission subscribes an Engagement, That he will endeavour to promote the Good of the Society: Which since its Incorporation is, by way of Eminence, distinguished by the Name of *The Royal Society*; King CHARLES himself designing to become a Member thereof.

The Reputation of this Establishment raised an Emulation in the Promoters of other Branches in the ARTS and SCIENCES; especially amongst the Masters of *Music* and *Painting*. For we find upon Record a *Royal Academy for Music*, and another for *Painting*, established by Letters Patents, and put under proper Directions; though at present they seem to have dwindled away.

Some Attempts have, of late Years, been made to form an *Academy* in LONDON for promoting *Sculpture*. And there is a flourishing SOCIETY for promoting ARTS and MANUFACTURES, which is supported by Gentlemen of great Eminence for Birth and Learning, and begun with a noble Design to encourage *Art* and *Industry*, and to discover the necessary Means to improve *Agriculture* and the *Manual Arts*, as well as other Branches of useful Knowledge: Tho' neither of these Societies, which are conducted upon *Academic* Principles, and for *public* Utility, have the Sanction of a Royal Charter.

The Society of *Antiquarians* in *London*, is an *Academy* or Meeting of Men learned in all curious Pieces, which are capable of giving any Light into the Lives, Actions, Customs, Manners, Buildings, &c. of the Ancients. It is said to have been founded by Mr. *Camden*, in Company with Sir *Robert Cotton*, *Stow*, and others; and we find that *R. Carew* was admitted a Member thereof in 1589. These Gentlemen applied to Queen *Elizabeth* for a Charter, and the Grant of a House for holding their Meetings, erecting a Library, &c. but her Death deprived them of their Expectations.

We hear no more of this excellent Institution till the Year 1717, when this Society was revived by a select Number of the Nobility, Gentry, Clergy and other learned and ingenious Men, whose Business is to discover the Antiquities of our own, as well as of other Nations. There has been no Interruption since its Revival; but it now flourishes under favour of a Royal Charter, dated 2 *November* 1751, by which the Number of its Members is limited to one Hundred and Fifty.

The College of *Physicians* in *London* is mentioned by the Author of *Mem. de Trev.* under the Name of *Academy*: And the Institution of *Gresham College* in the same Metropolis deserves the same Appellation: The former being established for the Improvement of *Physic*; the latter for Lectures in *Divinity*, *Civil Law*, *Astronomy*, *Geometry*, *Rhetoric*, *Physic* and *Music*; founded by Sir *Thomas Gresham* in 1581, with sufficient Salaries for the several Professors, and genteel Apartments for their Lodging.

IN FRANCE we meet with *Academies* of various Kinds: The principal is the *Royal ACADEMY of Sciences* at *Paris*; which owes its Existence to *F. Merfenne* in the Beginning of the 17th Century, who entertained *Gassend*, *des Cartes*, *Hobbs*, *Robensal*, *Pascal*, *Blondel* and other eminent Philosophers, and proposed to each of them certain Problems to examine, or Experiments to be made. These private Meetings were followed by more public ones under the Direction of Mr. *Montfort* and M. *Thevenot*, the celebrated Traveller; till, in the Year 1666, it obtained the Royal Sanction, and was constituted a Society for the Improvement of *Physics*, *Mathematics* and *Chemistry*. But this Society was not honoured with the Name of *Royal* till the Year 1699; when his Majesty, by a Regulation, dated on 26 *January* of that Year, gave it a new Form, and placed it upon a more solemn Footing: By which it was ordained that the *Academy* should be composed of ten *Honorary* and ten *Eleves* Members, and of twenty *Pensionary* and twenty *Associate* Members. — That the *Honorary* Members should be all *Reciprocales*, and all the *Eleves* and *Pensionaries*, Inhabitants of *Paris*, and that eight *Associates* might be Foreigners: To be governed by a President, named yearly by the King out of the *Honorary* Members, and by a Secretary and Treasurer, who were to be perpetual.

It was also ordained that the Secretary and Treasurer should be chosen out of the *Pensionaries*, and that the remaining eighteen of that Class should be divided into three *Geometricians*, three *Astronomers*,

three *Mechanics*, three *Anatomists*, three *Chemists* and three *Botanists*: — That two *Associates* should apply themselves to *Geometry*; two to *Botany*, and two to *Chemistry*: — That all the *Eleves* should apply themselves to some kind of Science; but never speak, except called up thereto by the President: — That no Regular nor Religious should be admitted, except an *Honorary Member*; nor any one admitted a *Pensionary* or *Associate*, who had not distinguished himself by some considerable Work in Print, or by some useful Machine or Discovery.

The *Academy* thus composed was allowed to meet twice a Week in the King's Library; and afterwards in a more convenient Apartment in the *Louvre*; where they transacted literary Business for two Hours at least: And every *Pensionary*, at the Beginning of the Year declared in Writing, what Work he intended to prosecute chiefly in that Year, with an Invitation for the Assistance of every Member.

His Majesty not only dignified them with his *Royal Sanction*; but to encourage them in the Pursuit of the Sciences, he gave besides their ordinary Pensions, some extraordinary Gratuities for Performances of superior Merit; bearing also the Expence of Experiments, Printing, Engraving, and of other Enquiries and Incidents necessary for improving the Subjects undertaken by the *Academists*; if approved and signed by the President.

But as this Regulation, in course of Time, was found too confined, and excluded many foreign Artificers and Mechanics, who excelled in Professions not yet brought to Perfection in *France*; the Duke of *Orleans*, Regent of the Kingdom, in the Year 1716, in order to invite over Foreigners, augmented the Number of *Honorary Members* and of *Associates* capable of being Foreigners: Admitted Regulars amongst such Associates: Suppressed the Class of *Eleves*, and in Lieu thereof, established twelve *Adjuncts* to the six several Sciences cultivated principally by the *Academy*. He also appointed a *Vice-president* to be chosen annually by the King out of the *Honorary Class*; and a *Director* and *Sub-director* from amongst the *Pensionaries*.

Their Motto is *Invenit & Perfecit*: and their Proceedings are published under the Title of *Histoire de l'Academie Royale*, &c. But no Member is allowed to make use of his Quality of *Academist*, in any private Work he shall publish, before it has been read to, and approved by, the *Academy*.

Before this Institution we meet with another under the Name of the *French Academy*, which was at first a private Assembly of the Learned in the House of M. *Courant* at *Paris*, Anno 1628, and afterwards established in 1635 by Cardinal *Richlieu*, under *Lewis XIII.* for refining and ascertaining the *French Language* and Style. The Number of its Members was confined to *Forty*; who have generally been Persons of the greatest Distinction in the Church, the Army, and at the Bar.

The primary Object of the Labours in this *Academy* was the compiling of a *Dictionary* for a Standard of the *French Tongue*: But that Performance was so long in *Embryo*, that the Public had almost lost all Hopes of ever seeing it: And when after Forty Years and upwards, these Forty Members were lampooned into the Necessity of publishing their *Dictionary*, the learned were extremely disappointed in their Expectations.

Its modern State may be gathered from a humorous Writer, who in the Year 1737 informs his Correspondent, “ That the *French Academy* had then produced nothing but a System of Compliments, and consisted of Forty Persons, who met three times a Week, and paid their Attendance very regularly; because the King gives a Silver Medal to every one that attends, and permits the Medals of the Absenters to be distributed to the Members present. Their Meetings for near fourscore Years past, says he, have been spent in Harangues of Congratulation and Reception, and in commending each other to the Skies. They applaud one another for their Merit and Talents, and then return home. They sometimes are wholly employed in the spelling of a Word or accenting of a Syllable; upon which Occasion the whole *Academy* labours, disputes and studies for about six Months, and then pass Sentence of Death upon some insignificant Word or Syllable. This *Academy* was fifty Years about a *Dictionary*, of which they were continually publishing Praises before hand; but when it came out, it was universally despised. That which compleatly ruined its Character was another *Dictionary* compiled by *M. Furitiere* only, a Member of this *Academy*, which was published at the same Time, and generally esteemed. The *Academy* was resolved to revenge their injured Honours and to ruin the Man effectually: And therefore expelled him for no other Crime than for having merited the Applause of the Learned World.

“ In the Reign of *Lewis XIV.* all the great Men were Members of this Society, and were admitted by the Royal Mandate: But since his Death they have been succeeded by a Rabble of Ecclesiastics, Prelates and Fops: Nay they have admitted Stage-Players, *French Comedians*, and preferred two or three Buffoons and Merry-Andrews to five or six Men of the first Class.”

This *Academy* distributes two Prizes annually, one for an eloquent Discourse, whose Subject shall be proposed and taken out of the *New Testament* by the *Academy*. This is the Gift of Mr. *De Belzar*.

The other is given by the Academy, which is to be for the best Poem in Praise of the King, and proposed by the Academy also.

The Merit of these Pieces directed to the Secretary, and distinguished by some Motto, Letters, or Characters, is decided by a Committee of the Members delegated for that Purpose; who appoint the Day for distributing the Prizes, and for publickly reading and printing the Discourse and Piece of Poetry, which they judge to have deserved it.

The *Academy of Painting and Sculpture* established at *Paris* by Cardinal *Mazarin*, and the Chancellor *Sequier* is still in good Repute. It consists of a Director or President, a Chancellor, four Rectors, a Treasurer, twelve Professors, *Adjuncts* to the Rectors and Professors, Counsellors, a Secretary, a Professor for *Anatomy*, and another for *Geometry* and *Perspective*.

Members are admitted either as *Painters* or *Sculptors*. And Painters are to be admitted according to their several Branches: Some as Painters of History: Others, as Painters of Portraits: Others, as Painters of Landships, Beasts, Fruits, Flowers, or in Miniature: Others, as only Designers, Engravers, Carvers, &c.

They expose their Works once a Year in the great Hall of the *Louvre*: The best Performances are rewarded with a Prize: And they, who shall be thus distinguished for their Works have a Right to Admission and Entertainment for three Years in an *Academy* of Painting, Sculpture, &c. established at *Rome* by *Lewis XIV.* for their further Improvement.

The *Academy of Medals and Inscriptions* at *Paris* is a Legacy to the Literary World by *M. Colbert*, who gave it Being in the Year 1663, and appropriated their Labours to the Study and Explanation of antient Monuments, and to the perpetuating of great and memorable Events, especially those of the *French* Monarchy, by Coins, Relievo's, Inscriptions, &c.

Its first Institution consisted only of *four* or *five* Members: But in 1701, they were increased to *forty*, viz. Ten *Honoraries*; ten *Pensionaries*; ten *Associates*; ten *Novices* or *Eleves*, under the Direction of a President and Vice-President, who are annually appointed by the King. The Secretary and Treasurer are perpetual.

Their chief Employ has been upon the *Metallic History* of the Reign of *Lewis XIV.* 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. See the *Hist. de l'Acad. Roy. des Inscrip.* PARIS, 4to, & AMSTEL. 12mo.

The *Chirurgical Academy* in *Paris* is a modern Institution, erected by public Authority, for publishing their own and their Correspondents Observations and Improvements in *Surgery*; to give an Account of all that shall be published on *Surgery*, and to compile a complete History of this Art from the Works of all ancient and modern Authors on this Subject.

The *Academy of Dancing* seemed to be the most highly favoured by the late King of *France*. His Royal Privileges to this Society indicate a true Estimate of the Levity of the *French*. But

The *Royal Academy of Belles Lettres* at *Caen* in *Normandy*, by Letters Patent in 1707, does Honour to his Memory. This rises from the private Conferences held by the Learned in and about the City in the House of *M. de Brieux*, about fifty Years before *M. Foucault* procured their Incorporation into a perpetual *Academy*. Their Charter nominated *M. Foucault* Protector thereof for his Life, with Power for him to chuse *thirty* Members; after his Demise, the Choice of Protector and Members was left to the Society, with Leave to add *six* more Members to be elected out of the *Ecclesiastical Communities* in the City of *Caen*.

At *Lyons* in the same Kingdom is an *Academy* of the Learned. It consists of *twenty* Members, a Director and a Secretary; who have shewn themselves inferior to none of the *Royal Academies*, by their learned Dissertations; amongst which is one upon *Infinity* by *F. Lombard*, a *Jesuit*: See *Novo. Liter. T. 2. p. 82.*

The *French* have also Academies at *Montpelier*, *Nismes*, *Arles*, *Angiers*, &c.

If we travel over the *Alps*, it will be seen that *ITALY*, the ancient Seat of Literature, has abounded most with *Academical Institutions*.

At *BOLOGNA* there was established an *Ecclesiastical Academy* in 1687, for the Examination of the Doctrine, Discipline, and History of each Age of the Church.

Here was the *Academy Degl'Inquieti*, which united with the *Academy Della Traccia*. They met in the House of the Abbot *Stut. Saupieri*, and were highly entertained with the Physical and Mathematical Discourses of *Geminiana Montanari*, one of the Members, published in 1667, under the Title *Pensieri Fisica Matematici*. The Members afterwards met in the House of *Eustachio Manfredi*; then in that of *Jacob Sandri*, but arrived at its greatest Lustre in the Palace of *Marfilli*.

In this City also is an *Academy of Arts and Sciences*, called the *Institute of Bologna*, founded in 1712 by Count *Marfigli* for cultivating of *Physics*, *Mathematics*, *Medicine*, *Chemistry*, and *Natural History*. Whose History is published by *M. de Limiers* in 8vo. 1723, at *Amsterdam*.

To this add the *Sittientes* in the same City, who apply themselves particularly to *Law*.

At *VENICE* is a *Cosmographical Academy*, called the *Argonauts*, instituted for the Improvement of *Geography* by the Interest of *F. Coronelli*. Their Plan was to make and publish exact Maps, both *Geographical*, *Topographical*, *Hydrographical*, and *Ichnographical* of the *Celestial* and *Terrestrial* Globes, and the several *Regions* and *Parts* thereof, together with *Geographical*, *Historical*, and *Astronomical* Descriptions. Each Member in order to support the Expence of such a Society, is obliged to subscribe a proportionate Sum towards raising the Money for publishing their Improvements. And for the more effectual Execution of this grand Design they established two corresponding Societies, one at *Paris* and the other at *Rome*. In all three, the *Argonauts* number 196 Members; and their Device is the *Terraqueous Globe* with the Motto, *Plus ultra*.

Here are also three *Academies of Sciences*: One called *La Veneta*, founded by *Frederic Badoara*, a noble *Venetian*: Another, which acknowledges *Campegio*, Bishop of *Feltro* for its Founder: And a third named *Consenza* or *la Consentina*; amongst whose Members are numbered the celebrated Philosophers *Telefio*, *Quatromanni*, *Paulus Aquinas*, *Cavalcanti* and *Fabio Cicali*.

At *NAPLES* we read of the first *Academy of Sciences*. It was known by the Name of the *Academy Secretorum Naturæ*, first form'd for the Improvement of *Natural* and *Mathematical* Knowledge in the House of *Baptista Porta*, about the Year 1560.

In the same Kingdom we meet with the *Academy of Rossano*, called *La Societa Scientifica Rossanese*. *Degl'Incuriosi*, which was founded about the Year 1540, by the Title *Naviganti*, and changed its Name to *Spenserati* about the Year 1600, when it was renewed by *Camillo Tufcano*.

This Academy underwent another Change in 1695, when *Dou Giacinto Gimma*, its President got it transformed from an *Academy of Belles Lettres* into an *Academy of Sciences*; at which Time he gave them a new Set of Regulations, and divided the Members into *Grammarians*, *Rhetoricians*, *Poets*, *Historians*, *Physicians*, *Mathematicians*, *Philosophers*, *Lawyers*, and *Divines*; with a Proviso for the Admission of *Cardinals* and *Persons of Quality*.

The *Academy of Arcadi* established at *Rome* in 1690 for reviving the Study of *Poetry* and the *Belles Lettres*, has been honoured by many *Princes*, *Cardinals*, &c. and consists of the most polite Wits of both Sexes in *Italy*; who to avoid Disputes about Precedence, were obliged to come all masked in Dresses resembling the *Shepherds of Arcadia*: and at their first setting off, they used to meet seven Times in the Year in a *Meadow* or *Grove*; but now they are entertained in the *Gardens* of the *Duke of Salviati*; where they recite the Compositions of the Members. The six first Meetings are allotted for reciting the *Poems* and *Verses* of the *Arcadi* residing at *Rome*; and every one reads his own Composition; except *Ladies* and *Cardinals*, who are allowed to depute another *Shepherd* in their stead: And at the seventh Meeting are read the Compositions of *foreign* or *absent* Members. It does not appear how many Members this Academy comprehends; but we know that their Number amounted to 600 within ten Years from its first Establishment.

At *ROME* several learned Men under the Name of *Lyncei* established an *Academy of Sciences*, soon after that at *Naples*. Several of whose Members, amongst whom was the celebrated *Galileo Galilei*, are famous for their Discoveries.

At *FLORENCE* is the *Academy of Umidi*, known also by the Name of *Florentina*, in Honour of the Grand *Duke Cosmo I.* its Protector in 1549. It is illustrious both for the Works it has produced and for its Members, who for more than two Ages have been Persons of the most Eminence in all *Italy*.

Their chief Attention is bent to the *Italian Poetry*; so that they spend much Time in commenting, &c. on *Dante* and *Petrarch*, their chief Authors in that kind of Learning.

Nevertheless this *Academy* has contributed greatly to the Progress of the Sciences by giving excellent *Italian* Translations of the ancient *Greek* and *Latin* Historians.

In the same City and in the Year 1582 arose the *Academy della Crusca*, which has eternized its Name by the famous Dictionary of the *Italian* Tongue. And the Discourses delivered in this Academy by *Torricelli*, the celebrated Disciple of *Galileo*, concerning *Levity*, *Wind*, *Power of Percussion*, in *Mathematics* and *Military Architecture*, convince that these Academists did not confine their Labours to Words only.

AT FLORENCE also is the *Academy del Cimento* under the Protection of Prince *Leopold Cardinal de Medicis*. *Redi* was one of its chief Members; and the Studies pursued by the rest may be collected from those curious Experiments published by Count *Laurence Magulotti*, their Secretary in 1667, under the Title of *Saggi di naturali Esperienze*, presented to the *Royal Society* in *London*, and published in *English* by Mr. *Waller* in 4to.

I could tire your Patience in the Recital of the Number and Variety of *Academies* in *Italy*, which has more *Academies* than all the rest of the World: For the *Italians* are very vain of the Title of *Academists*, which to them seems an essential Part of a regular Constitution. At *Milan* only there are twenty-five *Academies*, and not less than Five Hundred and Fifty in all *Italy*; but none of them very famous, except those set apart for *Music*, *Painting* and *Sculpture*: And even these are much degenerated from the Skill of their Ancestors.

Let us give due Honour to the *Academy of Filarmonici* at *Verona*; whose Members, though they apply themselves to the *Belles Lettres*, don't neglect the *Sciences*. The *Academy of Ricovrati* at *Padua* exists with Reputation, as may be collected from the Discourse on the *Origin of Springs*, by *Ant. Vallisnieri* one of its Members; who also has given the learned World a Sample of the Studies of his Colleagues in the *Academy of the Monti de Reggio* at *Modena*, in his excellent Discourse on the *Scale of Created Beings*, inserted in his History of the Generation of Man and Animals, printed at *Venice* in 1723.

GERMANY is not destitute of *Academies*: And perhaps that called the *Leopoldine* differs from all others.

It is named also the *Academy of Naturæ Curiosæ*, begun by private Conferences in the House of *Jo. Laur. Bauschius*, who invited all *Physicians* to communicate their Observations of extraordinary Cases. His Associates meeting with Encouragement, chose him President. But the Society was not fully established till the Presidentship of *Jo. Mich. Febr.*

Their Works were originally published separately. But in 1670 it was agreed to publish their Observations periodically, by a Volume every Year. The first annual Volume did not make its Appearance till the Year 1684. It had the Title of *Ephemerides*. This Publication has been continued under some Interruptions, and under various Titles, &c.

In 1687 the Emperor *Leopold* granted this *Academy* several Privileges; particularly that their Presidents should be Counts Palatine of the Holy *Roman Empire*.

It consists of a President, two Adjuncts or Secretaries, Colleagues or Members without Restriction: Who at their Admission engage to handle some Subject in the Animal, Vegetable, or Mineral Kingdom, not treated of by any other College, and to furnish Materials for the Annual *Ephemerides*. Each Member also is to wear a Gold Ring, whereon instead of a Stone is a Book open, and on the Face thereof an Eye; and on the other Side the Motto, *Nunquam otiosus*.

The greatest Peculiarity in this *Academy* is its inconstant Situation. It has no fixt Residence or regular Assemblies. It is confined to a *Bureau* or Office first established at *Breslau*, and afterwards removed to *Nurcumberg*; where Letters, &c. from its Members and Correspondents are acceptable, till it be necessary to remove to some other Place of Safety.

AT BERLIN, *Frederic I.* the late King of *Prussia* in the Year 1700 founded a *Royal Society*, which besides the Improvement of natural Knowledge, is engaged in the promotion of the *Belles Lettres*. By the Charter, which was amended in the Year 1710, it is granted, that the President shall be nominated by the King, and be one of the Counsellors of State.

The Members are divided into four Classes: I. For *Physic*, *Medicine* and *Chemistry*; II. For *Mathematics*, *Astronomy* and *Mechanics*: III. For the *German Language* and the *History of the Country*; and the IVth. For the *Oriental Learning*, particularly as it may concern the Propagation of the Gospel amongst Infidels.

Each Class elects a Director for themselves, who is continued for Life. They meet once a Week alternately by their Classes in the Castle called the *New Marshal*. The Members of any of the Classes have free admission into the Assemblies of any of the rest.

The great Promoter of this Foundation was the celebrated *M. Leibnitz*, who was made the first Director.

The present King, *Frederic II.* is said to be a Member thereof; and has thereby occasioned many to give it the Name of the *Academy of Princes*. By his Countenance and Influence many learned Men from all Nations have raised its Reputation throughout the Literary World.

Before we leave the Northern Climes let us travel to RUSSIA, and we shall find an Academy of a particular and excellent Institution, founded by Czar PETER the Great, at *Petersburg*, who modelled it upon the Plan of the *Academy of Sciences* at *Paris*, but did not live to finish his Design: which was carried into Execution and completed by *Catherine* his Relict and Successor upon the Throne.

This Academy held its first Public Meeting in *December* 1725, and was favoured with the Presence of the Duke of *Holstein*, and a large Number of other noble Personages.

The Czar invited hither the Learned from all Parts of *Europe*, and established regular Professors with good Salaries to read stated Lectures in the several Faculties.

The ordinary Meetings are twice a Week, in a very sumptuous Building, furnished with a good Library, and an Observatory, &c. and thrice in the Year there is a public or solemn Meeting, in which is rendered an Account of what has been done in the common Assemblies.

Their Business is not only to promote the Study of the *Arts* and *Sciences*; but they are employed in Compiling a *RUSSIAN Dictionary, Grammar, &c.*

JOHN V. King of PORTUGAL founded a *Royal Academy* for the collecting and ascertaining the *History* of his own Kingdoms and Dominions. It was instituted in the Year 1720, and the Marquis *de Allegrette* thereof was appointed Secretary thereof.

This Institution was honoured by a Medal with the Effigy of King JOHN V. on one Side, with the Legend JOANNES V. LUSITANORUM: and on the Reverse is the same Prince standing, supporting and raising HISTORY almost prostrate before him, with the Legend HISTORIA RESURGES: and below is this Inscription REG. ACAD. HIST. LUSIT. INSTIT. VI. Idus Decembris MDCCXX.

This Academy consists of fifty Members, a Director, four Censors, and a Secretary.

None are admitted to be Members, who have not given great and public Examples of their Abilities, and after Admission every Member is obliged to treat of such part of the Ecclesiastical or Civil History of the Nation, as shall be prescribed by the Director.

The Method observed in compiling *Church History*, the Historiographer is to relate distinctly in twelve Chapters, an Account of the Prelates, Synods, Councils, Churches, Monasteries, Academies, Persons illustrious for Sanctity or Learning, Places famous for Miracles or Relicks, to be found in each Diocese. And in the pursuit of the *Civil History*, he is to relate the Transactions of the *Romans, Goths, and Moors* during their Government in this Country: the Genealogies of the Kings; the Wars and Acquisitions in *Asia, Africa, and America*, and to give the several Treaties, and other Matters relating to the Political and Military State of the Kingdom.

The Meetings for carrying on this useful Institution, are to be held once in fifteen Days. And those Members, who are dispersed in the Country, are enjoined to employ their Time in making Extracts and Collections of all the Registers &c. within the particular Districts, where they reside.

This Foundation was, in the next Year, followed by a similar Institution of an Academy for *Suabian History* at TUBINGEN; where several Gentlemen eminent for Letters associated with an Intention to Publish the best Historical Writings, the Lives of the chief Historians, and for Compiling new Memoirs, on the several Points and Periods thereof.

SPAIN also boasts of her *Royal Academy* at *Madrid*. This Foundation was laid by Don *Joan Emanuel Fernandes Pacheco*, Duke *d'Escalona*, in his own Palace, with seven Associates; who held their first Meeting in *July* 1713.

Their Number was presently increased to Twenty-two *Academists*; and the Founder being chose President or Director, and Don *Vincent Squarcafigo* Secretary, they petitioned for, and obtained the King's Confirmation and Protection in 1714.

In this Charter they are enjoined to cultivate and improve the *National Language*. In order to which, they are to begin with chusing carefully such Words and Phrases, as have been used by the best *Spanish* Writers; noting the low, barbarous or obsolete ones, and compiling a *Dictionary* in which these may be distinguished from the former, &c. by which Method, adds that Prince, it will clearly appear that the *Castilian* Tongue is inferior to none of those most esteemed in the World; and may be employed with Advantage either in teaching the *Arts* and *Sciences*, or in expressing the most perfect *Latin* or *Greek* Originals in exact Translations, when the Dictionary shall be finished, they are to compile a *Grammar*, and *History* of the *Spanish* Tongue.

The Duke *d'Escalona* was constituted Director for Life: But it was ordained that, after his Decease, the Members, who were confined to Twenty-four in Number, should chuse a Director annually.

For greater Encouragement the *Academists* are favoured with the Privileges and Immunities enjoyed by the Domestic Officers, who are actually in the King's Service, and in the Royal Palace. The Secretary is for Life; and their Motto is *Limpia, Fya, y da Ejsplendor*, i. e. *It purifies, fixes, and gives Brightness*.

ACADEMIA, in an exalted Degree, has been commonly used to signify a UNIVERSITY, as *Academia Oxoniensis*, the University of Oxford; and *Academia Cantabrigiensis*, the University of Cambridge; because in each University are usually taught *Theology, Medicine, Law, Arts and Sciences*. But these Repositories of Learning ought rather to be considered as *Universal Schools*, not only because they improve the whole Compass of Literature; but on Account of their being an Assemblage of several Colleges or *Academical Societies* established under one form of Government, and partaking of the same Privileges and Immunities; wherein Students in the several Sciences are trained up by established Professors; and *Academical Degrees* or Certificates of Study, in the divers Faculties, are granted on certain Conditions: though, it is certain, this Institution, in the *Literary World*, took its rise from a Custom, in or about the *eighth Century*, set a foot by the *Monastic Orders*, of erecting *Seminaries* or *Public Schools* in some pleasant and happy Situation for training up not only their own Novices, but for the Instruction of the Children of the Nobility and Gentry.

In this State they continued till almost the *thirteenth Century*. For, though the University of *Paris* endeavours to carry its Origin up to the Year of CHRIST 814, when four *Englishmen* Disciples of Venerable *Bede*, read public Lectures on the *Sciences* in certain Places assigned to them by *Charlemain*; it can be proved beyond all Dispute, that it was not considered under the Acceptation of an *University*, till about the middle of the *twelfth Century*, when *Peter Lombard* Bishop of *Paris*, is supposed to have obtained the Incorporation of all the public Schools or Colleges under the single Denomination of an UNIVERSITY: For which Benefaction his Anniversary is kept in that University to this Day.

The most celebrated Colleges in this University for *Theological Learning* are the *Sorbonne* and *Navarre*.

The College of *Sorbonne* takes its Name from *Robert de Sorbonne*, who dedicated his own House to the Study of Divinity in 1254; which owes the present Magnificence of its Building, great Halls for Disputations, &c. and of its Church, to the Magnificence of Cardinal *Richelieu*.

There are six Residentiary Doctors or Professors in the *Sorbonne*, who each give a Lecture of half an Hour every Day; three in the Morning, and three others in the Afternoon.

The College of *Navarre* was founded by *Jane of Navarre*, Countess Palatine of *Champagne* and *Brie*, Wife of *Philip the Fair*, King of *France* in 1304, with an Obligation upon the Professors to read two Lectures in *Divinity*, Morning and Evening daily.

In this City are found fifty three other Colleges, many of which *Philip the Fourth* in 1295, and *Lewis Hutin* his Son, and *Philip de Valois* in 1340, incorporated into one Body, and honoured with very great Privileges and Immunities. These are confined to the study of Divinity.

But there are other Colleges for the Study of the *Canonical and Civil Law*, and for *Medicine*.

In the Street of *St. John de Beauvais* are six Professors, who read public Lectures, each of them once a Day, besides a Professorship for the *French Law* in particular, founded in this College by *Lewis XIV*.

In the Street *de Bucherie* is a College for the study of *Medicine*, founded in 1469, in which is a large *Anatomical Theatre*, and it is famous for the Education of several eminent Physicians, amongst whom the Faculty mentions the learned *Ferrel*, with Respect, who was Physician to *Henry II. of France*.

However, the *Faculty of Arts* is the Mother of all the other Colleges. From this Foundation is always taken the *Rector*, who is an elective Dignitary, that seldom continues more than *three*, and never beyond *nine Months*.

The *Rector* is the highest Post or Office in the University of *Paris*; whose Privilege is to take Place of all Personages, except the Princes of the Blood. In public Arts he has a Right to precede the Pope's Nuncio, and Foreign Ambassadors, as well as the Dukes and Peers of *France*; and at the King's Funerals he walks abreast with the Archbishop of *Paris*. His Robes are, a Violet Gown tied with a Violet Sash, adorned at both Ends with Gold Glands; at his Side hangs the *Escarcelle*, an old fashioned Violet coloured Velvet Purse trimmed with Gold Lace and Buttons. Over all flows a Mantelet of white Ermine, which reaches to the middle of his Arms.

The *Faculty of Arts* is divided into four Nations: I. The Nation of *France*: II. The Nation of *Picardy*: III. The Nation of *Normandy*: IV. The Nation of *Germany*; which includes *English, Irish, Scotch, Italians, &c.* and is divided into very large Provinces.

The *Provost of Paris*, for the Time being, is Conservator or Chancellor of this University; and it is worthy of Notice, that almost all these Colleges have been founded for poor Students both Natives and Foreigners;

Foreigners; and that none can be admitted to enjoy the Benefits of their Foundation, but such as are not in a Capacity to pay the Expences of an University Education: All others who study in those Colleges being obliged to pay for their Board, Lodgings, &c. except Learning, which is given to every Body without Distinction, that are desirous to attend the public Lectures.

F R A N C E has also its Universities.

At <i>Toulouse</i>	founded by	— Pope <i>Gregory XI.</i>	— —	A. D.	1233
<i>Bordeaux,</i>	—	King <i>Lewis XI.</i>	— —		1473
<i>Poitiers,</i>	—	<i>Charles VII.</i>	— —		1431
<i>Orleans,</i>	—	Pope <i>Clement V.</i>	— —		1305
<i>Bourges,</i>	—	King <i>Lewis XI.</i>	— —		1465
<i>Angiers,</i>	—	—	— —		1346
<i>Gaen in Normandy,</i>	—	<i>Charles VII.</i>	— —		1452
<i>Montpellier,</i>	—	Pope <i>Nicholas IV.</i>	— —		1289
<i>Cahors,</i>	—	Pope <i>John XXII.</i>	— —		1332
<i>Nantes,</i>	—	—	— —		1460
<i>Rheims,</i>	—	<i>Charles Cardinal of Lorraine.</i>	— —		1548
<i>Valence,</i>	—	King <i>Lewis XI. when Dauphin.</i>	—		1458
<i>Aix,</i>	—	Pope <i>Alexander V.</i>	— —		1409
<i>Perpignan,</i>	—	King <i>Peter of Arragon.</i>	— —		1349
<i>Bejaucou,</i>	—	Emperor <i>Ferdinand I.</i>	— —		1564
<i>Orange,</i>	—	—	— —		1365
<i>Artes,</i>	—	—	— —		
<i>Avignon,</i>	—	Pope <i>Boniface VIII.</i>	— —		1303
<i>Duay,</i>	—	—	— —		
<i>Louvain,</i>	—	<i>John Duke of Brabant</i>	— —		1426
<i>Dole,</i>	—	<i>Philip Duke of Burgundy</i>	— —		1426
<i>Fleche,</i>	—	King <i>Henry IV.</i>	— —		
<i>Mountaban and Soissons,</i>	—	—	— —		
<i>Pont-a-Mousson,</i>	—	<i>Charles Cardinal of Lorraine.</i>	— —		1573
<i>Richelieu,</i>	—	King <i>Lewis XIII.</i>	— —		1640
<i>Tournon,</i>	—	<i>Francis Cardinal de Tournon.</i>	— —		

At *Montpelier* is studied the Faculty of *Medicine* with greater Applause than in any Place throughout all *Europe*: insonmuch that not only the King of *France*, but several other Potentates have granted the Graduates of this University the Privilege to practise *Medicine* in their Dominions without any Interruption.

At *Orleans* the University is founded on the Model of that at *Paris*. It enjoys the same Dignities. There is an Establishment of four Professors to teach the Civil and Imperial Law; to the Study of which *Philip the Fair*, in 1312, annexed many Privileges in favour of the Students, which were confirmed by the Bull of Pope *Clement V.* in 1367, who was a Native of *Bordeaux*, and had studied at *Orleans*.

By this Means here was a very great Conflux of Scholars from all Nations; who by certain Regulations, were comprised under ten Nations: But these in 1538, were by an Arret of the Parliament of *Paris*, in the Reign of *Francis the First*, reduced to four, viz. The FRENCH, which includes the *Bourgeois*, *Gascons*, and *Teurangeaux*: The GERMAN which includes *Lorraine*: PICARDY, which includes the *Champanois*: and NORMANDY, which includes the *Scotch*. But

The German Nation enjoy the greatest Privileges granted by former Kings, and confirmed by the Letters Patent of *Henry IV.* dated July 15, 1608, and in June 1616, at *Paris*.

At *Angiers*, *Louis II.* Duke of *Anjou*, founded an University in 1348, and obtained for it several Privileges and Immunities both from the King and the Pope. Its first Institution was for the Study of Law only; but *Henry Duke of Anjou*, and Brother to King *Charles IX.* added the Faculty of *Medicine*, and procured for it new Privileges. The famous *Royer*, Chancellor of *France*, *John Bodin* and other eminent Lawyers were Members of this University, which now has three Colleges in great Esteem.

The other Universities dispersed through the *French* Dominions are in great Reputation for their good Discipline and Care of their Students; but as they are all modelled on the *Parisian* Plan, it will be ex-

cusable to pass them over; I shall only remark, That the *English Secular Priests* have a very flourishing College in the University of *Douay*, founded by Cardinal *Allen*, immediately after the Reformation took Place in *England*, for the fugitive Students and Professors that retired beyond Seas from the *English* Universities. The Learning in this College is in great Reputation amongst the *Roman Catholics*: But it is confined too much to *Classical Knowledge*, *Aristotelian Philosophy*, *Metaphysics*, and *Polemical Divinity*; which last seems to be the greatest Object of its Institution, Namely, to make the Members thereof expert Controversialists in defence of the Church of *Rome*, and to breed up *Missionaries* for drawing *Protestants* into their Communion.

Here was written and printed the *Douay Bible* by the self-same Men, who had just before published their Annotations on the *New Testament* at *Rheims*: nevertheless, these *Collegians* have not for many Years been able to preserve themselves from a Suspicion and Charge of *Jansenism*; because in the grand Dispute amongst the *French* Clergy and Laity, they would not implicitly run into all the Extremes of the Fautors of the *Bull Unigenitus*; as the *English Jesuits* seated at *Liege* and *St. Omers* have done.

The Advantages of *Universal Schools* or *Academical Societies* uniting under one Government becoming very obvious to other Nations, they began presently to multiply throughout *Europe*. So that at present there is not to be found scarce any one sovereign State, where this Institution has not taken Root, and become almost an essential Part of its Existence; so far as *Universities* are designed to finish the Education of such, as are devoted to the Church and State, or to any Branch of Literature. For, in *England* in particular the *Statute Law* has made the *Academical Degrees* of her own *Universities* a Condition (*sine qua non*) for the Tenure of certain Church Benefices, &c.

In the UNITED PROVINCES are the	<i>Pampelon</i> ,	—	—	1608
Universities of	<i>Saragoça</i> , by the Emperor <i>Charles V.</i>			
<i>Leyden</i> founded by the States in the Year	<i>Signenza</i> , by Cardinal <i>Ximenes</i> .			
<i>Utrecht</i> .	<i>Taragona</i> , by King <i>Philip II.</i>			
<i>Franeker</i>	<i>Valladolid</i> , by Pope <i>Clement VI.</i>			1346
<i>Groeninghen</i>	<i>Sevill, Toledo, Avila, Compostella, Gandia, Huesca,</i>			
<i>Harderwick</i>	<i>Valencia, Tudela, and Murcia</i> , whose Dates of			
	Institution and Founders are not come to our			
	Knowledge.			

SPAIN IN EUROPE has the Universities of

<i>Salamanca</i> founded by <i>Alphonfus IX.</i> King } of <i>Leon</i> in the Year	1239
<i>Alcala</i> or <i>Complutum</i> by Cardinal <i>Ximenes</i>	1517
<i>Granada</i> , by the Emperor <i>Charles V.</i>	1537
<i>Palencia</i>	1200
<i>Baeza</i>	1538
<i>Onate</i>	1543
<i>Lerida</i> , by Pope <i>Calistus III.</i>	
<i>Offuna</i>	1549
<i>Oviedo</i> , by <i>Ferdinando Valdes.</i>	1536

SPAIN IN AMERICA has the Universities of

<i>Mexico</i> , founded by the Emperor <i>Charles</i> } <i>V.</i> in the Year.	1551
<i>Guatimales</i> , by King <i>Philip IV.</i>	1628
<i>Lima</i> in <i>Peru</i> , by King <i>Philip III.</i>	1614
<i>Quito</i> , by King <i>Philip II.</i>	1586
<i>St. Domingo</i> in <i>Hispaniola</i> , by King } <i>Philip II.</i>	1558

PORTUGAL rivals her Neighbours with the Universities of *Evora*, *Coimbra* and *Lisbon*.

The Commentaries on *Aristotle's* Philosophy by the *Conimbricenses* have done their Nation great Honour; and were formerly a Tutor's Book recommended to the perusal of the Under-graduates in *Oxford*.

At *Lisbon* is an *University* founded by Pope *Nicholas IV.* A. D. 1290, and before the late Earthquake laid that City in Ruins it had many Colleges, but none in greater esteem for Learning and Discipline than the *English* College of *Secular Priests* dedicated to the Apostles *St. Peter* and *St. Paul*.

This College by particular Privilege is exempt from the Jurisdiction of the *University* of *Lisbon*, which till lately was under the Government or Direction of the *Society of Jesus*.

This Institution is a Branch of the *Secular English Clergy* detached from *Douay*, who were invited to *Lisbon* and fixed in a convenient Situation, in *Bairo Alto*, by *Don Lewis d'Acunha*, to be a *Seminary* for *Missionaries* to be sent to obstruct the Progress of the Reformation in *England*.

The Founder did little more than find them a House and spacious Gardens in the most conspicuous and pleafantest Part of the City. But what by private Donations and Subscriptions both in *Portugal* and in *England*, they soon improved their Habitations with a Church and proper Offices.

At the Time of the Earthquake most of the old decayed Buildings had been replaced with a capacious Stone Dormitory, agreeable Apartments for the President and other Officers; towards which the late King *John V.* had contributed by a large annual Pension for many Years.

There are none admitted into this College but such as are Natives of *England* or *Wales*, or born of *English* or *Welsh* Parents; except they pay for their Board, Lodging, &c.

The Number of *Scholarships* are no more than twenty-five, all founded (except two or three) by *Roman Catholic* Families, and paid out of their Estates in *England*. So that as these *Scholarships* depend upon a Variety of Accidents, it sometimes happens that they are not regularly paid, and sometimes drop; as in the Case of two *Scholarships* founded in this College by the *Ratcliff* Family; which are lost in the Forfeiture of the *Derwentwater* Estates.

The Government of this College is by a President, Vice-President, Confessor, Procurator, a Prefect of Studies, two Professors in *Divinity*, one in *Philosophy*, and one in *Humanity*; who are subject to a Chapter of secular Clergy established in *London*, and are under the Protection of the *Inquisitor-General* at *Lisbon* for the Time being. The President of this College was buried in the Ruins occasioned by the late Earthquake.

These *Seminariists* are distinguished from all other Students in that University by a Piece of Cloth, *Coloris Leonini*, of a kind of Brick colour, which, cut in the shape of an *Oar*, doubles on the Breast and hangs over the Shoulders with each End as low as the bend of the Knee behind, upon a black Serge Gown without Sleeves, with a Cassock of the same Stuff underneath; the Collar whereof is made of stiff Pasteboard covered, and edged with a Piece of Cambric, which they call a Band.

In this Dress they pretend to preserve the old Fashion of the Students of *Oxford*: and they also tell you that they are governed by the Statutes brought by their first Professors from the same University.

In ITALY are the Universities of

<i>Rome</i> ,			
<i>Bologna</i> ,			
<i>Padua</i> , founded by the Emperor <i>Frederic II.</i>	1222		
<i>Ferrara</i> , by the Emperor <i>Frederic.</i>	1316		
<i>Florence</i> , by <i>Cosmo de Medicis.</i>			
<i>Pavia</i> ,			
<i>Siena</i>	1387		
<i>Pisa</i> ,	1339		
<i>Turin</i> , by Pope <i>Benedict XII.</i>	1405		
<i>Naples</i> ,			
<i>Salerno</i> ,			
} by <i>Frederic II.</i>			
<i>Venice</i> ,			
<i>Ferona</i> ,			
<i>Mantua</i> ,			
<i>Milan</i> ,			
<i>Perugia</i> , by Pope <i>Clement V.</i>			
<i>Macerata</i> , by Pope <i>Paul III.</i>			
<i>Catania</i> , in <i>Sicily</i> ,			
<i>Cagliari</i> , in <i>Sardinia</i> ,			

<i>Heidelberg</i> , by <i>Rupert II.</i> Elector Palatine.	1346
<i>Jena</i> , by <i>John Frederick</i> Elector of <i>Saxony.</i>	1558
<i>Ingolstadt</i> , by <i>Lewis</i> , Duke of <i>Bavaria</i>	1472
<i>Liege</i> before	1129
<i>Tubingen</i> , by <i>Eberhard</i> Count of <i>Wur-</i>	} 1477
<i>temberg.</i>	
<i>Vienna</i> , by <i>Albert III.</i> Arch Duke of <i>Austria.</i>	1365
<i>Wittemberg</i> , by <i>Frederic III.</i> Elector of <i>Saxony.</i>	1502
<i>Mentz</i> ,	1482
<i>Triers</i> or <i>Treves</i> ,	1558
<i>Friburg</i> in <i>Brisgaw</i> , by <i>Albert</i> Duke of	} 1463
<i>Austria.</i>	
<i>Rostock</i> ,	1490
<i>Marpurgh</i> , by <i>Philip</i> , Landgrave.	
<i>Gissen</i> , by <i>Lewis</i> Landgrave of <i>Hesse</i>	1607
<i>Gripswold</i> by <i>Philip</i> Duke of <i>Pomeran.</i>	1547
<i>Dillinghen</i> , by <i>Otho</i> Cardinal <i>Truchses</i>	
<i>Kiel</i> , by <i>Albert</i> Duke of <i>Holstein.</i>	1669
<i>Altorf</i> , by Emperor <i>Ferdinand II.</i>	1622
<i>Helmstadt</i> , by <i>Julius</i> Duke of <i>Brunswick.</i>	1576
<i>Paderborn</i> ,	1592
<i>Sigen</i> , by <i>John</i> Count of <i>Nassau</i> ,	1589
<i>Lawengen</i> , by <i>Wolfgangus</i> Count Palatine.	
<i>Gratz.</i>	
<i>Wurtzburg.</i>	
<i>Duisburg.</i>	

In SWITZERLAND are the Universities of

<i>Basil</i> ,	1459
<i>Geneva</i> or <i>Colonia Allobrogum</i> , founded by	} 1365
the Emperor <i>Charlès IV.</i>	

In GERMANY are the Universities of

<i>Cologne</i> or <i>Colonia Agrippina</i> , founded by	} 1388
Pope <i>Urban VI.</i>	
<i>Leipsick</i> , by Elector <i>Frederic I.</i>	1408
<i>Francofort</i> upon <i>Oler</i> , by <i>Joachim</i> Elector	} 1506
of <i>Brandenburgh.</i>	
<i>Strasburg</i> ,	1538
<i>Erfurt</i> ,	1391

In BOHEMIA is the University of

<i>Prague</i> , founded by the Emperor <i>Charles V.</i>	1358
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In POLAND are the Universities of

<i>Cracow</i>	1364
<i>Wilna</i> in <i>Lithuania</i>	1579

*Koningsberg and Elbing in Prussia, by Albert }  
Duke of Prussia. } 1544*

In DENMARK is the *University of  
Copenhagen*, founded in the Year 1497

In SWEDELAND are the *Universities of  
Upsal  
Lunden or Londinum Scanorum* founded by  
King *Charles IX.*  
*Abo*, by Queen *Christina*, 1640  
*Dept.*, by *Gustavus Adolphus* in *Livonia*, 1632

In TRANSILVANIA is the *University of  
Alba Julia or Waisemburg*, founded by Prince  
*Ragotzi.*

In ASIA is the *University of  
Goa*, founded by a King of *Portugal* in the  
sixteenth Century.

But let us look now at home. No Nation goes before our own either in the point of the Antiquity, Magnificence, or Learning of our Universities of *Oxford* and *Cambridge*. For, whatever *France* may boast of her *Parifian* Foundations, we find it more certain and eminent in these.

As to their Antiquity, it is beyond Contradiction, that the Foundation of *University, Baliol* and *Alerton* Colleges in *Oxford*, and *St. Peter's* in *Cambridge*, were all made such in the thirteenth Century; and therefore claim their Title amongst the first regular Endowments of the Kind in *Europe*.

We might contend for a Priority in favour of *University College*, which was a Place for Students in the Year 872; and some Authors insist upon King *Alfred's* Foundation thereof. Yet as these Students did not live in Society, but at their own Charge at private Houses, their Places of meeting for Improvement in Learning were not called *Colleges*, but *Inns* and *Halls*; and are not to be accounted Universities till those *Inns* and *Halls* were endowed and made *Collegiate* for the Reception, Diet, Apparel, &c. of the Students, and with Salaries for Professors.

Dr. *Newton's* Account of the Original of this University is this, "That in ancient Times, certain learned Men resided in the City of *Oxford*; and there taught those Arts and Sciences, which are called liberal to such as were disposed to learn them. The Reputation of their Skill, and the fine Situation of the Place, invited such a general Resort of Scholars to it from all Parts, that it soon obtained the Name of an University. The Citizens for the better Accommodation of the Students, from whose Residence amongst them they received great Benefit, let out such of their Houses, as they did not themselves inhabit, to the Teachers of these Arts; who again let out the several Rooms thereof to their respective Scholars, as to Under-Tenants. Such Houses, from the Time they were applied to the Purposes of liberal Education, were called Halls; and the several Governors of these voluntary Societies, Principals of Halls. Long before any of these Halls were converted into Colleges, the University, by Prescription, used a public Seal, received Lands, was possessed of Customs, and made Laws for the Government of its own Body, as a Corporation." The Schools established at *Oxford* were entirely burnt and destroyed by the *Danes* about the Year 1000, and all Learning banished from thence for many Years. *Edward* the Confessor restored the Students to their Seats and Privileges about the Year 1050, according to some Writers; while others assure us, that the Universities lay in a miserable Condition, almost expiring, till the Time of the Conquest *Anno* 1066.

It is not a Point to be debated here whether *Oxford* or *Cambridge* is the eldest University. But we will begin with *Oxford*, as Custom always gives it the Precedence, when those two Universities are mentioned together.

The *University* of *OXFORD* is governed by a *Chancellor*; whose Office is to superintend the Government of the whole University; to maintain the Privileges and Liberties thereof; to call Assemblies; to learn and determine Controversies where Scholars are concerned; to summon Courts; punish Delinquents; to prove Wills; to grant Administration, &c.

He is always a Person of the first Rank, and holds his Office for Life, into which he is elected by a Majority of Fellows or Regents, and Non-Regents in Convocation.

The present Chancellor was elected on the fourth Day of *January* 1759.

The next Office in Dignity is the *High Steward*; whose Office enjoins him to assist the *Chancellor*, *Vice-Chancellor*, and the *Proctors* in the due Execution of their respective Offices; and also to hear and determine capital Causes, where a Scholar, or privileged Person is the Offender, when required so to do by the Chancellor, who also may appoint him to keep the Court-Lect. He is nominated by the Chancellor; but must be approved by the *University* in Convocation. This Office also is for Life.

There is also a *Vice-Chancellor*, nominated annually, but commonly continued for three Years, by the Chancellor, from amongst the Heads of Colleges.

This Officer may be said to bear the greatest Burden in the Government of the University. He is obliged to reside at *Oxford*, so that he may be always at hand to supply the Place of the Chancellor, who

who never attends but upon some very special Occasion. He licenses Books printed at the University-Press. He is particularly to take Care that Sermons, Lectures, Disputations, and other Exercises be performed; that Hereticks, Fanaticks, Non-Conformists, Panders, Whores, &c. be expelled from the University, and kept from the Conversation of the Students: To license Taverns, Ale-houses, Coachmen, Carriers, &c. To see that the *Proctors* and *other Officers*, and public Servants of the University perform their respective Duties; that Courts be called, and Law-Suits be determined without Delay.

*N. B.* The Chancellor of the University, and in his Absence, the *Vice-Chancellor* is superior to the *Mayer* of the City in Affairs of Moment; even where they concern the City itself. And the *Mayer* and *Burgeses*, and the High-Sheriff of *Oxfordshire* take an Oath in a solemn Manner before the *Vice-Chancellor* to observe and preserve the Rights, Privileges, and Rights of the *University of Oxford*.

The other Officers concerned in the Government of the University are,

Two *Proctors*, chosen by all the Doctors and Masters of Arts in College, out of the several Colleges by Turns: They must be Masters of Arts, whose particular Duty is to assist in what regards Scholastic Exercises and taking of Degrees: To punish all that break the Statutes: To examine Weights and Measures, and to punish common Strumpets, &c. to inspect the Publicans, &c.

The Public *Orator* is next in Office. His Business is to write Letters by Order of the Convocation, and to make public Speeches on solemn Occasions. He must be a Master of Arts or Bachelor of Law. His Election is for Life, and made in Convocation.

There is a *Keeper of Records*, chosen in Convocation, who keeps the Charters, and other public Papers belonging to the University; and is to be ready to plead those Rights and Privileges when called in Question.

Next to him is the *Register*, who is chosen (as all other Officers of the University) are by Scrutiny in Convocation; and ought to be a Master of Arts, or a Bachelor of Law, and a Public Notary at the Time of Election; his Business being to register all Acts and Deeds, which pass under the public Seal of the University; and all Acts in judicial Causes before the Delegates of Appeal.

For the better Regulation of *Provisions* the *University* has a Right to chuse two Clerks to inspect the *Markets*. They must be of the Degree of a Master of Arts, or Bachelor of *Divinity, Law, or Physic*, and are nominated, one by the Chancellor; the other by the Vice-Chancellor, yearly.

These Clerks are to take care of the Assize of Bread, Beer and Wine, of Weights and Measures, the Prices and Qualities of Victuals and other Provisions: For which End, they are often obliged to weigh the Bread, and once a Year (at least) to gauge all Brewers Vessels, and to break or burn the same, if wanting of the Statutable Measure; besides an arbitrary Mulct to be inflicted on the Brewer by the Vice-Chancellor: Their Business is also to take care of Hay, and all kind of Horses Provender, of the just Measure of Faggots and Coals, and if defective, to distribute them among the Poor; and lastly, to see that all Things belonging to the Market be exposed to Sale therein; to amerce Regrators, Fore-stallers, &c.

For the better Execution of the Laws of the University there are six public Servants called *Beadles, Cryers*, and *Foot Messengers*. Three of these are called *Squire Beadles*; the other three *Yeomen Beadles*.

Every College has its Visitor also, who takes Cognizance of such Matters as particularly relate to Breaches of the distinct Statutes of each House or Society: This Officer is nominated by the Will of the Founder, and is empowered to deprive or suspend any Member under his local Jurisdiction for Contumacy, or any Crime of a high Nature, committed against the Laws of God or the Statutes of the College; provided he always governs himself by the Rules and Order of his Founder: Where he exceeds his Power the injured Party has a Right of Appeal to the Crown.

Under this Government there are *nineteen Colleges* and *five Halls*.

1. *University College* claims the Precedence in Point of Antiquity; it being commonly said to derive its Foundation from the Munificence of King *Alfred*, the first Monarch of *England*; and has by various Revolutions and Benefactions arrived to its present flourishing Condition. Amongst these Benefactors we find *William Archdeacon of Durham*, who soon after the *Norman Conquest* endowed it to largely, that he is numbered amongst its Founders.

In this College is one Master, twelve Fellows, and seventeen Scholars. Dr. *Ratcliff* has established two travelling Fellowships at the Charge of 600*l. per Annum*, in this College.

2. *Baliol College* was founded by *John Baliol* Father to *John Baliol*, King of *Scotland*, about the Year 1263, and by numerous Benefactions it is now provided with Estates for the Support of a Master, twelve Fellows, fourteen Scholars and eighteen Exhibitioners.

3. *Merton* College so called from *Walter de Merton*, its Founder, Lord Chancellor of *England* and Bishop of *Rocheſter*, was founded, endowed and chartered in 1270. It has been favoured with many Benefactions; and is governed by a Warden. Here are twenty-four Fellows and fourteen Exhibitioners called Poſt-maſters, and two Clerks.

4. *Exeter* College is a Foundation ſo early as 1316, by *Walter Stapledon*, Biſhop of *Exeter*. It for many Years paſſed under the Name of *Stapledon-Hall*, till there roſe up another Biſhop of *Exeter*, *Edmund Stafford*, who became a ſecond Founder, and changed its Name, by Authority, to *Exeter* College.

The Government of this College is in a Rector, and twenty-three Fellows. Here is a Beadle Clerk and three Exhibitioners.

5. *Oriel* College founded in 1323, by *Adam de Broome*, takes its Name from a large Meſſuage named *Le Oriel*, granted to this College by King *Edward III.* It has had many great and royal Benefactions; and at preſent maintains a Provoſt, eighteen Fellows, and fourteen Exhibitioners.

6. *Queen's* College was founded and endowed in the Year 1340, by *Robert Engliſhfield*, by Direction from *Queen Philippa*, Confort to *Edward III.* *Robert* was then Chaplain, and gave this Foundation the Name *Aula Scholarium Reginae de Oxon*, or *Queen Scholars Hall of Oxford.*

By the Charter of Incorporation of this College it appears, that the Founder had made Proviſion for a Provoſt and twelve Fellows to be choſen out of ſeventy poor Children or Scholars, to be alſo maintained and educated here. It alſo appoints, that the Society ſhould be called together at their Meals by the Sound of a Horn; and that when the Fellows in their Purple Gowns had placed themſelves on the further Side of the Table, with the Provoſt in the Middle thereof, the poor Scholars ſhould kneel before them on the oppoſite Side, and answer ſuch Questions in Philoſophy, as ſhould be put to them by the Fellows, before Dinner began.

The Number of Members upon the Books of this College at a late public Act, were one Provoſt, ſixteen Fellows, eight Chaplains, nine Taberders, ſixteen poor Scholars, two Clerks and twenty Exhibitioners, beſides Gentlemen Commoners.

7. *New* College is a Monument of the Munificence of that great Prelate and Statesman *William Long*, born at *Wickham* in *Hampſhire*, by which Name he is moſt generally known: Who before he erected this College, in 1379, maintained for ſeven Years, ſeventy Students in ſeveral Halls in *Oxford.* The Foundation was laid on the 5th of *March* 1379, and the Building being completed in the beginning of 1386, his Warden and Fellows took Poſſeſſion of it by a ſolemn Proceſſion.

This Foundation was made for a Warden, ſeventy Scholars, ten Chaplains, three Clerks and ſixteen Choiriſters with handſome Stipends; on Condition that fifty of the Scholars ſhould apply themſelves to *Arts* and *Divinity*, ten to the Study of the *Civil Law*, and ten to the Study of the *Canon Law.*

The preſent Members of this Society are one Warden, ſeventy Fellows, ten Chaplains, three Clerks, and one Sexton.

8. *Lincoln* College, this Foundation was begun in 1430, by *Richard Flemming* Biſhop of *Lincoln*, who obtained a Charter for its Eſtabliſhment, and left a Sufficiency to complete his Deſign not finiſhed at his Death.

It has had a Succeſſion of valuable Benefactors; amongſt whom is *Thomas Rotheram*, Biſhop of *Lincoln* alſo, afterwards Archbiſhop of *York* and Chancellor of *England.* Who by his Donations, and his Body of *Laws* for their better Regulation, is eſteemed a ſecond Founder.

The preſent Members are a Rector, twelve Fellows, nine Scholars, and twenty Exhibitioners.

9. *All-Souls* College was founded and endowed by Archbiſhop *Chicheley* in 1437, for forty Fellows; of whom twenty-four were ordained to ſtudy *Divinity* and *Philoſophy*, and the other ſixteen the *Canon*, and *Civil Law.* But *Henry VI.* was ſo largiſh in his Royal Favours to this Foundation, that he has been ſuppoſed to be the real Founder of the Fellowſhips, though the Archbiſhop expended near 5000 *l.* in the Buildings, &c.

Colonel *Codrington*, ſome time Fellow of this College, and Governor of the *Leeward Iſlands*, in the beginning of this Century bequeathed 6000 *l.* for building a Library, and not only left his own valuable Study of Books to be depoſited therein; but gave 4000 *l.* more to purchaſe new ones.

The preſent Members are one Warden, forty Fellows, two Chaplains and nine Scholarſhips.

10. *Magdalen* College was another Foundation in the Reign of *Henry VI. An. Dom. 1456*, erected and endowed by *William Patten* of *Wainſlect*, uſually called *William of Wainſlect.* He was Biſhop of *Winebeſter* and Lord High-Chancellor of *England.*

This College is founded on the Site of the diſſolved Hoſpital of *St. John*, and endowed with the Revenues of thoſe Hoſpitaſſers; which were ſettled by Charter for a perpetual Maintenance of poor and indigent Clerks in the Univerſity of *Oxford*, ſtudying *Arts* and *Sciences*; and the ſaid Charter ordains that

that there should be forty Fellows, thirty Scholars, called Demies or Semi-Commoners, four Chaplains, eight Clerks and sixteen Choristers, besides Servants. Since which Institution it has been augmented by several large Benefactions. And at present it consists of a President, forty Fellows, four Chaplains, thirty Demies, and twenty Exhibitioners, besides a Number of Gentlemen Commoners.

11. *Brazen-Nose* was founded by *William Smith* Bishop of *Lincoln* in 1511, who obtained for it a Charter of Incorporation from *Henry VII.* by the Name and Stile of the Principal and Scholars of *King's-Hall* and *Brazen-Nose* College, with Power to purchase Lands of the yearly Value of 300 *l.* exclusive of all Taxes and Reprisals.

In this College are a Principal, twenty Fellows, thirty Scholarships and four Exhibitioners, who enjoy the Advowsons of the great Parishes of *Christ-Church* in *Spittle-Fields*, of *St. Matthew Bethnal Green*, of *St. Mary Stratford-Bow*, of *St. Ann Lime-House*, of *St. George Ratchiff Highway*, or *St. George's* in the *East*, together with the Mother-Church of *St. Dunstan* at *Stepney*, in the County of *Middlesex*, by a cheap Purchase of the Impropriation and Advowson of the old Parish and Parish Church of *St. Dunstan* at *Stepney*, a little before it was by Act of Parliament divided into those several Parishes, as they now are; the least of which being of the yearly Value of 200 *l.*

12. *Corpus Christi* College was founded in the Year 1516, by *Dr. Richard Fox*, Bishop of *Winchester*, for the Study of *Divinity*, *Philosophy*, and the *Liberal Arts*; who endowed it for the Support of a President, twenty Fellows or Scholars, two Chaplains, two Clerks and two Choristers. He also settled a *Humanity* Lecture, a *Greek* Lecture, and a *Divinity* Lecture.

The present Members are a President, twenty Fellows, two Chaplains, twenty Scholars, and four Exhibitioners.

13. *Trinity* College sprung out of the ancient *Monastic* College belonging to the Monks of the Cathedral of *Durham*, which was dissolved with other religious Houses by King *Henry VIII.*

This dissolved House being afterwards conveyed to *Sir Thomas Pope* of *Tittenhanger* in *Hertfordshire*, he obtained a Charter from *Queen Mary* in 1554, to convert it into a College, and improved it, and endowed it for a President and twelve Fellows, to be educated in the Studies of *Philosophy* and *Divinity*, and eight Students in *Logic*, *Rhetoric* and other *Arts*.

The Members now are a President, twelve Fellows, twelve Scholars and two Exhibitioners; besides Gentlemen Commoners.

14. *St. John's* College, a noble Foundation by *Sir Thomas White*, an Alderman and Merchant-Taylor of the City of *London*: but greatly enriched by the Favours and Benefactions of Archbishop *Laud* and *Dr. Juxon*, Bishop of *London*, which last alone gave 6000 *l.* to it. This College is supplied with Scholars from *Merchant-Taylor's* School in *London*; and its Members are one President, thirty-nine Fellows, and eleven Scholars, who are all elected on *St. Barnaby's* Day from *Merchant-Taylor's* School.

15. *Wadham* College, a modern Foundation; was begun by *Nicholas Wadham*, Esq; of *Marefield* in *Somersetshire*, and finished pursuant to her Husband's Will, by *Dorothy* his Relict, in the Year 1613. It was endowed by them for a Warden, fifteen Fellows, fifteen Scholars, two Chaplains, two Clerks, one Manciple, two Cooks, two Butlers, and a Porter; with these Restrictions; That the Warden should be a Native of *Great-Britain*, and to quit this College upon Marriage or Advancement to a Bishopric; and that the Fellows to quit their Fellowships after having completed eighteen Years from their Regency.

The present Members are a Warden, fifteen Fellows, two Chaplains, fifteen Scholars, two Clerks and eight Exhibitioners, besides many Gentlemen Commoners.

16. *Pembroke* College, was founded on the Site of *Broadgate-Hall* in 1624, by *Thomas Tisdale* and *Richard Wightwick*, S. T. B. for the Study of *Divinity*, *Physic*, *Civil* and *Canon-Law*, &c.

The Members are a Master, ten Fellows and ten Scholars. Four Fellows to be chosen out of *Mr. Tisdale's* Relations; the others from *Abingdon* School: and two Fellows and two Scholars to be of the Name and Kindred of *Mr. Wightwick*.

King *Charles I.* became a Benefactor to this infant Foundation. His Majesty founded a Fellowship to be filled from *Guernsey* or *Jersey*; and *Dr. Morley* Bishop of *Winchester* augmented it with five Scholarships for Natives of the same Island.

The Members are a Master, thirteen Fellows and twenty-three Scholars.

17. *Worcester* College is risen from the Remains of *Glocester-Hall*, anciently the Seminary for educating the Novices of the *Benedictine* Monks of *Glocester*. Which being suppressed at the Dissolution of the Monasteries, under *Henry VIII.* fell, in Process of Time, into the Hands of *St. John's* Collegians, who erected it into a Seminary by the Name of *St. John Baptist's* Hall, and made one of their Fellows Principal thereof. But in the Year 1714, *Sir Thomas Cooksey*, Bart. obtained a Charter from *Queen*

Ann to erect it into a College, and to endow it for a Provost, six Fellows, and six Scholars: Since which Time many considerable Benefactions have been given to this Society.

18. *Hartford* College was converted into its present Institution from *Hart Hall*, by the Rev. Dr. *Newton*, in the Year 1740: Who has expended great Sums in its Building and Endowment.

19. *Christ-Church* College I have reserved to the last, as it may be said to excel them all in its Dimensions, Revenues, and Number of Students.

This College is indebted to Cardinal *Wolsey* for its first Foundation. To which he persuaded King *Henry VIII.* in the Year 1524; and it was then named *Cardinal-College*. But the Design of that Great Prelate dropt with his Disgrace: And though the King in the Year 1532, at the Instance of Lord *Cromwell*, &c. was prevailed upon to grant Letters Patent to continue the Foundation under the Name of King *Henry VIII.*'s College, with an Endowment of 2000 *l. per Annum*, in Lands, for the Maintenance of a Dean and twelve Canons, we find in the Year 1545, that it was suppressed, surrendered into the King's Hands, and the Dean and five Canons reduced to the greatest Necessity.

However in 1546 the King transferred the Episcopal See of *Ousney* to this College, and constituted the Church of *St. Frideswide* to be the Cathedral Church, by the Name of *Christ-Church*, founded by King *Henry VIII.* and endowed it with Lands to the Value of 2000 *l. per Annum*, for the Maintenance of a Dean, seven Canons, eight Petty Canons, one Possillator, eight Clerks, or Chaplains, a Master and eight Choristers, and an Organist; reserving out of the same 40 *l. per Annum* each, to a Professor in *Divinity*, a Professor of *Greek*, and another of *Hebrew*: 8 *l. per Annum* each, to sixty Students or Scholars. 20 *l. per Annum* to a Schoolmaster, and 10 *l. per Annum* to an Usher.

Queen *Elizabeth* added forty Scholars to be chosen from *Westminster-School*, with an Exhibition of 6 *l. per Annum* each, and *William Thurston's* Legacy of 800 *l.* for the Education of one Scholar, makes the Number of its Students 101.

Here also are two Lectures, one for the *Oriental Languages*; the other for *Mathematicks*, founded and handsomely endowed, by Doctor *Busby*, S. T. P. Master of *Westminster* School.

The Five HALLS are known by the Names of

1. *St. Alban* Hall.
2. *St. Edmund* Hall.
3. *St. Mary* Hall.
4. *New-Inn* Hall.
5. *Maudlin* or *St. Mary Magdalen* Hall.

These Seminaries are mere *Hostels* or *Inns*, where the Students hire their Chambers of the *Principal*, and pay for their Diet. Whereas every College consists of a Head, Fellows and Scholars incorporated by Royal Charter, and endowed with Lands, &c. which yield the Fellows and Scholars a certain Revenue, and defray all Expences of their Commons; and every College has its Statutes, which the Members are obliged to obey by their Oaths, at their Admittance, under Pain of Expulsion.

The Principals of these Halls are in the Nomination of the Chancellor and University; except the Principal of *Edmund* Hall, who is appointed by *Queen's* College.

The Colleges have all Libraries within themselves. But we must not leave this Seat of Learning, till we have taken a Survey of that Foundation, which is particularly known by the Name of

The *University Library*, otherwise the *Bodleian Library*, so called from Sir *Thomas Bodley* its principal Founder. It is built in the Form of a *Roman H*, and said to contain the greatest Number of Books, except the *Vatican* and *Parisian* Libraries.

Sir *Thomas Bodley* found upon this Spot an old Library called the Library of *Humphrey* Duke of *Gloester*, which he enlarged and furnished with the best Books he could procure from all Parts of the World; and left a considerable Estate for Salaries to the Officers, and for keeping the Library in Repair.

The Earl of *Pembroke* afterwards enriched it with his valuable Collection of *Greek* MSS. To which Sir *Thomas Roe* added another choice Parcel of *Greek* MSS. as did also Sir *Keuchm Digby*.

Here was deposited the most excellent Study of the learned *John Selden*: Which with several great Purchases as well as Donations, have made it the largest *University* in the World.

Besides this, *Oxford* enjoys the Benefit of another great public Library; which if it does not exceed the former in Number and Value of Books and MSS. is allowed to excel in the Magnificence of its Structure; it having cost 40,000 *l.* in building one Room, the Legacy of the celebrated Physician Doctor *John Radcliff*.

This is called the *New Library*, or *Radeliffæ Maufolæum*; the Keeper whereof is intituled to 150 *l. per Annum*, by the Doctor's Will.

*Ashmole's Musæum*, a handsome Edifice, is another Repository of learned Pieces, so called from the great Antiquarian, *Elias Ashmole*, Esq; whose valuable Collection of *Antiquities* and foreign Curiosities and MSS. given to this University, are preserved under this Inscription, *Musæum Ashmoleanum Scholæ Naturalis Historiæ Officina Chymica*. To which have been added some *Egyptian Hieroglyphicks*, an entire Mummy, a large Collection of Natural Curiosities, several *Roman Urns*, Medals, Altars, &c. many Collections of Plants and Animals preserved in Spirits; and other Curiosities, which have made it the richest Repository of such Matters in *Europe*.

Here are public Schools, and a Theatre of curious Structure, for public Lectures and Academical Exercises.

Every Person, who is willing to become a Member of this University, in any College or Hall, is to appear within fifteen Days after his Arrival before the Chancellor or his Commissary, to be matriculated or registered in a Book, kept by one of the Beadles for that Purpose. At which Time the Scholar being fifteen Years old, is to subscribe the thirty-nine Articles of Religion, and to take the Oaths of Allegiance and Abjuration.

He must have a Tutor, a Graduate of some Faculty, and approved of by the Head of the House, in which he is admitted, till he himself shall be promoted to a Degree: Nor shall he change his House for another, without Leave from the Head thereof, or from the Vice-Chancellor.

ALL Scholars (except *Noblemen*) must keep *sixteen* Terms before they can take a BACHELOR'S Degree: They ought also to attend public Lectures, and perform all other statutable Exercises, such as *Generals*, *Juraments*, *Answering*, *Under-bachelors*, &c.

GENERALS, are Disputations on three *Logical* Questions from one in the Afternoon, till three, and are held every *Monday*, *Wednesday* and *Friday* in full Term, in the public Schools of ARTS, under the Moderatorship of some Senior *Sophist* or *Bachelor of Arts*; the Respondent giving out his Questions to be disputed on, a Week before the Disputation.

THIS Exercise is not to be performed, until the Student is *two* Years standing in the University, and *three* Terms at least before he supplicates for a *Bachelor's* Degree; and he is created *General* or *Senior Sophist*, immediately after these Disputations, by one of the *Masters*, who presides at them: These *Senior Sophists* are obliged every Term afterwards, till they take their Degree, to dispute once, at least, under Pain of the former Disputation's not going *pro forma*, which is stil'd *Juraments* from the Oath taken at the Time of proceeding *Bachelor*, that they have done all the Statutable Exercises.

FROM the Time of Admission to a *Bachelor's* Degree, the ARTIST is obliged to wait *twelve* Terms before he can sue for his Grace, to have a *Master's* Degree: As to the Exercise for a *Master's* Degree, every *Bachelor of Arts*, after Admission to his Degree, shall solemnly determine in *Lent*; and these *Lent* Disputations are called *Determinations*, because they do determine and finish the Conditions of a *Bachelor's* Degree, and truly compleat the same; and also for the *Degree of Master*, he must answer at *Quodlibet* Disputations, so called; because he must answer on three Questions to be propounded by any *Master* at Pleasure, after he has finished his *Lent* Determinations. Besides these *Determinations* and *Quodlibets*, such *Bachelor* must either, as a Respondent, or Opponent, dispute in *Austin's*, speak *two* Declamations, and read *six* solemn Lectures before he can be promoted to a *Master's* Degree.

On *Ashwednesday*, immediately after the *Latin* Sermon, a Bell rings out, calling the Presentator or Dean of every College and Hall, with his *determining Bachelors* of that *Lent* attending him in their proper Habits, to the Schools, which they chuse, according to the Seniority of every Dean or Presentator; and having made Choice of their several Schools, the Dean or Presentator mounts the Pew, and has three Questions propounded to him in *Natural Philosophy*, with *Verses* read, briefly explaining the Sense thereof, by each of the Determiners: Which *Questions* and *Verses*, as soon as propounded and read, one of the *Senior Bachelors* takes upon him to answer the Dean, who is always Opponent; after the Dean has propounded a *Syllogism* or two to his *Determiner*, who thereupon prays his *Aristotle* (for so is the *Senior Responding Bachelor* called) to answer for him as long as the Dean shall think fit; and these Disputations last from One o'Clock till Five in the Afternoon.

On *Mondays*, *Tuesdays*, *Wednesdays* and *Thursdays*, these *Determiners* dispute on *Logical* Questions, which they are obliged to defend according to the Authority of their great Master *Aristotle*; and on *Fridays* on *Grammatical*, *Rhetorical*, *Political*, and *Moral* Problems; in *Grammar* they are to follow the ancient and received Authors, and in *Rhetorick*, *Politicks* and *Moral* Philosophy, they are likewise bound to defend *Aristotle*, and the whole Doctrin of the *Peripateticks*, under Pain, that if any one should do otherwise, his Answer shall not be taken *pro forma*, and he shall also be mulcted five Shillings, *toties quoties*.

EVERY Bachelor of Arts, after his full Determination, ought once every Year to answer or oppose at *Austin* Disputations, every Saturday in Full Term, from one o'Clock, till three, in the *Natural Philosophy* School, if he be required.

THERE is a general Commencement once every Year in all the Faculties of Learning, which is called, the ACT at *Oxford*: This *Act* is opened on *Friday*, following the seventh of *July*, and Exercises performed in the Schools on *Saturday* and *Monday* following, and also in the publick Theatre. On *Saturday* all the Professors and Lecturers read in the several ARTS and SCIENCES, cloathed in their proper Habits.

THE Inceptors in Arts dispute on three *Philosophical* Questions, and one of these Inceptors (for so are the Masters called, who stand for their Regency in this solemn *Act*) to be appointed by the Senior Proctor, has the Place of the Respondent; and first the Senior Proctor opposes on all the Questions, and confirms an Argument on the first, then the Pro-Proctor and *Terræ-Filius* dispute on the second; and lastly, the Junior Proctor on the third Question; and all the Inceptors are obliged to attend these Disputations from the Beginning to the End, under Pain of three Shillings and four Pence. At the equal Expence of all the Inceptors, there is an elegant Supper at the College or Hall of the Senior of each Faculty, for the Entertainment of the Doctors, called the *Act Supper*: On *Sunday*, between the *Vespers* and the *Comitia* (for so are Exercises of *Saturday* and *Monday* stiled) there are two Sermons in the *English* Tongue at *St. Mary's* Church, preach'd by any one of the Inceptors, as the *Vice-chancellor* shall appoint, being Doctors of *Divinity*, in this *Act*. On *Monday*, at nine o'Clock, all the Inceptors go with the Beadles of their several Faculties to *St. Mary's*, and there after Prayers at the Communion Table make Oblations; and if any Person shall absent himself, or be irreverently present, he shall be mulcted Five Shillings; and moreover punished at the *Vice-chancellor's* Pleasure. Then the *Comitial Exercises* beginning, the Senior Proctor mounts the Pew on the West Side of the Theatre, and the Junior Proctor the Pew opposite to him on the East Side. The Professor of *Physick*, with his Inceptors, on the West; and the Law Professors, with his Inceptors, on the East Side thereof; and the *Divinity* Professor, with his Inceptors, on the North Side, under the *Vice-chancellor*; and the Inceptors in *Musick*, with their Professor in the Musick Gallery, on the South; and at these *Comitial* Disputations, the same Method is used in Respect of the Agents, as at *Vespers*, viz. first the Senior Proctors; then the *Terræ Filius* and Pro-Proctor; and lastly, the Junior Proctor; and he who was Respondent the Year before, is the *Magister Replicans* this Year. The first Opponent, among the Inceptors, has a Book given him at the End of the Disputations by the Senior Proctor (who in Respect of the Artists Inceptors is called *Father of the Comitia*) and is also created *Master* by a *Kiss*, and putting on his Cap.

After the *Comitial Exercises* in Arts are ended, if there be any Person taking a *Musick Degree*, he is to perform a *Song* of six or eight Parts on *vocal* and *instrumental* Musick, and then he shall have his Creation from the *Savilian* Professors, &c. After the performing of the Exercises, and the Creation of Doctors, according to a Prescript Form in each Faculty, the *Vice-chancellor* closes the *Act* with a solemn Speech; wherein it is usual for him to commemorate the Transactions of the Year past, and especially such Benefactions as have been given to the University: And after the End of the *Act*, the *Vice-chancellor*, with the *Regents* of the foregoing Year, immediately assemble in the Congregation House, where, at the Supplication of the *Doctors* and *Masters*, newly created, they dispence with the Wearing of *Boots* and *Slop Shoes*, to which the *Doctors* and *Masters* of the *Act* are obliged during the *Comitia*.

On *Tuesday*, after the *Comitia*, a *Latin* Sermon is preached to the Clergy, at eight in the Morning, in *St. Mary's* Church, the Preacher to be either some Doctor or Bachelor in *Divinity*, and of the *Vice-chancellor's* Appointment, with a Pre-monition, for this End, from the *Vice-chancellor* for three Months beforehand.

The Questions to be disputed on in each Faculty are to be approved by the Congregation of Masters some time before the *Act*; and because that *Civilians* ought to know the Difference between the *Civil* and *Municipal* Laws, one of the Law Questions ought to have some Affinity with the *Common Law* of *England*; wherein the Professor, by a short Speech, ought to shew, what the one, and what the other Law maintains.

If any contumelious, reproachful, or defamatory Language, be given in any Speech or Arguments at Disputations, the *Vice-chancellor* may convene the Person before him, and command a Copy of his Speech, and if he pretends, that he has no Copy, he may convict him by Oath, and punish him according to the Heinousness of the Offence, in Respect of Persons and other Circumstances, either by publick Recantation, Imprisonment, or Banishment from the University, as a Disturber of the publick Peace; besides the Satisfaction he is obliged to make to the Party injur'd.

In the Faculties of *Divinity*, *Law* and *Physick*, every one takes Place according to the Order of his Presentation or Admission, to be an Inceptor in these Sciences, and shall keep the same for ever afterwards; only *grand Compounders* have the Precedence of all others of the same Year: But *Inceptors* in

*Arts* have their *Seniority* according to the Proctor's Discretion; unless they be grand Compounders, who have Precedence, as aforesaid. Yet it is provided, that this Disposition shall not prejudice Fellows of Colleges, in Respect of their Seniority; but that the same be governed and disposed according to the Seniority which they bear in their respective Colleges, according to the local Statutes thereof.

THE ordinary Disputations in *Divinity* shall be had ten times a Year in the Divinity School, viz. on the first and last *Thursdays* in every Full Term, on the *Thursday* before the first *Sunday* in *Advent*, and also the *Thursday* immediately preceding *Lent*, which Day, if a Holiday, then Disputations shall be had the Day following; and all the *Bachelors* in *Divinity*, of what Standing soever, as well as *Masters of Arts* (unless Proctors of the University, or publick Professors of Arts) are obliged to perform these Disputations, as soon as they have completed four Years from the Time of their Regency, whether they live in Colleges or Halls, unless it does notoriously appear, that they are obliged to the Studies of *Law* or *Physick* by the local Statutes of their College for a Year (at least) before they have received any Monition to answer or oppose at these Disputations, which may evidently appear by their entering their Names in the *Beadle's* Book.

At these Disputations, the *Senior Bachelor*, or *Master*, is Respondent, and the two next downwards in Degree after the *Regius Professor* (who is Moderator here) are Opponents, and so on till they have all had their Turns; and then they revert to the Seniors. The two Questions to be here disputed on, from one o'Clock, till three in the Afternoon, are to be approved by the next Congregation ensuing the Date of the Monition; and all *Bachelors of Divinity*, and *Masters of Arts*, of two Years Standing from their Regency, who have not applied their Studies to any other Faculty, are bound to be present.

THE ordinary Disputations are only had twice every Year in *Physick*, viz. on the first *Tuesday* in *Trinity* and *Hilary* Term; at which Disputations, all *Bachelors*, and other Students in *Physick*, on the *Physick Line*, and privileged Persons, are Agents, except the Proctors of the University, and the publick Professors of Arts; and the Senior of these is the Respondent, and the other two are Opponents, according to the Course and Method of *Divinity* Disputations; whereat all *Bachelors* and Students in *Physick* are obliged to attend.

THE ordinary Disputations in the *Civil Law* (called Disputations *pro Termino*) are also had but twice a Year, viz. on the last *Tuesday* of *Easter* and *Michaelmas* Term; at which Disputations, all *Bachelors* of *Law*, and Persons of *Bachelors* standing, being Students in the *Law*, are to bear their Turns in the same Course and Manner, as at *Physick* Disputations, the Proctors and Professors excepted, as aforesaid; and at these Disputations, all *Bachelors* of *Law* and Students in that Faculty, are to attend, and frequent the same.

Graces or Supplications for Degrees are proposed and granted in the Congregation of *Regent Masters*, except it be for the Fellows of *New College*, who have their Graces given them in their own House by a certain Privilege: And here are all Dispensations ask'd in Matters dispensable by the Congregation, that fit Persons may be admitted to *Scholastical Degrees*, and also that Men recommended by other Universities, may be incorporated, and, according to Custom, be licensed in each Faculty. This Congregation now, as antiently, consists of the *Chancellor*, or *Vice-chancellor*, the two *Proctors*, or their Deputies, and of such *Masters* as are necessary, or Regents *ad placitum*. And nothing can be decreed in this Assembly, to which the *Chancellor*, or his *Vice-chancellor*, both *Proctors*, or their Deputies, or the major Part of the *Masters* present (whose Number ought not to be less than nine) do not consent; but ought to be taken for not granted, if either the *Chancellor*, or his Deputy, or the two *Proctors*, or their Deputies, or the major Part of the *Masters* dissent; unless it be in Elections, which are to be made freely, according to ancient Custom, by the major Part of the Voters.

By a received Custom immediately after the End of the *Ac*, every Year, the *Masters of Arts*, and *Doctors* in *Divinity*, *Law* and *Physick*, on the solemn Day of their Creation, supplicate to be admitted into the *Congregation House*, and to their Regency in each Faculty, i. e. to all and every *Ac* of their necessary Regency before the third Congregation, unless some grievous Crime be objected to them, which may draw a Scandal on the University; and if they be deferred any longer, the *Chancellor*, or his *Locum-tenent*, may summon and admit them thereunto by his own proper Authority: Which *Doctors* and *Masters* are necessarily Regents for two Years; unless they be dispensed with for the second Year's Regency (as usual) after the Creation of other *Doctors* and *Masters* the next *Ac*, and admitted to their Regency in the like manner, in the Congregation: Then the *Doctors* and *Masters* admitted to their Regency, take an Oath not to reveal the Secrets of that House, and also swear, that they will not promote unfit Persons, nor hinder those, who are fit, from proceeding to their Degrees, &c. Every *Master*, for this Admission, pays 12 *d.* to the Register, and 4 *d.* to the *Beadle* of his Faculty, and a *Doctor* gives 12 *d.* to be distributed among the Poor, at the Pleasure of the *Vice-chancellor* and *Proctors*.

All publick Professors and Lecturers, Royal, as well as others, are accounted Regents *ad placitum*; so are all Resident Doctors, of what Faculty soever, and all Heads of Colleges and Halls, who have been for some time Regents in Arts, and (in their Absence) their Deputies, all Masters of Schools, and Deans and Censors of Colleges, together with all Masters during the second Year of their Regency, if they are dispensed with for the second Year of their necessary Regency, as aforesaid.

The Scholars are obliged to be in their respective Colleges by *nine of the Clock* at Night, immediately after the Tolling of the great Bell at *Christ-Church*, and if any Person shall be found in the Streets, or in any House in the Town; unless on his lawful and necessary Occasions, he is mulcted in the Sum of 40 s. being a Graduate; which Sum the Vice-chancellor demands, if he be a Master of Arts, or a Batchelor of Law; otherwise the Proctors may do it, and imprison him for Contumacy, Suspicion of Flight, or any rebellious Behaviour: If the Person offending be an Under-graduate, he is left to the discretionary Punishment of the Vice-chancellor.

All *Plays* and *Gaming* (especially for Money) are prohibited, under the Pain of 6 s. 8 d. if a Graduate, and if not, then he is punished according to the Vice-chancellor's Pleasure, besides Restitution of Money so won; and 20 s. inflicted on all *Gaming Houses*, and Imprisonment, till they find Sureties not to receive any Scholars upon the-like Account.

Scholars are also forbid to carry *Guns, Bows, &c.* to keep *Dogs, Ferrets, Nets, &c.* under the Pain of 6 s. 8 d. *toties quoties*, and to forfeit and lose the same.

*Rope Dancers, Stage-Players* and *Sword Fighters* are also prohibited the *University*, unless they get the Vice-chancellor's Leave to come, under Pain of Imprisonment; and all Graduate Scholars, attending them, are punished 6 s. 8 d. and Under-graduates are corrected as aforesaid.

The *HABITS* at *Oxford* are all black, except the *Sons of Noblemen*, having Voices in the House of Lords, who may wear colour'd Gowns of any kind, how rich soever; and on certain Days, on some Occasions, all Doctors here are honoured with *Scarlet Robes*. The *Scarlet Days* are *Circumcision* or *New Year's Day, Epiphany* or *Twelfth Day, Purification* or *Candlemas-Day, Annunciation* or *Lady-Day*; when the Sermon is at *New College*; *Easter-Day, Ascension* or *Holy Thursday*, the 29th of *May, Whitsunday, Trinity Sunday*, when the Sermon is again at *New College*; *Friday, Saturday, Sunday* and *Tuesday Morning* in *Act Time*, at Sermon and Congregation; *All Saints Day*, the 5th of *November, Christmas Day*, and all publick Thanksgivings. The *Habit-Days* are, the Day the Judges come to Town; when the Vice-chancellor, Doctors and Proctors assemble at *St. Mary's*, and from thence go to wait on the Judges in their Formalities; at all *Latin Sermons, Morning Sermons* in Term Time, and at all Sermons at *St. Peter's* in *Lent*, on Congregation Days, and on *Scholastica Day*; and the Day after *Michaelmas*, when the Mayor is sworn in *St. Mary's Church* in the Morning by the Senior Proctor. All Scholars whatsoever in Term Time ought to come to Church in their proper Habits.

*BARONETS* are esteemed *Noblemen* in this *University*, and their Habit is black, trim'd with Gold Lace.

In this *University* are sixteen *Publick Professors*, two in *Divinity*, and one each in *History, moral Philosophy, Geometry, Astronomy, Anatomy, natural Philosophy, Music, Law, Physic, Laws of England, Botany, Hebrew, Greek, and Arabic*.

One of the *Divinity Professorships* was founded by the Countess of *Richmond* and Mother to King *Henry VII.* and endowed with 20 Marks *per Annum*.

This is called the *Magaret Professorship*, and is to give a Lecture on the first Day of every Term, and on certain other Days in the *Divinity School*.

The other is an Institution by King *Henry VIII.* who endowed it with 40 l. *per Annum*, with a Canonry of *Christ Church* and the Rectory of *Eweline* annexed thereunto.

This is by way of Eminence called the *Regius Professor* in *Divinity*, and is enjoin'd to read Lectures on *Mondays* and *Fridays* at *Nine* in the Morning to Masters of Arts of a Year's standing, until they commence Doctors.

The *History Lecture* is the Gift of the learned Antiquary and Historian *William Camden, Esq.* who endowed it with the Manor of *Boxley* in *Kent*, worth, as some say, 400 l. *per Annum*, with an Obligation on the Professor to read a Lecture on *Mondays* and *Fridays* weekly in the *History School* to the Batchelors of Arts and Students in Law.

The moral Philosophy Lecture is a Foundation by Doctor *Thomas White*, Canon of *Christ Church, &c.* who endowed it with 100 l. *per Annum*.

Sir *Henry Savile*, a great Patron of Learning and Learned Men, founded two Lectures, one in *Geometry*, the other in *Astronomy, Anno Domini 1619*, endowed them both with suitable Revenues, and left the Professors a Library of Mathematical Books, Tables, Maps and Instruments proper for such Studies. But he debarred them from accepting of any Ecclesiastical Preferment whatever.

The *Anatomical* Lecture was founded by Mr. *Richard Tomlins*, who settled 25 *l. per Annum*, on the *Regius* Professor in *Physick* for reading the same at stated Times.

The natural Philofophy Professorship was founded and endowed with 120 *l. per Annum* in Land. Anno Domini 1618.

The *Musick* Lecture was founded by *William Heyther*, Doctor of *Musick* in 1626, who endowed it with sixteen Pounds six Shillings and Eight-pence *per Annum* Salary; thirteen Pounds Six and Eight-pence for a House and repairing Instruments, and three Pounds *per Annum* for teaching the Theory of *Musick*, once every Term.

The Lectures in *Law* and *Physic* were founded by King *Henry VIII.* with a Salary of 40 *l. per Annum* each, and a Prebend in the Church of *Sarum* annexed to the *Law* Professorship, and the Government of the Hospital of *Eweline* to the *Physic* Professorship.

The *Botanic* Lecture was founded in 1643 by *Henry Danvers* Earl of *Danby*; who purchased the *Physic* Garden at *Oxford* for the Uses thereof, and appropriated the Rectory of *Kirkdale* in *Yorkshire* to maintain a Gardener to encrease and propagate the Plants, and to explain the Nature and Virtue of them.

The Professorship of the Laws of *England* was lately founded by *Charles Viner*, Esq; who by his last Will and Testament, bearing Date 29 *December* 1755, divided (*inter alia*) to the Chancellor, Masters, and Scholars of the University of *Oxford*, whom he also appointed his Executors, all the printed Copies of his ABRIDGMENT of the Laws of *England*, and the Residue of his real and personal Estate not otherwise disposed of by his Will, “to be applied, by and with the Approbation of a Majority of the Members there in Convocation to be assembled for that Purpose, (on public Notice given) for the nominating, appointing and establishing a Professorship of the Common Law in the said University; and to put it upon a proper Foot, that young Gentlemen, who shall be Students there, and shall intend to apply themselves to the Study of the common Laws of *England*, may be instructed and enabled to pursue their Studies to their best Advantage afterwards, when they shall attend the Courts at *Westminster*; and not to trifle away their Time there in hearing what they understand nothing of, and thereupon perhaps divert their Thoughts from the Law to their Pleasures: That a certain, annual, handsome Allowance be fixed upon to be made to such Professor and his Successors, to be chosen from Time to Time by the said University in Convocation assembled;” and then directed that a competent Fund be raised from the Surplus to continue his ABRIDGMENT at proper Intervals. He also willed and desired, that such Professor so to be elected should be at least a Master of Arts or a Bachelor of the Civil Law in the said University, and likewise a Barrister at the common Law; and should read a solemn Lecture and Lectures when and so often as such Convocation should think proper and direct, so as such Time of Reading shall not interfere or be within the Time of the Law Terms.” And his Will farther was, that after an ample Provision, according to the Judgment and Approbation of the said Convocation, shall be made and secured for such Professor as aforesaid, the remaining Part of the Monies to arise from the Sale of the Residue of his said *Abridgment*, &c. shall be disposed of, by and with the Direction and Approbation of such Convocation assembled or to be assembled as aforesaid, for the constituting, establishing, and endowing one or more Fellowship or Fellowships, and Scholarship or Scholarships, in any College or Hall in the said University as to such Convocation shall be thought most proper for Students of the common Law; such Fellow or Fellows to be Master or Masters of Arts, or Bachelor or Bachelors of Civil Law, and such Scholar or Scholars to be of two Years standing at least at the Time of Election, and that one at least of such Fellows should be proposed as a Tutor to such Students in the said University as shall be intended for such Study; and that as often as a Fellow or Fellows die, or such Fellowship or Fellowships shall otherwise become vacant, the said Scholar or Scholars may from Time to Time succeed to such Fellowship or Fellowships, if approved of by the said Convocation; otherwise some other to be chosen or nominated by them, whom they shall think more proper. And in case such Professorship as is before mentioned shall at any Time or Times become vacant, his Will was that such Convocation shall from Time to Time nominate and appoint a proper Successor or Successors; but in such Case he would recommend it to them to appoint such Fellow, or one of such Fellows as aforesaid, in case he or either of them shall be really deserving to succeed to such Vacancy.”

Mr. *VINER*'s Estate and Effects were found to consist, on the 27th of *January* 1758, of upwards of 8000 *l.* in Money; of a Freehold Estate of 9 *l. per Annum* in Possession of a certain Reversion (after one very antient Life) of a Copyhold Estate of 30 *l. per Annum*; of a Reversion depending on a Contingency) of another Freehold Estate of 51 *l. per Annum*; and of a Number of Books, then unsold, which on a moderate Calculation may produce about 3000 *l.* but, if all sold at their present Prices, will amount to 500 *l.* more.

IN the Execution of this Trust the University has ordained and decreed in Substance as follows;

1. THAT the Accounts of this Benefaction be separately kept, and annually audited by the Delegates of Accounts and Professor, and afterwards reported to Convocation.

2. That a Professorship of the Laws of *England* be immediately established, with a Salary of 200*l.* per Annum; the Professor to be elected by Convocation, and to be at the Time of his Election at least a Master of Arts or Bachelor of Civil Law in the University of *Oxford*, of ten Years standing from his Matriculation; and also a Barrister at Law of four Years standing at the Bar.

3. THAT such Professor (by himself, or by Deputy to be previously approved by Convocation) shall read one solemn public Lecture on the Laws of *England* and in the *English* Language, in every academical Term, at certain stated Times previous to the Commencement of the common Law Term; or forfeit 20*l.* for every Omission to Mr. VINER's general Fund: And also (by himself, or by Deputy to be approved, if occasional, by the Vice-chancellor and Proctors; or, if permanent, both the Cause and the Deputy to be annually approved by Convocation) shall yearly read one compleat Course of Lectures on the Laws of *England* and in the *English* Language; consisting of sixty Lectures at the least, to be read during the University Term Time, with such proper Intervals that not more than four Lectures may fall within any single Week. That the Professor shall give a Month's Notice of the Time when the Course is to begin, and shall read gratis to the Scholars of Mr. VINER's Foundation, but may demand of other Auditors such Gratuity as shall be settled from Time to Time by Decree of Convocation: (which Gratuity is at present settled to be four Guineas for the first Course, and two for the Second; but nothing for any future Attendance) and that for every of the said sixty Lectures omitted, the Professor, on Complaint made to the Vice-chancellor within the Year, shall forfeit 40*s.* to Mr. VINER's general Fund; the Proof of having performed his Duty to lie upon the said Professor.

4. THAT every Professor shall continue in his Office during Life, unless in Case of such Misbehaviour as shall amount to Bannition by the University Statutes; or unless he deserts the Profession of the Law by betaking himself to another Profession; or unless, after one Admonition by the Vice-chancellor and Proctors for notorious Neglect, he is guilty of another flagrant Omission; in any of which Cases he shall be deprived by the Vice-chancellor, with Consent of the House of Convocation.

5. THAT out of the Residue of the said Effects such a Number of Fellowships with a Stipend of 50*l.* per Annum and Scholarships with a Stipend of 30*l.* be established, as the Convocation shall from Time to Time ordain, according to the State of Mr. VINER's Revenues: And that at present two Scholarships be established, and one Fellowship next afterwards, as soon as the Revenues will permit.

6. THAT every Fellow be elected by Convocation and at the Time of Election be unmarried, and at least a Master of Arts or Bachelor of civil Law, and a Member of some College or Hall in the University of *Oxford*; the Scholars of this Foundation or such as have been Scholars (if qualified and approved of by Convocation) to have the Preference: That, if not a Barrister when chosen, he shall be called to the Bar within one Year after his Election, but shall reside in the University two Months in every Year, or in case of Non-Residence shall forfeit the Stipend of that Year to Mr. VINER's general Fund.

7. That every Scholar be elected by Convocation, and at the Time of Election be unmarried, and a Member of some College or Hall in the University of *Oxford*, and shall have been matriculated twenty four Calendar Months at the least: That he proceed to the Degree of Bachelor of civil Law with all convenient Speed; (either proceeding in Arts or otherwise) and previous to his taking the same, between the second and eighth Year from his Matriculation, shall be bound to attend two Courses of the Professor's Lectures, to be certified under his Hand; and within one Year after taking the same shall be called to the Bar: That he shall annually reside six Months till he is of four Years Standing, and four Months from that Time till he is Master of Arts or Bachelor of civil Law; after which he shall be bound to reside two Months in every Year; or, in Case of Non-residence, shall forfeit the Stipend of that Year to Mr. VINER's general Fund.

8. That the Scholarships shall become void in case of Non-attendance on the Professor, or not taking the Degree of Bachelor of civil Law, being duly admonished so to do by the Vice-chancellor and Proctors. And both Fellowships and Scholarships shall expire at the End of ten Years after each respective Election; and shall become void in case of gross Misbehaviour, Non-residence for two Years together, Marriage, not being called to the Bar within the Time before limited, (being duly admonished so to be by the Vice-chancellor and Proctors) or deserting the Profession of the Law by following any other Profession. In any of which Cases the Vice-chancellor, with Consent of Convocation, shall declare the Place actually void.

9. That in Case of any Vacancy of the Professorship, Fellowships, or Scholarships, the Profits of the current Year be ratably divided between the Predecessor or his Representatives, and the Successor; and

and that a new Election be had within one Month afterwards, unless by that Means the Time of Election shall fall within any Vacation, in which Case it shall be deferred to the first Week in the next full Term. And that before any Convocation shall be held for such Election, or for any other Matter relating to Mr. *Viner's* Benefaction, ten Days public Notice be given to each College and Hall of the Convocation itself and the Cause of convoking it.

King *Henry VIII.* did also found two Lectureships for *Hebrew* and *Greek*, and endowed them with 40*l.* per Annum each; and annexed to the *Hebrew* Lecture a Canonry in *Christ Church*.

Archbishop *Laud*, in 1636, distinguished his Taste for Oriental Learning by founding another Lectureship, with an Endowment of 40*l.* per Annum for the Study of the *Arabic* Tongue.

The moral Discipline in this Univerſity is worthy of Imitation, and is not to be paralleled in any foreign Seats of Literature.

The Governors here try in the first Place, if the Offender is capable of being reclaimed by Advice; and if this has no Effect, they proceed to punish him by requiring extraordinary Exercises, withdrawing his Commons, or imposing a Fine upon him: And if these will not reform him, he is rusticated (sent home to his Friends) till it may be supposed he has reflected on the Deformity of his Conduct, and the fatal Consequences attending it: and if this does not prevail, he is finally expelled the Univerſity: But it must be acknowledged, it is scarce possible to exercise this Discipline equally on all. There are Gentlemen of Quality and Fortune that think themselves privileged to play the Fool in these Seats of Learning, and to be as irregular as they please. They neither rise to Chapel, or perform Exercises; but are entirely devoted to Pleasure, whose Example is of mischievous Consequence to their Inferiors, as well as Equals, who sometimes endeavour to imitate them in every fashionable Failing: However, it is very certain the Youth are generally improved both in Learning and good Manners by their Residence in the Univerſity. Those that are guilty of any Excesses are usually Freshmen and Under-graduates; and if ever these become Candidates for a Degree, they find it necessary to alter their Conduct: They must learn to behave with Decency at least, and apply themselves diligently to their Studies, or they are pretty sure to be stopped, when they come for a Degree. A notorious Defect either in Learning or Morals is fatal to them.

The Governors and Tutors are Men generally eminent for their Learning and Prudence, and polite Behaviour; and their Example seems to influence both the Univerſity and Town. The People of the Place are more civilized than the Inhabitants of any other Town in *Great-Britain*. Strangers admire their Hospitality. There is a Foible however that some of them are subject to, and that is a pardonable one, viz. a partial Fondness for the Place of their Education: They will scarce admit there can be any Defects in the Situation or Buildings of *Oxford*. They look upon the City as a perfect Paradise, and seem offended, that all Men cannot think as they do: And it must be admitted, that *Oxford* is a very desirable Place; their Streets are spacious; their public Buildings magnificent; and their Situation in one of the most fruitful Countries of *England*: But will Philosophers be proud of these Advantages. Do they condemn the Vanity of Dress, and prohibit young Students wearing Gold or Silver, and whatever has the Appearance of Finery in their Habits; and are they at the same time proud of fine Structures, and lay out Money in elegant, but superfluous, Buildings, which might be more usefully employed in the Encouragement of Learning, and the Support of poor Scholars: The Reputation of abounding in virtuous and learned Men, and the supporting and encouraging them in their Studies, will contribute more to the Honour of the Univerſity, and perpetuate their Fame more than the most magnificent Fabricks. [This is the Opinion of Mr. SALMON.]

The Discipline of the Univerſity, as has been observed already, is in a great Measure committed to the Proctors, who are empowered to punish Scholars for ordinary Irregularities; and where they prove immoral or refractory, their Names are entered in a black Book, as it is called, whereby they are rendered incapable of their Degrees, unless their future Behaviour recommends them to the Favour of the Univerſity. There is a Book also kept in every College of the like Nature, where Scholars are marked, who have been notorious for keeping ill Hours, absenting from Chapel, Idleness, Immorality, &c. And they may be stopped of their Degree by the Governors of the respective Colleges, and rusticated or expelled, which, if they be, no other House can entertain them; and though such irregular Gentlemen sometimes remove to the other Univerſity, they will not be easily received there, if they have been formally expelled this: Nor does it lie in the Power only of every particular College, and the Proctors, to stop a Lad of his Degree, but every Member of the Convocation may deny any Candidate for a Degree his Grace twice, without giving any Reason for it.

And here it may be proper to observe the Manner of calling and holding their Convocations in this University, and the Business transacted there.

The Beadle having given Notice of a CONVOCATION: All *Doctors, Regent* and *Non-Regent Masters*, are obliged to resort to the *Convocation-House* at the Time appointed in their proper Habits; where having taken the Places assigned them, the *Vice-Chancellor* enters, preceded by the *Beadles*, and having seated himself declares the Cause of their Meeting.

Here nothing is decreed or granted without the Consent of the *Vice-chancellor*, or both the *Proctors*, and a Majority of the *Regent* and *Non-regent Masters*: But Elections are all made by the major Part of all the Suffragans, either by a private Scrutiny in Writing, or publicly by dividing in the House, or otherwise by a publick Scrutiny in Writing.

The Business of this House is to make, abrogate, interpret, and moderate all Laws and Statutes of the University, to grant Dispensations and Presentations to Benefices, to examine and pass Accounts, demise Lands, write Letters to great Persons, to degrade Criminals, &c. But this House can neither abrogate or interpret Statutes made or confirmed by Royal Authority without special License from the Crown.

Before a new Law is made, or a Statute altered or explained, the *Vice-chancellor* lays it before the Heads of Houses at their *hebdomadal Meeting*; and as soon as they have prepared and settled the Draught, the *Proctors* report it to the Congregation in the Terms agreed on by the Heads of Houses, and in the following Convocation it is publicly read by the Register, and put to the Vote, whether it shall pass or not.

The Convocation may dispense with many Things; as, where Students, who have formerly been of the University, have applied themselves to the Study of Divinity fifteen or sixteen Years from the Time of their Regency, they may take their further Degrees by Accumulation, after doing exercise for them. The Convocation also may give Degrees to Bishops and Noblemen (*honoris gratiâ*) without Performance of Exercise for them.

All Elections (except for Members of Parliament) are made by private Scrutiny in Writing, wherein the *Vice-chancellor* is President, and the two *Proctors* Scrutators: But before they proceed to Election for any Lecturer, Officer, or Servant, the Candidate swears, that he has neither directly or indirectly by himself or others, made a Contract with any one, or given, or promised to give, any Thing for the same; and the *Proctors* are sworn to make a faithful Scrutiny; and that they will not induce any one to give a Vote contrary to his Inclination, but pronounce the Person elected, who hath the Majority: The Electors also are sworn, that they will vote but once in this Scrutiny, that they will name none but those they know or believe duly qualified for the Office, Benefice, &c. and that without any Reward or Expectation thereof. The Poll being cast up by the *Proctors*, it is burnt; after which the Election is pronounced; if two have an equal Number, the Senior is preferred, if they are Graduates; and if not, the *Vice-chancellor* determines the Election.

For the speedier Dispatch of Business, the Convocation and Congregation often chuse Delegates, who are a select Number of Men, who have sometimes a Power of acting without making Report to the Houses, and sometimes are obliged to make a Report for their Approbation: These Delegates consisting of *Doctors, Regent* and *Non-regent Masters*, swear to act according to the Statutes.

All Speeches are made in *Latin* in the Congregation and Convocation, unless the *Vice-chancellor* dispenses with their being spoken in *English*, and all opprobrious and indecent Language is prohibited on Pain of Exclusion.

For the better Government of the University, the *Vice-chancellor, Proctors* and Heads of all the Colleges and Halls, assemble every *Monday* in the Year, except Holidays, at one in the Afternoon, and here they consider the State of the University, what Invasions have been made on their Rights and Privileges, and how to remedy their Grievances. There is a large elegant Room in the *Clarendon Printing-House*, where the Heads assemble on these Occasions.

Having already treated of the several Degrees taken in the University, and the Qualifications required by those who are Candidates for them, it may be proper to say something of the Condition of Undergraduates, consisting of Noblemen, Gentlemen-Commoners, Commoners, Scholars of the Foundation, Exhibitioners; Battlers and Servitors.

Of these the Noblemen only are permitted to wear Gold and Silver Lace, or Net-work in their Habits. These Common with the Fellows, and have private Tutors usually, but do not seem to be subject to the Rules of the University any further than they please.

The *Gentlemen Commoners* live at their own Expence, and either eat with the Fellows, or have a Table to themselves (as in *Queen's*) and have every one his Battler (as a Fellow has) who is entitled to some small Perquisites.

The *Commoners* I presume are so called from their *commoning together*, and having a certain Portion of Meat and Drink provided for them, denominated Commons. Of these several are Scholars of the Foundation, and obliged to wait in the Hall on the Fellows, by Turns.

The Battlers are entitled to no Commons, but purchase their Meat and Drink of the Cook and Butler, unless they serve a Fellow or Gentleman Commoner, and then they have the Dishes, which come from their Tables, with some other small Perquisites.

Of these *Battlers*, some are *Servitors*, who attend the Batchelors and Commoners in the Hall, for which they have an Allowance.

The Education of all these is the same, but they pay for their Tuition and other Articles differently; if a Commoner pays 1*l.* 10*s.* a Quarter for Tuition, a Gentleman Commoner pays double, and a Battler pays less than a Commoner; and the different Respect given to each of these in the University, according to the Class they enter, is very remarkable, though it is not material, when they go out into the World, of what Class they were. There have been Instances of Battlers and Servitors that have arrived at eminent Posts in the Ecclesiastical and Civil Government: Neither is it any Disadvantage to the taking a Degree. A Battler, when he is four Years standing, becomes a Candidate for a Bachelor's Degree, as well as a Commoner, and perhaps there is no Place where pure Merit is more considered, and countenanced than in this University, when Students become Candidates for Degrees.

One Advantage all of them have in an Academical Education, which is not to be met with elsewhere, is the coming up in the Schools, and disputing publickly. There are some Lads, who are not to be moved by other Arguments, to apply themselves to Study, who will take true Pains to qualify themselves for these Encounters, lest they should be recorded *Blockheads*, *biffed* and *despised* in all Companies. Gentlemen, who are deaf to the Advice of their Superiors on other Occasions, will beg their Assistance, when they are to come upon this Stage, and use uncommon Diligence to acquit themselves with Applause in the Eyes of the University; and here Gentlemen learn to speak in Publick without Hesitation or Disorder, when they meet with Opposition, which are Advantages that cannot be had in private Education.

It having been intimated by some Gentlemen, that a Degree at *Oxford* may at present be obtained by performing a very slight Exercise: A Member of that University observes, that there is as much Exercise performed every Year, and that as strictly too, as ever was in former Times, and perhaps more than in any other University in the World. All the several Exercises that the Statutes of the University require, except the *Terræ Filius's*, and Musick, and a few other Speeches at the Act, are as rightly, and duly, and laudably performed in these modern, as ever they were in antient Times, except the Times of *courseing* as they called them, which were, in plain *English*, Times of fighting, very unbecoming Scholars; for after they had been sharply disputing College against College in the Schools, they fell to fighting it out in the Streets.

It is well known, that besides private Exercises of one Sort or other every Day in all Colleges and Halls, there are publick Exercises, such as Disputations, Lectures, Declamations and Examinations performed in the publick Schools almost every Day in Term Time, which every individual Scholar is obliged by the Statutes of the University to perform before he can be promoted to any Degree in the University. At some of which Exercises (especially at the more solemn Times for Exercise, as Lent and Act Time) the Vice-chancellor himself is often present: Nay, some of those Exercises cannot be performed, unless he or the Pro-vice-chancellor be there: And at some other Exercises, one of the Proctors is always present; and those Exercises cannot be performed, and pass *pro forma*, unless it be so. Besides this, there is no publick Scholastick Exercise at any Time performed, but either one of the Magistrates of the University is actually present at the Performance of it, or at least the Performers run the Risque of having one of the Magistrates present at the Performance, and consequently take all possible Care before-hand in providing for the due Performance of their respective Exercises, as not knowing, but that some Magistrate may be present at the Performance of them. And this some Scholars do to gain Applause, others to avoid the Disgrace of being *plucked*, as they call it, that is commanded to desist from the Performance of their Exercise for that Time, and so to provide themselves better against some other Time. Which Thing of being plucked is what seldom happens, scarce once in a Year; but when it does happen, it is scarce ever wiped off as long as a Man lives.

I shall conclude this History of the *University of Oxford* with Doctor *Newton's* Account of the Expences a Scholar is at in the House, of which he is a Member.

*A particular Account of a Commoner's Expences in Hart-Hall, for Michaelmas Quarter, 1723.*

	l.	s.	d.
Chamber-Rent	1	0	0
(a) Tuition and Officers Stipends	2	5	0
(b) Univerfity Dues	0	1	3
(c) Charter	0	0	6
Bedmaker's Wages	0	6	6
Domus	0	0	3
(d) Decrements	0	4	2
Servitor	0	2	6
Commons and Battels, Cook and Butler's Salaries, (e) included	3	16	11
	<hr/>	<hr/>	<hr/>
	7	17	1

A View of each Week's Expence, for *Commons* and *Battels* in the faid Quarter, exclusive of the Cook and Butler's Salaries.

	l.	s.	d.
June 28.	0	4	4
July 5.	0	4	5
12.	0	4	6
19.	0	4	5
26.	0	4	8
August 2.	0	4	5
9.	0	5	9
16.	0	5	3
23.	0	4	11
30.	0	4	10
Septem. 6.	0	5	1
13.	0	4	11
20.	0	4	9
27.	0	4	11
	<hr/>	<hr/>	<hr/>
	3	7	7

	l.	s.	d.
The Doctor observes, that this was a Quarter, in which were fourteen Weeks, and of which the <i>Commoner</i> was not absent from the Hall one Day, and that the pure <i>Commons</i> and <i>Battels</i> of the whole Quarter amount to no more than	3	7	7
Add to this, the Cook and Butler's Salaries for 14 Weeks.	0	9	4
Decrements	0	4	2
	<hr/>	<hr/>	<hr/>
	4	1	1

(a) To the Tutor, 1l. 10s. To the Publick Lecturer, 5s. To the Principal, Chaplain, Catechist and Moderator, 2s. 6d. each.

(b) To the Readers of the Un-endowed Lectures, 6d. To the Bedell of Arts, 2d. called Culet, i. e. Collecta. To the Keeper of the Galleries at St. Mary's, 6d. To the Clerk of St. Mary's, 1d.

(c) Paid to the Univerfity at Michaelmas and Lady-Day, only for the Defence of their Privileges.

(d) Each Scholar's Proportion for Fuel, Candles, Salt, and other common Necessaries, originally so called, as so much did on these Accounts decrease, or was discounted from a Scholar's Endowment.

(e) Four-pence a Week to each of those Servants, from every Commoner of the Society, in lieu of all Fees and Perquisites before received by them.

	<i>l.</i>	<i>s.</i>	<i>d.</i>
Brought over	4	1	1
Allowance to Domus	0	0	3
Allowance to the Servitor for waiting	0	2	6
The whole Expence of Eating and Drinking, and of the Accommodations and Attendance and Service relating thereto, comes but to	4	3	10
Which is 5 <i>s.</i> 11 <i>d.</i> $\frac{3}{4}$ . <i>per</i> Week, or 10 <i>d.</i> $\frac{1}{4}$ . each Day, (only three Halfpence over)			

From hence it appears, that the ordinary Expences of a College Life, including Chamber-Rent, Tuition and Officer's Stipends, does not amount to eight Pounds a Quarter, or thirty-two Pounds *per Annum*; and if it should be admitted, that the Expences are something more in other Colleges, and we add forty Shillings a Quarter, or eight Pounds *per Annum* to the Account; then the whole Expences will amount to but forty Pounds *per Annum*; and yet there is scarce a Commoner in the University that spends less than sixty Pounds *per Annum*, and many of them upwards of fourscore by an extraordinary way of Living: and exclusive of the Expences at his Entrance into the University.

	<i>l.</i>	<i>s.</i>	<i>d.</i>
For the Furniture of a Room	15	0	0
— A Gown, Surplice and Cap	7	0	0
— Cautionary Money	10	0	0
	32	0	0

Let us now take a Survey of the University of CAMBRIDGE.

Should I adopt the Opinion of some *Antiquarians*, it would lead me to assert that *Cambridge* is the most ancient *Academical* Foundation in *Europe*; the University of *Oxford* only excepted. For, from this Seat of Learning were sent certain Disciples of Venerable *Bede* to be the first Professors in the University of *Paris*; and *Bede* (in the Year of Christ 689) by consent of the Clergy and Prelates of the Kingdom, was, for his many learned Disputations against the *Heathens*, raised to the Chair of the *Elders*, with the Mantle of Honour, and Cap of Dignity, after the Manner of the *Athenians*, in the University of *Cambridge*.

If the Letter, which goes under the Name of *Alcuin* to the Scholars of *Cambridge*, be genuine, there can be no doubt of its being in a flourishing Condition in his Time, himself having commenced Doctor in this University under Venerable *Bede* in the Year of Christ 692. But let the Fate of that Letter, and the State of this *University* in the Reign of King *Alfred*, the *Solomon* of the *Saxon* Line in *Britain*, be what they will, I can, with great Certainty, affirm, that the *Norman* Conqueror committed the Education of *Henry Beauclerk*, his youngest Son, and afterwards King of *England*, to the Care of the Governors of this learned Body.

But it cannot be presumed that the University, in those early Ages, could be under the same Regulation, or so endowed, and settled as now we see it.

It might, and probably was here, as at *Oxford*, the Custom to erect public Schools for private Emolument: the Scholars at first boarded in private Houses, as is still the Custom at *Leyden*, &c. in *Holland*: Some Encouragers of Learning did in length of Time, and for the better Improvement of Youth built *Hospels* or *Inns* for the Students to live in Society, at their own Charges, under certain Rules or Regulations, as now practised at the *Inns of Court* in *London*; and which in course of Time obtained the Name of *Halls*; and at length the *Monks* and *Friars* taking it in their Heads to plant some of their young Branches in this learned Soil, they introduced Foundations for the full Maintenance of the Students and Fellows in *their Halls*, which proved so great an Encouragement to Learning, that we find their Example imitated, soon after, by all the other *Halls*.

These Endowments were attended with another alteration in the Circumstances of the Houses for the Reception of Students: for, many of the *Halls*, from the Time of their Endowment took the Names of *Colleges*.

The diligent Searchers into Antiquity have given the following List of the *Inns* and *Hofstels* at *Cambridge*, in which the Students originally lived and studied at their own Charges, and under the Government of a President.

- |   |   |
|---|---|
| 1 <i>Augustine Hofstel.</i>                                 | 18 <i>St. Katharine's Hofpital.</i>         |
| 2 <i>Barnard's Hofstel.</i>                                 | 19 <i>Knaption's Place.</i>                 |
| 3 <i>Bolton's Place.</i>                                    | 20 <i>St. Margaret's Hofstel.</i>           |
| 4 <i>Boden's Hofstel.</i>                                   | 21 <i>St. Mary's Hofstel.</i>               |
| 5 <i>St. Botolph's Hofstel.</i>                             | 22 <i>St. Michael's Hofstel.</i>            |
| 6 <i>St. Clement's Hofstel.</i>                             | 23 <i>Ovin's Inn.</i>                       |
| 7 <i>Cousin's Place.</i>                                    | 24 <i>St. Paul's Inn.</i>                   |
| 8 <i>St. Croffe's Hofstel.</i>                              | 25 <i>Phiswick's Hofstel.</i>               |
| 9 <i>St. Edward's Hofstel.</i>                              | 26 <i>Rud's Hofstel.</i>                    |
| 10 <i>Ely-Convent for Monks belonging to Ely-Monastery.</i> | 27 <i>St. Thomas's Hofstel.</i>             |
| 11 <i>Gerrard's Hofstel.</i>                                | 28 <i>Tiled Hofstel.</i>                    |
| 12 <i>God's Houfe.</i>                                      | 29 <i>Trinity Hofstel.</i>                  |
| 13 <i>God's Houfe.</i>                                      | 30 <i>Univerfity Hofstel.</i>               |
| 14 <i>God's Houfe.</i>                                      | 31 <i>A Dominican Convent.</i>              |
| 15 <i>St. Gregory's Hofstel.</i>                            | 32 <i>A Francifcan or Minorite Convent.</i> |
| 16 <i>Jesus and St. John's Hofstel.</i>                     | 33 <i>An Auguftine-Friars Convent.</i>      |
| 17 <i>St. John's Hofstel.</i>                               | 34 <i>A Carmelite Convent.</i>              |
|   | 35 <i>A Houfe of White Canons.</i>          |

I don't infift upon the tradition of *Pythagoras's Houfe*, (where, it has been faid, that antient Philofopher lived and read Lectures to the Youth of this Univerfity) fituated on the North Weft Side of *St. John's College*, now a Farm to *Merton College, Oxon.*

The *Colleges* and *Halls*, as now eftablifhed, differ only in Name. They entertain three forts of Scholars: Ift, *Great Penfioners* or *Fellow Commoners*, who are Gentlemen of *Quality* or of large Fortunes: Ildly, *Leffer Penfioners* or *Commoners*, who are dieted as Scholars, but both live at their own Expences: IIIly, *Sizars* or *Servitors*, who are fuch Scholars, as are maintained on the Revenues of the Foundations, Exhibitions, &c.

But this Difinction is no Impediment or Bar to the Advancement of them to the *Academical Degrees* conferred upon the Students of this Univerfity.

The Degrees conferred by this Univerfity are *Batchelor* and *Mafter of Arts*, *Batchelor* and *Doctor* in *Divinity*, *Phyfic*, and *Law*: to which all Students, according to their ftanding and proficiency in Learning, are intitled, viz. To the Degree of a *Batchelor of Arts* at the end of four Years from Admiffion: To the Degree of a *Mafter of Arts*, an the end of three Years more: To the Degree of a *Batchelor of Divinity*, feven Years after that: And to the Degree of *Doctor* in *Divinity* not till feven Years more fhall expire; which make twenty-one Years from the Student's firft admiffion upon the Books of this Univerfity.

The Degrees in *Law* and *Phyfic* are fooner conferred. In either of thefe the Student may commence *Batchelor* at the end of *five* Years; and *Doctor* at the end of five Years more.

The Times for conferring Degrees are called the *Commencement*; and for *Bachelors of Arts*, it begins on *Afh-wednefday*, and continues the whole Time of Lent: for *Mafters of Arts* and *Doctors* of all Faculties, on the firft *Tuefday* in *July*.

The Graduates are diftinguifhed by their *Dreffes*; and are intitled to certain *Privileges*, &c.

It is moft probable that the Habits ufed in this Seat of Learning have undergone as many Alterations and Changes, as we have feen Forms of the Houfes or Habitations; for, though the prefent Gown of the *Undergraduate* refembles the Garb of a *Novice* of the *Friars Preachers*: That of a *Mafter of Arts*, the Habit of a *Canon Regular* of the Order of *St. Auguftine*: and that of a *Doctor* in *Divinity* nearly approaching the Drefs of a *Benedictine Monk*; and though the *Cap* is exactly borrowed from the faid Canons; and the *Hood* is a near Representation of the large Couls ftill worn by fome of the Monaftic Orders, more for Ornament than Ufe; yet it cannot be imagined that a Place of fuch Antiquity and Fame for its Studies could be without *Academical Habits* before thefe *Monaftic Inventions* had any Exiftence in the *Island of Britain*: neither can the retaining of the prefent Forms be fubject to Cenfure, let their Origin be what they will; becaufe fome Habits are neceffary to convey an immediate Idea of a Students ftanding and

and Degree in the Univerſity, at ſight; and as theſe, delivered down from former Times, contain nothing indecent nor irreligious, they cannot be conſidered any otherwiſe than as Badges of Honour and Ornament, and not as Relicks of Popiſh Superſtition.

The Government of this *Univerſity* is in a *Chancellor, High Steward, Vice-Chancellor, two Proctors,* and ſeveral other inferior Officers, who are all choſen and empowered much in the ſame Manner as thoſe already mentioned in the *Hiſtory of the Univerſity of Oxford.*

This Univerſity is not only incorporated; but it ſends two Representatives to Parliament.

Here are only three Terms kept, *viz.*

*Lent Term,* which always begins on the 13th of *January*, except it falls on a *Sunday*; then on the 14th.

*Eaſter Term,* which begins *Wednesday* ſennight after *Eaſter*, and ends on *Friday* after the *Commencement.*

*October Term,* which begins on 10th of *October*, divides *November* 13th, and ends *December* 16th.

The *Colleges, Houſes* and *Halls* incorporated by the Name and Stile of the Univerſity of *Cambridge* at this Time are

1. *Peter Houſe,* which takes its Name from being built on the Burial Place belonging to *St. Peter's Church,* now *St. Mary's.* This College was founded by *Hugh de Balſham* about the Year 1257 or 1280, for fourteen Fellows, two Students in Divinity, and eight poor Fellows. He alſo gave them 300 Marks at his Death to make Additions to the College, and a large Collection of *Manuſcripts.*

The Lands, Revenues, &c. of this College have been very much encreaſed by a numerous Liſt of Benefactors from Time to Time; which has put it into a moſt flouriſhing Condition. For there are now a Maſter, fourteen Foundation Fellows, and forty-three Scholars.

From this College we can enumerate, two Archbishops of *Canterbury,* one Archbiſhop of *Armagh* in *Ireland,* one Cardinal, twelve *Biſhops* in *England* and *Wales,* and one *Irish* Biſhop.

Its State of Learning from the very Commencement of the Reformation is very conſpicuous in the Works of *George Joye,* a *Proteſtant* Fellow of this College in 1547, who tranſlated Part of the Old Bible: --- Of Archbiſhop *Whitgift,* who diſtinguiſhed himſelf by his learned Diſcourſes againſt the Church of *Rome*: --- Of *Andrew Perne,* Maſter; one of the Tranſlators of Biſhop *Parker's* Bible: --- Doctör *John Richardſon,* Maſter, and Doctör *Andrew Bing,* two of the Tranſlators of King *James the Firſt's* Bible: --- *John Holbroke,* Maſter; the great Mathematician: --- *Chriſtopher Cartwright,* a noted Linguift and Author of Annotations on *Genesis* and *Exodus*: --- Biſhop *Cofyns* Author of the *Schooliſtical Hiſtory of the Canon of Scripture*: --- Biſhop *Walton* Author of the *Polyglott Bible*: --- Doctör *William Sherlock,* Author of many Diſcourſes againſt *Papiſts,* &c. --- Sir *Samuel Garth,* Knt. M. D. Phyſician and Poet, Author of the *Diſpenſary.*

2. *Clare Hall;* which was founded in the Year 1326, by *Richard Baden,* then Chancellor of the Univerſity, by the Name of *Univerſity Hall,* without any Foundation Revenues. But this being deſtroyed by Fire about 16 Years after, he prevailed with Lady *Elizabeth Burgo,* alias *Burk,* Counteſs of *Clare* in *Suffolk,* to join with him in rebuilding and endowing the ſame. And he accordingly rebuilt and endowed it by the Name of *Clare Hall,* for the Maintenance of one Provoſt, ten Fellows, and ten Scholars: and from the additional Benefactions the Revenues now maintain a Maſter, ten Senior and ſeventeen Junior Fellows, and three Bye-Fellows, and a numerous Train of Scholars and others to the Amount of 100, or thereabout.

This *Hall* has given to the Church one Archbiſhop of *Canterbury,* one Archbiſhop of *York,* one Lord High Chancellor; four Biſhops in *England,* and one *Irish* Biſhop.

The Learned World is indebted to it for the Education of *Ralph Cudworth,* Maſter of this Hall, and Author of the *Intellectual System*: --- Of *Richard Thompſon* the Philoſopher: --- Of *Thomas Philpot,* the celebrated *Antiquarian*: --- Of Archbiſhop *Tillotſon,* admired for his Preaching and learned Sermons: --- Of Doctör *Thomas Burnet,* Maſter of the *Charter-Houſe,* and Author of the *Theory of the Earth,* &c.

The College as it now appears is a great Curioſity, and was built in that elegant Manner, *Anno Domini* 1638.

3. *Pembroke Hall;* which was founded by Lady *Mary de Valentine* Counteſs of *Pembrokè,* *Anno Domini* 1347, was endowed under a Charter from King *Edward III.* for ſix Fellows and two Scholars, leaving it to the Diſcretion of the Maſter and Fellows to increaſe the Number in Proportion to the Revenues he ſhould ſettle.

This Foundation was ſoon enlarged, by extending its Buildings over the Site of *Univerſity Hoſtel,* &c. King

King *Henry VI.* became its magnificent Benefactor, which, with the many Privileges and Benefactions that followed, both from Popes, Kings, Queens, and Subjects, procured it the Character, which was given under the great Seal of *England* by King *Edward IV.* of *The noble and renowned and most precious College, which does and always did shine wonderfully, among all Places in the Univerſity.*

In this College were educated two Archbishops of *Canterbury*; four Archbishops of *York*; two Archbishops of *Tuam* in *Ireland*; twenty-four Bishops in *England* and *Wales*, and one *Irish* Bishop.

*N. B.* From this Number of Bishops, this College was, of old, called *Collegium Episcopale.*

But what has made it more renowned is the Catalogue of Learned Men produced from its Foundation.

Here we find *William de Bottleſham*, the eloquent Preacher in King *Richard II.* Reign: --- *William Lyfwood* Author of the *Provincial*: --- *William Somerſet*, M. D. Phyſician to *Henry VI.* --- *John Rogers*, who translated the Bible, and was the first Proteſtant Martyr under Queen *Mary I.* --- Bishop *Ridley* the most learned of the Martyrs in that Reign, and one of the Compilers of our *Liturgy*: --- Doctor *William Turner* an eminent Phyſician, Divine and Preacher. He was Domestic Phyſician to the Protector Duke of *Somerſet*: Wrote divers Treatises against Popery; was Dean of *Wells*; and Author of the first *English Herbal*, Anno Domini 1568. --- *John Bradford* another Martyr: --- Bishop *Chriſtopherſon*, eminent for his Skill in the *Greek Tongue*: --- Doctor *Fulk*, the learned Conſuter of the *Reims Teſtament*: --- *Gabriel Harvey*, an elegant Prelate and Orator: --- The celebrated Poet *Edmund Spenser*: --- *William Rowley*, a great Wit and Theatrical Poet: --- Bishop *Brownrigge*, an eminent Preacher: --- *Thomas Stanley*, Author of the *History of Philoſophy*: --- Doctor *Thomas Wharton*, M. D. who diſcovered the *Ducts* in the *Glandule Maxillares*: --- Doctor *William Holder*, who first diſcovered the Method to teach a dumb Man to ſpeak, and an eminent Virtuoso: --- *Henry Hawſon*, the Chronologer: --- Doctor *George Folbury*, Poet Laureat, and a famous Rhetorician, celebrated for his *Epigrams* and *Orations*.

4. *Bennet-College* was founded by the joint Endeavours of the *Gild of Corpus Chriſti* and the *Gild of the Bleſſed Virgin Mary* by the Name of both their Gilds, in the Year 1344. But they about four Years after conſented to change its Name to *Benedict* or *Benet College*, becauſe it was ſituated near *St. Benet's Church*.

Its first Revenues were inconfiderable; and though it was put under the Protection of *Henry Plantagenet* the brave and good Duke of *Lancaſter*, the Income would hardly ſupport the Maſter and Fellows with Neceſſaries. However in Proceſs of Time the Benefactions enabled this Society to encreaſe the Number of Students very much. So that at preſent here are 12 Fellows and 45 Scholarſhips and Exhibitions.

From hence have proceeded three Archbishops of *Canterbury*; two Archbishops of *York*; two Archbishops in *Ireland*; eleven Bishops in *England* and *Wales*, and three *Irish* Bishops.

Alſo the learned Author of *Antiquitates Britannicæ*: --- *Richard Cavendiſh* the celebrated Phyſician and Mathematician: --- *Thomas Markunt* the Antiquarian: --- *John Crump* the great Divine: --- *William Briggs*, M. D. the Anatomist and Author of the *Anatomy of the Eye* and *Theory of Viſion*: --- *John Pulgrave*, S. T. P. the Grammmarian and Linguist: --- *John Spenser* Author of the learned Treatiſe *de Legibus Hebreorum*: --- *John Thorp* the Logician, Author of the *Labyrinth of Logic*: --- *Thomas Allen*, Author of *Scripture Chronology*: --- *John Johnson*, Author of *the bloody Sacrifice* and *Altar unveiled*, &c. --- Doctor *Robert Moſſe*, a celebrated Preacher, &c. &c. &c.

In this College is a Library over the Chapel conſiſting of *Manuſcripts* only; the Gift of Archbiſhop *Parker*. They were collected by himſelf and depoſited in this College under this Condition, that ſhould any one of the Records or Manuſcripts left by him, be ſecreted or miſſing from that Collection, the College ſhall looſe the whole; as by his Grace's Will doth more fully appear. Therefore ſuch Care is taken to preſerve this valuable Depoſit, celebrated all over the learned World, that even a Fellow of the Houſe is not permitted to enter the Library, without an Inſpector with him, to attend him during his ſtay there; and the Manuſcripts are carefully examined and numbered once a Year by two Perſons of another College.

5. *Trinity-Hall* is indebted to the Generoſity of divers Benefactors, who brought it out of its ancient Mediocrity of a poor *Hôtel* or *House of Study*, and added to it many Enlargements; which being all purchaſed by Doctor *William Bateman*, Biſhop of *Norwich*, was taken down, and at his own Expence was built and erected into a College, he endowing it with a conſiderable Eſtate; and is therefore generally reputed the Founder thereof, in the Year 1351.

The Founder appointed a Maſter, two Fellows, and three Scholars of this Houſe to be Students in the *Canon* and *Civil Law*, and one Fellow to the Study of Divinity. He afterwards encreaſed his Favours, and procured many Advantages and Additions to their Revenues from the Pope. We find alſo

many other Benefactions both for founding Scholarships, rebuilding the Premises, &c. But the greatest Sum was left to this College lately by *John Andrews*, L. L. D. sometime Fellow, Master of the *Faculties*, and Chancellor of the Diocese of *London*. This Gentleman, who died in 1747, gave to this Hall 20,000*l.* for six Fellowships, and six Scholarships for the Study of the *Civil Law*, which he appropriates to *Merchant Taylor's School* in *London*; and the Residue for finishing the new Buildings.

The present Members of this *Hall* are a Master, twelve Fellows, two of which are Divines, fourteen Scholars, and one Exhibitioner. Who enjoy the Advantages of a Library replenished with a fine Collection of choice and valuable Books, and an entire Study of Civil and Common Law Books.

Amongst the dignified Clergy we find eight Bishops; and amongst the Learned we can mention Doctor *Havido*; Master of the Requests to Queen *Elizabeth*, and one of the Restorers of Learning in *Britain*: --- Bishop *Thirleby*, one of the Compilers of the *Liturgy*: --- *Thomas Taper*, who has wrote well for his Time, on Husbandry: --- Doctor *Corvel* Author of the Interpreter and of the *Institutiones Juris Anglicanae*: --- Bishop *Barlow* one of the Translators of the *Bible*: --- Sir *Robert Naunton*, *Knt.* Public Orator, Secretary of State and Author of *Fragmenta Regalia*.

6. *Gonville and Caius College* takes its Name from a double Foundation. It was originally the Foundation of Mr. *Edmund Gonville* Minister of *Tarington* in *Norfolk*, who in the 22d of *Edward III.* obtained a Charter for building of a College to maintain a Master and thirty Scholars. To which the Chancellor and Masters of the University, and the Master and Brethren of *St. John's Hospital* in *Cambridge*, about four Years after, became Benefactors. Mr. *Gonville* did not live to complete this Institution: But having prevailed with Doctor *Bateman* Bishop of *Norwich* to finish the Work after his Death, that Prelate executed his Will, and gave it the Name of *Gonville Hall*: However the Revenues fell far short of the Maintenance intended by the Founder; for it does not appear that this Bishop endowed this Hall for more than a Master and three Fellows. It was afterwards endowed with the Augmentation of three more Fellows; which, with the Favour shewn by Pope *Sixtus IV.* Anno Domini 1481, who obliged all *Benedictine Monks* of the Diocese of *Norwich*, intending to follow their Studies at *Cambridge*, to study in no other Hall than this.

This brought the Society into great Reputation; and Benefactions tumbled in a-pace, infomuch that soon after we find seven Fellowships and eleven Scholarships added to the former Number.

In 1557 *John Caius*, M. D. who had been Master of this College, enlarged the House and increased its Revenues so much, that his Benefaction was deemed a new Foundation: So that from thenceforward it is called *Gonville and Caius College*.

*John Caius*, alias *Keys*, after he had taken his Doctor's Degree in *Physic*, left *Gonville College*, and travelling into foreign Parts for Experience, entered himself in the University of *Padua*, at that Time much in Vogue for the Study of *Physic*, under *John Baptist Montanus de Verona*, the greatest Physician of the Age: And having acquired great Reputation there by his public Lectures and Writings, Mr. *Caius* returned to his native Country, and then made the Foundation abovementioned.

He obtained a Charter of Incorporation for this united Foundation, which gave him Power to found two or more Fellows, and twelve or more Scholars; to be incorporated by the Name of the Master, Fellows and Scholars of *Gonville and Caius College*, founded to the Honour of the ANNUNCIATION of the Blessed Virgin *MARY*.

The Doctor soon after built *Caius Court* at his own Charge; and inscribed the Gate next to *St. Michael's Church*, HUMILITATIS, or the Gate of HUMILITY: the next VIRTUTIS, i. e. the Gate of VIRTUE: On the other Side of this *Portica* are these Words *Jo. Caius posuit Sapientiae* 1567, i. e. *John Caius created this in Honour of Wisdom*: the other Gate next the public Schools, commended much for its Architecture is inscribed HONORIS, i. e. The Gate of Honour, upon a Supposition that none should venture to pass through it to take their Degrees, who have not honourably acquitted themselves in their Studies, &c. Those Buildings, exclusive of his Settlements, cost him 1834*l.*

Amongst other Privileges the Doctor obtained a Licence in the 6th *Elizabeth*, that this College might for ever yearly take the Bodies of two Malefactors at their Discretion, and dissect them without the Controul of any Person, and without paying any thing for them; and settled the annual Sum of 1*l.* 6*s.* 8*d.* for the Expence of dissecting the Bodies.

By his Will he settled 100*l.* per Annum more upon this College; and appropriated his Fellowships and Scholarships to the Diocese and City of *Norwich*.

There have been many other good Benefactions made to this College. Mr. *Robert Trapp* settled four Scholarships. Mrs. *Jocosa Frankland* gave enough to maintain six Fellows, twelve Scholars, a Chaplain and a *Hebrew Professor*. Doctor *Thomas Legge* left Money to build the Side of the new Court next *St.*

*Michael's Church.* Mr. *William Brantwait*, S. T. B. gave a most valuable Library to this College, and 26 *l.* 13 *s.* 4 *d.* for founding four Scholarships, Mr. *Stephen Perse*, M. D. left 10 *l.* per Annum each to six Fellows: 4 *l.* per Annum each to six Scholars, and 500 *l.* to build the North Side of the new Court. *John Griffin*, M. D. gave 40 *l.* per Annum for ever to be employed for four Scholars at 5 *l.* each per Annum, and other Purposes. Mr. *Matthew Stokys* gave 5 *l.* 10 *s.* per Annum each to three Scholars, and 16 *l.* per Annum to one Fellow, who is a Divine, and applies himself to Study. Mr. *John Goslin* augmented his Great Uncle Doctor *Goslin's* Scholarships, with the Interest of 500 *l.* for ever. Archbishop *Parker* founded one *Physic* Scholar.

This College has the Guardianship and Direction of a *School* and *Alms-house* for six poor Women; both founded by Doctor *Stephen Perse*: The *School-House* so large as to contain 100 Boys; with Apartments adjoining for the Master and Usher: Endowed with 40 *l.* for the Master and with 20 *l.* for the Usher. The *Alms-house* for six single Women forty Years old, and upwards, to be paid 20 *s.* every Quarter.

Amongst the Regulations and Orders of this College, we find one, which obliges those Scholars, who intend to offer themselves for College Preferments, to reside four Calendar Months in each Year; and that such as shall not so reside the first Year after they are *Bachelors*, if they be possessed of any of the more valuable Scholarships, must quit the College or change their Scholarships.

The dignified Clergy, educated in this united Society, are one Archbishop of *Canterbury*, one Archbishop of *Armagh*, eleven Bishops in *England* and *Wales*, and two *Irish* Bishops.

Amongst the learned Members of this Society are noted the celebrated *Astronomer Walter de Aveden*, Author of an *Astronomical Table*: — Bishop *Skyppe*, a noted Preacher and one of the Compilers of the Liturgy: — Doctor *John Caius* the Founder, and Author of many excellent Books not only in *Physic*, but of the *Antiquities* of *Cambridge*: — Bishop *White*, who wrote learnedly against *Papery*: — Mr. *Fletcher*, M. D. famous for his Book of *Urinis*: — Doctor *William Harvey*, who discovered the Circulation of the Blood, and wrote de *Generacione Animalium*: — Doctor *Jeremy Taylor*, Author of the *Holy Living and Dying*, and many other Books in great Esteem for their Piety and Learning: — Doctor *Robert Sherringham* an excellent *Antiquarian*, and *Orientalist*, Author of *Liber de Anglorum Gentis origine*; and of two Sermons entitled *The King's Supremacy asserted*, &c. and Translator of *Joma*, a *Talmudical* Book, with his own Annotations: — Sir *Charles Scarborough*, M. D. an eminent *Mathematician* and *Anatomist*, the Author of the *Anatomy of the Muscles*: — Doctor *Henry Wharton* a celebrated *Antiquarian*, as appears by his *Anglia Sacra*, &c. — Sir *William Neve*, *Clarencieux* King at Arms, also esteemed for his Knowledge of, and Researches into *Antiquity*: — — Doctor *Brady* Author of the History of *England*: — *Robert Hare*, Esq; noted in *Heraldry*: — *Thomas Shadwell*, Esq; a *Theatrical Poet* and *Poet Laureat*: — Mr. *Jeremy Collier*, the learned Author of an *Historical Dictionary*, &c. — Doctor *Samuel Clarke*, whose *Sermons*, *Philosophical* and *Critical* Works are to be rated with the best Works of his Predecessors in Learning and Eloquence.

The Library of this College is not large, but well stocked with useful Books both in Print and Manuscript: amongst which is a large Collection of such as treat of *Physic* and *Heraldry*.

7. *Kings College*, begun by King *Henry VI.* in the Year of Christ 1441, was dedicated to the *Virgin Mary* and *St. Nicholas*, and intended for the Support of a Rector and twelve Scholars: But in 1443 his Majesty changed its Form and Name; placed in it a Provost (instead of a Rector,) seventy Fellows and Scholars, ten Priests, six Clerks, a Music Master or Organist, sixteen Choristers, sixteen Officers of the Foundation, twelve Servitors for the senior Fellows, and six poor Scholars; in all 140; and dedicated this new Conception to the *Blessed Virgin Mary*, and to the *glorious Confessor St. Nicholas*. However this grand Design was cut short by the Troubles, which he met with, from the *House of York*.

King *Edward IV.* diminished its Revenues, and gave Part of its Estate, called *Pythagoras's-House* to *Merton College* in *Oxford*, which enjoys it to this Day.

*Henry VII.* was the first that cast his Eyes upon this Royal Foundation with Favour: And he extended the Chaple 188 Feet in Length; and finished the outside Shell. The Inside, as we now see it, was the Work of his Son and Successor *Henry VIII.*

The College at *Eaton* was founded by King *Henry VI.* for a Provost, seven Fellows, and seventy Grammar Scholars to be maintained on the Foundation, for a Nursery to this College at *Cambridge*.

The succeeding Benefactions to this College have been chiefly made to the Library.

The present Members of this College are a Provost, seventy Members, two Conducts, six poor Scholars, an Organist, six Singing men, and sixteen Choristers, all upon the Foundation; and are not obliged to keep their Exercise in the public Schools, as those belonging to other Colleges do.

This College has produced two Archbishops of *York*; one Archbishop of *Dublin*; one Archbishop of *Armagh*; twenty-two Bishops in *England* and *Wales*, and two *Irish* Bishops.

It has educated several Statesmen, many of whom are celebrated for their learned Works ; as Doctor *Hartlyffe*, M. D. who was chief Physician to King *Henry VI.* eminent in his Faculty, and Secretary of State to King *Edward IV.* : — Lord Chief Justice *Couingsby* in the King's Bench, temp. *Henry VIII.* — Doctor *Thomas Wilson* Principal Secretary to Queen *Elizabeth*, and Author of two Discourses on the Art of *Rhetoric* and *Logic* : — Doctor *Giles Fletcher*, Author of *the History of Russia*, Master of the Requests, and Embassador into *Russia* : — Sir *Thomas Ridley*, Knt. Vicar General, and the learned Author of the *View of the Civil and Ecclesiastical Law* : — Sir *Robert Morton* Principal Secretary of State to King *James I.* — Sir *Francis Walsingham*, Knt. Principal Secretary of State to Queen *Elizabeth*.

The Number of its learned Members would be too long to enumerate. These may serve for a Specimen.

At the Foundation we find *Thomas Stacey* and *William Sutton*, both famous for *Astrology* : — Doctor *Richard Croke* Public Orator and Greek Professor, in which Language he greatly excelled : *William Buckley*, an eminent Mathematician and Author of *Arithmetica Memor.* — Doctor *Alley*, Author of a *Hebrew Grammar*, and one of the Translators of Queen *Elizabeth's* Bible : — *Richard Munceaster*, an eminent Grecian and Grammarian. — *Anthony Wotton*, first Professor of *Divinity* in *Gresham College*. *William Oughtred*, B. D. Author of *Clavis Mathematicæ*, and most renowned for *Mathematical Learning* : — *Edmund Waller*, Esq; that admirable Poet, who first refined *English Verse* : — Bishop *Montague* a great Antiquary, and Author of *Apello Casarem*, &c. for which he underwent great Persecution from the Fanatics and Republicans. He also wrote against *Sellen's History of Tythes*, and a new *Gage for the Old Gospel*; and he published *Photius's Epistles* and *Nazianzen's Inveective against Julian* : — Doctor *Whicott* a celebrated and pious Preacher : — Doctor *Pearson*, Bishop of *Chester*, well known for his elaborate Writings both in *History* and *Divinity* : — Doctor *Castel*, the laborious and most learned Author of the *Lexicon Heptaglot* : — Doctor *Stanhope* Dean of *Canterbury*, and Author of the Paraphrase on the *Epistles* and *Gospels* : — Bishop *Hare*, Editor of *Terence* : — Doctor *King*, Editor of *Eurypides*, and Doctor *Battie*, Editor of *Isocrates*.

The Chapel is one of the most sumptuous Gothic Edifices in the whole World ; it measures 304 Feet from East to West, 73 from North to South, and from the Ground to the Top of the Battlements 91; carrying an Octogon Tower at every Corner, each of which terminates in a Dome, with winding Stairs leading into the same. The whole is built of Free-stone, and is thought to be the largest Room in the World, whose Roof is not supported by Pillars. It is covered with a Stone Arch ; above which is another made of Timber well leaded, with Space enough between the two Arches, as to permit a tall Man to walk upright between them. On the North and South Side is a Porch and nine small Chapels, each of which had its Altar, before the Reformation ; but they now are used as burial Places, except those on the South Side, where one is converted into a Library, another into a Vestry, &c.

Doctor *Fuller* tells us, that the Stone-work, Wood-work and Glass-work in this Chapel, contend, which most deserves Admiration.

Here Prayers are read three Times a Day; at half an Hour past six in the Morning, and again at ten, and then at five in the Afternoon.

8. *Queen's College* is another Royal Foundation by *Margaret of Anjou*, Queen Consort to *Henry VI.* of *England*, in the Year of Christ 1448. Her Majesty dedicated this College to *St. Margaret* and *St. Bernard*, and endowed it with 20 *l. per Annum*. And though this Work received some Interruption by the Troubles brought upon her Husband and Family by the *Lancastrian* Party; it was finished Anno Domini 1465, by her Successor on the Throne, *Elizabeth* Wife to *Edward IV.* moved thereunto by her Confessor *Andrew Duckett*, a Minorite Friar : Whose Care for this College, and his Interest amongst the Great, obtained many large Donations from other Hands for its Support. Amongst the numerous Benefactions (in all 150) we find *Richard III.* who having seized upon the great Possessions of *John Vere* the thirteenth Earl of *Oxford*, gave them all to this Foundation. But King *Henry VII.* restored them again to the Earl.

At present it maintains a Master, twenty Fellows, forty-five Scholars, and eight Exhibitioners.

From hence the Church has received one Archbishop of *Canterbury*; one Archbishop of *York*, seventeen Bishops in *England* and *Wales*, and one Bishop in *Ireland*.

The Learned World have received from hence also, the learned Bishop *Fisher*, the first Lady *Margaret's* Professor in *Divinity* : — *Erasmus Rotterodamus*, an Author of the greatest Repute in *Critical*, *Theological* and *Grammatical Learning* : — Doctor *Haynes* and Doctor *May*, Compilers of the *Liturgy* : — Sir *Thomas Smith*, Knt. Secretary of State, and Greek Professor, &c. and the first Introducer of the new way of pronouncing that Language : — Bishop *Davenant*, Representative for the *Anglican Church* at the Synod of *Dort*, and Author of Annotations, &c. — The famous Antiquarian *John Weever*,

Author of the *Funeral Monuments*: — The Historian Doctor *John Fuller*, Author of the *Church History and Worthies of England*, &c. — The great *Mathematician* Doctor *John Wallis*: — Bishop *Sparrow*, Author of the *Rationale on the Common Prayer*, and other Pieces: — Bishop *Patrick*, Author of the very learned Commentary on great Part of the Old Testament; — Doctor *James Windlett*, M. D. an ingenious *Latin Poet*, an excellent *Linguist*, and a sacred *Critic*: — Doctor *Davyes*, Editor of several Classics, and of *Menutius Felix*, and *Lactantius*: — And Doctor *Thomas Brett*, the learned Author of the Discourse on *Church Government*, and of a Dissertation on *Liturgies*.

9. *Katharine Hall* is the Monument of a private Charity; being the Foundation of Doctor *Robert Woodlark* or *Wodelarke*, Chanceller of this University. He began this Work in 1457, but did not obtain a Licence for its Endowment with Revenues to support a Master and three Fellows, till the Year 1475.

Many Benefactions have since enabled this *Hall* to support a Master, six Fellows, one Fellow-Chaplain, one Bye-Fellow, thirty-five Scholarships, and about forty Exhibitioners.

Amongst the Benefactions none appears with a better Grace than a Gentlewoman, named *Mary Ramsden* of *Norton* in *Yorkshire*, who a few Years ago appropriated an ample Donation for maintaining six Fellowships and ten Scholarships, to be Natives of *Yorkshire*, and to be named *Kyrne's* Fellows and Scholars, in Memory of Mr. *Robert Kyrne* her Relation, and a former Benefactor to this Hall.

This Hall has produced two Archbishops of *York* and one of *Armagh*; nine Bishops in *England*, one Bishop of *Sodor* and *Man*, and one Bishop in *Ireland*.

Amongst the Men of distinguished Learning in this Hall, we read of the eminent Preacher Archbishop *Sandys*, who was one of the Translators of *Queen Elizabeth's Bible*: Of Bishop *Overall*, a Translator of *King James's Bible*, and Author of the *Cowpocacion-Book*: — Of *John Strype*, the noted *Antiquarian*: — Of the celebrated Naturalist *John Ray*, Author of the *Wisdom of God in the Creation*, &c. — Of Doctor *Benjamin Calamy*, a celebrated Preacher: — Of Doctor *Lightfoot*, eminent for his Skill in *Hebrew* and the other *Oriental*s, and Author of the *Harmony of the Bible*, *Horæ Hebraicæ*, &c. — Of Bishop *Blackball*, a celebrated Preacher, and Author of many learned Sermons: — And of Doctor *Wotton*, an excellent *Critic*, Author of *Reflections on antient and modern Learning*, and Editor of the *Welsh Laws*.

10. *Jesus College*, was founded on the Site of a *Benedictine* Nunnery dedicated to *St. Rbadegund*. To which Nunnery *Malcolm IV.* King of *Scotland* added a Church dedicated to the Name of *Jesus*. — The Nuns flourished here many Years; but at last degenerated into such a debauched way of Life, that, for Shame, says my Author, they all but two left the House; and one of the two that staid was with Child, and the other but a Child.

*John Alcock*, Bishop of *Ely*, and then Lord Chancellor of *England*, being informed of this Dissertation, obtained the Licence of *Henry VII.* and of Pope *Alexander VI.* to convert the abandoned Monastery into a Colloge. In which (*An. Dom.* 1496) he placed a Master, six Fellows, and six Scholars; and dedicated the Premises to the Blessed *Virgin Mary*, to *St. John the Evangelist*, and to the *Glorious Virgin St. Rbadegund*.

This Alteration for the Advancement of Piety and Learning was presently succeeded by several large Benefactions; so that at present here are Foundations sufficient to support a Master, sixteen Fellows, and fifteen Scholars; besides twenty-five Exhibitions.

From this Colloge we can produce four Archbishops of *Canterbury*, and three Archbishops of *York*: Ten Bishops in *England* and *Wales*; and two Bishops in *Ireland*. N. B. Both the present and the late Archbishops of *Canterbury* were Scholars of this Foundation.

Here also was educated the great Light of our Church, Archbishop *Cranmer*, who was burnt at *Oxford* for adhering to the *Protestant Faith*: — Bishop *Bale*, Author of *Libri de scriptoribus Britannicis*, &c. — Sir *Thomas Elliot*, Knt. who wrote a *Dictionary*, &c. — Doctor *Duport* and Doctor *A. drews*, concerned in the Translation of the *Bible*: — Sir *William Bosville*, Knt. Embassador in *Holland*: — Sir *Richard Hutton*, Knt. Judge of the Common Pleas, and Writer of Reports: — Sir *Richard Fenshaw*, an elegant Poet, Master of the Requests, and Embassador to *Spain*: — The celebrated *Astronomer* Doctor *John Flamsteed*, Royal Professor of *Astronomy*, &c. &c.

Here is a tolerable large Library well furnished with useful Books.

11. *Christ-College* was another Foundation by King *Henry VI.* for the Reception of the Scholars, &c. whom he removed hither from the *House of God*, which he intended to include within the Bounds of *King's-College*. He placed here a Provost and four Fellows and Scholars, intending to increase the Scholars to sixty, had not the fatal War that followed obstructed his pious Design.

However *Margaret* Countess of *Richmond*, and Mother to King *Henry VII.* arose like a tutelar Deity to this House, and got Leave of her Son to complete the Project of the Royal Founder *Henry VI.*

And she accordingly endowed it with Revenues for the Maintenance of a Master, twelve Fellows, and forty-seven Scholars; which Number have since encreased by other Benefactions. So that the present Members are a Master, fifteen Fellows, and fifty-four Scholars.

The Regard paid to the Credit of this Society by the State, cannot be more properly indicated than by the Number of Bishops taken from thence; they being no less than twenty-four, *viz.* two Archbishops of *Canterbury*; three Archbishops of *York*; one Primate of *Ireland*; one Archbishop of *Dublin*; fourteen Bishops in *England* and *Wales*, and three Bishops in *Ireland*.

Here was educated *John Leland*, whose Memory is highly revered amongst the *Antiquarians*: — *Hugh Broughton* the *Orientalist*: — Doctor *Andrew Willet*, Author of *Synopsis Papijmi*, &c. — Doctor *Richard Clarke* and *Francis Dillingham*, B. D. both Translators of the *Bible*, and learned in the Eastern Tongues: — Doctor *Henry More* a deep Divine and Philosopher: — Doctor *Laurence Echard*, an eminent Historian and Author of the History of *England*.

12. *St. John's College*, as it now stands, is another Foundation begun by the said Lady *Margaret*. She erected this House of Learning, upon the Ruins of a very ancient *Hôtel* or Monastery of *Regular Canons*, founded by *Nigelus*, Bishop of *Ely*, and Treasurer to King *Henry I.* in 1134, and afterwards divided between those *Regulars* and a certain Number of Scholars, by *Norwald*, or *Northwood*, Bishop of *Ely*, in the Year 1280. But the *Regulars* at last dwindled away to two Members only: When Lady *Margaret* obtained Leave from King *Henry VIII.* to rebuild it to dedicate it to *St. John the Evangelist*, and to endow it with her own Lands for the Maintenance of a Master and fifty Scholars.

Lady *Margaret* not living to see it finished, committed the Execution of that Part of her Will to *Richard Fox*, Bishop of *Winchester*, *John Fisher*, Bishop of *Rochester*, and others, who faithfully discharged their Trust in 1508, but not without great Difficulties.

For, the Foundress having trusted to a Codicil in her last Will and Testament for the Settlements intended to be made for this College, and dying before she had signed that Codicil, King *Henry VIII.* her Grandson, cast his Eye upon the Estates to be alienated from his Family for this Foundation, and neither his Majesty nor the Bishop of *Ely*, who had Pretensions to the former House, on which this College was to be grafted, could be prevailed upon to submit to the Will of the deceased Foundress; till the Executors with great Expence and Trouble obtained a Bull from the Pope, dated *Octavo Calend. Jul. Anno Domini 1510*, which decreed the utter Subversion of the old House, and confirmed the Foundation of a new College, and the Revenues designed for the Maintenance of a Master and fifty Clerks in it; set aside the Right of the Bishop of *Ely*, the Diocesan, and empowered the Bishops of *Lincoln* and *Norwich*, or either of them, to execute his Decree, and to excommunicate all Opposers thereunto. The King immediately granted his Licence to carry the Lady, his Grandmother's Will into Execution, so far as regarded the old House to be suppressed and its Revenues, but he kept back above 400 *l. per Ann.* Estate given by the Foundress.

By the King's Charter this College is incorporated by the Name of *St. John's College*, for one Master and fifty Fellows and Scholars, more or less, to study the *Liberal Sciences*, the *Civil* and *Canon Law*, and *Divinity*.

The Benefactions to this College have been very liberal. Inasmuch that here are one Master, fifty-nine Fellows, and one hundred Scholars upon the Foundation; and the whole Number upon the Books is feldom less than 300.

From hence have been taken thirty-nine Bishops, *viz.* Three Archbishops of *York*: Thirty-four Bishops in *England*, and two Bishops in *Ireland*.

In this House were famous for their Learning *Roger Ascham*, Preceptor to Queen *Elizabeth*: — Doctor *Richard Bayne*, Professor of *Hebrew* at *Paris*, and a Commentator on *Proverbs*: — Doctor *Bullock*, Author of the *Concordance*: — Sir *John Cheke*, Preceptor to King *Edward VI.* — Sir *Thomas Wyatt*, Knt the Poet: — *William Cecil* Lord *Rugley*, Lord Treasurer: — Doctor *John Dee*, a noted Philosopher and Mathematician: — *Thomas Gatacre*, B. D. well esteemed for his *Oera Critica*, and *Annotations on the Bible*: — Bishop *Moran*, who first translated the Bible into *Welsh*: — *John Hall*, a celebrated Poet, Historian, &c. — *John Cleveland*, a renowned Poet: — *Henry Briggs* the noted *Mathematician*, the first *Savilian* Lecturer in *Geometry* at *Oxon*; *Geometry* Professor at *Gresham College*; and Author of many curious *Mathematical*, *Logarithmetical* and *Geometrical Tables*; and of a Treatise concerning the *North-West Passage* to the *South Seas* through the Continent of *Virginia*: — *John Serjeant* and Doctor *Thomas Godden*, two of the most able *Controversialists* on the *Popish* Side; who left this College and entered themselves in *St. Peter and Paul's College* for the *English Nation* at *Lisbon*, of which they both became Presidents: — *Thomas Wentworth*, Earl of *Strafford*, Prime Minister to

King Charles I. --- *Lucius Carey*, Lord Viscount *Faulkland*, Secretary of State to the said King: --- *Ambrose Philips*, Esq; a celebrated Poet, and Author of the *Pastorals* under his Name: --- Doctor *William Cave*, Author of *Historica Literaria*, the Lives of the Apostles, and of other Works in the Service of Religion and Learning: --- Bishop *Stillingfleet*, that eminent and learned Author and Prelate: --- Doctor *Peter Berwick* the celebrated Physician: --- *Martyn Lyster* the famous *Naturalist* and President of the College of Physicians: --- Doctor *John Smith*, eminent for his Knowledge in Divinity and History: --- Bishop *Beveridge*, who at 20 Years of Age published a *Latin Treatise* on the Use of the *Oriental Languages*: Then his *Chronological Institutions* in the same Language: The *Pandex of the Canons of the Apostles*: The *Code of the Canons of the primitive Church vindicated and illustrated*, also in *Latin*: His *Private Thoughts*: An *Exposition of the thirty-nine Articles*: Two Volumes of Sermons, &c. --- Doctor *Thomas Bennet*, Author of an *Hebrew Grammar*: Of a *Paraphrase on the Common Prayer*, and of several Tracts against the *Dissenters*: --- *Matthew Prior*, Esq; the celebrated Poet; Minister in Queen *Ann's* Reign; and Author of several *Poetical, Historical and Political* Pieces: --- Doctor *Jerkyns*, Author of the *Reasonableness and Certainty of the Christian Religion*: --- Doctor *Richard Bentley*, accounted the most learned Writer and Critic of his Age, as may be collected from the Variety and Correctness of his Works: --- *Thomas Baker*, B. D. a celebrated *Antiquarian*, and the Author of *Reflections on Learning*: --- *William Lee*, A. M. the ingenious Inventor of the *Stocking Weavers Loom or Engine*: --- Doctor *Samuel Croxal*, an ingenious Poet, and Author of *Fables*, lately printed under his Name.

There is a very good Library: It is spacious and well supplied with Books, and decorated with original Pictures of the Benefactors.

13. *Mary Magdalen's College* is the Foundation of *Thomas Lord Audley of Welden*, Lord Chancellor of *England*, Knight of the Garter, and Privy Counsellor to *Henry VIII.* upon the Site of an ancient House, known in the Year 1092, by the Name of *St. Giles's Priory*, for six Canons. But these Canons being removed, the *Höfel or Priory* was purchased by certain Monasteries for a *Hôtel* to accommodate their young Broods sent to study at *Cambridge*. From which Incident it gained the Name of *Monks-College*; till *Edward Stafford Duke of Buckingham*, having purchased the Premises, built thereon a new College and called it *Buckingham-College*, *Anno Domini 1519*: And in 1521 this Duke being attainted of High Treason, before the Foundation thereof was perfected, this College, as Part of his Estates, fell to the Crown; and as such was granted by *Henry VIII.* to Lord *Audley* aforesaid, in 1542; who refounded the same by the Name of *St. Mary Magdalen's College*, endowed it with Parcels of the Priory of *Holy Trinity* near *Algate* in *London*, for a Master and four Fellows; reserving to himself and Successors the Patronage of the Mastership and visitatorial Power over the College. But such have been the good Will of the Opulent towards this poor Foundation; that it has now a Master, sixteen Fellows, and twenty-five Scholarships and Exhibitions; with a very grand new Library, well filled with Books neatly classed. Amongst which is the valuable Collection made by *Samuel Pepys*, Esq; Secretary to the *Admiralty*, and President of the *Royal Society*, valued at 4000 *l.* many of which are Manuscripts, relating to Maritime Affairs in several Reigns.

Here also is a curious and extensive Collection of Prints and Drawings by the most celebrated Masters and Artists in *Europe*, placed by themselves.

From hence have sprung one Archbishop of *Canterbury*, and seven other Bishops; besides a great Number of eminent Scholars in different Branches of Literature; amongst whom we find *Henry Lord Stafford* who was an ingenious *Latin Poet*: --- *Sir Orlando Bridgeman*, Lord Chief Justice of the Common Pleas and Lord Privy Seal; --- *Sir Robert Sawyer* Attorney General; --- Doctor *William Howel* the *Historian*; --- Bishop *Cumberland*, who wrote *de Legibus Naturæ, &c.* and published the *Phœnician History*; --- *Samuel Pepys*, Esq; one of the greatest Ornaments of the Age, and Secretary of the Admiralty under King *Charles II.* and *James II.* He wrote the History of the *Navy*; --- *Dr. Waterland* well known as an eloquent and powerful Preacher and Defender of the Catholic Doctrine of the Trinity against the *Arian Heresy*.

14. *Trinity College* is the Work of King *Henry VIII.* who built it upon the Site of *St. Michael's House*, *King's Hall* and *Whiswick's Hostel*, and the six ancient *Höfels* or *Inns* of *Gregory*, *Owings*, *Margaret*, *Gerard's*, *Katherine's* and *Tyler's*.

*Michael's House* had been founded in the Year 1324 and well endowed, so as to be accounted as complete a College, as any in the University, about that Time; and before its Dissolution, became famous for the Education of three Bishops, and several Men of Learning, among whom was Doctor *Mullet*, who translated *Erasmus's Paraphrase* on *St. John*.

*King's Hall* was founded by King *Edward III.* at the Desire of his Father deceased, for a Master and thirty-two Scholars. On whom his Majesty's Charter dated *October 27, 1337,* settled *40 l. per Annum,* to be paid out of the Exchequer.

From hence proceeded five Bishops in *England;* and an Archbishop of *Dublin,* and a Lord Chancellor; also that elegant *Latin Orator John Gunthorpe,* and Bishop *Tonstal,* a great Divine and Mathematician.

King *Henry VIII.* out of all these Nurseries of Learning composed the stately College dedicated to the *Holy and undivided Trinity;* and by his Charter of *December 19, 1546,* endowed it with *1300 l. per Annum,* to maintain a Master, sixty Fellows, forty Scholars, and ten Almoner Orators or Beadsmen; reserving the Right of nominating a Master.

Queen *Mary* his Daughter began a most grand Chapel for its Use, and augmented its Revenue with *338 l. per Annum,* for the Maintenance of twenty Scholars, ten Choristers, a Master for them; four Chaplains, thirteen Poor Scholars, and two under Sizars. But this Queen dying before the Chapel was finished; her Sister and Successor *Elizabeth* took Measures for completing both the Chapel and a Library.

There have been many and most liberal Donations to this College; which now maintain a Master, Vice-Master, sixty Fellows, (including the Vice-Master) and seventy-one Scholars. But we have an Account that in the Year *1641,* the State of this College was much more flourishing, when there belonged thereunto a Master, sixty Fellows, sixty-two Scholars, thirteen Poor Scholars, four Chaplains, ten Choristers with their Masters, six Singing-Men, twenty-four Alms Orators; besides as many Officers and Servants as in all amounted to about *440.* And there is annually paid out of the Treasury of this House the Sum of *120 l.* to three Public and Royal Professors founded by King *Henry VIII.* at *40 l.* each.

The Advantages of this Foundation, and of the Numbers educated therein, have given it the Preference both in the Favour of the Court and in a Variety of eminent Scholars. For,

Here we find no less than thirty-six Bishops since the Year *1555,* of whom one was Archbishop of *Canterbury,* two Archbishops of *York,* two Archbishops of *Dublin,* twenty-seven Bishops in *England* and *Wales,* and four Bishops in *Ireland.*

Amongst the *Statesmen,* who studied in this College, were Sir *Francis Bacon,* Viscount *St. Albans,* Lord Chancellor of *England,* and Author of many learned Works in *Philosophy, Divinity, &c.* — Sir *Edward Coke,* Chief Justice of both Benches successively, and Author of several Books of Law: — *Robert Devereux* Earl of *Essex:* — Sir *John Coke* Principal Secretary of State: — *Charles Montague* Earl of *Hallifax,* Knight of the Garter, and a noted Poet, Orator, and Statesman; and his Cotemporary *George Stepney,* Esq; employed abroad by King *William,* and admired for his poetical Genius.

Here were educated many eminent Critics; no less than seven of those that were employed to translate the Bible, who were distinguished for their Accuracy in the Knowledge of *Greek, Hebrew,* and other Languages: and *William Walker* Author of the *Idioms and Particles,* the completest Work of its Kind.

It has had many celebrated Poets, *viz.* The divine *Herbert,* whose sacred Poems are in great Esteem: — Doctor *John Donne,* a sacred Poet and eminent Preacher: and *Giles Fletcher* Bachelor of Divinity, a sacred Poet: — The Comedians *Walter Hawksworth, Thomas Randolph, Sir Ashton Cockain, Nathaniel Lee,* and *George Grenville* Lord *Lansdowne:* and *John Dryden,* and Mr. *Euesden,* Poets Laureat.

The Number of other learned Men on this Foundation, who have published their Works would be too tedious to be recited. I shall only mention Sir *Henry Spelman* in the highest Esteem for his Skill in *Antiquities:* The excellent divine *Herbert.* — *Thorndyke:* — Doctor *Anthony Scaterwood,* Editor of *Critici Sacri:* — Bishop *Wilkins,* a profound Philosopher and Divine: — Doctor *Barrow,* rendered immortal by his Treatise against the *Pope's Supremacy,* and upon the *Unity of the Church:* — Doctor *Thomas Gale,* the *Antiquarian* and Editor of several *Greek Authors:* — *John Le Neve,* Esq; Author of the *Fasti Ecclesie Anglicanæ* and *Lives of the Protestant Bishops:* — Doctor *John Mapletost* the pious Author of the *Principles and Duties of the Christian Religion:* — *Roger Cotes,* Professor of *Astronomy* and *Experimental Philosophy,* and most eminent in his Faculty: — Sir *Thomas Millington* Knight, Doctor of *Physick,* President of the College of Physicians, and Author of a Book of *Anatomy:* — Doctor *Thomas Comber,* Author of the *Church History* and the *Right of Tythes:* — Sir *Iaac Newton* the celebrated Founder of the *Newtonian Philosophy:* — Doctor *Conyers Middleton,* who has propagated his Memory by his *Life of Marcus Tullius Cicero;* and a free Enquiry into the *Miraculous Powers, &c.* and several other learned Pieces: — Doctor *Richard Bentley,* of whom before, was Master of this College.

The Library is reputed the greatest of its Kind in the three Kingdoms: and both its Floor and Stair-Cases are most elegantly laid with black and white Marble; and it is well furnished with a grand Collection

lection of scarce and valuable Books in Print and Manuscript, besides other Curiosities, all most beautifully classed

Here is also an Observatory well situated and furnished, with a Variety of Instruments for Observation.

15. *Emanuel College* was founded by *Walter Mildmay* Chancellor of the Exchequer, upon the Site of an ancient *Monastery of Dominican Friars*, founded in 1280 by *Alice* Wife to *Robert Vere*, Earl of *Oxford*. This *Monastery* being dissolved by *Henry VIII.* it became the Dwelling House of *Mr. Sherwood* a private Gentleman, who purchased it of the Crown, and afterwards sold the Premises to *Sir Walter* aforesaid.

*Sir Walter* obtained a Charter to incorporate this Purchase by the Name of *Emanuel College* to the Glory of *God*, in the Year 1584, and placed in it a Master, three Fellows, and four Scholars, intended for a Nursery of *Puritans*, to which *Sir Walter* was much addicted.

This House received in course of Time such Benefactions, that we now find in it a Master, fifteen Fellows, fifty Scholarships, ten Sizar, and thirty-seven Exhibitioners; and a very good Library well classed and stocked with Books, &c.

*William Sanderson*, Archbishop of *Canterbury*, was Master of this College; besides whom this Society has sent off five Bishops to the Church of *England*, and two Bishops to the Church of *Ireland*.

Bishop *Hall*, that pious and learned Divine, who was at the Synod of *Dort*, and published many Pieces in *Divinity*: — *Samuel Cradock*, B. D. Author of the *Harmony of the Evangelists*: — *Matthew Poole*, Author of the *Synopsis*: — Bishop *Kidder*, whose Memory is revered for his Piety and learned Works: — *William Eyre* the famous *Hebreian*: — *Samuel Foster*, *Astronomy* Professor of *Gresham*, and Author of the Use of the *Quadrant*: — *Sir Robert Twysden*, Bart. an excellent *Antiquary*, and Author of the *Historical Defence of the Church of England*: — *Sir William Temple*, Bart. the great Statesman and Ambassador: — *Anthony Blackwall*, Author of *Sacred Classics*, and the late Doctor *Nathaniel Marshall* the ingenious Translator of *St. Cyprian's* Works, and Author of a Discourse on the *Penitential Discipline of the primitive Church*.

16. *Sidney-Suffex-College* is built upon the Site of an ancient Convent of *Franciscan*, or *Grey Friars*; wherein the yearly Assemblies of the Univerfity were formerly kept.

This Convent being dissolved at the Reformation from *Popery*, was given by *Henry VIII.* to *Trinity College*; from whom the Executors of *Lady Frances Sidney*, Countess of *Suffex*, Widow of *Thomas Radcliffe*, third Earl of *Suffex*, purchased it in *Fee Farm*, under the Authority of an Act of Parliament obtained for that Purpose; and thereupon, pursuant to the Will of the said *Lady Frances* built a College by the Name of *Sidney Suffex*, for the Maintenance of seven Fellows, and ten Scholars, A. D. 1596. And by future Benefactions we find the Addition of ten Fellowships, sixteen Scholarships, and eight Exhibitioners, at least; though the present Members do not exceed eight Fellows, ten Scholars, and two Exhibitioners, besides Servants.

Here is a Foundation for a *Hebrew Lecture*, and another for a *Mathematical Lecture* within the College.

Hence have been advanced, one to the Archbishoprick of *Armagh* in *Ireland*; three to Bishopricks in *England*; one to *Sodor and Man*; and one to a Bishoprick in *Ireland*.

Amongst the learned Members of this Society we have Archbishop *Bramhall*, a celebrated Writer in *Divinity*: — *Seth Ward* one of the most esteemed Mathematicians and Divines of his Time: — *Sir John Ent*, Knt. M. D. President of the College of Physicians: — *William Wollaston*, the Author of the *Religion of Nature delineated*; to whom may be added *Thomas Woolstan*, whose crazy Discourses on our SAVIOUR'S Miracles, have blasted that good Character, which he had before justly deserved for his well known Parts in Literature.

Here is a pretty Library well filled with useful Books.

The Foundations for *Public Lectures* in this Univerfity are,

1. The *Lady Margaret's*, who was Foundress of *Christ's* and *St. John's* Colleges.
2. *Lady Margaret's* Sermon. It was instituted to instruct the Ignorant not only in and about *Cambridge* but in many other Places. But since learned Preachers have abounded in those Parts, this Institution is exchanged for a *Latin* Sermon, called *Concio ad Clerum* before the Univerfity, the Day before the Term begins; and for others in *English* at stated Times before that learned Body in the Church of *Great St. Mary's*. The Preachers by the Charter ought to be chosen every Year: But this Choice has also suffered an Alteration; being now chosen every three Years.
3. *Regius Professorship in Divinity* founded by King *Henry VIII.* for the Benefit of Bachelors in *Divinity* and Masters of Arts,

4. King's Law Professors, for the Benefit of all Students in *Law*; and of the same Royal Foundation.

5. King's Professors of *Physic*, founded also by King *Henry VIII.*

6. King's *Hebrew* Professors, founded by the said King *Henry VIII.*

7. King's *Greek* Professors of the same Foundation. *Thomas Smith* and *John Cheke*, the second and third Professors, undertook to reform the corrupt Pronunciation, which then prevailed of the *Greek* Language. But Bishop *Gardiner*, the Chancellor, in his own Name and in the Name of the Senate, forbid them by a public Order to proceed in their new Method (which was proved to be the ancient and true way of pronouncing *Greek*.) In this order it is said *Quisquis nostram potestatem agnoscis sonos Literis, sive Græcis, sive Latinis, ab usu Publico præsentis sæculi alienos, privato judicio, assignere ne audeo.* i. e. "Of all who acknowledge my Authority, let none dare to give Sounds according to his own private Judgment, different from the Custom of the present Age, to Letters either *Greek* or *Latin*." Again, *η, ι, υ, uno eodemque sono exprimito*, i. e. "Express the *Greek* Letter *η, ι, υ*." And the whole Order runs in the same Strain. To which they were obliged to submit till his Authority subsided, and the Reformation of Language was introduced with the Purity of Religion.

8. *Arabic* Professors. This was founded in 1632 by Sir *Thomas Adams*, Bart. with a Salary of 40*l.* per Annum to be paid by the Company of *Drapers* of *London*. It is for the Benefit of *Majors* of *Arts*.

9. *Mathematical* Professors. This was founded by one *Henry Lucas*, Esq; in 1663. Doctor *Nicholas Sanderson*, who was blind from his Birth, enjoyed this Professorship twenty-eight Years, and complied with its Institution with great Applause.

10. *Plumian* Professors, so named from Doctor *Thomas Plume* its Founder in 1704.

11. *Natural Philosophy*, commonly called the *Woodwardian* Professors, founded by Doctor *John Woodward*, M. D. at 150*l.* per Annum for Salary and to purchase Fossils.

12. Professors for *Modern History* and *Modern Languages*. This was founded by the late King *George I.* in 1724, with a Salary of 400*l.* per Annum.

13. *Casistical* Professors. This Foundation was made in the beginning of this Century and its Salary was augmented by Doctor *Thomas Smith* its first Professor, who died A. D. 1707.

14. Professors of *History*. This was founded by *Fulke Greville*, Lord *Broke* and Knight of the Garter, with a Salary of 100*l.* per Annum. The first Professor was Doctor *Isaac Dorislaus*, assassinated in *Holland* for being concerned in the Murder of King *Charles I.*

15. *Astronomy* Professors. This was founded no longer ago than in 1749 by *Thomas Lowndes* of *Overton* in *Cheshire*, Esq; with a Salary of 100*l.* per Annum.

Here are also Professors in *Music* founded in 1684; of *Chemistry*, in 1705; of *Anatomy*, 1707; and of *Botany* in —, all by the University, but without Salaries.

It is observed, that, notwithstanding there are not so many Colleges in *Cambridge*, as in *Oxford*, the Number of Students are nearly upon a Par: and the State of Learning is most flourishing in both Universities.

SCOTLAND the Northern Kingdom in the Island of GREAT BRITAIN contains four Universities, viz.

The University of St. *Andrew's*, which was instituted by the Interest of Bishop *Henry Wardlaw*, A. D. 1112, with very ample Privileges.

It was originally governed by a *Chancellor*, who was the Archbishop for the Time being. But since the Establishment of *Presbytery* in that Kingdom, the Government is committed to a *Rector* chosen annually from amongst the Heads of the Colleges, and invested with the Power and Authority of the Vice-Chancellor in the *English* Universities.

Here are three Colleges, viz.

St. *Salvator's*, founded by *James Kennedy* Archbishop of St. *Andrews*, and endowed by him for the Maintenance of a Provost, Masters and Professors, viz. a Doctor, Bachelor and Licentiate in *Divinity*; four Professors in *Philosophy*, and eight Poor Scholars, called *Bursers*, to be instructed gratis.

St. *Leonard's College*, founded by *John Hepburn*, Prior of St. *Andrews*, A. D. 1524, who endowed it with Revenues for the Maintenance of a Principal or Warden, who must be a Doctor in *Divinity*; four Professors called Regents, and eight Poor Scholars.

Sir *John Sott* did afterwards add a Professor of *Philosophy* with a handsome Stipend, and favoured it with other Benefactions.

St. *Mary's College* is the Monument of Archbishop *Beaton's* Regard for Literature. He founded this College in 1536, and endowed it with a Maintenance for two Professors in *Divinity*, besides other

Members. Here is no Provision for *Philosophical* Studies: But there is a fine *Observatory* and a *Professorship* of a *Modern Foundation* for *Mathematical* Improvements.

The *University* of *GLASGOW* was first erected by a Bull from Pope *Nicholas V.* 7 *mo. Calend Jan.* A. D. 1451, at the Request of King *James II.* of *Scotland*, and at the Expence of Doctor *Turnbull*, Bishop of *Glasgow*.

By this Bull, the Bishop of *Glasgow*, *pro Tempore*, was constituted perpetual Chancellor of this *University*, with the Power of the *Rectors* of the *University* of *Bononia* in *Italy*; and the *University* of *Glasgow* was to enjoy all the Powers, Privileges and Immunities, which had at any Time been granted by the Holy See to the said *University* of *Bononia*.

In 1543 King *James* by his Royal Charter confirmed the Pope's Institution, and added many ample Privileges to this Foundation. Which was followed by another Instrument, by which the Bishop, Dean and Chapter granted the Members thereof divers Ecclesiastical Immunities. All these Instruments were confirmed by succeeding Kings and Archbishops.

The Officers of this *University* is a Chancellor, who is elected for Life, and whose Power is chiefly to confer Academical Honours.

A *Rector*, elected annually in *Comitiis* by a Majority of Voices of all the matriculated Members. This Officer answers to the Vice-Chancellor's Power in an *English* *University*.

The *Dean of the Faculty* elected annually by the *Rector* and all the Regents and Professors in *Senatu Academico*, or in Convocation. His Duty is to preside in all Affairs of Literature and in public Examinations.

Thirteen Professors in different Branches of Literature: The Principal, and the second Professor in *Divinity* have the Right of Precedency; the others take Place according to Seniority.

Here is a Library Keeper, a Beadle, a Janitor or Porter, and about thirty Bursers.

Here is but one College, whose Professors (except the Principal, and those in *Anatomy* and *History*) are elected by the Faculty.

The Buildings of this College and its Endowments are not inferior to any in that Kingdom. It contains nine large Houses for the Professors; a very spacious and well finished *University Hall*; a common Hall; two Libraries; six convenient Schools for teaching; forty Apartments for Students to lodge in; a Printing House, and a public Kitchen: Besides other capacious Apartments, and a Garden of nine Acres inclosed with a hewn Stone Wall, and a *Physic* Garden.

It was generously endowed by the Founder for the Entertainment of the most learned, and some of the most noble in his Time; amongst whom is found matriculated in 1457, *Andrew Steward*, Dean of *Glasgow* *University*, and Brother to *James II.* King of *Scotland*. And all its first Regents were eminent Clergymen taken from the Cathedral, or neighbouring Counties.

But in 1560, when the Kirk prevailed, this *University* suffered greatly in the loss of its Revenues, and of its valuable Members, who fled to *France*. The College was almost entirely deserted by these Means, till Queen *Mary* in July 1563 encouraged them to re-settle, by a Grant of Lands and Annuities, together with the Houses and Dwellings of the *Dominican* Friars of *Glasgow*, for the Maintenance of Scholars or Bursers; which Grant was a few Years after, followed by another of the Lands, Houses, Annuities, &c. of all Churches or Monasteries found in *Glasgow*.

King *James*, her Son, not only confirmed these Donations, but gave to this College the Tythes of the Parishes of *Gowan*, *Renfrew* and *Kilbridge*; which Gifts were confirmed by Parliament.

To these let us add the Donations or Benefactions

Of the Reverend Mr. <i>Zachary Boyle</i>	_____	_____	1600 <i>l.</i> Sterling.
— <i>William</i> Earl of <i>Dondenal</i>	_____	_____	60 per Annum.
— <i>Ann</i> Dutches of <i>Hamilton</i>	_____	_____	1000
— King <i>William III.</i>	_____	_____	300 per Annum.
— Queen <i>Anne</i>	_____	_____	210 per Annum.
— King <i>George I.</i> a handsome Fund for a Professor in <i>Ecclesiastical History</i>			
— Mr. <i>John Snell</i> four Scholarships at 40 <i>l.</i> per Annum, each to be sent to <i>Baliol</i> College <i>Oxon.</i>			
— The late Duke of <i>Chandos</i> for building a Library	_____		500 <i>l.</i> Sterling.
— Mr. <i>John Arr</i> for buying of Books	_____		500 <i>l.</i>
— Mr. <i>John Sterling</i> for Ditto	_____	_____	165 <i>l.</i>

The Scholars of *Glasgow* wear *Red Gowns*, while they are *Under-graduates*; and the Professors wear *black Gowns*, like those of Doctors of *Civil Law*.

THE UNIVERSITY of ABERDEEN, by some called the *Caroline University*, was erected by the Bull of Pope *Alexander VI.* dated 4 *id. February*, A. D. 1494, at the Instance of King *James IV.* in the City of *Old Aberdeen* by the Stile of *Universitas studii generalis*, i. e. an University for the Study of *Divinity*, the *Canon and Civil Laws*, *Medicine*, *Philosophy*, and all *Liberal Arts and Sciences*; with the Privileges, &c. of the Universities of *Paris* and *Bononia*, and all other Universities. Which the King himself confirmed by his Royal Charter.

But Bishop *Elphinston* is to be esteemed its Founder. For it is to his Generosity this University owes the first Establishments for forty-two Doctors, Professors, Masters and Students, *viz.*

Four *Doctors*, one in *Divinity* and Principal of the whole College; one in *Common Law*; one in *Civil Law*; and one in *Medicine*.

Eight *Masters of Arts*; one to be *Sub-Principal*; the second Professor in *Humanity*; the other six to be Students of *Divinity*. Out of these were to be chosen the *Regents*, who together with the *Sub-Principal* were enjoined to teach *Philosophy* and the *Arts*.

Three *Bachelors*; two to study the *Civil Law*; and one the *Canon Law*.

Thirteen Students in *Philosophy* and *Arts*.

Eight *Prebendary Priests* or *Chaplains*, *viz.* a *Chantor*, a *Sacrist*, an *Organist*, and five *Choir Chaplains*.

Six *Singing Boys* to assist the Priests at Divine Service.

Thus stood the Condition of this Seat of Learning, considered only as one Society by the Name of *King's College* in *Old Aberdeen*, when

*George Earl Maréchal* in the Year 1593 founded another or College Society by the Name of the *Maréchal College*, and endowed it for the Maintenance of a Principal, three Regents to teach the *Languages* and *Philosophy*, six Bursers, a Steward, Butler and Cook.

The Government was ordained to be in the Power of a Chancellor, Rector, Dean of the Faculty, and four Assessors; the Rector to be chosen annually by all the Members of the University.

This College continued in this Form as a distinct University from *King's College* in *Old Aberdeen* till King *Charles I.* in the last Parliament held by him in *Scotland*, united them by the Name of the *Caroline University*, and annexed to them the Revenues of the Bishoprick of *Aberdeen*. But

This Royal Act was reversed at the Restoration of King *Charles II.* when the Parliament, in 1661 put the two Colleges again upon their original Foundation of two Universities: since which Time this College has been augmented by several Benefactions, which have increased the Number of Bursers, and (besides the Magistrates) the *Maréchal College* consists of a Principal, a Professor of *Divinity*, another of *Medicine*, another of *Mathematicks*, three Professors of *Philosophy*, one of *Greek*, and one of *Oriental Languages*, a *Librarian*, a *Porter* and his *Deputy*, &c.

By the Forfeiture of the Earl *Maréchal's* Estates and Privileges the Presentation to his Foundation of the Professorships of *Medicine*, *Philosophy*, and *Greek*, is in the King.

The Professor of *Divinity* by the Foundation is in the Nomination of the Magistrates and Town Council.

The Principal and Professors wear *black Gowns*; the Students wear *red Gowns*.

THE UNIVERSITY of EDINBURG founded by King *James VI.* in 1582, was endowed by the Royal Founder with all the Privileges enjoyed by any other University in his Dominions.

It was to consist of a Principal, a Professor in *Divinity*, four Professors in *Philosophy*, a Professor in *Humanity* and *Rhetoric*, and five *Regents*; under the Government of the Magistrates and Council of the City of *Edinburg*. who are perpetual Curators: and the Lord Provost is the Chancellor of the University.

The Advantages, which this University had by its Situation in the Metropolis and Place of Residence of the Kings of *Scotland*, and by its Royal Foundation, presently gave it a Reputation; and invited great Numbers of Students, and excited many and great Benefactors to promote its good Intention; so that in a little Time the *University of Edinburg*, though it consisted but of *one College*. was deemed the chief in that Kingdom.

Here is an extraordinary Provision made for the promoting of Learning; for there are in

*DIVINITY*, three Professors; the first is always the Principal of the College, and, *ex Officio*, presides in the Academical Meetings, confers Degrees, in the Presence, and by the Appointment of the

Faculties, appoints the public Exercises, visits the Classes, and takes an Account of the Behaviour of the Students.

The *second* is Ordinary Professor, and attends the public Schools five Days in the Week, reads Lectures in Divinity, appoints Exercises, proposes Questions, and solves Difficulties.

The *third* is *Regius Professor*, whose Duty is to read public Lectures on Church History during the Term or Session.

ORIENTAL Languages one Professor, who teaches the Students in Divinity the *Hebrew, Arabic, Syriac, &c.* without Fee or Reward.

PHILOSOPHY *three* Professors, who have each their peculiar Branch allotted, and receive the Students from one another, as they rise from *Logic* to *Physicks*; from *Physicks* to *Ethicks* and *Metaphysicks*.

HUMANITY one Professor, to instruct Beginners to read and write *English* and *Latin*, and in the understanding of the best *Roman* Authors.

GREEK one Professor, to instruct Youths in that useful Language.

MATHEMATICKS one Professor, who usually teaches *Algebra, Geometry, &c.* to three or four Classes.

LAW *three* Professors; one of the *Law of Nature and Nations*; founded by Queen *Anne*, and is in the Gift of the Crown; Another of the *Civil and Canon Law*; and a *third* of the *Municipal or Common Law*.

UNIVERSAL HISTORY and ROMAN ANTIQUITIES one Professor. *N. B.* These three Professorships last mentioned were founded and endowed by Act of Parliament; and each Professor is chosen by the Town Council of *Edinburg* out of two presented to them by the Faculty of Advocates.

ANATOMY, one Professor.

PHYSIC or MEDICINE *four* Professors, who consult together, and contrive the most proper Order and Method to teach *Medicine*, and go through a compleat Course of it, once a Year, in all its Branches; beginning about the middle of *October*.

In Session or Term Time the Principal orders divers *Latin* Discourses in the Common Hall in the Presence of all the Professors and Students; which are followed every *Wednesday* till the Month of *May* by Speeches from the Professors in Rotation. Then the public Disputations and Examinations take Place; when the Candidates for Academical Degrees are approved or rejected, according as they are found qualified by proper Examiners.

The Kingdom of IRELAND has but one University, and that consists of no more than one College, *viz. Trinity College* in DUBLIN, said to be founded as a Place of *Academical Learning* by Doctor *Alexander Bicknor* Archbishop of *Dublin*, about the Year 1320: But we don't find it of any repute till it was endowed and favoured with the Privileges of an *University* by Queen *Elizabeth* in 1591; since which Time it has given several eminent Scholars both to the Church and State.

The Province of NEW ENGLAND has already adorned the *Northern* Continent of *America* with a *University* called *Cambridge*, in which are two Colleges. Neither must be passed in Silence the Seat of Learning founded in the Island of *Barbadoes* under the *British* Dominion, by the learned and generous ——— *Codrington*, Governor of that Island, commonly known by the Name of *Codrington College* in *Barbadoes*, where we are told the Professors give remarkable Examples of their Learning and Industry in their several Professions.

The Name *Academy* is also applied by the *Jewish* Doctors or Rabbins to the Schools in which they instruct Youth in the *Hebrew* Tongue, read the *Law*, explain the *Talmud*, teach the *Caballa, &c.*

It is become the general Name of the private Seminaries, which the *Dissenters* have raised in divers Parts of *England* for the finishing the Candidates for the Ministry, and others, in Divinity, Philosophy, and Mathematical Learning.

Even some of our *Boarding Schools* of the best note in and about the Metropolis, have presumed to distinguish themselves by the Name of *Academy*, and we have seen *Fencing* and *Riding* Masters presumptuous enough to dignify their Schools with the same Appellation.

We might with much greater Propriety consider the INNS of *Court* and *Chancery* in *London* and *Westminster* for the Study of the *Law* under this Name. Sir *Edward Cooke* is of the same Mind, where he

writes that these *Inns* are the most flourishing and most honourable *Academies* of Gentlemen that ever was established in any Nation for the Study and Learning of the *Municipal Laws* thereof; and that they altogether, (saith another eminent Lawyer) make the most famous Univerfity for the Profession of the Laws only, or of any one human Science in the World; and advance itself above all others, *Quantum Viburna cupressus*. See *Blount's Law Diet.* Art. *Inns of Court*.

These *Academies* retain the ancient Name of *Inns* from the Custom of our Forefathers, who gave it to the Habitations of the Eminent either in Dignity, Title, or Learning: and has the Signification of the *Latin Word Hospitium*, and the Modern *French Name Hostel*.

The first Commencement of these *Inns* is ascribed to several Causes. Some incline to think they were established for the Sake of the Public, who might more easily find the learned in the Law on their different Occasions. But it is most rational to give into the Opinion, which ascribe, their Foundation to the Cultivation and Improvement of the Law, by social Conferences and public Lectures read in their respective Halls.

We date this Institution, according to Sir *John Fortescue*, in the Reign of King *Edward III.* about which Time the Common Law began to flourish upon the Ruins of the Canon and Civil Law Schools; which till then were publickly kept in *London, &c.*

Sir *John* also makes this Remark, That these Communities for the Study and Practice of the Common Law are *omni Univerfitate convenientiora et froniora*, more convenient and better appropriated for such Purposes than any other Univerfity; there being no Univerfity in any Nation, that can produce the like Number of Students in the Law of so ripe an Age, and of that high Quality, as are to be found in our *Inns of Court* and *Chancery*; in which they live, not upon Exhibitions and Salaries, as Scholars and Fellows in other Academical Institutions; but at their own, or Friend's, Expence: where, besides the Knowledge of the Laws, they may learn all other Accomplishments fit to form the Gentleman, as well as the Lawyer; their Study being *de optimis Disciplinis et Artibus*, that they may be more capable of pleading and presiding in the Courts of Judicature; from which Circumstance they were originally named *the Inns of Court*.

These *Inns* are known by the Names of

*Serjeant's Inn*, in *Chancery-Lane*.

*Serjeant's Inn*, in *Fleet-Street*.

*The Inner-Temple*, } In *Fleet-Street*.

*The Middle-Temple*, }

*Lincoln's Inn*, in *Chancery-Lane*.

*Gray's Inn*, in *Holborn*.

*Clifford's Inn*, in the Parish of *St. Dunstan's, Fleet-Street*.

*Thave's Inn*, in the Parish of *St. Andrew's, Holborn*.

*Furnival's Inn*, Ditto.

*Barnard's Inn*, Ditto.

*Staple Inn*, Ditto.

*Clement's Inn*, in the Parish of *St. Clement Danes*.

*New Inn*, Ditto.

*Lyon's Inn*, Ditto.

*Simon's Inn*, *Chancery-Lane*.

The two first mentioned take their Names from their being appropriated originally to the Lodging and Entertainment of *Serjeants at Law* and the *Judges*.

The *Temples* retain the Name of their first Founders, who were the Knights *Templars*, and for many Years enjoyed great Estates and a large House of Residence on this Spot; some of whose Monuments are still to be seen, well preserved in the *Temple Church*.

Upon the Dissolution of this House, called the *new Temple*, and the Suppression of the Knights *Templars*, it was given to *Valence Earl of Pembroke*, by King *Edward II.* But his Estates being forfeited to the Crown by the Attainder of that Earl's Son, King *Edward III.* granted the same to the Knights *Hospitallers* of *St. John of Jerusalem* here in *England*. And they in the same Reign devised the Premises to certain Professors of the Common Law, for a Quit-rent of 10 *l. per Annum*, in whose Possession it has remained ever since, with this Distinction, that what was called the *New Temple* is now divided into *two Inns of Court*, known by the Names of the *inner* and the *middle Temple*; and each of them pay 10 *l. per Annum*, into the Exchequer, by a Grant from King *James the First*.

These

These two Inns of Court are the most renowned and famous both for their Studies, Discipline, and Antiquity.

*Lincoln's-Inn* is so called from *Henry Lacy*, Earl of *Lincoln*, Constable of *Chester*, and *Custos* of *England*; who, in his great Affection for the Advancement of the Study of the common Law, founded this Inn for its Professors and Students. But we read very little of their Proceedings and flourishing State till the Reign of *Henry VI.* when it produced that great Light of the Law Sir *John Fortescue.* It is a spacious Building consisting of four Squares, and large Gardens, pleasantly situated; and this Society is in great Reputation for the Study of the Common Law, and for good Discipline.

*Gray's-Inn*, once the Mansion-House of the Family of Lord *Grey of Wilton*, begun to be inhabited by Students in the Law in the Reign of King *Edward III.* who leased the same from the Lord *Grey.* But at this Day the Honourable Society of *Gray's-Inn* hold the Premises by a Grant from King *Henry VIII.* in Fee-Farm at the yearly Rent of 6 *l.* 13 *s.* 4 *d.* payable into the Exchequer. It consists of three spacious Squares, and a very large and agreeable Garden, much frequented by the Citizens and Gentry to take the Air, and for agreeable Conversation.

The other Inns are known by the Name of *Inns of Chancery*, being the *Hospitia Minora* or lesser *Hofiels* of the municipal and common Laws of this Kingdom, for the Residence and Improvement of Students, Attornies, Solicitors and Clerks.

Thus I have laid before you the several *Seats* and *Nurseries* of the ARTS and SCIENCES throughout the known World: To whom we are indebted for the many and great Improvements in every Part of Literature.

We shall dismiss this Subject by giving some Account of those learned Men, who are properly distinguished by the Name of *Academics.*

*Academics* were those Philosophers, who adhered to the Doctrine of *Socrates* and *Plato*, concerning Uncertainty of Knowledge and Incomprehensibility of Truth. For,

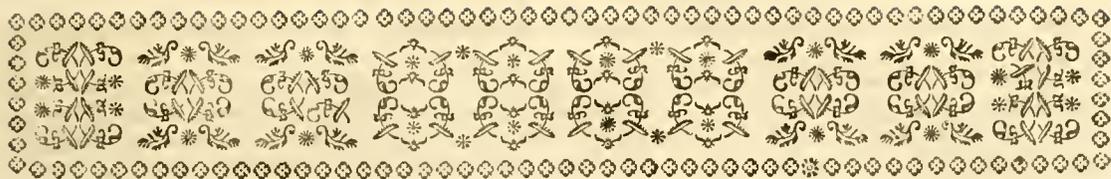
Their original Maxim was, *I am certain of nothing; no, not even that I know nothing:* And therefore insisted that the Mind ought always to remain in Suspense.

This Doctrine to doubt and distrust at every Step, we take in our Researches after Truth, was inculcated to his Disciples by *Plato*, not to deter them from the Pursuit of Knowledge. or to keep them fluctuating always between Truth and Error; but to curb them from those presumptuous and rash Decisions to which young Minds are subject to in their Studies and Arguments; and to engage them to attain to a more perfect Understanding of Things, and to avoid Error, by duely examining every Thing with Candour and Impartiality. According to the Advice of that inspired Writer, who adviseth, *That, we prove all Things, and hold fast what we shall find to be good.*

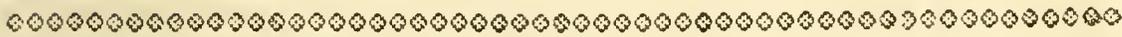
So that whatever might be the *Sceptic* Notions of some Philosophers, the *Academics* only doubted, that their Determinations afterwards might be the more certain and unalterable: Which I apprehend is the only Method to arrive at Truth and sound Knowledge in all Arguments and Parts of Literature. And upon this Principle is grounded the Practice of both *private and public Disputations* in all Universities; before any Scholar can be admitted to the *Academical Degrees.*

All which is agreeable to what *Cicero*, who was an *Academic* himself, says; *viz.* That all the Difference between the Academic Philosophers and those, who imagin'd themselves possessed of the Knowledge of Things consisted in this: 'That the Latter were fully persuaded of the Truth of their Opinions, without putting them to Trial; whereas the former held many Things to be only probable, which might very well serve to regulate their Conduct, though they could not positively assert the Certainty of them,' And he adds; 'In this we have greatly the Advantage of the *Dogmatists*, as being more disengaged, more unbiaffed, and at full Liberty to determine, as Reason and Judgment shall direct.' Which alludes to the common prudential Maxim, *Qui nihil dubitat, nil capit inde boni.* Upon which Occasion the Orator and Philosopher makes this Reflection: 'Yet the Generality of Mankind, I know not how, are fond of Error; and chuse rather to defend with the utmost Obstinacy, the Opinion, they have once taken up, than with Candour and Impartiality, submit to examine which Sentiments are most agreeable to Truth.'

After so clear a Declaration, as this from *Tully* himself, who was a rigid *Academic*, there appears the greatest Probability, That the first *Academies* were frequented by Philosophers, &c. who met to examine those Sentiments, with that Candour and Impartiality, which was denied them by the *Dogmatists*, that ruled the *Arcopagus*, &c.



A NEW  
 UNIVERSAL HISTORY  
 OF  
 ARTS and SCIENCES.



A L C H Y M Y.

**A** L C H Y M Y or *Alchimy*, (which the modern *Greeks* write *Archemia*; and others contend that *Halehymia* is the most genuine Orthography) denotes the more secret parts of *Chemistry*; this art being confined, 1st, to the making of *Gold*; 2d, to the discovery of an *universal medicine*, or *Panacea*; 3d, of an *universal dissolvent*, or *alkabest*.

How far these may be accounted proper objects of our study, the disappointments, which all the practitioners in this art have met with, will readily certify. For, after a succession of labour and vast expence, for many ages, and in different regions, not one of the pretenders to this art has been able to make *Gold*, or to produce any one *medicine*, dissolvent, or *ferment*, capable of operating effectually on every body or subject.

Yet we find the names of very learned men in the list of authors, who have espoused the study of *Alchimy*: and some of them vain enough to imagine the possibility of discovering an *universal menstruum*, to which some have given the name of *The Philosopher's Stone*; for performing the secret mysteries of this art.

This *Philosopher's Stone*, therefore, is the greatest object of *Alchimy*: because without this menstruum

there can be no transmutation: but by casting a little quantity thereof upon metals in infusion, it will convert all the true mercurial part of metal into pure gold: there being nothing more required, say they, than to do that by art, which nature does in many years and ages; for, as *Gold* and *Lead* do but differ little in weight, there cannot be much in lead besides *Mercury* and *Gold*. Consequently, if any body could be found, which would so agitate all the parts of *Lead*, as to burn all that is not *Mercury* therein, having also *Sulphur* to fix the *Mercury*, would not the mass remaining be converted into *Gold*?

Such is the foundation for the opinion of the *Philosopher's Stone*, which the *Alchymists* contend to be a most fixed, concentrated fire, which, as soon as it melts with any metal, does, by a magnetic virtue, immediately unite itself to the mercurial body of the metal, volatilizes and cleanses off all that is impure therein, and leaves nothing but a mass of pure gold.

Upon this principle many have set out to try their fortunes in the *Alchymist's* furnace: some have attempted the *transmutation* of the most imperfect into perfect metals, both *silver* and *gold*, by *Separation*; others by *Maturation* and by real *Transmutation*.

They

They who proceed by the method of *Separation*, muſt ſuppoſe that all inferior metals contain a quantity of *gold* more or leſs. For, unleſs it could be made appear that ſuch a *Separation* was ever diſcovered, or made by the *Chemists* in their frequent and different preparations of metals; and that the quantity of gold ſeparated from the baſer metals was ſufficient to defray the expence of the operation; neither of which can be affirmed; there can be very little or no hopes of making gold by this method or proceſs.

The proceſs by *Maturation* is no leſs liable to exceptions. None but mercury could be changed into gold by *Maturation*: becauſe the principles of all other metals not being pure mercury, their abundant heterogeneous particles, and the ſmall quantity of imperfect ones, which enter into their compoſition, cannot be ſeparated from it by a digeſtion.

Here Mr. *Chambers* interſeres with a ſuppoſition, that, could *mercury* be once purged of its impurities by *Maturation*, it might eaſily be changed into *gold*: becauſe, ſays he, it would then be as *heavy*, as *gold*.

A very ſuperficial reaſon! for *weight* is not the eſſential quality conſtitutive of that perfect metal. It muſt be *ductile* and *malleable*. Qualities which have never been diſcovered by the *Maturation of mercury*. Beſides there is another moſt eſſential quality: The *mercury* ſhould equal gold in its fixedneſs in the fire, reſulting from the homogeneity and equality of its parts, who all have equal pores or interſtices, through which the fiery corpuscles find an eaſy paſſage, and therefore can't haſten its fuſion with the ſame facility, as that of leſs perfect metals; where through the obliquity and unequal poſition of the pores, they meet with more reſiſtance.

The affair of *M. Languelle* an adept in this art, about the middle of the laſt century, will ſerve to illuſtrate and confirm this obſervation. This gentleman piqued himſelf very highly of having diſcovered the art of converting *mercury* into *gold* by *Maturation*: but when his metal ſo prepared was put into the crucible, he was ſoon convinced of his error and preſumption. For its pores not being in the ſame poſition, nor at the ſame equal diſtance, his metal evaporated into ſmoke.

Let us now conſider the practice of real *Transmutation*. This the Alchymiſts ſeem to have moſt at heart: and they ſay, this *Transmutation of metals* is to be done by melting them in the fire, and by caſting a certain quantity of a powder termed by them, *The Powder of Projection*, into the matter fuſed: whoſe effects they aſſert will be the ſame, as mentioned before in the account of the *Philoſopher's Stone*. The practicability of which operation has never been proved; and its poſſibility much controverted.

*Cardan*, and ſome others declare poſitively againſt

the probability of *transmuting* other metals into *gold* or *ſilver*. Becauſe, as ſuch a work is not pretended to be performed without a calcination of theſe metals, it is impoſſible to bring them again to their priſtine purity: to which may be added the *Generation* required in ſuch a caſe; which is the work of *Nature*, and not to be performed by *Art*; and is a bar againſt all *Transmutations* of imperfect metals into the like imperfect; as of iron into Braſs; or of Copper and Lead into Tin.

The *Alchymiſts* nevertheleſs are ſo far from being diſcouraged by theſe arguments and their own diſappointments, that they look for the *ſeed of gold* not only in baſe metals, but in *plants*, *blood*, *hair*, and even in the *excrements* of divers animals; with as little ſucceſs. Nay the great *Boyle*, (of whom let us not ſpeak without veneration for his profound knowledge in Natural Philoſophy) ſeems to be of opinion, That the chalk or earth, which was left at the bottom of the *alembic* after a quantity had been diſtilled and rediſtilled 200 times, might have been converted into gold; perhaps by the help of the miraculous *Powder of Projection*: a powder never yet defined, nor pretended to be acquired by any of the *adepts in Alchymy*; nor did any any of the *Alchymiſts* ever preſume to ſhew the manner by which that powder operates.

This art (however prostituted by deſigning Juglers and Impoſtors, or miſapplied to ſatiſfy ambition and avarice) is not to be rejected with contempt.

The artiſt in his affiduous and indefatigable labour to find the method of making gold, has frequently ſtumbled upon *ſpecific remedies* or *medicines*, which cure effectually, and ſooner, a *chronic*, or ſome other dangerous malady, than a *Galenic*, or other preparation uſed by our anceſtors. A diſcovery well worth the moſt laborious and expensive proceſs, and more to be prized than the acquiſition of a ſecret, which, could it be found, would only ſerve to gratify covetouſneſs, avarice and ambition; the worſt of paſſions.

But it does not yet appear that any of theſe hits have deſerved the name of a *Panacæa* or *univerſal medicine* to cure all diſeaſes: though this is ſo frequently boaſted of by *Impoſtors*, *Quacks* and *Charletans* in all countries.

Here we are called by *Paracelſus* and *Van Helmont* to acknowledge an *univerſal diſſolvent*, diſcoverable by the art of the *Alchymiſt*: “ There is, “ ſay they, a certain fluid in nature capable of re- “ ducing all ſublunary bodies, as well homogene- “ ous, as mixed, into their firſt principle, or ori- “ ginal matter, of which they are compoſed; or “ into an uniform, equal and portable liquor, that “ will unite with water, and the juices of our “ bodies, yet retain its ſeminal virtues; and if “ mixed

“ mixed with itself again, will thereby be converted into pure elementary water.”

*Van Helmont* is positive that he was master of that noble *menstruum*; and *Mr. Boyle* conceived such an advantageous opinion thereof, on the single report of *Helmont*, that he preferred it to the discovery of the *Philosopher's Stone*. For why? Because there is not the absurdity in the notion of a universal *Ens*, that resolves all bodies into their general *Ens*, by freeing them of the heterogeneous particles they were wrapt in, and thereby restore them to their pristine liberty of directing themselves, as there is to believe, that at the same instant they are thus freed, they acquire another form, without the allowance of the least moment for a new *direction*.

No one can doubt but that all bodies proceed originally from a first matter, which was itself once in a fluid form; whose particles by the continual agitation and compression of the atmosphere, the diversity of their figures, and the occult quality, which direct them to their different poles, have been concatenated together, for the formation of those different bodies.

This *menstruum* is called ALKAHEST, by the artists; and *Van Helmont* gives the honour of its invention to *Paracelsus*; who has left this character of it: “ There is, says this author, the liquor of Alkahest of great efficacy in preserving the liver; as also in curing hydropical and all other diseases, arising from disorders of that part. If it have once conquered its like, it becomes superior to all hepatick medicines; and though the liver itself were broken and dissolved, this medicine could supply its place.”

Yet neither *Paracelsus*, nor *Van Helmont*, has done that justice to mankind as to transmit so valuable a medicine to posterity; and perhaps the reason was that they might have, in the course of their practice, great reason to doubt that sovereign power ascribed to it, above. Be that as it will, there is great reason to doubt of its efficacy; because, as he who proves too much, proves nothing; so to ascribe to the *alkehest* the power of supplying the place of a broken and dissolved liver, is in effect to say, what no one can believe, that it could restore a dead man to life.

However let us enquire into this wonderful working *menstruum*, or universal dissolvent of the *Alchymists*.

From the known practice of *Paracelsus* (who in giving names to things introduced a kind of mystery in their sound, by transposing or reading the letters of the real name backwards) we might conjecture that *Alkahest* is no more than a word formed from *est* and *Alkali*, which composition, by making *est* the termination, sounds *Alkalhest* or *Alcal'est*,

or corruptly *Alkahest*, and consequently this may be supposed to be nothing but the *alkaline salt* of tartar volatilized; as *Glauber* imagines.

Others seek for its original in the *German* word *algeist*, which signifies spirituous and volatile; or in the compound word *saltz-geist*, i. e. *spirit of salt*; and these are supported by this fact, that spirit of salt was the great *menstruum* used by *Paracelsus* on most occasions. But this opinion is overruled by the commentator, who gives an edition of the works of *Paracelsus* at *Deift*, who assures us that the *alkahest* was a *mercury* converted into spirit. And such is the disagreement about this *menstruum*, that one judges it to be a *spirit of vinegar* from *verdigrease*; another discovers it in *soap*; and the elder *Helmont* gives it the name of *fire water*; and in another place styles it, “ the highest and most successful amongst salts; which having obtained the supreme degree of simplicity, purity, and subtilty, alone enjoys the faculty of remaining unchanged, and unimpaired by the subject it works upon, and of dissolving the most stubborn and untractable bodies; as stones, gems, glass, earth, sulphur, metals, &c. into real salt equal in weight to the matter dissolved; and this with as much ease, as hot water dissolves snow; and by being several times cohobated with *Paracelsus's sal circulatum*, this salt loses all its fixedness; and at length becomes an insipid water, equal in quantity to the salt it was made from.”

All which shews that *Paracelsus* and *Van Helmont*, whatever deficiencies might be in their *alkahest*, took water for, the universal instrument of *Chemistry* and *Philosophy*; and earth for the unchangeable basis of all things; that fire was designed as their efficient cause; that seminal impressions were lodged in the mechanism of earth; and that water by dissolving and fermenting with the earth, as it does by means of fire, brings every thing forth; from whence proceed the animal, vegetable, and mineral kingdoms.

If we enquire into the properties of the ALKAHEST, we are told it operates in the five following ways.

1. The first operation converts the subject into its three principles, *salt*, *sulphur* and *mercury*; then into salt alone, which now becomes volatile; after which it is turned wholly into an insipid water.

The manner of application is by touching the body, e. g. gold, mercury, sand, &c. once or twice with the *Alkahest*, and if the preparation answers the description of *Paracelsus* and *Helmont*, the body so touched will be converted into its own quantity of salt.

2. The seminal virtues of the bodies thus dissolved are not destroyed. For, gold acted upon by

this operation is not debased into any other salt, but the salt of gold: antimony becomes a salt of antimony: saffron a salt of saffron, &c. of the same seminal virtues or character, as the subject thus converted had in its original state, as a metal, &c. where by seminal virtues we are to understand those virtues, which depend upon the structure or mechanism of a body, and makes it what it is.

Hence an actual and genuine *aurum potable* might readily be made by the *Alkabeft* converting the whole body of gold into salt, and making it so soluble in water, without depriving the metal of its seminal or radical virtues.

3. The bodies dissolved by this *Alkabeft* may be rendered volatile by a sand heat; and if after volatilizing the solvent, it be distilled therefrom, the body is left pure insipid water, equal in quantity to its original self, but deprived of its seminal virtues. Thus if gold be the body dissolved by this *Alkabeft*, the metal first becomes a salt, which is potable gold: But when the *menstruum* itself by further application of fire is dissolved therefrom, the gold is left mere elementary water; so that pure water appears to be the last production or effect of the *Alkabeft*.

4. It suffers no change, nor diminution by dissolving the bodies it works upon; and consequently sustains no reaction from them, being the only immutable *menstruum* in nature.

5. Neither is it capable of mixture; and therefore is free from fermentation and putrefaction; coming off as pure from the body it hath dissolved, as when first put thereon, without leaving the least impurity behind.

Such are the properties ascribed to the *Alkabeft*, which is rather an imaginary than a real solvent: a *menstruum* highly desirable, but no where to be found; and though possible, it is hidden somewhere with the philosopher's stone. For, neither the commentator on *Paracelsus* nor *Van Helmont* appears thoroughly convinced that *Paracelsus* was master of a real and true *Alkabeft*; the one pretending that it was some mercurial preparation; the other allowing it to be nothing but the spirit of salt, which we all know is far from producing the surprising effects attributed to the pretended *Alkabeft*.

Yet how dark and mysterious the study of this art continues to be, the advocates in its favour pretend to a very great antiquity. Some are weak enough to take *Adam* himself into their school; who neither had necessities nor passions to induce him to seek after *arts*; whose origin could take its rise only from covetousness, avarice or ambition. Others go no higher towards the epocha of the

world's creation than to the age of *Tubal Cain*, whose skill in metals furnishes them with conjectures of his taste in *Alchymy*; but without any glimmerings of truth. Others are satisfied with establishing their school under *Moses* or *Trismegistus*. But these are mere dreams; suppositions without any authority whatsoever: for neither poet, philosopher, nor physician, from *Homer* till 400 years after *Christ*, mentioned any such thing as *Alchymy*.

In the beginning of the fifth century, (when the priests were establishing the doctrine of *Transubstantiation*, or the change of the substance of bread and wine into the substance of flesh and blood, *in instanti*, by the power of certain words pronounced by themselves) *Zosimus* the *Panopolite*, availing himself of the people's credulity, attempted to persuade them that he had discovered the secret of *transmutation* of base metals into gold and silver; and wrote a treatise to confirm the same under the title of *the divine art of making gold and silver*: which was followed soon after by another treatise from *Aeneas Gazeus*, in the same century, in which we have this passage; "such as are skilled in the ways of nature, can take Silver and Tin, and, changing their nature, turn them into Gold." Where then is there foundation for the opinion of *Suidas*, who would insinuate that the secret of the Philosopher's Stone is couched in the table of the *Argonauts*. And though I would be understood to pay great deference to the authority of *Kircher*, who is positive that the theory of the *Philosopher's Stone* is delivered at large in the tables of *Hermes*; and that *Alchymy* was an art well known to the ancient *Egyptians*; the universal silence of antiquity, and the little assistance the *Alchymists* of later times have been able to get from their books or traditions, are sufficient to warrant a dissent in this argument: which I shall conclude with a caution against the attempts of impostors that try to rook us out of our money, by raising our hopes to make Gold of every thing we touch; or of our lives, by poisonous *nostrums* or *quackeries*, under the character of *Catholicons* or *Universal Medicines*.

They that desire further light into this mysterious study may consult *Heliodorus* and *Synefius* published by *Fabricius*; *Boerhaave's* elements of *Chemistry*, tom. I. and *Norton*, *Ripley*, *Pearce* the *Benedictine*, *Carpenter*, *Andrews*, *Charnock*, *Blomfield*, *Kelly*, *Robinson*, *Dr. Dee*, *Elias Ashmole*, &c. and a number of monkish authors, whose manuscripts are deposited in the *French king's* library, and elsewhere, written chiefly from the time of *Zosimus* downwards.

## A L G E B R A.

**A**LGEBRA known by the name of *Ars Magna*, or the *Great Art*, amongst the ancients, is an *Arabic* invention, and brought first into *Europe* by the *Moors*, who settled in *Spain*. From thence it past into *Britain*, before this nation knew any thing of the system of *Algebra*, written by *Diophantus* in *Greek*, about the year 800 of the *Christian Æra*; but not printed and published till the the year 1575, by *Xylander*.

The *Western* empire knew so little of *Diophantus* that *Lucas Pacciolus*; or *De Burgos*, a *Cordelier*, whose treatise on *Algebra* was published in 1494 at *Venice*, never mentions his name, and takes it for granted that the world is indebted to the *Arabs* for the invention.

*Pacciolus's Algebra* went no further than simple and quadratic Equations; in which he was followed by *Stifelius*, without making any improvement to extend the Art.

These were a little improved by *Scipio Ferreus*, *Cardan*, *Tartaglia*, &c. who reached as far as the solution of some cubic Equations. *Bombelli* took the same tract, and proceeded a little further, who was improved by *Nunnius*, *Ramus*, *Schoner*, *Salignac*, *Clavius*: who all took different courses.

But *Diophantus* coming upon the stage of literature, and being found very different from the method derived from the *Arabs*, hitherto practised in *Europe*, *Vieta*, in 1590, published his *spacious Arithmetic*, and the method of extracting roots of Equations by approximations; since much facilitated by *Ralphson* in his *Analysis Æquationum*; and by *Oughtred*, who in 1631 published his *Clavis Mathematica*, with great improvements upon *Vieta*, and with the invention of several compendious characters, to shew the sums, differences, rectangles, squares, cubes, &c.

In the same year 1631, was also published an *Analysis on Algebra*, written by one Mr. *Harriot*, which brought *Vieta's* method into a more practical form, and is that which obtains the approbation of the learned at this time.

In 1657, *Des Cartes* in his *Geometry* then published, gave a specimen of the use of *Algebra* in that science; in which he made use of the literal *Calculus*, and the *Algebraic* rules of *Harriot*. A use which has been greatly improved by all the geometrical writers since his time, both abroad and in *Great Britain*.

Mr. *Kersey* in 1671, was the first that, in the *English* tongue, professedly compiled and published

*The Elements of this Art*. The like has been done by *Prectet*, in 1694; by *Ozanam* in 1703; by *Guisne* in 1704. But in the most masterly manner by the great *Sir Isaac Newton*, in his *Arithmetica Universalis* in 1707.

They that desire to see the improvement in this Art since that *Æra* will find them in *Ward*, *Saunderson*, *Simpson*, *Maclaurin*, *Fenner*, &c.

This Art by some is defined an *Universal Arithmetic*; by others *The Art of Resolution and Equations*. I describe it a peculiar kind of *Arithmetic*, which takes the quantity sought, whether it be a number, or a line, or any other quantity, as if it were granted; and by means of one or more quantities given, proceeds by consequence, till the quantity, at first only supposed to be known, is found to be equal to some quantity or quantities, which are certainly known, and consequently itself is known.

ALGEBRA is both *numeral* and *literal*.

*Numeral Algebra*, is also called *vulgar*, was used by the ancients, and served only for the resolution of *arithmetical* questions. This kind expresses all the given quantities by numbers, and shews the quantity sought by some letter or character.

*Literal*, which is also called *spacious Algebra*, is the modern method of expressing or representing the given known quantities, as well as the unknown by their species or letters of the alphabet: which is found to be a great relief to the memory, when obliged to keep several matters, necessary for the discovery of the truth in hand, present to the mind.

This kind has also this peculiar advantage, not to be confined, like the *numeral Algebra*, to certain kinds of problems; but to serve *universally* for the investigation of *Theorems*, as well as the solution and demonstration of all kinds of *Problems*.

A THEOREM is a speculative proposition deduced from several definitions compared together, to demonstrate the properties of any subject.

Suppose a *Triangle* be compared with a *Parallelogram*, standing on the same base, and of the same attitude, partly from their immediate definitions, and partly from other of their properties already determined, it is inferred that the *Parallelogram* is double the *Triangle*: This would be the proposition called a *Theorem*.

So that in every *Theorem* we are to regard chiefly the proposition and the demonstration; in the first is expressed, what agrees to some certain thing, under certain conditions, and what does not; in the

latter the reasons are laid down, by which the understanding comes to conceive that it does not agree thereto.

A THEOREM is either *universal, particular, negative, local, plain, solid, or reciprocal.*

The *Universal* THEOREM extends to any quantity without restriction; as, the rectangle of the sum, and the difference of any two quantities is equal to the difference of their square.

The *particular* THEOREM extends only to a particular quantity; as, in an equilateral right-lined triangle, each of the angles is sixty degrees.

The *negative* THEOREM expresses the impossibility of an assertion; as, the sum of two biquadrate numbers cannot make a square number.

The *local* THEOREM relates to a surface as the triangles of the same base and altitude are equal.

The *plane* THEOREM relates to a rectilinear surface, or to one terminated by the circumference of a circle; as all angles in the segment of a circle are equal.

The *solid* THEOREM considers a space terminated by a solid line, *i. e.* by any of the three Conic sections; as, if a right line cuts two asymptotic parabolas, its two parts, terminated by them, shall be equal.

The *reciprocal* THEOREM, is that whose converse is true; as, a triangle, which has two equal sides, will have two equal angles; the converse of which is true, *viz.* if it have two equal angles, it must have two equal sides.

As to the LETTERS used in ALGEBRA; they separately represent either lines or numbers agreeable to the *Problem*, if arithmetical or geometrical; but placed together they represent planes, solids, and powers more or less high, as the letters are in a greater or less number.

Thus  $a b$  represents a rectangle, with a side  $a$ , and with another side  $b$ , which mutually multiplied produce the plane  $ab$ .

Where the same letter, as  $a a$  is repeated twice, they denote a square; three letters,  $a, b, c$ , represent a solid, or rectangled parallelepiped, whose three dimensions are expressed by the three letters  $a, b, c$ , the length by  $a$ , the breadth by  $b$ , and depth by  $c$ ; so that by their mutual multiplication they produce the solid  $a, b, c$ .

The POWER, above-mentioned, is the produce of a number or other quantity, multiplied into itself.

They, who copy after *Des Cartes* distinguish most of their powers by the exponents, *first, second, third, &c.* But there is a difference as to the names of the several powers.

The *Ara's* and their disciples call them, the *Square, Cube, Quadrato Quadratum* or *Biquadrate; Surdesolid, Square of the Cube, second Surdesolid,*

*Quadrato-Quadrato, Quadratum, or Cube of the Cube, Square of the Surdesolid, third Surdesolid, &c.* But *Diophantus, Vieta, Oughtred*, and their followers distinguish the names of the Powers by the Side or Root, *Square, Cube, Quadrato Quadratum, Quadrato Cubus, Cubo-Cubus, Quadrato Quadrato Cubus, Quadrato Cubo-Cubus, Cubo-Cubo-Cubus, &c.*

These POWERS are denoted both in the *Arabic* and *Cartesian* system by the following characters.

Arabic	$\overset{2}{R}$	$\overset{4}{q}$	$\overset{8}{c}$	$\overset{16}{bq}$	$\overset{32}{s}$	$\overset{64}{qc}$	$\overset{128}{Bf}$	$\overset{256}{tq}$	$\overset{512}{bc}$	$\overset{1024}{sq}$
Cartesian	$a$	$a^2$	$a^3$	$a^4$	$a^5$	$a^6$	$a^7$	$a^8$	$a^9$	$a^{10}$

The Characters used in general by *Algebraists* are  $a, b, c, d, \&c.$  (the first letters of the alphabet) for *given* quantities  $z, y, x, \&c.$  (the last letters) are characters for quantities sought,  $^m, ^n, ^r, ^s, \&c.$  are characters of undeterminate exponents both of *Ratios*, and of *Powers*; thus  $x^m, y^n, z^s$  &c. denote undetermined powers of different kinds;  $mx, ny, rz$ , denote different multiplies or submultiplies of the quantities  $x, y, z$ , according as  $m, n, r$ , are either whole numbers or fractions.

+ Is an affirmative or positive Sign; and is also the mark of addition signifying *Plus* or *More*: thus  $a + b$ , or  $3 + 5$ , implies that  $a$  is added to  $b$ , and that 3 is added to 5.

— Before a single quantity is a negative Sign: But between quantities it is the Sign of Subtraction, and signifies *Minus* or *less*; thus  $a - b$  or  $8 - 4$  implies  $b$  subtracted from  $a$ , and 4 from 8.

= and  $\infty$  are signs of Equality; thus  $a = b$  signifies that  $a$  is equal to  $b$ . *N. B.* Some use  $=$  to denote the identity of Ratios.

× Is the Sign of Multiplication, shewing that the quantities it stands between are to be multiplied by one another; as,  $a \times b$  signifies that  $a$  is multiplied into  $b$ , and  $4 \times 8$ , the product of 4 multiplied into 8; yet some make a dot . between the two factors, the Sign of Multiplication, as,  $5.4$  to signify the product of 5 and 4. But our modern *Algebraists* seldom use any Sign in Multiplication, but express the product of two quantities, *viz.* of  $b$  and  $d$ , by putting them together thus  $bd$ .

A — drawn over the top of the sum shews that the factors are compounded of several letters; thus the factum of  $a + b - c$  into  $d$  is wrote  $\overline{d \times a + b - c}$ . But others distinguish the compound factors by a parenthesis, thus  $(a + b - c) d$ .

÷ Is the sign of Division; as,  $a \div b$  is  $a$  divided by  $b$ ; or thus  $\frac{a}{b}$  denotes the quotient of  $a$  divided by  $b$ . But *Wolffius* uses only two dots :, as  $12 : 4$  to denote 12 divided by 4. And instead of writing the quotient like a fraction, as is commonly done

done, if either the divisor, or dividend, or both be composed of several letters, thus  $\frac{a+b}{c}$  he includes the common quantities in a parenthesis, thus  $(a+b) : c$ .

⊖ Is the character of *Involution*.

∞ Is the character of *Evolution*.

> Or  $\lfloor$  are signs of majority, as,  $a > b$ , that  $a$  is greater than  $b$ .

< Or  $\lceil$  are signs of minority, as  $a < b$ , that  $a$  is less than  $b$ .

∩ Is a character of similitude in some authors; and used by others for the difference between two quantities, while it is unknown which is the greater of the two.

√ Is the character of radicality, and with a line added to it, thus  $\sqrt{\quad}$ , denotes the sum of the square roots, as explained hereafter.

\* An asterisk supplies the want of a term of an equation, as in this equation

$$y^2 + py + \frac{1}{4}p^2 + q \} = 0, \text{ the term } \pm py \text{ vanishing, is marked with } * \text{ as } y^2 * - \frac{1}{4}p^2 + q.$$

Hence to raise a quantity to a given power or dignity is the same as to find the factum arising, upon its being multiplied a given number of times into itself; for to raise 2 to the 3d power, is to find the factum 8; whose factors are 2, 2, 2.

Powers of the same degree are to one another in the Ratio of the Roots, as manifold as their exponent contains units: Thus Squares are in a duplicate Ratio; Cubes in a triplicate Ratio; Quadrato-Quadrato or fourth Powers in a quadruple Ratio.

The Powers of proportional quantities are also proportional to one another.

From a given Power to extract the Root or Side is the same as to find a number: Thus by multiplying 2 twice, it will produce a 3d Power or 8, which was the Power given. And

To multiply or divide any Power by another of the same Root, you perform it thus

To Multiply.

Add the Exponents of the Factors; and the Sum is the Exponent of the Factum. e. g.

$$\begin{array}{l} \text{Factors} \left. \begin{array}{l} \} x^3 \quad y^m \quad y^m \quad a^m \quad x^n \\ \} x^4 \quad y^m \quad y^n \quad ar \quad x^s \end{array} \right\} \\ \hline \text{Prod.} \quad x^7 \quad y^{2m} \quad y^{m+n} \quad am + rx^n + s \end{array}$$

To Divide.

Subtract the Exponent of the Power of the Divisor from the Exponent of the Dividend; and

the Remainder is the Exponent of the Quotient. e. g.

$$\text{Divid. } \frac{x^7}{x^3} \left( \frac{x^7}{y^n} \middle| \frac{y^m + n}{y^n} \middle| \frac{y^m}{a^m} \frac{x^n}{x^s} \left( \frac{am - rn - s}{a \quad x} \right. \right)$$

Note. In regard to number 6; all the natural Cubic Numbers, viz. 8, 27, 64, 125, whose Root is less than 6, being divided by 6, the Remainder of the Division is the Root itself; and if we proceed, 216 the Cube of 6, being divided by 6, leaves no Remainder, but the Divisor 6, is itself the Root. Again, 343 the Cube of 7 being divided by 6, leaves 1, which added to the Divisor 6, makes 7 the Root, &c. And it will be found in practice, that all Numbers raised to any power whatever, have Divisors, which have the same effect, with regard thereto, that 6 has to Cubic Numbers.

To find those Divisors observe these Rules.

When the Exponent of the Power of a number be even, viz. if the number be raised to the 2d, 4th, 6th Power, &c. it must be divided by 2; then the remainder of the Division, if there be any added to 2, or to a multiple of 2, gives the Root of this Number, corresponding to its Power, whether it be the 2d, 4th, 6th, or any other Root.

When the Exponent of the power is an uneven number, or raised to the 3d, 5th, or 7th power, the double of that exponent will be the divisor, which has the property mentioned.

Thus it is found in 6, the double of 3, the exponent of the power of all the Cubes.

Thus also 10 is the divisor of all numbers raised to the 5th power, &c.

Root is a quantity considered as the basis or foundation of a higher power; or which multiplied into itself, any number of times, produces a square, cubic, biquadratic, &c. quantity, &c. called the second, third, fourth, &c. power of the root or quantity so multiplied into itself.

Thus if 2 be multiplied by itself, the square 4, or second power of 2, is the product; and 2 itself, in regard to that power, is called the root, or square root of 4. For, as unity is to the square root, so is the root to the square; the root being a mean proportion between unity and the square; as, 1 : 2 :: 2 : 4.

If a square number, as 4, be multiplied by its root 2, the product 8 is called the Cube or third power of 2; and with respect to the cube number 8, the number 2 is called the Cube root: For as unity is to the root, so is the root to the square; and as unity is to the root, so is the square to the cube, i. e. Unity, the root, the square, and the cube

cube are in continual proportion; as, 1 : 2 :: 4 : 8, where the *Cube root* is the first of the two means proportionals between unity and the cube.

Where observe, that to extract the *root* out of a given number or power, suppose 8, is the same thing as to find a number, as 2, which being multiplied by itself twice produces 8, the number given.

The *roots* of *powers* are expressed by placing this character  $\sqrt{\quad}$  called the *radical sign* over them, with a number denoting what kind of *root* they are: Thus, the square or second *root* of 16 is expressed by  $\sqrt{16}$ , and the cube or third *root* of 27 by  $\sqrt[3]{27}$ ; and, in general, the *n*th *root* of *a* raised to the power *m* is expressed by  $\sqrt[n]{a^m}$

When the *root* of a compound quantity is wanted the vinculum or — of the *radical sign* must be drawn over the whole, as the *square root* of

$$a^2 + 2ab + b^2 \text{ is thus expressed } \sqrt{a^2 + 2ab + b^2}$$

Observe also that when the *radical sign* has no number above it, to shew what *root* is wanted, the square root is always meant; as,  $\sqrt{a^2}$  or  $\sqrt{16}$  is the *square root* of  $a^2$  and of 16.

Roots are divided into

*Binominal*, which consists of two parts; as 24 of 20 + 4.

*Trinominal*, which consists of three parts, as 245 of 240 + 5, or 100 + 140 + 5.

*Multinominal*, which consists of more than three parts, as 2456 of 2450 + 6, or 2400 + 56, or 2000 + 456, or 2000 + 400 + 50 + 6.

*Real*; when the quantity is positive, as  $x = r$  the *root* is a *real* or *true root*. Because *positive quantity*, known by + prefixed or supposed to be prefixed, is a real quantity greater than nothing.

*False*; when the value  $x$  of is negative; as  $x = -5$  the *root* is said to be false. Because *negative quantity*, known by the sign —, is supposed to be less than nothing.

*Root of an equation*; which denotes the value of the unknown quantity in an equation: Thus if the equation be  $a^2 + b^2 = x^2$ , the *root* of the *equation* is the *square root* of  $a$ , and that of  $b$ , expressed thus  $\sqrt{a^2 + b^2}$

These explications premised, let us proceed to shew the method of performing the several operations in *Algebra*.

The OPERATIONS are performed by *Addition*, *Subtraction*, *Multiplication*, *Division*, *Involution*, *Evolution*, *Fraction*, *Equation*, *Fluxion*, &c.

By ADDITION.

ADDITION in *Algebra* is the connecting or writing into one sum all the letters or numbers, to be

+

added, with their proper signs, + or —; as *a* and *b* make  $a + b$ , *a* and  $-b$  make  $a - b$ ;  $-a$  and  $-b$  make  $-a - b$ ; *ya* and *ga* make  $ya + ga$ ;  $-a\sqrt{ac}$  and  $b\sqrt{ac}$  make  $-a\sqrt{ac} + b\sqrt{ac}$  or  $b\sqrt{ac} - a\sqrt{ac}$ ; it not signifying what order they are written in.

ADDITION of whole quantities.

To add single or whole quantities that are alike, and have the like signs, add together their coefficients, to the sum of which prefix the common sign, and subjoin the common letter or letters.

Example.

$$\begin{array}{r} \text{To } + 19a \\ \text{Add } + 6a \\ \hline \text{Sum } + 25a \end{array}$$

$$\begin{array}{r} \text{To } 4a + 6 \\ \text{Add } 2a + 8b \\ \hline \text{Sum } 6a + 9b \end{array}$$

$$\begin{array}{r} \text{To } - 2b \\ \text{Add } - 5b \\ \hline \text{Sum } - 7b \end{array}$$

$$\begin{array}{r} \text{To } a - 5x \\ \text{Add } 2a - x \\ \hline \text{Sum } 3a - 6x \end{array}$$

When quantities are alike, but have unlike signs, then subtract the quotient or coefficient from each other, prefix the sign of the greater quotient to what remains, and subjoin the common letters.

Example.

$$\begin{array}{r} \text{To } - 5a \\ \text{Sub. } + 2a \\ \hline \text{Sum } - 3a \end{array}$$

$$\begin{array}{r} \text{To } a - 6b \\ \text{Sub. } 3a + 2b \\ \hline \text{Sum } -2a - 4b \end{array}$$

$$\begin{array}{r} \text{To } + 8b \\ \text{Sub. } - 2b \\ \hline \text{Sum } + 6b \end{array}$$

$$\begin{array}{r} \text{To } 4a - 8b \\ \text{Sub. } -4a + 8b \\ \hline \text{Sum } 0 \quad 0 \end{array}$$

N. B. This rule is proved by the nature of positive and negative quantities.

When quantities are unlike (be the signs so or not) set them all down after one another with their signs and quotients prefixed.

Example.

$$\begin{array}{r} \text{To } + 4a \\ \text{Add } + 2b \\ \hline \text{Sum } + 4a + 2b \end{array} \quad \begin{array}{r} \text{To } + a \\ \text{Add } - 7x \\ \hline \text{Sum } + a - 7x \end{array} \quad \begin{array}{r} \text{To } + 4a - 2b \\ \text{Add } - 8y + 4x \\ \hline \text{Sum } + 4a - 2b - 8y + 4x \end{array}$$

When more than two quantities are to be added, first, add the positive quantities into one sum; and then the negative; and then the produce of both sums.

Example.

Example.

$$\begin{array}{l} \text{To } \{ + 5 a \} \\ \text{Add } \{ - 8 a \} \end{array} \left. \begin{array}{l} \text{To the sum of} \\ \text{the positive} \end{array} \right\} + 14 a$$

$$\begin{array}{l} \text{To } \{ + 9 a \} \\ \text{Add } \{ - a \} \end{array} \left. \begin{array}{l} \text{Add the sum of} \\ \text{the negative} \end{array} \right\} - 9 a$$


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Sum of all is  $+ 5 a$

By SUBTRACTION.

SUBTRACTION in Algebra is performed by connecting the quantities with all the signs of the subtrahend changed, and then by adding it, so changed, to the quantity from which it was to be subtracted, by the rules of addition; and the sum, which shall arise from this addition, will be the remainder.

Example.

$$\begin{array}{r} \text{From } + 9 a \\ \text{Subtr. } + 7 a \\ \hline \text{Rem. } + 9 a - 7 a \text{ or } 2 a \end{array}$$

N.B. The characters of the subtracted are to be changed into the contrary ones, viz. + into —, and — into +. So in general the subtraction of a negative quantity is equivalent to adding its positive value.

To subtract *specious* numbers or quantities: if the quantities designed by the same letters, have the same signs, and the less to be subtracted from the greater; the subtraction is performed as in common Arithmetic.

Example.

$$\begin{array}{r} \text{From } 5b + 4d - f = 5b + 4d - f \\ \text{Subtract } 2b + d - f = 2b + d - f \\ \hline 3b + 3d - 0 \quad 3b + 3d \quad 0 \end{array}$$

When a greater quantity is to be subtracted out of a less; the less must be subtracted out of the greater, and to the remainder must be prefixed the sign —, if the quantities be affected with the sign +; but prefix the sign +, if the quantities be affected with the sign —.

Example.

$$\begin{array}{r} \text{From } 16 a + 2b - 9d = 16 \text{ lib.} + 2b - 9d \\ \text{Subtract } 19 a + 3b - 11d \quad 19 \quad + 3 \quad - 11 \\ \hline \text{Remains } - 3 a - 1b + 2 \quad - 3 \quad - 1 \quad + 2 \end{array}$$

When the quantities have different signs, the subtraction is converted into addition, and to the aggregate is prefixed the sign of the quantity, from which the subtraction is to be made.

Example.

$$\begin{array}{r} \text{From } 8 a - 5 c + 9 d = 8 \text{ lib.} - 5 + 9 d \\ \text{Subtract } 6 a - 8 c + 7 d = 6 \quad - 8 - 7 \\ \hline \text{Remains } 2 a + 3 c + 16 d = 2 \text{ lib.} + 3 + 16 \end{array}$$

If the quantities are expressed in different letters they must be connected; only the character of the subtrahend must be changed into the contrary ones.

Example.

$$\begin{array}{r} \text{From } a + b - c \\ \text{Subtract } d - e + f \\ \hline \text{Remains } a + b - c - d + e - f \end{array} \qquad \begin{array}{r} a + d \\ c - c - g \\ \hline a + d - c + e + 9 \end{array}$$

By MULTIPLICATION.

The general rule of the signs is, That when the signs of the factors are alike, i. e. both + or both —, the sign of the product is +; but when the signs of the factors are unlike, then the sign of the product is —.

1<sup>st</sup> Case: When any positive quantity, + a is multiplied by any positive number, + n. Note, that + a is to be taken as many times as there are units in n, and the product is evidently n a.

2<sup>d</sup> Case: 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.

3<sup>d</sup> Case: Multiplication by a positive number implies a repeated addition: but by a negative number, 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 a, therefore the product is negative or — n a.

4<sup>th</sup> Case: When — a is to be multiplied by — n, then — a is to be subtracted as often as there are units in n; but to subtract — a is equivalent to adding + a, consequently the product is + n a.

To illustrate the second and fourth Cases:

It is evident that + 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 1<sup>st</sup>) therefore, the second term of the product must be n — a, which destroys more + n a; so that the whole product must be + n a — n a = 0. Therefore — a multiplied by + n gives — n a.

If we also multiply + a — a by — n; the first term of the product being — n a, the latter term must be + n a, because the two together must destroy each other, or their amount must be 0, since one of the factors, a — a is 0. Therefore — a multiplied by — n, must give + n a.

If the quantities multiplied are simple, and the sign of the product by the last rule: after it place the

the product of the co-efficients, and set down all the letters after one another.

Examples.

$$\begin{array}{r} \text{Multiply} \quad + a \quad | \quad -2 a \quad | \quad + 6 x \\ \text{By} \quad \quad \quad + b \quad | \quad + 4 b \quad | \quad - 5 a \\ \hline \text{Product} \quad + ab \quad - 8 ab \quad - 30 ax \end{array}$$

$$\begin{array}{r} \text{Multiply} \quad -8 x \quad | \quad + 3 a b \\ \text{By} \quad \quad \quad -4 a \quad | \quad - 5 a c \\ \hline \text{Product} \quad + 32 ax \quad - 15 a abc \end{array}$$

MULTIPLICATION of *compound Quantities* is performed by multiplying every part of the multiplicand by all the parts of the multiplier, taken one after another; and then collect all the products into one, and the sum they produce shall be the product required.

Example.

$$\begin{array}{r} \text{Multiply} \quad a + b \quad | \quad 2a - 3b \\ \text{By} \quad \quad \quad a + b \quad | \quad 4a + 5b \\ \hline \text{Prod.} \quad \left\{ \begin{array}{l} aa + ab \\ + ab + bb \end{array} \right\} \left\{ \begin{array}{l} 8aa - 12ab \\ + 10ab - 15bb \end{array} \right. \\ \hline \text{Sum} \quad aa + 2ab + bb \end{array}$$

$$\begin{array}{r} \text{Multiply} \quad 2a - 4b \quad | \quad xx - ax \\ \text{By} \quad \quad \quad 2a + 4b \quad | \quad x + a \\ \hline \text{Prod.} \quad \left\{ \begin{array}{l} 4aa - 8ab \\ + 8ab - 16bb \end{array} \right\} \left\{ \begin{array}{l} xxx - axxx \\ + axx - ax \end{array} \right. \\ \hline \text{Sum} \quad 4aa \quad 0 \quad - 16bb \quad xxx \quad 0 \quad - aax. \end{array}$$

$$\begin{array}{r} \text{Multiply} \quad \quad \quad aa + ab - bb \\ \text{By} \quad \quad \quad \quad \quad a - b \\ \hline \text{Product} \quad \left\{ \begin{array}{l} aaa + aab + abb \\ - aab - abb - bbb \end{array} \right. \\ \hline \text{Sum} \quad \quad \quad aaa \quad 0 \quad 0 \quad - bbb \end{array}$$

Sometimes instead of multiplying compounded quantities, it is convenient only to set them down with  $\times$  the sign of multiplication between them, and to draw a line over each of the compound factors: thus  $a + b \times 1$  expresses the product of  $a + b \times$  by  $a - b$ . Note. Products, which arise from the multiplication of 2, 3 or more quantities, as  $a, b, c$ , are said to be of 2, 3 or more dimensions; and those qualities are called *Factors*.

Again: when all the *Factors* are equal, then these products are called *Powers*; as  $aa$  or  $aaa$  are *Powers* of  $a$ ; and these *Powers* are sometimes denoted by placing, above the root to the right hand, a figure expressing the Number of factors that produce them: Thus

$$\begin{array}{l} a \\ a a \\ a a a \\ a a a a \\ a a a a a \end{array} \left. \begin{array}{l} \left. \begin{array}{l} 1^{st} \\ 2^{d} \\ 3^{d} \\ 4^{th} \\ 5^{th} \end{array} \right\} \text{Power} \right\} \text{of the Root } a \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \begin{array}{l} a \\ a^2 \\ a^3 \\ a^4 \\ a^5 \end{array}$$

which figures are properly called *Indices* or *Exponents*: and *Powers* of the same root are multiplied by adding their Exponents thus  $a^3 \times a^3 = a^6$ ;  $a^4 \times a^5 = a^9$ ;  $a^2 \times a = a^3$ .

By DIVISION.

DIVISION in *Algebra* is performed by placing the dividend, as,  $ab$  above, and the divisor, as  $cd$  under a short line, thus  $\frac{ab}{cd}$

Then expunge all similar letters found in all the quantities of the dividend and divisor, and divide the coefficients of all the terms by any common measure.

Example.

$$\begin{array}{r} \text{Dividend} \quad 10 ab + 15 ac \\ \hline \text{Divisor} \quad \quad \quad 20 a d \end{array}$$

Here expunge  $a$  out of all the terms, and divide all the coefficients by 5, and it will be reduced to  $\frac{2b + 3c}{4d}$ . In the same manner  $2b) ab + bb = \frac{ab + bb}{2b} = \frac{a + b}{2}$ . Again  $12 ab) 30 ax - 54 ay = \frac{30 ax - 54 ay}{12 ab} = \frac{5x - 9y}{2b}$ ; and  $4 aa) 8 ab + b ac = \frac{8 ab + 6 ac}{4 aa} = \frac{4b + 3c}{2a}$ ; and to add no more,  $2b c) 5 abc = \frac{5 abc}{2bc} = \frac{5a}{2}$ .

Note, If the signs of the divisor and dividend be alike, the sign of the quotient must be +; but if they are unlike, the sign must be -.

Divide powers of the same root by subtracting their exponents. Thus if  $a^5$  be divided by  $a^2$ ; and  $b^8$  by  $b^2$ , it gives the quotient  $b^6 - 2 = b^6$ ; and so in other cases.

In the *division* of a *Compound Quantity*, you must range the parts according to the dimensions of some one of its letters.

Example.

To divide  $a^2 + 2ab + b^2$  you range them according to the dimensions of  $a$ , the quantity of  $a^2$ , (where  $a$  is of two dimensions) being placed first;  $2ab$  where it is of one dimension) next; and  $b^2$ , (where  $a$  is not found) last. Then range the divisor  $a + b$  in the same manner, you are to divide the

first term of the dividend by the first term of the divisor : and having set down the quotient, which, in this case, is  $a$ , multiply this quotient by the whole divisor, and subtract the product, viz.  $a^2 + ab$  from the two first terms of the dividend  $a^2 + 2ab$ , and the remainder  $ab$  together with the last term  $b^2$ , gives a new Dividend  $ab + b^2$ , 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  $b$ ; then multiplying the whole divisor by this part of the quotient, subtract the product from the new dividend, and if there be no remainder, the division is finished, as is the case here

$$\begin{array}{r} a+b) a^2+2ab+b^2 \quad (a+b \\ \underline{a^2+ab} \\ ab+b^2 \\ \underline{ab+b^2} \\ \phantom{ab+b^2} \end{array}$$

But should there be a remainder ; then proceed after the same manner till no remainder can be found, or till it appear that there will always be some remainder, as in the following examples.

EXAMPLE without a REMAINDER.

$$\begin{array}{r} 3a-6) 6a^4-96 \quad (2a^3+4a^2+8a+16 \\ \underline{6a^4-12a^3} \\ 12a^3-96 \\ \underline{12a^3-24a^2} \\ 24a^2-96 \\ \underline{24a^2-48a} \\ 48a-96 \\ \underline{48a-96} \\ \phantom{48a-96} \end{array}$$

EXAMPLE with a REMAINDER.

$$\begin{array}{r} a+x) a^2+x^2 \quad (a-x+\frac{2x^2}{a}-\frac{2x^3}{a^2}+\frac{2x^4}{a^3}-\&c. \\ \underline{a^2+ax} \\ -ax+x^2 \\ \underline{-ax-x^2} \\ +2x^2 \\ +2x^2+\frac{2x^3}{a} \\ \underline{-2x^3} \\ a \\ \underline{-2x^3+2x^4} \\ a \quad a^2 \\ \underline{+2x^4} \\ a^2. \&c. \end{array}$$

Where *Note*, in this example the signs are alternately  $+$  and  $-$ , the coefficient is always 2, after the two first terms, and the letters are powers of  $x$  and  $a$ ; so that the quotient may be continued without any farther division.

But in common examples after you come to the remainder of one term, as  $2x^2$ , it is usually set down in the quotient, with the divisor under it, after the other terms ; and the quotient in the last example will stand thus,  $a - x + \frac{2x^2}{a+x}$

By INVOLUTION.

INVOLUTION is the raising of a quantity from its *Root* to any *Power* assigned, and is thus performed.

If the quantity is simple, it is *involved* by multiplying the exponent by that of the power required: for, to raise any simple quantity to its 2d, 3d, 4th, &c. Power, we only multiply its exponent 1 by 2, 3, 4, &c. and, in general the power expressed by  $m$  of any quantity is had by multiplying its exponent by  $m$ .

Example.

- The second Power of  $a$  is  $a_2 \times 1 = a^2$ .
- The third Power or Cube is  $a^3 \times 1 = a^3$ .
- The  $m$ th Power of  $a$  is  $a^m \times 1 = a^m$ .
- The Square  $a^+$  is  $a^2 \times 4 = a^8$ .
- The Cube of  $a^+$  is  $a^3 \times 4 = a^{12}$ .
- The  $m$ th Power of  $a^+$  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  $m$ th Power is  $a^m b^m c^m$ .

The coefficients 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.

Example.

- The Square of  $3a$  is  $3 \times 3 \times a^2 = 9a^2$
- The Cube of  $3ab$  is  $3 \times 3 \times 3 \times a^3 b^3 = 27a^3 b^3$

When the quantity to be involved is *positive* all the powers must be *positive* too: and when *negative*, all its powers, whose exponents are even numbers, must be *positive* also; but if their exponents are odd numbers, it must be *negative*; because any number of multiplications of a negative, if that number be even, gives a positive: therefore the power can then only be negative, when its exponent is an odd number; though the quantity to be involved be negative. Thus the powers of  $-a$  are  $+a^2, -a^3, +a^4, -a^5, +a^6, \&c.$

These Powers, whose Exponents are 2, 4, 6, &c. being positive: but those whose Exponents are 1, 3, 5, &c. negative.

The *Involution* of any *Compound Quantity* is performed by a continual Multiplication of itself by itself, as in the binominal  $a + b$ .

Example.

$$\begin{array}{r}
 a+b = \text{Root.} \\
 \times a+b \\
 \hline
 a^2+ab \\
 +ab+b^2 \\
 \hline
 a^2+2ab+b^2 = \text{the Square, or second Power.} \\
 \times a+b \\
 \hline
 a^3+2a^2b+ab^2 \\
 +a^2b+2ab^2+b^3 \\
 \hline
 a^3+3a^2b+3ab^2+b^3 = \text{Cube, or third Power.} \\
 \times a+b \\
 \hline
 a^4+3a^3b+3a^2b^2+ab^3 \\
 +a^3b+3a^2b^2+3ab^3+b^4 \\
 \hline
 a^4+4a^3b+6a^2b^2+4ab^3+b^4 = \text{biquadratic, or fourth Power.} \\
 \times a+b \\
 \hline
 a^5+4a^4b+6a^3b^2+4a^2b^3+ab^4 \\
 +a^4b+3a^3b^2+3a^2b^3+4ab^4+b^5 \\
 \hline
 a^5+5a^4b+10a^3b^2+10a^2b^3+5ab^4+b^5 = \text{the fifth Power.} \\
 \times a+b \\
 \hline
 a^6+5a^5b+10a^4b^2+10a^3b^3+5a^2b^4+ab^5 \\
 +a^5b+5a^4b^2+10a^3b^3+10a^2b^4+5ab^5+b^6 \\
 \hline
 a^6+6a^5b+15a^4b^2+20a^3b^3+15a^2b^4+6ab^5+b^6 = \text{the sixth Power, \&c.}
 \end{array}$$

If the Powers of  $ab$  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 negative; because an odd number of multiplication of a negative, as observed before, produceth a negative. Thus the cube of  $a-b$  will be found to be  $a^3 - 3a^2b + 3ab^2 - b^3$ ; where the second and third terms are negative; the exponent of  $b$  being an odd number in these terms.

In general, the terms of any power of the Binominal  $a-b$  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 differences, *viz.* unit; and that in the last terms it is never found. The powers of  $b$  are in the contrary order; it is never found in the first term; but its exponent in the second term is unit; in the third term 2; and so increases, till in the last term the exponent 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, as in the sixth power of  $a+b$ , you have seen  $a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$  where 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. The sum of their exponents in any term being always 6.

Therefore if  $a + b$  is to be raised to any power  $m$ , the terms without their coefficients will be  $a^m, a^{m-1}b, a^{m-2}b^2, a^{m-3}b^3, a^{m-4}b^4, a^{m-5}b^5, \&c.$  till the exponent of  $b$  becomes equal to  $m$ .

The Coefficients of the respective terms 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  $m$ .

Hence it follows that  $a + b^m = a^m + m a^{m-1} b + m \times \frac{m-1}{2} \times a^{m-2} b^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times a^{m-3} b^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times a^{m-4} b^4 + \&c.$

which is the *Binominal*, or 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*, it may be distinguished into two parts, which are to be raised to any power in the same manner as a Binominal: and by the same Rules, you may substitute, instead of the powers of these compound parts, their values; as,

$a +$

$$\begin{aligned} a + b + c^2 &= a + b + c^2 = a + b^2 + 2c \\ \times a + b + c^2 &= a^2 + 2ab + b^2 + 2ac + 2 \\ bc + c^2. \text{ And, } a + b + c^3 &= a + b^3 + 3c \times \\ a + b^2 + 3c^2 \times a + b + c^3 &= a^3 + 3a^2b \\ + 3ab^2 + b^3 + 3a^2c + 6abc + 3b^2c + \\ 3ac^2 + 3bc^2 + c^3. \end{aligned}$$

In which Examples  $a + b + c$  is considered as composed of the compound parts of  $a + b$  and the simple part  $c$ , and then the powers of  $a + b$  are formed by the Binominal Theorem, and substituted for  $a + b^3$ , and  $a + b^2$ .

For the better understanding of the premisses, and to assist the learner in the attainment of what follows, we shall explain more minutely what is meant by a *Coefficient*, and its uses.

COEFFICIENTS in *Algebra* are such numbers, or given quantities, as are put before letters, or unknown quantities, into which letters they are supposed to be multiplied: thus, in  $3a$  or  $bx$ , or  $cxx$ , 3 is the *Coefficient* of  $3a$ ,  $b$  of  $bx$ , and  $c$  of  $cxx$ .

When no number is prefixed, unit is supposed to be the *Coefficient*; as, 1 is the *Coefficient* of  $a$ , or of  $b$ .

In a *quadratic* Equation the *Coefficient* is, according to its sign, either the sum, or the difference of its roots.

In any equation, the *Coefficient* of the second term is always equal to the sum of all the roots, keeping their proper signs.

The *Coefficient* of the third term is the sum of all the rectangles, arising by the multiplication of every two of the roots, how many ways soever these combinations of the two can be had, as, three times in a *cube*, six in a *biquadratic* equation, &c.

The *Coefficient* of the fourth term is the aggregate of all the solids made by the continual multiplication of every three of the roots, how often soever such a *ternary* may be had, *ad infinitum*.

In *Fluxions* the *Coefficient* of any *generating term* is the quantity arising from the division of that term.

By EVOLUTION.

EVOLUTION or the *Extraction of Roots* is the finding the roots of the powers of any quantity, whether simple or compound.

This is the reverse of *Involution*; and therefore the roots of the single quantities are easily extracted by *dividing* their exponents by the number that denominates the root required; for the powers of any root are found by multiplying its exponent by the index that denominates the power; consequently, 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; thus,

The square Root of  $a^8$  is  $2^{\frac{8}{2}} = a^4$

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  $a^{\frac{6}{3}} b^{\frac{3}{3}} = a^2 b$ ; and

The cube Root of  $x^9 y^6 z^{12}$  is  $x^3 y^2 z^4$ .

It also appears, from what has been 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 an even number: 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 therefore called 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  $-a$ .

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 powers, then shall the root be only a lower power of the same quantity; as,

The cube root of  $a^{12}$  is  $a^4$ , 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; as,

The square root of  $a^3$  is  $a^{\frac{3}{2}}$

The cube root of  $a^5$  is  $a^{\frac{5}{3}}$ .

The square root of  $a$  is  $a^{\frac{1}{2}}$ .

Those Powers that have *fractional* exponents are called *imperfect powers* or *furds*, and are multiplied and divided, *involved* and *evolved*, after the same manner as *perfect Powers*; thus,

The square of  $a^{\frac{3}{2}}$  is  $a^2 + \frac{3}{2} = a^2$ .

The cube of  $a^{\frac{2}{3}}$  is  $a^2 \times \frac{2}{3} = a^{\frac{4}{3}}$ .

The square root of  $a^{\frac{2}{3}}$  is  $a^{\frac{2}{3 \times 2}} = a^{\frac{1}{3}}$ .

The cube root of  $a^{\frac{3}{4}}$  is  $a^{\frac{1}{4}}$ .

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



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, therefore, of such numbers, being *incommensurable*, are expressed by placing the proper radical sign over them: thus  $\sqrt[2]{2}$ ,  $\sqrt[2]{3}$ ,  $\sqrt[2]{5}$ ,  $\sqrt[2]{6}$ , &c. express numbers *incommensurable* with Unity.

However, though these numbers are *incommensurable* themselves with unity, yet they are *commensurable* in power with it; because their powers are integers, that is, multiples of unity. They may also be *commensurable* sometimes with one another, as the  $\sqrt[2]{8}$  and  $\sqrt[2]{2}$ ; because they are to one another as 2 to 1: and when they have a common measure, as  $\sqrt[2]{2}$  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.

The common measure is found as in *commensurable* quantities, only the root of the common measure is to be made their common divisor: thus  $\frac{\sqrt{12}}{\sqrt{3}} = \sqrt{4} = 2$ , and  $\frac{\sqrt{18a}}{\sqrt{2}} = 3\sqrt{a}$ .

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,  $a = \sqrt[2]{a^2} = \sqrt[3]{a^3} = \sqrt[4]{a^4} = \sqrt[5]{a^5} = \sqrt[n]{a^n}$ , and  $4 = \sqrt{16} = \sqrt[3]{64} = \sqrt[4]{256} = \sqrt[5]{1024} = \sqrt[6]{4^6}$ .

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  $\sqrt[n]{a} = a^{\frac{1}{n}}$ , and  $\sqrt[m]{a} = a^{\frac{1}{m}}$ , and  $\sqrt[n]{a} = a^{\frac{1}{n}}$ , 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  $\sqrt[2]{2}$  to the same denominator, consider  $\sqrt[3]{3}$  as equal to  $3^{\frac{1}{3}}$ , and  $\sqrt[2]{2}$  as equal to  $2^{\frac{1}{2}}$ , whose indices reduced to a common denominator, you have  $3^{\frac{2}{6}} = \sqrt[6]{3^2}$ , and  $2^{\frac{3}{6}} = \sqrt[6]{2^3}$ , and consequently,  $\sqrt[3]{3} = \sqrt[6]{3^2} = \sqrt[6]{27}$ , and  $\sqrt[2]{2} = \sqrt[6]{2^3} = \sqrt[6]{4}$ , so that the proposed surds  $\sqrt[6]{27}$  and  $\sqrt[6]{4}$  are reduced to other equal Surds  $\sqrt[6]{27}$  and  $\sqrt[6]{4}$ , having a common radical sign.

*Surds* of the same rational quantity are multi-

plied by adding their exponents, and divided by subtracting them; thus,  $\sqrt[2]{a} \times \sqrt[3]{a} = a^{\frac{1}{2}} \times a^{\frac{1}{3}} = a^{\frac{3+2}{6}} = a^{\frac{5}{6}} = \sqrt[6]{a^5}$ ; and  $\frac{\sqrt[3]{a}}{\sqrt[2]{a}} = \frac{a^{\frac{1}{3}}}{a^{\frac{1}{2}}} = a^{\frac{1}{3}-\frac{1}{2}} = a^{\frac{2-3}{6}} = a^{-\frac{1}{6}} = \frac{1}{\sqrt[6]{a}}$

$$= a^{\frac{2}{3}} = \sqrt[3]{a^2}; \sqrt[m]{a} \times \sqrt[n]{a} = a^{\frac{m+n}{mn}}; \frac{\sqrt[n]{a}}{\sqrt[m]{a}} = a^{\frac{n-m}{mn}};$$

$$\sqrt[2]{2} \times \sqrt[3]{2} = \sqrt[6]{2^5} = \sqrt[3]{2^2}; \frac{\sqrt[2]{2}}{3} = \frac{6}{\sqrt[2]{2}}.$$

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 by one another, and set the common radical sign over their product or quotient. Thus,

$$\sqrt[n]{a^2} \times \sqrt[m]{b^2} = \sqrt[nm]{a^2b^2}; \sqrt[2]{2} \times \sqrt[2]{5} = \sqrt[2]{10}; \frac{\sqrt[m]{a^4}}{\sqrt[b]{b^3a}} =$$

$$\frac{\sqrt[m]{a^4}}{\sqrt[b]{b^3a}} = \sqrt[b]{\frac{a^4}{b^3a}}; \sqrt[3]{9} = \sqrt[3]{\frac{9}{24}} = \sqrt[3]{\frac{3}{8}} = \sqrt[2]{\frac{3}{2}}.$$

If *Surds* have not the same radical sign, reduce them to such as shall have the same radical sign, and proceed as before;

$$\sqrt[m]{a} \times \sqrt[n]{b} = \sqrt[nm]{a^nb^m}; \frac{\sqrt[m]{a}}{\sqrt[n]{a}} = \frac{\sqrt[m]{a^{\frac{1}{m}}}}{\sqrt[n]{a^{\frac{1}{n}}}} = \sqrt[\frac{nm}{x}]{a^{\frac{1}{x}}}; \sqrt[2]{2} \times \sqrt[3]{4} = 2^{\frac{1}{2}} \times$$

$$4^{\frac{1}{3}} = 2^{\frac{2}{3}} \times 4^{\frac{2}{3}} = \sqrt[6]{2^3} \times \sqrt[6]{4^2} = \sqrt[6]{8 \times 16} = \sqrt[6]{128};$$

$$\frac{\sqrt[3]{4}}{\sqrt[2]{2}} = \frac{4^{\frac{1}{3}}}{2^{\frac{1}{2}}} = \frac{4^{\frac{2}{6}}}{2^{\frac{3}{6}}} = \frac{\sqrt[6]{4^2}}{\sqrt[6]{2^3}} = \frac{\sqrt[6]{16}}{\sqrt[6]{8}} = \sqrt[6]{2}.$$

If the *Surds* have any rational coefficients, their product or quotient must be prefixed; thus,  $2\sqrt[2]{3} \times 5\sqrt[2]{6} = 10\sqrt[2]{18}$ .

The *Powers* of *Surds* are found as the powers of their quantities, by multiplying their exponents by the index of the power required; thus the square of  $\sqrt[3]{2}$  is  $2^{\frac{1}{3}} \times 2 = 2^{\frac{2}{3}} = \sqrt[3]{4}$ ; the cube of  $\sqrt[2]{5} = 5^{\frac{1}{2}} \times 3 = 5^{\frac{3}{2}} = \sqrt[2]{125}$ . 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*  $\sqrt[m]{a^m x} = a \sqrt{x}$ ; and, in like manner

ner, if a power of any quantity, of the same name with the *furd*, 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 *furd* will be reduced to a more simple expression. Thus  $\sqrt{75} = 5\sqrt{3}$ ;  $\sqrt[3]{48} = \sqrt[3]{3 \times 16} = 4\sqrt[3]{3}$ ;  $\sqrt{81} = \sqrt{27 \times 3} = 3\sqrt{3}$ .

When *furds* 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,  $\sqrt{75} + \sqrt{48} = 5\sqrt{3} + 4\sqrt{3} = 9\sqrt{3}$ ;  $\sqrt[3]{81} + \sqrt[3]{24} = 3\sqrt[3]{3} + 2\sqrt[3]{3} = 5\sqrt[3]{3}$ ;  $\sqrt{150} - \sqrt{54} = 5\sqrt{6} - 3\sqrt{6} = 2\sqrt{6}$ ;  $\sqrt{a^2 x} + \sqrt{b^2 x} = a\sqrt{x} + b\sqrt{x} = a + b \times \sqrt{x}$ .

*Compound furds* are such as consist of two or more joined together; the *simple furds* are commensurable in power, and by being multiplied into themselves, give at length rational quantities; yet *compound furds* multiplied into themselves, commonly give still irrational products. But, when any *compound furd*, is proposed, there is another *compound furd* which, multiplied into it, gives a rational product. Thus if  $\sqrt{a} + \sqrt{b}$  were proposed, multiplying it by  $\sqrt{a} - \sqrt{b}$ , the product will be  $a - b$ .

The investigation of that *furd*, which multiplied into the proposed *furd*, gives a rational product, is made easy by three theorems, delivered by Mr. *Maclaurin*, in his *Algebra*, p. 109, seq. to which we refer the curious.

This operation is of use in reducing *furd* expressions to more simple forms. Thus suppose a *binomial furd*, divided by another, as  $\sqrt{20} + \sqrt{12}$ , by  $\sqrt{5} - \sqrt{3}$ , the quotient might be expressed by  $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}}$ . But this might 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,  $\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} = \frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} \times \frac{\sqrt{5} + \sqrt{3}}{\sqrt{5} + \sqrt{3}} = \frac{\sqrt{100} + 2\sqrt{60} + 6}{5 - 3} = \frac{16 + 2\sqrt{60}}{2} =$

$$\frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} = \frac{\sqrt{20} + \sqrt{12}}{\sqrt{5} - \sqrt{3}} \times \frac{\sqrt{5} + \sqrt{3}}{\sqrt{5} + \sqrt{3}} = \frac{\sqrt{100} + 2\sqrt{60} + 6}{5 - 3} = \frac{16 + 2\sqrt{60}}{2} =$$

$8 + 2\sqrt{15}$ . To do this generally, see *Maclaurin*, ib. p. 113.

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  $3 + 2\sqrt{2}$ , first calculate  $\sqrt{2} = 1,41421$ . Hence  $3 + 2\sqrt{2} = 5,82842$ , the root of which is found to be nearly  $2,41421$ .

In like manner we may proceed with any other proposed root. And if the index of the root, proposed to be extracted, be great, a table of lo-

garithms may be used. Thus  $\sqrt[7]{5 + \sqrt[13]{17}}$  may be most conveniently found by *logarithms*.

Take the *logarithms* of 17, divide it by 13; find the number corresponding to the quotient; add this number to 5; find the *logarithm* of the sum, and divide it by 7, and the number corresponding to this quotient will be nearly equal to  $\sqrt[7]{5 + \sqrt[13]{17}}$ .

But it is sometimes requisite to express the roots of *furds* exactly by other *furds*. Thus, in the first example the square root of  $3 + 2\sqrt{2}$  is  $1 + \sqrt{2}$ : for  $1 + \sqrt{2} \times 1 + \sqrt{2} = 1 + 2\sqrt{2} + 2 = 3 + 2\sqrt{2}$ . For the method of performing this the curious may consult Mr. *Maclaurin's Algebra*, p. 115, & seq.

### By FRACTION.

FRACTION is a part or parts of a number or quantity considered as an unit or integer.

There is so great an affinity between the process in *fractions* of algebraic quantities, and in *arithmetical fractions*, that it will be necessary, before we proceed to the *algebraic* process, to give a clear description of *numerical fractions*, which are usually divided into *decimal*, *sexagesimal* and *vulgar*; and each of these divisions has a part called the *denominator*; another named the *numerator*.

The *denominator* of a *fraction* always represents an *integer*, and is the number or letter below the line  $\frac{7}{12}$  or *seven twelfths*; where 12 is the *denominator*, and shews that the integer here is divided into 12 parts. Its real use is to shew what aliquot part the broken number has in common with unity.

The *numerator* is that part of the *fraction*, which expresses the parts to be taken out of the *integer*, and is placed above the line, thus  $\frac{7}{12}$  where *seven* is the *numerator*, and shews that *seven twelfths* is the number of parts to be taken out of *twelve*.

*Decimal fractions* are those, whose *denominator* is 1, with one, or more cyphers to the right of the

the unit, as 10, 100, 1000, 10,000, &c. thus  $\frac{5}{10}$ ,  $\frac{6}{100}$ ,  $\frac{7}{1000}$ ,  $\frac{8}{10,000}$ , &c. are *decimal fractions*.

Note, When the cypher or cyphers are set on the left of the *integers*, as 0005, they have no value and serve only to fill up places, the whole making no more than *five units*.

*Sexagesimal fractions* are those, whose *denominator* proceeds in a sexageuple ratio, or is always 60 or a multiple thereof. These are sometimes called *astronomical fractions*; in which the *denominator* is usually omitted, as in 4°, 59', 32'', 50''', 16''''', where there is only the *numerator* set down, and we read thus 4 degrees, 59 minutes, 32 seconds of a degree, 50 thirds, 16 fourths, &c.

*Vulgar fractions*, or *simple fractions* are always expressed by two numbers thus  $\frac{2}{3}$  where the *denominator* 3 shews that the whole line is supposed to be divided into *three* equal parts; and the *numerator* 2 indicates, or assigns two of such parts.

If the *numerator* of a *fraction* is equal to its *denominator*, then the *fraction* is equal to unity. Thus

$$\frac{4}{4} = 1 \text{ and } \frac{a}{a} \text{ or } \frac{b}{b} \text{ are likewise equal to unity.}$$

If the *numerator* is greater than the *denominator*, then the *fraction* is greater than the unit. And in both these cases the *fraction* is called *improper*. But if the *numerator* be less than the *denominator*, then the *fraction* is less than unit, and is called *proper*. Thus  $\frac{3}{2}$  is an *improper fraction*; but  $\frac{2}{3}$  or  $\frac{3}{3}$  are *proper*.

There is also a *mixt quantity*, one part whereof is an *integer*, and the other a *fraction*; as,  $3\frac{2}{3}$  and  $5\frac{2}{3}$  and  $a + \frac{a^2}{b}$

**Problem I.** To reduce a *mixt quantity* to an *improper fraction*, multiply the part that is an *integer* by the *denominator* of the *fractional part*; and, to the product, add the *numerator*; then place the former *denominator* under this sum, and you will have the *impr per fraction* required.

Thus,  $2\frac{2}{3}$ , reduced to an *improper fraction*, gives  $\frac{14}{3}$ ; for  $2 \times 3 = 6$ , and  $6 + 2 = 8$ , which divided by the former *denominator* 3, gives  $\frac{14}{3}$ . In the same manner  $4\frac{1}{2}$  gives  $\frac{9}{2}$ ; and  $a + \frac{a^2}{b}$  gives  $\frac{ab+a^2}{b}$ ; 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*, divide the *numerator* of the *fraction* by the *denominator*, and the quotient shall give the *integral part*; and the remainder, set over the *denominator*, shall be the *fractional part*. Thus,

$$\frac{14}{3} = 2\frac{2}{3}; \frac{ab+a^2}{b} = a + \frac{a^2}{b}; \frac{ax+2xx}{a+x} = x + \frac{ax}{a+x}$$

and  $\frac{aa+xx}{a-x} = a+x + \frac{2xx}{a-x}$ .

**Problem III.** To reduce *fractions* of different *denominations* to *fractions* of equal value, that shall have the same *denominator*; multiply each *numerator*, taken separately, 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  $\frac{2}{3}$ ,  $\frac{1}{4}$ , and  $\frac{3}{5}$  are respectively equal to  $\frac{4}{60}$ ,  $\frac{15}{60}$ , and  $\frac{36}{60}$ ; and  $\frac{a}{b}$ ,  $\frac{b}{c}$ , and  $\frac{c}{d}$  are respectively equal to  $\frac{acd}{bcd}$ ,  $\frac{bbd}{bcd}$ , and  $\frac{ccb}{bcd}$ .

**Problem IV.** To add and subtract *fractions*, first reduce them to a common *denominator* (by *Probl. III.*) then add or subtract the *numerators*, and the sum or difference set over the common *denominator*, will be the sum or difference required. Thus,  $\frac{2}{3} + \frac{1}{4}$

$$= \frac{8+9}{12} = \frac{17}{12} = 1\frac{5}{12}; \text{ and } \frac{3}{4} - \frac{2}{3} = \frac{9-8}{12} = \frac{1}{12}.$$

In the same manner,  $\frac{a}{b} + \frac{c}{d} + \frac{e}{f} = \frac{adf+cbf+cbd}{bdf}$ ;  
 $\frac{a}{b} - \frac{c}{d} = \frac{ad-cb}{bd}$ ; and  $\frac{x}{2} - \frac{x}{3} = \frac{3x-2x}{6} = \frac{x}{6}$ .  
 See SUBTRACTION.

**Problem V.** To multiply *fractions*; let their *numerators* be multiplied into one another, to obtain a new *numerator*, and the *denominators* into one another, to obtain a new *denominator*; and the *numerator* and *denominator* so found will be the product required.

Thus,  $\frac{2}{3} \times \frac{1}{4} = \frac{2}{12}$ ; and  $\frac{1}{2} \times \frac{2}{3} = \frac{2}{6} = \frac{1}{3}$ . In the same manner,  $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$ ; and  $\frac{a+b}{c} \times \frac{a-b}{d} = \frac{a^2-b^2}{cd}$ .

If a *mixt quantity* is to be multiplied, first reduce it to the form of a *fraction* (by *Probl. 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. Thus,  $5\frac{2}{3} \times \frac{3}{4} = \frac{17}{3} \times \frac{3}{4} = \frac{17}{4} = 4\frac{1}{4}$ , (by *Probl. II.*) Also  $9 \times \frac{2}{3} = \frac{9}{1} \times \frac{2}{3} = \frac{18}{3} = 6$ ; and, in the same manner,  $b + \frac{bx}{a} \times \frac{a}{x} = \frac{ba+bx}{a}$   
 $\times \frac{a}{x} = \frac{a^2b+abx}{ax} = \frac{ab+bx}{x}$ .

**Problem VI.** To divide *fractions*; first multiply the *numerator* of the *dividend* by the *denominator* of the *divisor*, and the product will be the *numerator*

of the quotient; then multiply the denominator of the dividend by the numerator of the divisor, and their product will give the denominator of the quotient. Thus.

$$\frac{1}{3} \cdot \frac{1}{3} = \frac{1}{9}; \quad \frac{3}{7} \cdot \frac{5}{8} = \frac{15}{56}; \quad \frac{c}{d} \cdot \frac{a}{b} = \frac{ac}{db};$$

$$\text{and } \frac{c \pm b}{a \mp b} = \frac{a \mp b}{a} \left( \frac{a^2 \mp ab + b^2}{a^2 + ab} \right).$$

These last four problems are easily demonstrated from the definition of a fraction. I. It is obvious,

that the fractions  $\frac{a}{b}, \frac{c}{d}, \frac{c}{f}$ , are respectively equal to  $\frac{adf}{bdf}, \frac{cdf}{bdf}, \frac{ebd}{bdf}$  since if you divide  $adf$

by  $bdf$ , the quotient will be  $\frac{a}{b}; \frac{cdf}{bdf} = \frac{c}{b};$

$$\text{and } \frac{ebd}{bdf} = \frac{c}{f}.$$

2. Fractions reduced to the same denominator are added by adding their numerators and subscribing the common denominator.

Thus,  $\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}$ ; for call  $\frac{a}{b} = m$ , and  $\frac{c}{b} = n$ , and it will be  $a = mb$ , and  $c = nb$ ; and  $mb + nb = a + c$ , and  $m + n = \frac{a+c}{b}$ ; that is,  $\frac{a}{b} + \frac{c}{b}$ .

After the same manner,  $\frac{a}{b} - \frac{c}{b} = m - n = \frac{a-c}{b}$ .

3. Again,  $\frac{a}{b} \times \frac{c}{d} (= m \times n) = \frac{ac}{bd}$ ; for  $bm = a$ ,  $dn = c$ ; and  $b d m n = a c$ , and  $m n = \frac{ac}{bd}$ ; that is,  $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$ .

4. Lastly,  $\frac{a}{b} \div \frac{c}{d}$ , or  $\frac{m}{n}$ , gives  $\frac{ad}{cb}$ ; for  $mb = a$ , and  $mbd = ad$ ;  $nd = c$ , and  $ndb = cb$ ; therefore  $\frac{mbd}{ndb} = \frac{ad}{cb}$ ; that is,  $\frac{m}{n} = \frac{ad}{cb}$ .

*Problem VII.* To find the greatest common measure of two numbers; that is, the greatest number that can divide them both without a remainder. 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 that remainder; 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, as appears from the operation at large.

$$\begin{array}{r} 45 \overline{)63(1} \\ \underline{45} \end{array}$$

$$\begin{array}{r} 18 \overline{)45(2} \\ \underline{36} \\ 9 \overline{)18(2} \\ \underline{18} \\ 00 \end{array}$$

$$\begin{array}{r} 48 \overline{)256(5} \\ \underline{240} \end{array}$$

$$\begin{array}{r} 16 \overline{)48(3} \\ \underline{48} \\ 00 \end{array}$$

Much after the same manner, the greatest common measure of algebraical 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  $a^2 - 2ab + b^2$ , the operation is thus:

$$\begin{array}{r} a^2 - b^2 \quad a^2 - 2ab + b^2 (1 \\ \underline{a^2 - b^2} \\ \underline{-2ab + 2b^2} \text{ remainder, which divided by } -2b \text{ is reduced to} \\ a - b \quad a^2 - b^2 (a + b. \\ \underline{a^2 - b^2} \\ 0 \quad 0 \end{array}$$

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: find the greatest common measure of the numerator and denominator; divide them by that common measure, and place the quotients in their room, and you shall have a fraction, equivalent to the given fraction, expressed in the lowest terms. Thus  $\frac{3}{5}$  is reduced to  $\frac{3}{5}$ , by dividing the numerator and denominator by the greatest common measure 3. In the same manner  $\frac{2}{5} = \frac{2}{5}$  for  $2 = 2$ , and  $\frac{2}{5} = \frac{2}{5}$ .

In algebraical terms, the operation is thus:  $\frac{25bc}{25bc} = \frac{75abc}{125bcx} = \frac{3a}{5x}$ ; which is found by rejecting the divisor (as being nothing) rejecting the letters  $b c$  of the dividend (as being common to numerator and denominator) and dividing the coefficients

efficients 75 and 125 by their greatest common measure 25; the result of which is  $\frac{3a}{5x}$ . In the same

manner,  $\frac{156a^2 + 156ab}{572a^2 - 572ab} = \frac{3a + 3b}{11a - 11b}$ ;

$$\frac{a^2 - b^2}{a^2 - 2ab + b^2} = \frac{a + b}{a - b}; \frac{a^3 b^2 a}{a^2 + 2ab + b^2} = \frac{a^2 - b^2}{a + b};$$

and  $\frac{a^4 - b^4}{a^5 - a^3 b^2} = \frac{a^2 + b^2}{a^3}$ .

When *unit* is the greatest common measure of the numbers and quantities, then the fraction is already in its *lowest terms*. Thus,  $\frac{3ab}{3dc}$  cannot be reduced lower. It ought also to be remarked, that numbers whose greatest common measure is unit, are said to be *prime* to each other.

If it is required to reduce a given fraction to a fraction equal to it, that shall have a given *denominator*; you must multiply the *numerator* by the given *denominator*, and divide the product by the former *denominator*; and this quotient, set over the given *denominator* will be the fraction required. Thus, if it were required to reduce  $\frac{2}{3}$  to an equal fraction, whose denominator shall be 6; find the quotient of  $2 \times 6 - 3 = 4$ , then will  $\frac{4}{6}$  be the fraction required. In the same manner,  $\frac{a}{b}$  is reduced to an equal fraction, which has the denominator *c*, viz.  $\frac{ac - b}{c}$ ; for rejecting *c* out of both numerator and denominator, there remains  $a \div b = \frac{a}{b}$ .

Besides the common notion of a *fraction* there is this also to be considered.

Suppose  $\frac{3}{4}$  of 20*s.* or a pound *sterling*, were the fraction; this fraction, instead of three quarters of a pound may be considered as a 4th part of three pounds, i. e. by taking as many of the integers as the *numerator* expresses, viz. 3, and dividing them by 4 the *denominator*, for then instead of 4 there will arise 60*s.* the quotient of the same value will arise for 4) 60*s.* (15*s.* which shews the reason of the manner of expressing used by *Geometers* and *Algebraists*, who read  $\frac{a}{b}$  thus as divided by *b*.

By EQUATION.

EQUATION is the expression of the same quantity in two different, i. e. dissimilar, but equal terms or denominations; Thus 2,  $3=4+2$ , or twice three is equal to four and two. And *Stifelius* defines it, the ratio of equality between two

quantities differently denominated; Thus 3 shillings = 36 pence, or 50 *sb* = 2*l.* 10 *s.* = 600 pence = 2400 farthings; or,  $6=d+c$ ; or  $12=a-p$ , &c.

Hence, the reduction of two heterogeneous, or dissimilar quantities to the same value, i. e. to an equality is called *the bringing them to an equation*, i. e. The bringing the several mediate equations to a final one.

But before we shew how this is to be done it will be necessary to be informed somewhat concerning the terms, root and division of an *equation*.

The *terms* are the quantities or parts that compose the *equation*, and are connected by the signs + and -; as,  $b+c=d$ , where *b*, *c*, *d* are the terms, and shew that what is represented by *d* is equal to the two quantities *b* and *c*.

The *root* of an equation is the value of its unknown quantity; as, in  $a^2+b^2=x^2$ ; the root will be  $\sqrt{a^2+b^2}$ .

EQUATIONS, in regard to the powers of unknown quantities are divided into *simple*, *quadratic*, *cubic*, *biquadratic*, &c.

In *simple equation* the unknown quantity is only of one dimension, or in the first power, as  $x=(a+b):2$ .

In the *quadratic* the unknown quantity is in the second power, as  $x^2=a^2+b^2$ .

In the *cubic*, it is in the 4th power, as,  $x^3=-a^3b^3$ , &c.

In the *biquadratic*, it is in the 4th power; as  $x^4=a^4-b^4$ .

*Equations* are (1) those *ultimate conclusions* we arrive at in the solution of *problems*; or (2) the *means* to obtain those final resolutions.

The first sort consists only of one unknown quantity, intermixed with other quantities.

The other kind consists of several unknown quantities to be compared, and connected together, till there arises a *new equation*, in which the unknown quantity sought is mixt with the known.

To perform this, or to *solve questions* by *equations* you must observe.

1st. That all *equations* have as many *affirmative roots*, as there are permutations of signs; and as many *negative roots*, as there are successions of them; as, in the *quadratic*  $x^2+x-6=0$ , there is only one succession of signs ++, and one permutation of them, + -; hence the *equation* has two roots, one *affirmative* + 2. and the other *negative* - 3. Also in the *cubic*  $x^3 - 3x^2 - 10x + 24=0$  there are two permutations of signs + - and - +; and only one succession - -; hence its *roots* are two *affirmative* + 2 and + 4, and only one *negative* - 3.

2. That the several quantities and signs be properly set down and expressed.

3. That the quantities thus denoted be brought to an equation.

4. That the equation be reduced to its lowest and simplest terms.

5. That the equation be constructed or represented in geometrical lines.

For a question or problem being proposed, you are to conceive the thing required, as already done, *i. e.* to form a clear conception of the conditions and nature of it, and to express it by one of the last letters of the alphabet  $x$ ,  $y$ , or  $z$ , noting the known quantities by the letters that begin the alphabet  $b$ ,  $c$ ,  $d$ , &c.

Then, by due reasoning from the conditions of the question, let the quantities concerned therein be justly stated, and carefully compared; so that their *relation* to one another may appear, and the *difference*, which renders them unequal, be discovered; and consequently, the same thing found expressible two ways, or brought into an equation, or several equations independent on each other. And

Here again it is to be observed,

1. That if there are as many equations given, as there are quantities sought, then the question has a determinate number of solutions, or is truly limited, *viz.* each quantity sought hath but one single value. Thus,

Suppose a question proposed concerning the age of three persons, was conditioned as follows, *viz.* the *second* is seven years older than the *first*, the age of the *third* is triple that of the *first* and *second*, and the sum of all their ages is 68. Required the age of each.

In order to bring this question to an equation, put  $z$  for the age of the *first*; then will the age of the *second* be  $z + 7$ , and the age of the *third*  $6z + 12$ : the sum of all their ages  $z + z + 7 + 6z + 12 = 68$ . So that here is but one equation given, and one quantity required, *viz.* the age of the *first*.

2. When the number of the quantities sought exceed the number of the given equations, the question is capable of an indeterminate number of answers; and, therefore, can be but imperfectly determined. If the question when stated, is found to have a determinable number of solutions, then the *equation*, directly drawn from the conditions of the question, must be reduced into another, by equal augmentation and diminution; so that the known quantities may stand on one side, and one of the unknown quantities, or some power of it, on the other side of the equation. This is called *reduction of equations*, and depends upon a right application of the five following *axioms*:

1. If equal quantities be added to equal quantities, the sum of those quantities will be equal.

2. If equal quantities be subtracted or taken from

equal quantities, the quantities remaining will be equal.

3. If equal quantities be multiplied by equal quantities, their products will be equal.

4. If equal quantities be divided by equal quantities, their quotients will be equal.

5. Quantities that are equal to one and the same thing, are also equal to one another.

If these axioms be well understood, the reduction of equations will appear very plain, and the operations be easily performed.

1. *Reduction by transposition*, is performed by transferring a quantity to the other side of the equation with a contrary sign; or by equal addition, if the quantity be negative; and by equal subtraction, if affirmative. Thus, the equation  $x - 10 = 40$ , is reduced by adding  $+ 10$  to each side, and the result will be the same as if  $- 10$  had been transposed to the opposite side with the contrary sign; for  $x - 10 + 10 = 40 + 10$ , is the same with  $x = 40 + 10$ , the  $- 10$  and  $+ 10$  destroying each other. In the same manner  $x + 10 = 40$ , is reduced to  $x = 40 - 10$ , by transposing the  $+ 10$  with a contrary sign.

2. *Reduction* is performed by equal multiplication, in case there are fractional quantities; for by multiplying every term in the equation by the denominators of the fractions, it will be cleared of fractions: thus, by multiplying every term of the equation  $\frac{z}{a} = b$  by the denominator  $a$ , we will have

$z = ab$ . Again, if  $\frac{z^3 + 3a^2}{c} + n + a = z + a$ ;

then by multiplying by the denominator  $c$ , we will have an *equal equation* free from fractions, *viz.*  $z^3 + 3a^2 + cn + ac = c + ac$ , or  $z^3 + 3a^2 + cn = c$ , the  $ac$  on each side being rejected.

3. By equal *division*, as in the equation  $ax = c$ ; for by dividing each side by  $a$ , we will have  $x \left( \text{or } \frac{ax}{a} \right) = \frac{c}{a}$ . In the same manner, in the equation  $az + ez = cb$ , by dividing each side by  $a + e$ , we get the equation  $z = \frac{cb}{a + e}$ .

4. *Equations* are cleared of *surd* quantities by *involution*: thus, if the equation be  $\sqrt{a} = 6$ ; then by *involution* or squaring each side of the equation, we have the equation  $a = 36$ . If both sides be similar *surds*, or of the same power, all that we have to do is to reject the radical sign: thus, for  $\sqrt{a} = \sqrt{d + c}$ , we write  $a = d + c$ , rejecting the radical sign of both.

5. When any single power of the unknown quantity is on one side of the equation, evolve or extract the root of both sides, according as the index of that power denotes, and their roots will be

be equal. Thus, if  $z z = 25$ , by extracting the root of each side we have  $z = 5$ . In the same manner if  $aaa = 27$ , their cube roots will be equal, viz.  $a = 3$ . Or, if any compound power of the unknown quantity be on one side of an equation, that hath a true root of its kind; then, by *evolving* both sides of the equation it will be expressed in lower terms: thus,  $a^2 + 2ba + b^2 = d^2$ , by *evolving* both sides, comes out  $a + b = d$ .

6. A *proportion* may be converted into an equation, asserting the product of the extremes to be equal to that of the means; or, any one of the extremes may be made equal to the product of the means divided by the other extreme: thus, if  $12 - x : \frac{x}{2} :: 4 : 1$ , then  $12 - x = 2x$ ; and by transposing the  $-x$ , we will have  $3x = 12$ , and dividing by 3,  $x = \frac{12}{3} = 4$ , by the preceding rules.

7. If any quantities be found on both sides of the equation, with the same sign prefixed, they may be taken away from both: thus, for  $3x + b = a + b$ , we say  $3x = a$ . Also, if all the quantities of the equation be multiplied or divided by the same quantity, it may be struck out of them all: thus, if  $3ax + 5ab = 8ac$ , dividing by  $a$ , we have  $3x + 5b = 8c$ ; and transposing  $5b$  and dividing by 3, we have  $x = \frac{8c - 5b}{3}$ , according to the first and third rules.

8. Instead of any quantity in an equation, you may substitute another equal to it: thus, if  $3x + y = 24$ , and  $y = 9$ ; then  $3x + 9 = 24$ , or  $x = \frac{24 - 9}{3} = 5$ .

To solve Simple EQUATIONS.

1. After an equation is formed, if you have only one unknown quantity, then, by the preceding rules, you bring it to stand alone on one side, so as to have none but known quantities on the other side; by which means you will discover its value. Thus, if the question proposed be that of the three persons ages already mentioned, the equation thence resulting has been found to be as in

Example I.

By quest.	1	$  z + z + 7 + 6z + 21 = 68$
1 transp.	2	$  8z = 68 - 28 = 40$
$2 \div 8$	3	$  z = \frac{40}{8} = 5 = \text{first age.}$
Hence	4	$  z + 7 = 12 = \text{second age.}$
And	5	$  12 + 5 \times 3 = 51 = \text{third age.}$

Example II.

$$\frac{3x}{4} \times \frac{x}{12} = x$$

$$\frac{3x^2}{48} = x$$

and  $3x^2 = 48x$  by the second rule.

and  $3x = 48$  by the seventh rule.

and  $x = \frac{48}{3} = 16$  by the third rule.

2. If there are two unknown quantities, then there must be two equations arising from the conditions of the question; suppose  $x$  and  $y$ . The rule is, to 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 only one unknown quantity, which must be reduced by the same rules as formerly.

Example.

Let the sums 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 the quantities to be  $x$  and  $y$ ; then, by the question,  $x + y = s$ , and  $xy = d$ ; whence  $x = s - y = d + y$ ; and, by transposition,  $2y = s - d$ ; so that dividing by 2, we have  $y = \frac{s - d}{2}$ ; and by comparing the value of  $x$ , viz.  $s - y$ , we find  $x = s - \frac{s - d}{2}$ , or  $2x = 2s - s + d$ , and dividing by 2, the value of  $x = \frac{s + d}{2}$ , as expressed in this form.

$$\begin{array}{l} x + y = s \\ x - y = d \\ \hline x = s - y \\ x = d + y \\ s - y = d + y \\ 2y = s - d \\ y = \frac{s - d}{2} \\ \hline x = \frac{s + d}{2} \end{array}$$

3. 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 will obtain an equation that will have only one unknown

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.

Example.

The sum of two quantities, and the difference of their squares, being given, to find the quantities themselves. Suppose them to be  $x$  and  $y$ , their sum  $s$ , and the difference of their squares  $d$ . Then,

$$\begin{aligned} x + y &= s \\ x^2 - y^2 &= d \\ \hline x &= s - y \\ x^2 &= s^2 - 2sy + y^2 \\ x^2 &= d + y^2, \text{ whence} \\ d + y^2 &= s^2 - 2sy + y^2 \\ d &= s^2 - 2sy \\ 2sy &= s^2 - d \\ y &= \frac{s^2 - d}{2s} \end{aligned}$$

$$\text{and } x = \frac{s^2 + d}{2s}$$

4. 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 an equation involving only one unknown quantity; which may be resolved by the rules for reduction of equations already mentioned.

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: find three values of  $x$  from the three given equations; then, by comparing the first and second value, you will find another 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 solved by the second direction:

Example: suppose

$$\left. \begin{aligned} x + y + z &= 12 \\ x + 2y + 3z &= 20 \\ \frac{x}{3} + \frac{y}{2} + z &= 6 \end{aligned} \right\} \text{then } x = \left\{ \begin{aligned} 12 - y - z &\text{ first} \\ 20 - 2y - 3z &\text{ second} \\ 18 - \frac{3y}{2} - 3z &\text{ third} \end{aligned} \right\} \text{value}$$

$$\begin{aligned} 12 - y - z &= 20 - 2y - 3z \\ 12 - y - z &= 18 - \frac{3y}{2} - 3z \end{aligned}$$

These two last equations involve only  $y$  and  $z$ , and are to be resolved by the second direction. Thus.

$$\begin{aligned} \begin{cases} 2y - y + 3z - z = 20 - 12 = 8 \\ y + 2z = 8 \end{cases} \\ \begin{cases} 36 - 3y - 6z = 24 - 2y - 2z \\ 12 = y + 4z \end{cases} \\ \text{whence } y = \begin{cases} 8 - 2z \text{ first} \\ 12 - 4z \text{ second} \end{cases} \text{ value} \\ \text{and } 8 - 2z = 12 - 4z \\ 2z = 12 - 8 = 4 \\ z = \frac{4}{2} = 2 \\ y (= 8 - 2z) = 4 \\ x (= 12 - y - z) = 6 \end{aligned}$$

This method is general, and will extend to all equations that involve three unknown quantities; but there are often easier and shorter methods, to deduce an equation, involving only one unknown quantity, which is best learned from practice.

To solve quadratic EQUATIONS.

1. If, after the equation is reduced, as directed above, and the unknown quantity brought to stand on one side, it is found to be a simple square power, all that you have to do is to evolve both sides of the equation, by which means you will find the value of the simple unknown quantity. Thus, if  $xx = 36$ ; then, by evolution or extraction,  $x = 6$ . As before.

2. In the solution of any question, where you have got an equation that involves only one unknown quantity, but involves 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 an *affected quadratic equation*, which may be resolved by the following rules:

1. Transpose all the terms that involve the unknown quantity to one side, and the known terms to the other side of the equation.

2. If

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 complete 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.

Example.

Suppose the *quadratic* to equation be,

$$y^2 + ay = b$$

Add the square of  $\frac{a}{2}$  to both sides,  $\left. \begin{matrix} y^2 + ay = b \\ y^2 + ay + \frac{a^2}{4} = b + \frac{a^2}{4} \end{matrix} \right\}$

Extract the root,  $y + \frac{a}{2} = \pm \sqrt{b + \frac{a^2}{4}}$

Transpose  $\frac{a}{2}$ , and  $y = \sqrt{b + \frac{a^2}{4}} - \frac{a}{2}$

Here is to be observed, that the square root of any quantity, as  $+a^2$ , may be  $+a$ , or  $-a$ ; and hence all *quadratic* equations admit of two solutions. Also, since the squares of all quantities are

positive, it is evident that the square root of a negative quantity is imaginary, and cannot be assigned.

However, the following examples will illustrate the rules for quadratic equations.

Example I.

The sum of two quantities is 32, and their product 240; required the quantities themselves. Suppose them to be  $x$  and  $y$ ; then

$$x + y = 32; \text{ and } x = 32 - y$$

$$xy = 240; \text{ and } x = \frac{240}{y}$$

therefore  $32 - y = \frac{240}{y}$

and  $32y - y^2 = 240$

transpose,  $y^2 - 32y = -240$

add  $16^2$ ,  $y^2 - 32y + 256 = -240 + 256$

extract  $\sqrt{\quad}$ ,  $y - 16 = \pm \sqrt{16}$

and  $y = \pm \sqrt{16} + 16 = 20$

$x (= 32 - y) = 12$

Example II.

Three merchants join stocks; the stock of the first was less than that of the second by 13 *l.* and the sum of the second and third man's stock amounted to 175 *l.* In trading they gained 48 *l.* more than their whole stock was; and the first man's share of the gain was 78 *l.* required each man's stock and share of the gain?

Suppose	1	$x, y, z$ , to represent each man's stock,
Then	2	$x + y + z = s$ = the whole stock,
	3	$s + 48$ = the whole gain.
	4	$x + 13 = y$
By the question	5	$y + z = 175$
	6	$x + y + z = 175 + x$
	7	$s = 175 + x$
By the question	8	$s + 48 = 223 + x$
	9	$175 + x : 223 + x :: x : 78$
	10	$x^2 + 223x = 78x + 13650$
	11	$x^2 + 145x = 13650$
	12	$x^2 + 145x + 5256,25 = 18906,25$
	13	$x + 72,5 = \sqrt{18906,25} = 137,5$
	14	$x = 137,5 - 72,5 = 65$
	15	$y = x + 13 = 78$
	16	$z = 175 - y = 97$
Then	17	$65 + 78 + 97 + 48 = 288$ the whole gain
And	18	$y$ 's gain = 93 <i>l.</i> $z$ 's = 116 <i>l.</i> 8 <i>s.</i>

To solve cubic EQUATIONS.

The second term of a cubic equation can be taken away, so that it will be transformed to this form  $x^3 + qx + r = 0$ .

Let us suppose that  $x = a + b$ ; and  $x^3 + qx + r = a^3 + 3a^2b + 3ab^2 + b^3 + qx + r = a^3 + 3ab \times a + b^3 + qx + r = a^3 + 3abx + b^3 + qx + r =$  (by supposing  $3ab = -qa^3 + b^3 + r = 0$ . But  $b = -\frac{q}{3a}$ , and  $b^3 = -\frac{q^3}{27a}$ , and consequently  $a^3 - \frac{q^3}{27a^3} + r = 0$ ; or,  $a^6 + ra^3 = \frac{q^3}{27}$ . Suppose  $a^3 = z$ ; and you have  $z^2 + rz = \frac{q^3}{27}$ ; which is a quadratic, the resolution whereof gives

$$z = -\frac{1}{2}r \pm \sqrt{\frac{1}{4}r^2 + \frac{q^3}{27}} = a^3, \text{ and}$$

$$a = \sqrt[3]{-\frac{1}{2}r \pm \sqrt{\frac{1}{4}r^2 + \frac{q^3}{27}}};$$

$$x = a + b = a - \frac{q}{3a} = \sqrt[3]{-\frac{1}{2}r \pm \sqrt{\frac{1}{4}r^2 + \frac{q^3}{27}}} - \frac{q}{3\sqrt[3]{-\frac{1}{2}r \pm \sqrt{\frac{1}{4}r^2 + \frac{q^3}{27}}}}$$

$$3 \times \sqrt[3]{-\frac{1}{2}r \pm \sqrt{\frac{1}{4}r^2 + \frac{q^3}{27}}}$$

in which expressions there are only known quantities: and this method is commonly called *Cardan's* rule.

But when, in a cubic equation  $x^3 - qx + r, q$  is negative; in this case the expression  $\sqrt{\frac{1}{4}r^2 + \frac{1}{27}q^3}$ , will be transformed into  $\sqrt{\frac{1}{4}r^2 - \frac{1}{27}q^3}$ ; which root becomes impossible, or imaginary, when  $\frac{1}{27}q^3$  is greater than  $\frac{1}{4}r^2$ , as being the square root of a negative quantity. And yet, even in this case, the

$$1^\circ. x = p + 2m = 4 - 2 = 2,$$

$$2^\circ. x = p - m - \sqrt{-3n} = 4 + 1 - \sqrt{4} = 5 - 2 = 3.$$

$$3^\circ. x = p - m + \sqrt{-3n} = 5 + 2 = 7$$

So that the three roots of the proposed equation are 2, 3, and 7.

To solve Biquadratic EQUATIONS.

The roots of these may be found by reducing them to cubic ones, thus:

Let the second term be taken away,

And let the equation that results, be  $x^4 + qx^2 + r = 0$ . Suppose this biquadratic to be the product of these two quadratic questions.

$$x^2 + ex + f = 0.$$

$$x^2 - ex + g = 0.$$

$$\frac{x^4 + f}{-e^2} \left\{ \begin{array}{l} +g \\ -ef \end{array} \right\} \times \frac{x^2 + eg}{-ef} \left\{ \begin{array}{l} +f \\ -eg \end{array} \right\} \times x + fg = 0.$$

root  $x$  may be a real quantity; though algebraists have not, hitherto, been able to find a real expression of its value.

Again, any cubic equation may be reduced to this form, and the value of  $x$  discovered without exterminating the second term.

$$x^3 - 3px^2 - 3qx - 2r \left. \begin{array}{l} + 3p^2x - p^3 \\ + pq \end{array} \right\} = 0; \text{ which}$$

by supposing  $x = z + p$ , will be reduced to  $z^3 - 3qz - 2r = 0$ , in which the second term is wanting. But, from what is advanced above, it follows that  $z = \sqrt[3]{r + \sqrt{r^2 - q^3}} + \sqrt[3]{r - \sqrt{r^2 - q^3}}$  = (if you suppose that the cubic root of the binomial  $r + \sqrt{r^2 - q^3}$  is  $m + \sqrt{n}$ ). =  $m + \sqrt{n} + m - \sqrt{n} = 2m$ . And, since  $x = z + p$ , it follows that  $x = p + 2m$ . But, as the square root of any quantity is twofold, so the cubic root is threefold, and can be expressed three different ways.

Example I.

Let it be required to find the roots of the equation  $x^3 - 12x^2 + 41x - 42 = 0$ .

Comparing the coefficients of this equation with these of the general equation, viz.

$$x^3 - 3px^2 - 3qx - 2r \left. \begin{array}{l} + 3p^2x - p^3 \\ + 3pq \end{array} \right\} = 0, \text{ you}$$

will find  $3p = 12$ , so that  $p = 4$ ;  $3p^2 - 3q$  (=  $48 - 3q$ ) =  $41$ , so that  $q = \frac{7}{3}$ ; and  $3pq - p^3 - 2r$  (=  $-36 - 2r$ ) =  $42$  so that  $r = 3$ . And consequently  $r^2 - q^3 = 9 - \frac{343}{27} = -\frac{100}{27}$ , and  $r + \sqrt{r^2 - q^3} = 3 + \sqrt{-\frac{100}{27}}$ . Now the cubic root of this binomial is found to be  $-1 + \sqrt{-\frac{1}{3}}$  (=  $m + \sqrt{n}$ ); whence

Where  $e$  is the coefficient of  $x$  in both equations, but affected with contrary signs; because when the second term is wanting in an equation, the sum of the affirmative roots must be equal to the sum of the negative.

Compare now the proposed equation with the above product, and the respective terms put equal to each other, will give  $f + g - e^2 = q, eg - ef = r,$  and  $fg = s$ . Whence it follows, that  $f + g = q + e^2$ , and  $g - f = \frac{r}{e}$ ; and consequently,  $f + g$

$$+ g - f (= 2g) = q + e^2 + \frac{r}{e}, \text{ and } g = \frac{q + e^2 + \frac{r}{e}}{2}.$$

In the same manner you will find, by subtraction, &c.  $f = \frac{q + e^2 - \frac{r}{e}}{2}$ , and  $f \times g (= s) = \frac{\frac{1}{4} \times q^2 + 2q e^2 + e^4 - \frac{r^2}{e^2}}{4}$ ; and, multiplying by  $4e^2$ , and ranging the terms, you have this equation,  $e^6 + 2qe^4 + q^2 - 4s \times e^2 - r^2 = 0$ .

Suppose  $e^2 = y$ , and it becomes  $y^3 + 2qy^2 + q^2 - 4s \times y - r^2 = 0$ , an equation whose roots are to be discovered by the method of resolving cubic equations.

Then the values of  $y$  being found, their square roots will give  $e$  (since  $y = e^2$ ;) and having  $e$ , you will find  $f$  and  $g$ , from the equations  $f =$

$$\frac{q + e^2 - \frac{r}{e}}{2}, \text{ and } g = \frac{q + e^2 + \frac{r}{e}}{2}.$$

Lastly, extracting the roots of the roots of the equations  $x^2 + ex + f = 0$ , and  $x^2 - ex + g = 0$ , you will find the four roots of the biquadratic  $x^4 + qx^2 + rx + s = 0$ ; for either  $x = \frac{1}{2}e \pm \sqrt{\frac{1}{4}e^2 - f}$ , or  $x = \pm \frac{1}{2}e \pm \sqrt{\frac{1}{4}e^2 - g}$ .

Or you may find the roots of a biquadratic, without taking away the second term.

Example.

Suppose it to be of this form,  
 $x^4 - 4px^3 - 2q \left. \begin{matrix} x^2 - 8r \\ + 4p^2 \end{matrix} \right\} x^2 - 8r \left. \begin{matrix} x - 4s \\ + q^2 \end{matrix} \right\} x - 4s \left. \begin{matrix} x - 4s \\ + q^2 \end{matrix} \right\} = 0.$   
 then the values of  $x$  will be

$$x = p - a \pm \sqrt{p^2 + q - a^2 - \frac{2r}{a}}$$

$$\text{and } x = p + a \pm \sqrt{p^2 + q - a^2 + \frac{2r}{a}}$$

where  $a^2$  is equal to the root of the cubic equation  $y^3 - p^2 \left. \begin{matrix} y^2 + 2pr \\ - q \end{matrix} \right\} y^2 + 2pr \left. \begin{matrix} y - r^2 \\ + s \end{matrix} \right\} y - r^2 = 0$ .

By FLUXION.

FLUXION denotes the velocity by which the the *fluents* or *flowing* quantities increase or decrease: So that all this doctrine may be considered as positive, or negative; according as it relates to an improvement or decrement.

Foreigners usually define the method of *fluxions*. The arithmetic, or analysis of infinitely, or rather

indefinitely, small variable quantities; or, the method of finding an infinite small or an indefinitely small quantity, which being taken, an infinite number of times, becomes equal to a given quantity.

Sir *Isaac Newton* and his followers call these infinitely small quantities, *moments*; as considering them the momentary increments and decrements of variable quantities of a *line* or a *surface*, &c. considered as generated by the flux of a *point*, or by the flux of a *line*.

Hence the variable quantities are called *fluent*, or flowing quantities; and the method of finding either the *fluxion* or *fluent*, is the method of *fluxions*.

M. *Leibnitz* considers the same infinitely small quantities as the differences of two quantities, and names the moments of finding those differences, the *differential calculus*.

Both these ways of considering and denominating have their advantages. But there is not only a difference in the name but also in the notation.

Sir *Isaac Newton* expresses the *fluxion* of a quantity, as,  $x$  by  $\dot{x}$ , a dot being placed over it, as  $\dot{x}$ .

M. *Leibnitz* expresses the differential of the same  $x$  by prefixing a  $d$ , as,  $dx$ . Both of which notations have their advantage likewise.

In all other respects the two methods practised by the followers of *Newton* and *Leibnitz*, are the same.

The advantages derived from this doctrine of *fluxions* are most sublime. It opens a new world, and extends our knowledge, as it were to infinity, or beyond the bounds that seemed to be described to the human mind.

A discovery reserved by the Almighty for the latter ages of the world; yet, though of so modern a date as within the memory of man, it is not clear to whom we are indebted for its invention. Sir *Isaac Newton* and M. *Leibnitz* separately lay in their claim for the honour. Let the reader from the facts before him determine to whom the merit of so noble a discovery is due.

M. *Leibnitz* in 1684 gave the rules for *fluxions* in the *Acta Lipsiensia*, or literary transactions of the university of *Leipsic* for that year, without publishing the demonstrations.

This set the learned world to work; and the two brothers, the *Benoulli*, never rested till they conquered the difficulty, found the demonstrations, and practised them with surprising success.

Nor was it till the year 1687 that Sir *Isaac Newton* attempted any thing, this way, in public. In that year he published his admirable *Principia*, which is almost wholly founded on the same *calculus*.

It does not appear that either of these great men arrogated any peculiar claim to this invention.

Nor did the learned world, at that time, declare any opinion in that matter, otherwise than giving due applause to both those happy genius's, for both their inventions of the same doctrine about the same time; being convinced that neither of them had copied from the other; because they did not mention one another; and because, though they agreed in the substance of the thing, they differed in their way of conceiving; called it by different names, and used different characters,

However each had his partisans: foreign nations adopted the character invented by *Leibnitz*, as more commodious, And as his character gained acceptance, the geometricians on the continent of *Europe* were insensibly led to look upon him to be the sole author and principal inventor of *Fluxions*.

In the year 1699 *M Fatio*, who followed the *Newtonian* practice opposed that opinion. And in a treatise on the *line of swiftest descent*, advanced that *Sir Isaac Newton* was not only the inventor, but was the first that practised the *differential calculus* for many years; and mentioned *Mr. Leibnitz* only as the second inventor. Which precise distinction between *first* and *second* inventor, with the suspicion it insinuated, (though hitherto the two great authors themselves enjoyed the glorious prospect of the progress made continually under their auspices without any concern or dispute, as to the property of the invention) awakened *M. Leibnitz*, and his editors at *Leipzig* maintained his priority of the invention of fluxions against the *English geometricians*, who declared for *Sir Isaac Newton*.

*Sir Isaac* took no part in this controversy; contented with the attitude in which he was placed by the learned world above the glory of all that went before him in philosophical discoveries. But his countrymen could not be reasoned into silence. They persisted in their claim of the priority of *Sir Isaac's* invention to *M. Leibnitz*: till at last *M. Leibnitz* in the year 1711, laid a formal complaint before the *Royal Society* in *LONDON* against *Dr. Keil* for accusing him of publishing the method of *FLUXIONS*, invented by *Sir Isaac Newton*, under other names and characters. At the same time appealing to *Sir Isaac* himself for an attestation of his innocence; and insinuating that *Dr. Keil* should publicly disavow the ill construction, which might be put upon his words.

This appeal to the *Royal Society*, as judges, brought the controversy to an issue. On the one part *Leibnitz* stands to the award of their tribunal: on the other part the *Society*, after due examination of the merits of both the claimants, from the best vouchers they could find in old letters, papers, &c. and the strictest examination of all the evidences, that could be produced, gave this report or verdict, viz.

“ That it did not appear that *M. Leibnitz* knew any thing of the *Differential Calculus* before a letter wrote him by *Sir Isaac Newton*, and sent to him at *Paris*, in the year 1672; wherein the method of *Fluxions* was sufficiently explained to let a man of his sagacity into the whole matter; and that *Sir Isaac Newton* had even invented his method before the year 1669; and in consequence fifteen years before *M. Leibnitz* had given any thing on the subject in the *Leipfic Arts* :” concluding,

That *Doctor Keil* had not at all injured *M. Leibnitz* in what he had advanced and said.

This, nevertheless, did not silence the foreign advocates and admirers of *M. Leibnitz*. For, though this censure, with all the pieces relating thereunto, were printed in one collection under the title of *Commercium Epistolicum de Analyfi promotâ*, *London*, 1712, and carefully circulated all over *Europe*, in vindication of the Title of the *English* nation to so useful a discovery, *M. Leibnitz* and his friends could not brook the name of a *Plagiary*, with which the censure, &c. plainly stigmatized him. So that soon after we find a loose sheet printed at *Paris*, and also at *Bremen* with much fire, in behalf of *Leibnitz*, maintaining boldly, That the method of *Fluxions* did not precede that of *Differences*; and insinuates, that it might have arisen from it. *M. Leibnitz* himself is said to have been employed in an elaborate answer to the *Commercium Epistolicum*, when death took him off the stage of contention.

They, who reason coolly upon the merits of these claimants, (though it is a fact without the least doubt, that *Sir Isaac Newton* was the first inventor of *Fluxions*) can't be so harsh as to declare *M. Leibnitz* to be a *Plagiary*. If they would but recollect that *M. Leibnitz* in his *Theory of Abstract Motions*, dedicated to the *Royal Academy* in 1671, did then suppose, infinitely small quantities, some greater than others (which is one of the great principles of *Fluxions*) it might go a great way towards acquitting him of *Plagiarism*, and to convince us that *M. Leibnitz* did not take the doctrine of *Fluxions* from *Sir Isaac Newton*; but that he accidentally fell upon the same thing with him.

These things premised it will be necessary to add somewhat more on the subject of *notation of Fluxions*.

*Invariable quantities*, or those which neither increase nor decrease, are represented by the first letters of the alphabet, as *a, b, c, d, &c.* and the variable or flowing quantities by the last letters, as *v, w, x, y, z*: thus, the diameter of a given circle may be denoted by *a*; and the sine of any arch thereof, considered as variable, by *x*. The fluxion of a quantity represented by a single letter, is expressed

pressed by the same letter with a dot or full point over it: thus, the fluxion of  $x$  is represented by  $\dot{x}$ , and that of  $y$  by  $\dot{y}$ .

And, because these fluxions are themselves often variable quantities, the velocities with which they either increase or decrease, are the fluxions of the former fluxions, which may be called *second* fluxions, and are denoted by the same letters with *two* dots over them, as  $\ddot{x}$ ,  $\ddot{y}$ .

In the same manner the fluxions of *second* fluxions are called *third* fluxions, and denoted by the same letters with *three* dots over them, as  $\ddot{\dot{x}}$ ,  $\ddot{\dot{y}}$ ; and so on for *fourth*, *fifth*, &c. fluxions, which are expressed by the same letters, with four, five, &c. dots over them, as  $\ddot{\dot{\dot{x}}}$ ,  $\ddot{\dot{\dot{y}}}$ ; and  $\ddot{\dot{\dot{\dot{x}}}}$ ,  $\ddot{\dot{\dot{\dot{y}}}}$ , &c.

If the flowing quantity be a fraction, as  $\frac{xx}{d-y}$ , its first, second, third, &c. fluxions are expressed by one, two, three, &c. dots placed in the break of the line that separates the numerator from the denominator, thus  $\frac{\dot{x}x}{d-y}$ ,  $\frac{\ddot{x}x}{d-y}$ ,  $\frac{\ddot{\dot{x}}x}{d-y}$ , &c.

The fluxions of *surds* are denoted in the same manner, by one, two or more dots placed in the break of the vinculum of the radical character: thus, if the *surd* quantity be  $\sqrt{x-y}$ , then will its first, second, third, &c. fluxions be  $\sqrt{\dot{x}-\dot{y}}$ ,  $\sqrt{\ddot{x}-\ddot{y}}$ ,  $\sqrt{\ddot{\dot{x}}-\ddot{\dot{y}}}$ , &c.

The whole doctrine of fluxions consists in solving the two following Problems, *viz.* 1. From the fluent, or variable flowing quantity given, to find the fluxion; which constitutes what is called the *direct method of fluxions*. 2. From the fluxion given, to find the fluent, or flowing quantity; which makes the *inverse method of fluxions*.

The latter is directly opposite to the former, and is a sequel to it. Both of them are adopted into the new *Geometry*, and make reigning methods therein.

The *first* descends from finite to infinite. The *second* ascends from infinitely small to finites. The one decomposes a magnitude; the other re-establishes it.

The foundation of the *direct method of fluxions* amounts to this Problem. The length of the square described being continually, or at all times, given to find the velocity at any time proposed.

The foundation of the *inverse method* amounts to this Problem. The velocity of the motion being continually given, to find the space described by it at any time proposed.

The Doctrine of the *direct method of FLUXIONS* is comprised in these rules.

1. To find the fluxion of any simple variable quantity, the rule is to place a dot over it: thus, the fluxion of  $x$  is  $\dot{x}$ , and of  $y$ ,  $\dot{y}$ . Again, the fluxion of the compound quantity  $x + y$ , is  $\dot{x} + \dot{y}$ ; also the fluxion of  $x - y$  is  $\dot{x} - \dot{y}$ .

2. To find the fluxion of any given power of a variable quantity, multiply the fluxion of the root by the exponent of the power, and the product by that power of the same root; whose exponent is less by unity than the given exponent.

This rule is expressed more briefly, in *algebraical* characters, by  $n x^{n-1} \dot{x} =$  the fluxion of  $x^n$ .

Thus, the fluxion of  $x^3$  is  $\dot{x} \times 3 \times x^2 = 3x^2 \dot{x}$ ; and the fluxion of  $x^5$  is  $\dot{x} \times 5 \times x^4 = 5x^4 \dot{x}$ . In the same manner the fluxion of  $\sqrt{a+y}$  is  $\frac{1}{2} \dot{y} \times \sqrt{a+y}$ ; for the quantity  $a$  being constant,  $\dot{y}$  is the true fluxion of the root  $a+y$ .

Again, the fluxion of  $\sqrt{a^2+z^2}$  will be  $\frac{3}{2} \times 2z \dot{z} \times \sqrt{a^2+z^2}^{-\frac{1}{2}}$ : for here,  $x$  being put  $= a^2+z^2$ , we have  $\dot{x} = 2z \dot{z}$ ; and therefore  $\frac{3}{2} x^{\frac{1}{2}} \dot{x}$ , for the fluxion of  $x^{\frac{3}{2}}$  (or  $\sqrt{a^2+z^2}^{\frac{3}{2}}$ , is  $= 3z \dot{z} \sqrt{a^2+z^2}$ .

3. To find the fluxion of the product of several variable quantities, multiply the fluxion of each, by the product of the rest of the quantities; and the sum of the products, thus arising, will be the fluxion sought.

Thus the fluxion of  $xy$  is  $\dot{x}y + \dot{y}x$ ; that of  $xyz$  is  $\dot{x}yz + \dot{y}xz + \dot{z}xy$ ; and that of  $xyz$  is  $\dot{v}xyz + \dot{x}vyz + \dot{y}vxz + \dot{z}vxy$ . Again, the fluxion of  $\frac{a+x}{b-y} = \frac{ab+bx-ay-xy}{b-y}$ , is  $b\dot{x} - a\dot{y} - \dot{x}y - \dot{y}x$ .

4. To find the fluxion of a *fraction*, the rule is, from the fluxion of the numerator multiplied by the denominator, subtract the fluxion of the denominator multiplied by the numerator, and divide the remainder by the square of the denominator.

Thus the fluxion of  $\frac{x}{y}$ , is  $\frac{\dot{y}x - x\dot{y}}{y^2}$ ; that of

$$\frac{x}{x+y}, \text{ is } \frac{\dot{x} \times x + y - \dot{x} + \dot{y} \times x}{(x+y)^2} = \frac{y\dot{x} - x\dot{y}}{(x+y)^2};$$

and that of  $\frac{x+y+z}{x+y}$ , or  $1 + \frac{z}{x+y}$ , is

$$\frac{\dot{z} \times x + y - \dot{x} + \dot{y} \times z}{(x+y)^2} \text{ and so of others.}$$

In the examples hitherto given, each is resolved by its own particular rule; but in those that follow,

low, the use of two or more of the above rules is requisite: thus (by rule 2. and 3.) the fluxion of  $x^2 y^2$  is found to be  $2 x^2 y \dot{y} + 2 y^2 x \dot{x}$ ; that of  $\frac{x^2}{y^2}$

is found (by rule 2, and 4.) to be  $\frac{2 y^2 x \dot{x} - 2 x^2 y \dot{y}}{y^4}$ ;

and that of  $\frac{x^2 y^2}{z}$ , is (by rule 2, 3, and 4.) found

to be  $\frac{2 x^2 y \dot{y} + 2 y^2 x \dot{x} \times z - x^2 y^2 \dot{z}}{z^2}$ .

5. When the proposed quantity is affected by a coefficient, or constant multiplier, the fluxion, found as above, must be multiplied by that coefficient or multiplier: thus, the fluxion of  $5x^3$ , is  $15x^2 \dot{x}$ , for the fluxion of  $x^3$  is  $3x^2 \dot{x}$ , which multiplied by 5, gives  $15x^2 \dot{x}$ . And in the very same manner, the fluxion of  $ax^n$  will be  $nax^{n-1} \dot{x}$ .

Having thus explained the manner of determining the *first fluxions of variable quantities*, it remains to say something of *second, third, &c. fluxions*.

We have already observed, that the second fluxion of a quantity, is the fluxion of the first fluxion; and by the third fluxion is meant the fluxion of the second; the fourth, of the third; and so on. The fluxions, therefore, of every order are only the measure of the velocities, by which their respective flowing quantities, *viz.* the fluxions of the immediately preceding order, are generated.

Hence it appears, that a second fluxion always shews the rate of the increase or decrease of the first fluxion; and that the third, fourth, &c. fluxions differ in nothing, except their order and notation, from first fluxions; and therefore are also determinable in the very same manner, by the rules already laid down.

Thus, (by rule 4.) the (first) fluxion of  $x^3$  is  $3x^2 \dot{x}$ : and if  $\dot{x}$  is supposed constant, that is, if the root  $x$  be generated with an equable or uniform velocity, the fluxion of  $3x^2 \dot{x}$  (or  $3 \dot{x} \times x^2$ ) again taken (by the same rule) will be  $3 \dot{x} \times 2x \dot{x}$ , or  $6x \dot{x}^2$ ; which therefore is the second fluxion of  $x^3$ . Again, the third fluxion of  $x^3$ , or the fluxion of  $6x \dot{x}^2$ , is found to be  $6x^3$ ; further than which we cannot go in this case, because the last fluxion,  $6 \dot{x}^3$ , is here a constant quantity.

In the preceding example, the root  $x$  is supposed to be generated with an equable velocity: but if the velocity be an increasing or decreasing one, then  $\dot{x}$ , expressing the measure thereof, being variable, will also have its fluxion, which is denoted, as said above, by  $\ddot{x}$ ; and the fluxion of  $\dot{x}$  by  $\ddot{x}$ , and so on with respect to higher orders.

EXAMPLES, wherein the root  $x$  (or  $y$ ) is supposed to be generated with a variable velocity.

Thus, the fluxion of  $x^3$  being  $3x^2 \dot{x}$  (or  $3x^2 \times \dot{x}$ ) the fluxion of  $3x^2 \times \dot{x}$ , considered as a rectangle, will (by rule 3.) be found to be  $6x \dot{x} \times \dot{x} + 3x^2 \times \ddot{x} = 6x \dot{x}^2 + 3x^2 \ddot{x}$ ; which is the second fluxion of  $x^3$ . Moreover, from the fluxion last found, we shall in like manner get  $6 \dot{x} \times x^2 + 6x \times 2 \dot{x} \ddot{x} + 6x \dot{x} \times \ddot{x} + 3x^2 \times \ddot{\ddot{x}}$  (or  $6x^3 + 18x \dot{x} \ddot{x} + 3x^2 \ddot{\ddot{x}}$ ) for the third fluxion of  $x^3$ . Thus also, if  $y = nx^{n-1}x$ , then will  $\dot{y} = n \times n-1 \times x^{n-2} \dot{x}^2 + n \dot{x} x^{n-1}$ ; and if  $\dot{z} = \dot{x} \dot{y}$ , then will  $2 \dot{z} \ddot{z} = x \dot{y} + \dot{y} \ddot{x}$ : and so of others.

Once for all, take particular notice, that the fluxions of all kinds and orders whatever, are contemporaneous, or such as may be generated together, with their respective velocities, in one and the same time.

The doctrine of the *inverse methods of Fluxions*, or *Calculus integralis*, (which consists in finding finite magnitudes from the infinitely small parts thereof, or in determining the *fluents* of given *Fluxions*) is to proceed from infinitely small quantities to *finite*, and to recompound and sum up, what the other had resolved; whence this method of *Fluxions* is also called, *the summatory Calculus*.

Yet, this does not always re-establish what has been decomposed: for, as there is no method for deducing the fluent from the fluxion *a priori*, by a direct investigation; so it is impossible to lay down rules for any other forms of fluxions, than those particular ones that we know, from the direct method, belong to such kinds of flowing quantities. For example, the fluent of  $2x \dot{x}$  is known to be  $x^2$ ; because, by the direct method, the fluxion of  $x^2$  is found to be  $2x \dot{x}$ : but the fluent of  $y \dot{x}$  is unknown, since no expression has been discovered that produces  $y \dot{x}$  for its fluxion. However, the following rules are used by the best *mathematicians* for finding the *fluents* of given *fluxions*.

1. To find the fluent of any simple fluxion, you need only write the letters without the dots over them: thus, the fluent of  $x$  is  $x$ , and that of  $ax + by$ , is  $ax + by$ .

2. To assign the fluent of any power of a variable quantity, multiplied by the fluxion of the root; first divide by the fluxion of the root; add unity to the exponent of the power, and divide by the exponent so increased; for dividing the fluxion  $nx^{n-1} \dot{x}$  by  $\dot{x}$ , it becomes  $nx^{n-1}$ ; and adding 1 to the exponent ( $n-1$ ) we have  $nx^n$ ; which divided by  $n$ , gives  $x^n$ , the true fluent of  $nx^{n-1} \dot{x}$ .

Hence, by the same rule, the fluent of  $3x^2 \dot{x}$  will

will be  $= x^3$ ; that of  $2x^5x = x^6$ ; that of  $y^{\frac{1}{2}}j$   
 $= \frac{2}{3}y^{\frac{3}{2}}$ ; that of  $ay^{\frac{2}{3}}j = \frac{3ay^{\frac{5}{3}}}{8}$  and that of

$y^n j = \frac{y^{n+1}}{\frac{m}{n} + 1} = \frac{ny^n}{m+n}$ ; that of  $\frac{ax}{x^n}$ , or  $axx^{-n}$

$= \frac{ax^{1-n}}{1-n}$ ; that of  $\overline{a+z}^3 \times z = \frac{a+z}{4}$ ; and that of

$\overline{a^m + z^m}^n \times z^{m-1}z = \frac{a^m + z^m}{m \times n + 1}$ .

In assigning the fluents of given fluxions, it ought to be considered, whether the flowing quantity, found as above, requires the addition or subtraction of some constant quantity, to render it complete:

for instance. the fluent of  $nx^{n-1}x$  may be either represented by  $x^n$  or by  $x^n \pm a$ , for  $a$  being a constant quantity the fluxion  $x^n \pm a$ , as well as of  $x^n$ , is  $nx^{n-1}x$ .

Hence it appears, that the variable part of a fluent only can be assigned by the common method, the constant part being only assignable from the particular nature of the problem.

Now to do this, the best way is to consider how much the variable part of the fluent, first found, differs from the truth, when the quantity, which the whole fluent ought to express, is equal to nothing; then that difference, added to, or subtracted from, the said variable part, as occasion requires, will give the fluent truly corrected.

To make this plainer by an example or two, let  $y = a + x^3 \times x$ . Here we first find  $y = \frac{a+x}{4}$ ;

but when  $y=0$ , then  $\frac{a+x}{4}$  becomes  $= \frac{a^4}{4}$ ; since  $x$ , by hypothesis, is then  $= 0$ , therefore  $\frac{a+x}{4}$

always exceeds  $y$  by  $\frac{a^4}{4}$ ; and so the fluent properly corrected, will be  $y = \frac{a+x}{4} - \frac{a^4}{4} = a^3x + \frac{3a^2x^2}{2} + a^3x + \frac{x^4}{4}$ .

Again, let  $y = \overline{a^m + x^m}^n \times x^{m-1}x$ : here we first have  $y = \frac{a^m + x^m}{m \times n + 1}$ ; and making  $y=0$ , the

latter part of the equation becomes  $\frac{a^m}{m \times n + 1} = \frac{a^{m+n}}{m \times n + 1}$

whence the equation or fluent, properly corrected is  $y = \frac{a^m + x^m}{m \times n + 1} - \frac{a^{m+n}}{m \times n + 1}$ .

Hitherto  $x$  and  $y$  are both supposed equal to nothing, at the same time; which will not always be the case; for instance, though the sine and tangent of an arch are both equal to nothing, when the arch itself is so; yet the secant is then equal to the radius.

It will therefore be proper to add some examples, wherein the value of  $y$  is equal to nothing, when that of  $x$  is equal to any given quantity  $a$ .

Thus let the equation  $y = x^2x$ , be proposed; whereof the fluent first found is  $y = \frac{x^3}{3}$ ; but when

$y=0$ , then  $\frac{x^3}{3} = \frac{a^3}{3}$ , by the hypothesis; therefore the fluent corrected is  $y = \frac{x^3 - a^3}{3}$ .

Again, suppose  $y = x^n x$ ; then will  $y = \frac{x^{n+1}}{n+1}$ ;

which, corrected, becomes  $y = \frac{a^{n+1} - x^{n+1}}{n+1}$ .

Lastly, if  $y = \overline{c^3 + bx^2}^{\frac{3}{2}} \times x$ ; then, first,  $y = \frac{c^3 + bx^2}{3b}$ ; therefore the fluent corrected is  $y = \frac{c^3 + bx^2}{3b} - \frac{c^3 + b^2a^2}{3b}$ .

3. To find the fluents of such fluxionary expressions, as involve two or more variable quantities, substitute, instead of such fluxion, its respective flowing quantity; and, adding all the terms together, divide the sum by the number of terms, and the quotient will be the fluent.

Thus the fluent of  $xy + yx = \frac{xy + xy}{2} = \frac{2xy}{2} = xy$ ; and the fluent of  $xyz + yxz + zyx = \frac{xyz + xyz + xyz}{3} = \frac{3xyz}{3} = xyz$ .

Having thus shewn the manner of finding such fluents as can be truly exhibited in algebraic terms, it remains now to say something with regard to those other forms of expressions involving one variable quantity only; which yet are so affected by compound divisors and radical quantities, that their fluents cannot be accurately determined by any method whatsoever.

The only method with regard to these, of which there are innumerable kinds, is to find their fluents, by approximation, which, by the method of infinite series, may be done to any degree of exactness.

Thus, if it were proposed to find the fluent of  $\frac{ax}{a-x}$ , it becomes necessary to throw the fluxion into an infinite series, by dividing  $ax$  by  $a-x$ ; thus,  $ax \div a-x = x + \frac{x^2}{a} + \frac{x^3}{a^2} + \frac{x^4}{a^3} + \frac{x^5}{a^4} + \dots$

Now the fluent of each term of this series, may be found by the foregoing rules to be  $x + \frac{x^2}{2a} + \frac{x^3}{3a^2} + \frac{x^4}{4a^3} + \frac{x^5}{5a^4} + \dots$

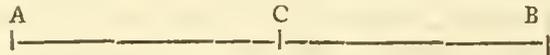
Again, to approximate the fluent of  $\frac{a^2-x^2}{c^2-x^2}$ , we first find the value of  $\frac{a^2-x^2}{c^2-x^2}$  expressed in a

series to be  $\frac{a}{c} + \frac{a}{2c^3} - \frac{1}{2ac} \times x^2 + \frac{3a}{8c^5} - \frac{1}{4ac^3} - \frac{1}{8a^3c} \times x^4 + \frac{5a}{16c^7} - \frac{3}{16ac^5} - \frac{1}{16a^3c^3} - \frac{1}{16a^5c} \times x^6 + \dots$

which value being multiplied by  $x^n \dot{x}$ , and the fluent taken by the rules above laid down, we get  $\frac{ax^{n+1}}{n+1 \times c} + \frac{a}{2c^3} - \frac{1}{2ac} \times \frac{x^{n+3}}{n+3} + \frac{3a}{8c^5} - \frac{1}{4ac^3} - \frac{1}{8a^3c} \times \frac{x^{n+5}}{n+5} + \frac{5a}{16c^7} - \frac{3}{16ac^5} - \frac{1}{16a^3c^3} - \frac{1}{16a^5c} \times \frac{x^{n+7}}{n+7} + \dots$

To shew the usefulness of fluxions more accurately, we shall give an example or two.

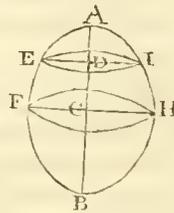
Suppose it were required to divide the given right line AB into two such parts, AC, CB, that their



products or rectangles, may be the greatest possible. Let  $AB = a$ , and let the part AC, considered as variable (by the motion of C towards B) be denoted by  $x$ . Then BC being  $= a - x$ , we have  $AC \times BC = ax - xx$ , whose fluxion  $a \dot{x} - 2x\dot{x}$  being put  $= 0$ , we get  $a \dot{x} = 2x\dot{x}$ ; and, consequently,  $x = \frac{1}{2}a$ . Hence it appears that AC (or  $x$ ) must be exactly one half of AB.

Again, suppose it were required to find the solid contents of a spheroid AFBH.

Let the axis AB, about which the solid is generated, be  $= a$ , the radius  $= p = 1$ , and the other axis FH, of the generating ellipsis  $= b$ ; then, from the property of the ellipsis, we have  $a^2 : b^2 :: AD \times BD (x \times a - x) : DE^2$



( $y^2$ ). Hence  $y^2 = \frac{b^2}{a^2} \times a x - x x$ ; and the flux-

ion of the solid  $s (= p y^2 \dot{x}) = \frac{p b^2}{a^2} \times a \dot{x} - x \dot{x}$ ;

and the solidity  $s = \frac{p b^2}{a^2} \times \frac{1}{2} a x x - \frac{1}{3} x^3 =$  the segment AIE; which, when AD ( $x$ ) = AB

( $a$ ), becomes  $(\frac{p b^2}{a^2} \times \frac{1}{2} a^3 - \frac{1}{3} a^3) = \frac{1}{6} p a b^2 =$  the content of the whole spheroid. Where, if  $b$  (FH) be taken  $= a$  (AB,) we shall also get  $\frac{1}{6} p a^3$  for the true content of the sphere, whose diameter is  $a$ . Hence a sphere or spheroid is  $\frac{2}{3}$  of its circumscribing cylinder: for the area of the circle

FH being expressed by  $\frac{p b^2}{4}$ , the content of the cylinder, whose diameter is FH, and altitude AB, will be  $\frac{p b^2 a}{4}$ ; of which  $\frac{1}{6} p a b^2$  is evidently two third parts.

Before we take our leave of Fluxions, it is necessary to explain what is understood, and what is to be done by that part of ALGEBRA called *Maximum*, and *Minimum*.

MAXIMUM denotes the *greatest* Quantity attainable in any given case.

MINIMUM denotes the *least* Quantity attainable in any given case.

The method *de maximis et minimis* is, therefore, the way, whereby mathematicians arrive at the *greatest* or *least* possible Quantity attainable in any case.

If a quantity conceived to be generated by motion, *increases* or *decreases*, till it arrives at a certain magnitude or position, and then, on the contrary, grows *lesser* or *greater*, and it be required to determine the said magnitude or position, the question is called a problem *de maximis et minimis*.

Thus; let a point  $m$  move uniformly in a right line, from A towards B, and let another point  $n$  move after it, with a velocity, either *increasing* or *decreasing*, but so that it may, at a certain position, D, become equal to that of the former point  $m$ , moving uniformly. Then let the motion of  $n$  be first considered, as an *increasing* one, in which case the distance of  $n$  behind  $m$  will conti-



nually *increase* till the two points arrive at the contemporary positions C and D; but afterwards it will again *decrease*; for the motion of  $n$ , till then being slower than at D, it is also slower than that of the preceding point  $m$  (by the hypothesis;) but becoming quicker afterwards, than that of  $m$ , the distance  $m n$ , (as has been already said) will again *decrease*: and therefore is a *maximum*, or the *greatest* of

of all, when the celerities of the two points are equal to each other.

But, if  $n$  arrives at  $D$  with a *decreasing* celerity, then its motion being first swifter, and afterwards slower than that of  $m$ , the distance  $mn$  will first *decrease* and then *increase*; and therefore is a *minimum*, or the *least* of all, in the forementioned circumstance.

Since then the distance  $mn$  is a *maximum*, or a *minimum*, when the velocities of  $m$  and  $n$  are equal, or when that distance *increases* as fast through the motion of  $m$ , as it *decreases* by that of  $n$ , its fluxion, at that instant, is evidently equal to nothing. Therefore, as the motion of the points  $m$  and  $n$  may be conceived such, that their distance  $m$  and  $n$  may express the measure of any variable quantity whatever, it follows, that the *fluxion* of any variable quantity whatever, when a *maximum* or a *minimum*, is equal to nothing.

The rule, therefore, to determine any flowing quantity in an *equation* proposed, to an extreme value, is, Having put the *equation* into *fluids*, let the *fluxion* of that quantity (whose extreme value is sought) be supposed equal to nothing; by which means all those members of the *equation* in which it is found, will vanish, and the remaining ones will give the determination of the *maximum* or *minimum* required.

Problem I.

To divide a given *right line* into two such parts, that their product or rectangle may be the greatest possible.

This is the case, when the line is bisected, or divided into equal parts, as has been shewn under FLUXION.

In any *mechanical engine* the *proportion* of the *power* to the *weight*, when they balance each other, is found by supposing the engine to move, and reducing their velocities to the respective directions in which they act; for the *inverse ratio* of those velocities is that of the *power* to the *weight* according to the general principle of *mechanics*. But it is of use to determine likewise the *proportion* they ought to bear to each other, that when the *power* prevails, and the engine is in motion, it may produce the *greatest effect* in a given time. When the *power* prevails, the *weight* moves at first with an accelerated motion; and when the velocity of the *power* is invariable, its action upon the *weight* decreases, while the velocity of the *weight* increases.

Thus the action of a stream of water, or air, upon a wheel, is to be estimated from the excess of the velocity of the fluid above the velocity of the part of the engine, which it strikes, or from

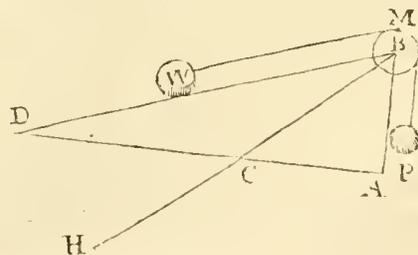
their *relative velocity* only. The motion of the engine ceases to be accelerated when this *relative velocity* is so far diminished, that the action of the *power* becomes equal to the resistance of the engine arising from the gravity of the matter that is elevated by it, and from friction; for when these balance each other, the engine proceeds with the uniform motion it has required.

Let  $a$  denote the velocity of a stream,  $u$  the velocity of the part of the engine, which it strikes, when the motion of the machine is uniform, and  $a-u$  will represent their *relative velocity*. Let  $A$  represent the weight, which would balance the force of the stream, when its velocity is  $a$ , and  $p$  the weight, which would balance the force of the same stream, if its velocity was only  $a-u$ ; Then  $p : A :: a-u^2 : a^2$ , or  $p = A \times \frac{a-u^2}{aa}$ , and  $p$  shall represent the action of the stream upon the wheel. If we abstract from friction, and have regard to the quantity of the weight only, let it be equal to  $qA$  (or be to  $A$  as  $q$  to 1) and because the motion of the machine is supposed uniform,  $p = q \times A = \frac{A \times a-u^2}{aa}$ , or  $q = \frac{a-u^2}{aa}$ . The momentum of this weight is  $q A u = \frac{A u \times a-u^2}{aa}$ ; which is a *maximum* when the fluxion of  $\frac{u \times a-u^2}{aa}$  vanishes, that is,

when  $u \times a-u^2 - 2uu \times a-u = 0$ , or  $a-3u=0$ . Therefore, in this case the machine will have the *greatest effect*, if  $u = \frac{a}{3}$ , or the weight  $q A =$

$\frac{A \times a-u^2}{aa} = \frac{4}{9} A$ . That is, if the weight, that is raised by the engine be less than the weight, which would balance the power in the proportion of 4 to 9; and the momentum of the weight is  $\frac{4}{27} A a$ .

Problem II.



Suppose that the given weight  $P$ , descending by its gravity into the vertical line, raises a given weight  $W$  by the cord  $PMW$  (that passes over the pulley  $M$ )



CB, is when the angle ACE, in which the wind strikes the sail, is of  $54^{\circ} 44'$ .

The best position of the rudder, where it may have the *greatest* effect in turning round the ship, is determined in like manner.

Much might be added in this place concerning

*tangents* and *subtangents* in an *Algebraic* curve; whose method is one of the great results of the *calculus differentialis*: but as its description and use comes more naturally under the title GEOMETRY, it shall be deferred till we treat of that *science*.

A N A T O M Y.

**A**NATOMY, in a strict *Physical Sense*, is the art of *dissecting*, or taking to pieces the several *solid* parts of *animal* Bodies, with a view to discover their *Structure* and *Uses*.

This Art in respect of its subject is *divided* into *human* and *comparative*.

*Human* ANATOMY is confined to operations on the *Human Body*: *Comparative* is employed in the dissection of *other animals*, to obtain a more accurate distinction of several parts, and to supply the defects of human subjects.

The *first* great use of this SCIENCE is to bring us acquainted with the work of the CREATOR in the composition of the human frame. In this view, it is properly called *Philosophical* or *Theological Anatomy*; because an intimate knowledge of the figure, connections, actions and uses of the several parts of the human body, is one of the strongest arguments against *Atheism*.

The *second* is the *preservation* and *restoration* of *health*. In this view it is styled *medical Anatomy*: because nothing is more necessary than a true knowledge of the structure of that frame subject to infirmity and injury, to preserve health, to cure diseases or to prevent them, and to heal fractures and wounds. Therefore this use has been commonly understood to be the *primary* object of this *Science*.

*Thirdly*, ANATOMY is of the greatest use in determining the cause and manner of the death of distempered persons, from a subsequent dissection of the body. A practice of the utmost consequence in *Physic*: for, thereby only is it possible to discover the latent causes of many diseases.

Neither is this SCIENCE confined to the bounds of *Medicine* alone. The Philosopher and the Magistrate: the Painter and Sculptor are in their respective employments more or less qualified, in proportion to their knowledge of ANATOMY. But the *Physician* and the *Surgeon* can't, without a perfect knowledge of it, do justice to their patients in their several professions: nay, we might venture to say that any one, who attempts the practice of either faculty without the assistance of ANATOMY, must do more harm than good to mankind.

From this view of the *uses* we have reason to suppose that ANATOMY is a study of very ancient date. But the oldest writings on this subject run no higher than HIPPOCRATES, who, notwithstanding he has left us no particular treatise on this subject, has given a multitude of observations relative to the *structure* of the human body. Besides he consecrated a *Brazen SKELETON* of admirable contrivance to *Apollo* of *Delphos*; for an eternal monument of his labours in this study.

In this HIPPOCRATES was imitated by ARISTOTLE; who to all other branches of his studies, added the *dissention* of human bodies: though subjects of this kind, were, in those times, very rare.

GALEN, commonly acknowledged to be the father of *Anatomists*, carried this art infinitely beyond what others had discovered before his time. His great judgment, penetration and dexterity of hand enabled him to deliver it down to posterity in the perfection we now enjoy it; except some few discoveries made by modern *Anatomists*: and even some of them are taken from *Galen's* works.

After this the invasions of the *Goths* and *Vandals* drove ANATOMY, with the other sciences, out of *Europe*; and, as *Doctor Friend* expresses himself, it sunk into total *Barbarism*; till MUNDINUS the *Milanese* Professor, whose system is still in esteem and read in some of the principal *Academies* in *Italy*, restored this study and published his lectures, *Anno Domini* 1315, in an uncouth style.

MUNDINUS's system was published two hundred years after with the comments of *Jac. Berengarius*, alias *CARPUS* or *Carpenfis*. Who afterwards wrote a much better treatise of his own, on the subject.

CARPUS is said to have dissected above one hundred bodies with his own hands, and some of them live subjects. For which it is said he was at last banished his country.

But VESALIUS has the honour of being accepted for the reformer and improver of ANATOMY, as we now enjoy it. His inclination to this *Science* was so great, that, in his childhood, he could not forbear dissecting *moles*, *dormice*, *cats*, &c. This innate passion increased with his years: so that, at last he scrupled not to steal bodies off *Gibbets*, when they

they could not be procured by other means: and those that were dug out of graves, he used to keep several weeks in his bed-chamber.

He published his famous work on the *structure of the human body*, at twenty-eight years of age. Yet he has not escaped severe censures from the learned. Our countryman *Caius* accuses him of corrupting *Galen's Text*. Others tax him with mistaking, or of imposing wrong and imaginary sentiments and constructions on that author, when he was entrusted by *Aldus* to revise his works. *Columbus* writes, that he had given the description of *brutes* for *men*, as the larynx, tongue and eye of an *ox*, and of giving *muscles* to the *epiglottis*, which is proper only to *brutes*. *Eustachius* shews that he has described the kidney of a *dog*, for the *human* kidney: and *Arantius* taxes him with giving the *pudding* of a *brute* instead of a *woman's*, for want of a female subject.

*VESALIUS*, with all these censures, has deserved well of the students in *physic* and *surgery*. He was chief *physician* to the Emperor *Charles V.* and to *Philip the second* King of *Spain*. But growing weary of a court life, he obtained leave to visit the holy sepulchre at *Jerusalem* by way of atonement for the many murders committed in his darling study; and he died *Anno Domini 1564*, in his return.

From this age the world has abounded with *anatomical* authors. But some of them have wrote on this subject only *occasionally*, while others have treated on it *professedly*.

Under the *occasional* writers we may rank *physicians*, *natural historians*, and those, who treat of *human nature* and of *brutes*.

Under the *professed* writers are numbered such as treat on the whole subject; or on any part of *Anatomy*.

The Treatises on the whole subject, in greatest repute, are the works of *Winslow*, *Doctor George Douglas*, *Albinus*, *Cheselden*, and the excellent *compendium* of *ANATOMY* by *Heister*.

They, who have merited most in *particular* branches of the *human structure*, are *Mr. MONRO* upon the *bones*: *Mr. COWPER* and *BROWN* upon the *muscles*: *DRYANDER* upon the *head*: *GALEN*; *HOFFMAN*, and *RUDIUS* upon the *uses* of the parts: *RUFUS Ephesius* and *CAMERARIUS* upon the *names* of the parts: *GALEN*, *CAPPIVACCIUS*, *HIPPOLITUS*, *BOSCUS* and *LACUNA* upon the art of *dissecting*: and *HORSTIUS* upon the art of *preserving* carcases.

*ASSELLIUS*, in the year 1622, discovered the *lacteal* vessels: the immortal *HARVEY* in 1628 published his discovery of the *circulation* of the *blood*: *BECKET* in 1651 discovered the *reservoir* of the *chyle*, and the *thoracic duct*. In 1650 and 1651

*RUDEECKS*, a *Swede*, and *BARTHOLINE*. a *Dane*, discovered the *lymphatic* vessels: *Mr. CARTOR* in 1655 discovered the *lower salival* ducts: in 1661 *STENO* described the upper *salival* ducts, those of the *palate*, the *nose* and the *eye*: *WIRTSUNGUS* in 1662 discovered the *pancreatick* duct: *WILLIS*, who succeeded him, published an *ANATOMY* of the *brain* and *nerves*; which was improved considerably by *VIEUSSENS*: *GLISSON* treated of the *liver*: *GRAAF* of the *pancreatick* juice and the *parts of generation*: *LOWER* on the *motion* of the *heart*: *THURSTON* upon *respiration*: *PEYER* upon the *glands* of the *intestines*: *DRELINCOURT* upon the *conception* of the *ova* in women, the *placenta*, and the *membranes* of the *fœtus*. We must not forget *MALPIGHI*, who died in 1694. *ANATOMY* is greatly indebted to his discoveries in the *lungs*, *brain*, *liver*, *spleen*, *glands* and *lymphaticks* by the help of the microscope, &c. Nor shall we do justice to the memory of *RUYTHE*, who died 1727, if we don't give him the merit of inventing *injections*; by which means great light has been thrown into many of the finer and more intricate parts of the human frame; particularly the *glands*.

We might add *MANGET* and *LE CLERC*, *Physicians* of *Geneva*, who have published a *Bibliotheca Anatomica*, containing all the new discoveries in *ANATOMY*: but till the numerous mistakes noted in that work by *MONGAGNI* in his *Adversaria Anatomica* shall be corrected, it will not be proper to place it amongst the classical authors in this science.

So that after reading *HEISTER*, *WINSLOW*, *MALPIGHI*, *CHESELDEN*, and consulting the *Tables* of *VESALIUS* and *ALBINUS*, a student may consider other books more, as curious, than necessary. And from these we acknowledge the adopting of the following Extracts.

It is evident from the Premises that *ANATOMY* is by some treated of only as an *ART*; by others, as a *SCIENCE*. The former consider it as an *artificial* dissection of a body: the latter, as a means to discover the *structure* and *uses* of the whole, and of every part of the body.

In both acceptations it is divided principally into *OSTEOLOGY*, or a dissection of the *Bones* and *Cartilages*; and *SARCOLOGY*, or a dissection of the *Flesh* and other *tender parts*.

#### Of OSTEOLOGY.

*OSTEOLOGY*, (a compound of  $\delta\sigma\tau\epsilon\omicron\nu$  λόγος, a *discourse* on *bones*) contains an exact disquisition of what belongs to bones in common, and what is proper to each bone in particular. But before we enter into this disquisition, it will be proper to consider

sider their definition, differences, articulations, causes, parts and number.

A BONE is the hardest, driest and most solid and earthy part of the whole animal body: and is cloathed with a membrane externally, called the *Periosteum*.

The *Periosteum* is divided into *layers* of fibres. The *external layers* are composed of fibres of the muscles connected to the *bones*; but vary in their number, size and direction; so as to occasion a very great difference in the thickness and strength of the *periosteum* of different *bones*, and even of the different parts of the same *bone*. The *internal layer* is nearly of a similar structure, and its fibres are in the same direction with those of the *bone*, to which they are connected.

This connection is made by their cellular membranes, (except where the muscles are inserted into the *periosteum*) which collapse into such a small space, when they are cut or broken in taking out a *bone*, that the external surface of the *periosteum* seems very smooth and equal.

When the *periosteum* is torn from the *bone*, we observe a great number of white threads produced from the membrane into the *bone*: and after a successful injection of the *arteries* with a red liquor, according to RUYSEN, numerous vessels are not only seen on the *periosteum*; but most of the fibres going from the membrane to the *bone*, shew themselves to be vessels entering the *bone*, with the injected liquor in them.

The *Veins* corresponding to these arteries, though they are not to be discovered by injection of liquor, are sometimes to be seen in subjects, that die with their vessels full of blood.

The great sensibility of the *periosteum* in several cases is a proof of its being well provided with *nerves*; though they are too small to be traced.

*Vessels* also pass through the *periosteum* to the *marrow*; and the *muscles* frequently pierce through the *periosteum* to be inserted into the *bones*.

The chief uses of the *periosteum*, according to MONRO, are,

1. To allow the *muscles*, when they contract or are stretched, to move and slide easily upon the *bones*: the smooth surface of this membrane preventing any ill effects of their friction upon each other.
2. To keep in due order, and to support the vessels in their passage to the *bones*.
3. To assist in setting limits to the increase of the *bones*, and to check their over growth, by firmly bracing them.
4. To strengthen the conjunction of the *bones* with their *epiphyses*, ligaments and cartilages.
5. To afford a convenient origin and insertion to several muscles, which are fixed to this membrane.

6. To warn us, when any injury is offered to the parts it covers, which, being *insensible*, might otherwise be destroyed without our knowledge, or endeavour to procure a remedy.

When the cellular substance connecting the *periosteum* to the surrounding parts is destroyed, these parts are fixed to that membrane, and loose the sliding motion they had upon it; as we see in *issues*, and other tedious suppurations near the *bone*. And when the vessels, which go from the *periosteum* to the *bones*, are broken or eroded, a collection of their liquids is made between the membrane and the *bone*, which produces a fordid ulcer, or a rotten *bone*; as appears often in *fractures* of the *bones* and *inflammations* of the *periosteum*.

The less and fewer the vessels are under the surface, and the thicker and firmer the bony surface covering the vessels, is, the *bones* will appear *whiter*, so that the *white* colour of *bones* will always be in proportion to their solidity and vessels. A circumstance that requires the attention of the *Surgeon*, when he is to judge of the condition of bones laid bare.

BONES differ much in their substance, quantity, figure, situation, uses, motion, sense, generation, cavities, &c.

Some are very hard, which nature has assigned to those parts of the animal structure, as require most strength, *viz.* the *tibia*; --- others are softer, as the *vertebræ*; and some are very soft and spongy, as the *sternum*.

They differ greatly in their quantity, both as to their number and equality. It is surprising to find such a number of bones within the compass of a foot or a hand, and so few in a leg or an arm. And of these some are large, as those of the *legs* and *arms*: others are smaller, as those in the *head*; and those in the *fingers* and *toes* are very small.

Their figure also varies in these proportions and shapes. The *femur* and *tibia* requires long *bones*: the *wrist* short *bones*. Some again are *flat*, as that of the *palate*: others *round*, as the *rotula*: others *square*, as the *ossa parietalia*: and some *triangular*, as the first *bone* of the *sternum*.

Doctor MONRO treating of this distinction, writes; --- the *broad bones* have thin sides, occasioned by the *plates* (or *laminæ*, of which bones are composed) being soon and equally sent off to form the *cancelli*; and this *lattice-work* is thicker and nearer of an equal form all through: and by this structure they are well adapted to their uses of affording a sufficient surface for the muscles to rise from, and to move upon, and of defending the parts, which they inclose.

The *round* BONES have thick strong walls in the middle, and become very thin towards the ends; occasioned

occasioned by very few plates separating at their middle; where the *cancelli* is so fine and small as scarce to be perceived. But such bones are said to have a large reservoir of oil in this place. Towards the extremities the *lattice-work* becomes very thick, and rather more complete than in the other sort of bones. These *round bones* having strong natural y 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. Moreover they are provided with thick sides towards the middle, where the greatest forces are applied to injure them; while their hollowiness increases their diameter, and consequently their strength to resist forces applied to break them transversely, as is demonstrated by GALLÆUS in *Mechanic. Dialog. 2.*

Therefore, as the strength of bones depends on their number of fibres or quantity of matter, and the largeness of their diameters; it follows, that the part of a bone formerly fractured, and re-united by a *callus* must be stronger than it was before the accident happened. See MONRO *Anat. of BONES*, p. 24.

Before we dismiss this subject of the figure of BONES; it will be proper to say something about the *apophysis* or *processes*, or *protuberances* of bones. If a *process* rises out of a bone, like a ball; it is called *caput* or a *head*. See D. in the *skeletons* on the plate of *Osteology*. If the *head* is flattened; it is called *condyle*. See E. *ib.* If the *process* be rough or unequal, it is a *tuberosity*. If it rises narrow and grows large at the extremity, it is named *cervix* or *neck*. See F. *ib.* Where it spreads into long ridges, are called *spines*. *Coronoid* or *coronæ* is a common name for such *processes* as terminate in a sharp point: but they receive particular names (as *mastoid*, *styloid*, *anchocoid*, *coracoid*, *spinal*, &c. according to the real or imagined resemblance they have to other substances. See G. *ib.* and such *processes* as form brims of cavities are called *supercilia* and *labra*.

These deformities have also their uses: for *processes* serve for the advantageous origin and insertion of *muscles*, and render the *articulations* firmer and more stable.

The greatest number of what are called *processes* in *adult bones*, discover themselves in *children* to be *epiphysis*, or *distinct bones*, to be affixed afterwards; as the *styloid* or the *temporal bones*, and the *processes* of the *vertebræ*, *trochanters* of the *thigh*, &c. See H *ib.*

As the *Apophysis* is a *protuberance* that rises on the superficies of the bones, with which it has the very same continuity, such as we find in the prominence of the *os potresum*, called *apophysis mastoides*; See B. *ib.* So

The *epiphyses*, or *appendages* are *additional bones* joined to the principal bone by a simple connection,

or cartilage; as the prominence on the *os tarsæ*. See C *ib.*

Some bones have one; others two, or more of the *appendages* annexed by means of cartilages, which are of a considerable thickness in children; but by age become thinner, the *ossification* proceeding from the extremity of the bone on one side, and from the *epiphyses* on the other, till the place of their conjunction in adults can scarce be perceived on the external surface.

The *epiphyses* are chiefly united to such bones as are destined for frequent and violent motion; and for this purpose are of a larger diameter than the bone they belong to. Thus they strengthen the articulations, and also secure the ligaments of the articulations, which rise out from between the bones and them.

It may not be useless to consider BONES in regard to their *situation*. For, though every one knows that some are placed in the *head*; others in the *trunk*; and others in the extremities of the body; they may not have observed that among those in the *head*, some have a *deeper* situation, as the three *ossicula* of the *hearing*; and others a more *superficial*, as those of the *cranium*.

The uses of the bones are to support, and to contain parts, as those of the thighs and legs, and *costæ*: others both to contain and defend, as the bones of the *cranium*.

BONES also have their *motion*, either *manifest*; as in the great bones of the extremities: or, *secret*, as in the wrist and heel. But it must be allowed that the bones of the head and some others have no motion at all.

No BONES except the TEETH have any sense.

The *generation* of bones is a subject of some consideration. For, those that lie in the cavities of the ears are perfected in the womb: all others receive their increase and strength by time and nourishment. But of these some, as the *lower mandible*, harden sooner; some later, as those of the *vertex* or *top of the head*.

The *cavities* of bones are very singular, some are very capacious and replete with marrow, as the *tibia*: some are only porous, as the *calcaneum*, containing a medullary juice. Others have holes for transmission of the vessels, as the bones of the basis of the *cranium*. See K. *ib.* and *Vertebræ*. Others have only a hollowness, as the *os sternum*: others have *sinus's*, as the *ossa frontis* and *temporum*. See M. *ib.* And some consist of abundance of little holes like a sieve, as the *os ethmoides*.

If these *cavities* are deep with large brims, they are called *cotylæ*; if only superficial, *glenæ* or *glenoid*. And these general *classes* are divided into particular *species*; as,

*Pits,*

*Pits*, or small roundish channels sunk perpendicularly into the bone. See *L. ib.*

*Furrows*, or long narrow channels formed in the surface.

*Notches*, or small breaches in the bone.

*Sinuosities*, or broad superficial depressions without brims.

*Sinuses*, or large cavities within the substance of the bones with small apertures.

*Foramina*, holes or channels, which pierce quite through the substance of the bone. *N. B.* When this last fort extends any long way within a bone, the middle part is called *canal*, and its extremities *holes*.

The uses of the cavities are many, such as, to allow the heads of the bones to play in; to lodge and defend other softer parts, to give a safe passage for vessels, muscles, &c. as shall be shewn more fully hereafter.

Our next consideration is to enquire into the conjunction of BONES. This is performed either by *articulation* or *symphysis*.

ARTICULATION is a natural conjunction of two bones touching one another by their extremities.

This conjunction is *twofold*: one is named *diarthrosis*; the other *synarthrosis*.

*Diarthrosis* is the articulation, in which the motion is manifest, or in which the bones are so loosely connected as to allow a large motion; and is subdivided into the *enarthrosis*, *arthrodia*, and *ginglymus*.

*Enarthrosis* is the ball or socket, when a large long head is received into a cavity, as the head of the *os femoris* into the *acetabulum coxendicis*. (C) See plate OSTEOL. fig. 1.

*Arthrodia* is when a round head is received into a superficial cavity; as in the articulation of the arm bone and *scapula*; where the head of the *humerus* is received into the *glenoid* cavity of the *scapula*; and the heads of the *metacarpus* or *metatarsus* are received into the cavities of the first *phalanx*. See *D. ib.*

*Ginglymus* (which properly signifies the hinge of a door) is that fort of articulation, where two bones receive each other mutually, allowing motion two ways. Thus the bone of the *carpus* is received into that of the *cubitus*, and that of the *cubitus* into that of the *carpus*. See *E. ib.* This is what workmen call *charnal*.

This *ginglymus* is generally divided into *proximus*, *longus*, and *compositus*.

*Proximus* 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*. See *O. ib.*

*Longus* is when a bone receives another at one end, and is received by the same bone at the other extremity, as in the *radius* and *ulna*. See *P. ib.*

*Compositus* is when a bone receives another, and is received by a third, as in the oblique processes of the *vertebrae*.

I shall add Dr. MONRO's opinion on the *ginglymus*. I would, (says the *Doctor*) reckon that articulation, by the form of which, the motion of the joined bones must be chiefly confined to two directions, in the manner that the hinges of a door are confined.

The first species of which is the *trochoides*, when the one bone turns on the other, as a wheel does on its axis; or the first *vertebrae* of the neck moves on the tooth-like process of the *second*; which is a most proper kind of *ginglymus*, though commonly neglected by the modern writers.

The second species should be esteemed that articulation, where several prominent and hollow surfaces of two bones move on each other within the same common ligament; as in the *knee*, *elbow*, &c.

The third sort is when two bones are articulated to each other at different parts, with a distinct apparatus of the motory machines at each; such as the articulation of the *os occipitis* with the first *vertebra* of the neck, and of the *astragalus* with the *calcaneum*, &c.

SYNARTHROSIS, the second part of articulation, is so firm and so strong that it has no distinct motion. See *G. ib.*

It is subdivided into *future*, *harmonia*, *gomphosis*, and *schyndylesis*.

*Future* is that articulation where two bones are mutually indented into each other, or as if they were sewed together. A future may be either true or genuine; a false or a bastard future. The true future is when two bones are joined like two saws, whose teeth meet close together, as the *ossa parietalia* with the *os coronale*. See *H. ib.* The false future is when two bones are articulated in form of plates or *lamina* placed over one another, as the *parietalia* with the *os temporum*. See *I. ib.*

*Harmonia* is when the bones are joined in a simple streight, or a circular line, as the bones of the face, nose and palate. See *K. ib.*

*Gomphosis* is a compact articulation, on the fixing of one bone into another, as a nail is fixed in a board; thus the *teeth* are secured in their sockets. See *L. ib.*

*Schyndylesis* or *plough*, is when a thin *lamella* of one bone is received into a long narrow furrow

of another, as the *processus azygos* of the *sphæroid* bone, and the nasal process of the *ethmoid* bone, are received by the *vomer*. *ib.*

To these some add the *anphiarthrosis* or articulation, which cannot be reduced either under *diarthrosis* or *synarthrosis*; because it has not a manifest motion; and yet it is not totally void of motion. Of this kind they mention the articulation of the *costæ* with the *vertebræ* of the back, and of the bones of the *carpus* and *tarfus* with one another. See M. M. *ib.*

*SYMPHYSIS* properly signifies the concretion or growing together of parts, when used to express the articulation of bones. Dr. MONRO says, it 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. We shall define it, a *natural union or adhesion*, as when bones that were, at first, plainly distinct, seem to be grown together, as one bone.

This union being made either by some intermediate substance or without it, and there being different substances serving to this purpose, the *symphysis* is divided into *three* species, *viz.*

*Synchondrosis*, where a *cartilage* is the connecting substance joining the *ribs* to the *sternum*; as it is also in the connection of the *vertebræ*, and of the *ossa pubis*.

*Synneurosis* or *Syndesmosis*, when *ligaments* are the connecting bodies: as in all moveable articulations.

*Syffarcosis* or *syfurcosis*, where bones have no other ligaments but the flesh; and the muscles are stretched from one bone to another.

If we enquire into the *cause* or *origin* of BONES, it will be found that they are generated from the seminal liquor elaborated by natural heat, as are all the other parts of the human body.

Here it will be necessary to revise what has been said concerning the *periosteum*, the *generation* and *figure* of BONES on page 40, and to say somewhat of the *cartilages* and *ligaments*, so frequently mentioned,

CARTILAGES are solid, smooth, white, elastic substances, and almost of the same nature with *bones*; from which they differ only, in more or less; and are covered with a membrane named *perichondrium*, of the same structure and use of the *periosteum* in *bones*.

The *cartilages* are composed of plates: which are formed of fibres disposed much in the same way,

as those of *bones* are, and *blood vessels* and *nerves* are also distributed to the *cartilages*, in much the same manner as to the *bones*.

They are of three sorts: some are hard and become quite bony in time; as those, which compose the *sternum*, and those that connect the *appendages* to the principal *bone*; others are softer, and contribute to the composition of the parts, as in the *nose*, *ears*, *xiphoides* and *coccix*: and others are very soft, of the nature of *ligaments* and called *ligamentary cartilages*.

They are different in *figure*, taking the name of such things as they resemble; as, *annular*, when shaped like a *ring*: *xiphoides*, when resembling a *sword*, &c.

Their situation is commonly in contact with the *bones*; but those of the *larynx* and the eye lids don't touch them.

They have neither *sensation* nor *cavities*, and instead of marrow they have a viscous flexible substance that preserves them,

But as the specific gravity of *cartilages* is near one third less than that of *bones*; so the cohesion of the several plates, is not so strong as in *bones*: whence it is to be remarked, that *cartilages* laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much sooner than *bones*.

CARTILAGES seem to be principally kept from *ossifying* either by being subject to alternate motions of flexion and extension; or being constantly moistened. They that ossify begin the *metamorphosis* or their external surface, and the ossification proceeds internally, till the *cancelli* are at last formed. Then we may find a sort of *marrow* deposited in them; and that the *blood vessels* decrease on the external, and grow more visible towards their internal substance.

This change is always made soonest and most remarkably where the pressure is greatest, *i. e.* at their external surface. But the cartilage still retains its former dimensions. Because what is lost is the cohesion of the plates, is recovered by a cavity formed in the middle for to receive the marrow.

The *cartilages*, which are subservient to *bones*, are sometimes found the extremities 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. Besides we find them interposed between such other cartilages, as cover the heads and cavities of *articulated bones*, and sometimes between *immoveable bones*.

The *uses* of *cartilages* are to hinder the *bones* from hurting one another by mutual collision; to join them together in divers places by *synchondrosis*, and

and to contribute much to the better shape of many parts, as may be seen in the *nose, ears, trachæa, eye-lids, &c.*

LIGAMENTS are a solid white substance, thicker and firmer than the nerves or membranes, and not so hard and firm as the cartilages or gristles, without any remarkable cavity in their substance, stretched with difficulty and with little elasticity; serving to connect one part to another, or to prevent the parts, to which they are fixed, from being moved out of that situation, which is useful and safe.

Some of them are strong placed within between the bones. Some are thick and round, called *cartilaginous ligaments*; and others that cover the *bones* outwardly, are thin, and of a membranous nature. Others are called *membranous* and *nervous ligaments*, only from the resemblance they bear, in their figure, to a *membrane* or *nerve*.

It is allowed that *ligaments* are void of motion; and some would have it that they are void of sensation also. But they, who assert their insensibility would do well to consider from whence comes all that excruciating 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 whence that insufferable torture occasioned by a collection of acrid matter in a joint, or by *tophi* in the *gout*. In both cases it is evident that *ligaments* are abundantly supplied with *nerves*, and subject to diseases.

*Ligaments* are composed of *layers*, and each layer of fibres, the largest of which are disposed in a longitudinal direction. Into this composition there enter *arteries* discoverable by injection; and *veins*, which sometimes distend with blood. Besides, as it is certain that such *ligaments*, as form the sides of cavities, have numerous orifices of their *arteries* opening upon their internal surface, which keep it always moist with an oozing liquor from small pores; these exhalent arteries must have corresponding absorbent *veins*; otherwise the cavities would soon be too full of liquor,

It is observed that in whatever articulation the *ligaments* are few, long, and weak, motion will be more free and quick; and luxations more frequent: But where the *ligaments* are numerous, short and strong, the motion will be more confined and the luxations more rare.

Sometimes *ligaments* supply the place of *bones*; thus the parts of the *pelvis* are more safely supported below by *ligaments* than they would have been by a bone. They afford convenient origin for *muscles* placed between the *bones* of the fore-arm and the leg, and in the great holes of the *ossa innominata*. Again the *ossa innominata* and the *os sa-*

*crum* shew that the immoveable bones are more firmly connected by them; and they make a socket for moveable bones to play in; as we see part of the *astragalus* does on the *ligaments* stretched from the *heel bone* to the *scaphoid bone*.

The liquor, which principally serves to moisten the *ligaments* and *cartilages* of the articulations, is supplied by *glands*, commonly situated in the joint; in such manner as to be gently pressed, but not destroyed by its motion. Thus, when there is most need for this liquor, *i. e.* when the greatest motions are performed, the greatest quantity of it will be separated.

These *glands* are soft and pappy, but not friable. They are mostly 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.

But besides these *glands*, *Morgagni* has observed, that here are also certain small simple *folliculi* full of liquor.

This mucilaginous liquor pressed out of the *glands* resembles the white of an egg, or *serum* of blood, and is salt to the palate; and of all discharges of wounds and ulcers this mucilage makes a considerable part.

Those *glands*, in a state of sanity, don't seem to have any sense; but when inflamed and suppurated, they suffer most racking pain; which is a proof that they also have *nerves*. And when this liquor of the articulation 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. On the other hand, it will inspissate (for want of rubbing between the *bones* of the articulation) so much, that when the head of a *bone* has been long out of its cavity, this liquor will fill up the place of the bone, and hinder its reduction; and if the joint has continued long unmoved, it will cement the bones of the articulation, and cause a true *anchylosis*. If it becomes too acrid, the cartilages and bones will be eroded, as in the *scurvy, pox, &c.* When it separates in too small a quantity, the joint becomes stiff; and when with difficulty it is moved, a crackling noise is heard: as they, who are advanced in years, frequently experience. If it be deposited in too great a quantity, and the absorbent vessels do not perform their office sufficiently, it may occasion a dropsy of the joints; or it becomes acrid and occasions swellings or pains in the joints, long sinuous ulcers or *fistulæ*, rotten bones, and immobility of the joints. See these cases in *Chirurgie de AMBR. PARE* lib. 15. c. 18. *HILDANUS observat.* cent. 3. obs. 77. *De Ichere & melicaria.*

*liceria acri Celsi. GALEN de usu part. lib. 12. c. 2. AQUEPENDENTE de articul. part. utilitat. pars. 3. and HIPPOCRATES de locis in homine et de articul.*

I shall conclude this general description of the bones, &c. with an account of their number.

It is the most received opinion, that makes the number of bones 249 in the whole human body, viz.

In the head sixty.

In the trunk sixty-seven.

In the arms and hands sixty-two.

In the thighs and legs sixty.

#### The BONES in the HEAD are

In the CRANIUM fourteen; which are the *os coronale*, *os occipitis*, the two *bregmas* or *parietalia*, the two *temporal*, the *os ethmoides*, *sphenoides*, the six *auditory bones*, or the *incus*, *stapulus* and *malleus* on each side.

In the FACE are the *os hyoides*, twenty-seven in the upper mandible, the *cheek bone*, the *nail bone*, the *maxillary* or *jaw bone*, the *bone of the nose*, and the same number on the other side. The *eleventh*, which is single, having no fellow, is like a *plough share*. There are sixteen upper *teeth*, and eighteen in the lower mandible, viz. two bones and sixteen *teeth*.

#### The BONES in the TRUNK are

Thirty-two in the *spine* and twenty-nine in the *breast*; those of the *spine* are seven in the *neck*, twelve in the *back*, five in the *loins*, five in the *os sacrum*, and three in the *cocciæ* or *rump bone*. Those of the back are the four and twenty *ribs*, the two *clavicules*, and three in the *sternum*. There are also six *ossa innominata*, which are the two *ilia*, the two *ischia*, and the two *ossa pubis*.

#### The BONES in the ARMS and HANDS are

Thirty-one in each *hand* and *arm*, viz. the *shoulder-blade*, the *humerus*, *cubitus*, *radius*; eight in the *wrist*, four in the *metacarpus*, and fifteen in the *fingers*. The same number in the other arm and hand.

#### The BONES in the THIGHS, LEGS and FEET are

Thirty on each side; as the *femur*, *rotula*, *tibia*, *fibula*, seven in the *tarsus*, five in the *metatarsus*, and fourteen in the *toes*.

#### The ANATOMY of the HUMAN BONES.

Here we shall treat of the *skeleton*, which we

†

define the arrangement of the bones of a dead animal, dried, cleaned, and disposed in their natural situation by art.

The human *skeleton* of which we treat is generally divided into the *head*, the *trunk*, the *limbs*, or the *superior* and *inferior extremities*.

#### Of the HEAD.

The HEAD is defined by *Hippocrates*, a bony part, consisting of two tables, woven together with the *diploe* between them, and covered outwardly with the *pericranium*, and lined inwardly with the *dura mater*.

The HEAD is all that spheroidal part placed above the first *vertebra* of the neck, and comprehends the *cranium* which is covered with hairs, and the bones of the *face*.

The *cranium*, (gr. the helmet or brain case) consists of several pieces, which joined, form a vaulted cavity for lodging and defending the brain, *cerebellum*, membranes and vessels: and it is divided into two tables, like two *lamina* laid upon one another. Between these tables is the *diploe* or a medullary substance, full of little cells of different sizes, which receive the arteries from the brain, and transmit the veins into the sinus of the *dura mater*. Between those tables is lodged the blood, which nourishes the *cranium*, and drops through upon boring the first table with the *trepan*.

The cavity of the *cranium* is proportionate to its contents; and its *roundish* figure is chiefly formed by the equal pressure of the contents, as they grow and increase, before it is entirely ossified; but some what also to the management of nurses: to whose bandages it is owing that, amongst the *Turks* we commonly find the *scull* globular; in *Germany* the *occiput* is broad and flat: and the *Dutch* and *English* are known by their oblong shapes. A form most to be desired; because it enlarges the sphere of vision, and serves both to help the hearing and to cover the ears from external injuries.

The external surface of the upper part of the *cranium* is smooth, and equally covered with the *pericranium*, the thin frontal and occipital muscles, their tendinous *aponeurosis*, and with the common tegaments of the body. But the external surface of the lower part is all full of risings, depressions, and holes.

The internal superface of the upper part of the *scull* is commonly smooth, except where the vessels that creep upon the *dura mater* have made it otherwise, while the bones were soft, or the *cranium* moist and cartilaginous. Therefore care must be taken when we *trapan* here, that we don't wound the vessels of the *dura mater* by that operation.

In

In the upper part of the internal surface of several *sculls* are found pits of different sizes and figures. There the *scull* is so much thinner than in other parts, and it is often rendered diaphorous; the two tables in such cases being closely compacted with a *diploe*; whose deficiency is supplied by vessels going from the *dura mater* into a great many holes observable in the pits. Therefore in performing the *trepán* great care ought to be taken not to hurry too much; because in such a patient the brain may be injured before the instrument has pierced near the ordinary thickness of the *scull*.

The holes of the *cranium* give passage to the *medulla spinalis*, and to the nerves, arteries, and veins; which fill up those holes so exactly, that neither vapours nor fumes, can come into them, nor go through them, but by means of the vessels themselves.

The *diploe* found between the tables of the *cranium* has much the same texture as the *cancelli* of the bones, and contains marrow, which seems bloody, on account of the numerous vessels spread on its membranes, and its use is here the same as the *cancelli* and marrow in other bones. But the *diploe* is scarce to be found in some old subjects, nor in some of the hard craggy bones at the base of the *scull*. Therefore let not the operator of a *trepán* trust to the bleeding, want of resistance, and change of sound, for knowing when his instrument has sawed through the first table, and reached the *diploe*.

The bones of the *cranium* are already numbered. These are distinguished by the junctures called *sutures*, known by the names of the *coronal*, *lamdoid*, *sagittal*, and the true *squamous*.

The three first are indented like the teeth of a saw, and are therefore termed *true sutures*.

The *squamous* are called *false sutures*, because they join like the *scales* of fish.

Besides these *five*, called *proper sutures*, anatomists have described *four* more called *common sutures*, namely, the *transversal*, *ethmoidal*, *sphenoidal*, and *zigmatick*; which separate the bones of the *cranium* from those of the face.

The *coronal* future is so called from its circular figure, and it extends itself over the head, from within an inch or so of the external canthus of the eye, to the like distance from the other; thus, joining the *os frontis* with the bones of the *sinciput*. See plate OSTEOLOG. A. on the *scull*.

The *lamdoid* future, formed in the shape of the Greek letter  $\Delta$  *lambda* begins below and further back than the *vertex* or crown of the head; whence its two legs are stretched obliquely downwards, and to each side as far as the *base* of the *scull*. See B. *ib*.

The *sagittal* future resembles an arrow by its straightness, goes from the *coronal* on the upper part

of the head to the *lamdoid*, and joins the two bones of the *sinciput* in their uppermost part. This future is sometimes continued through the middle of the *os frontis* down to the nose. See C. *ib*. And it is found by *Vessalius* and others, sometimes to divide the *occipital* bone, as far down as the great hole, through which the *medulla spinalis* passes. See *Vessalius* in lib. 1. c. 6. *Paaw* in Cels. de *remedic.* c. 1. and *Laurent.* in hist. anat. l. 2. c. 16.

In old *sculls* these three futures are sometimes so strongly united, that they seem to be but one entire piece.

The *squamous* futures join the upper and smaller parts of the *os petrosum* with the *parietalia*, or bones of the *sinciput*. See D. *ib*. These futures are one on each side of the *scull*, seated 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*. Note, In both bones there are a great many small risings and furrows indented into each other; though these inequalities don't appear till the bones are separated; except in some few subjects; and always in the posterior part of this future.

*Vessalius* and *Winslow* remark, that the true *squamous* futures join all the edges of the bones, on which the *temporal* muscles are placed, and are not confined to the conjunction of the temporal and parietal bones. See *Vessalius's* anat. l. 1. c. 6. and the *Memoires de l'Academy des sciences* 1720.

The *transversal* or transverse future takes its name from its crossing the face from side to side; from the external *canthus* of one orbit to the same place of the other, by sinking from the *canthus* down the outside of the orbit to its bottom; then mounting upon the inside, it is continued by the roof of the nose down the internal part of the other orbit, and up again to the other *canthus*; though not without some interruption in its course.

The *ethmoidal* is so called from incircling the *os ethmoides*, which it separates from the adjacent bones. See E. *ib*.

The *sphæroidal* future is so named from its encompassing the *os sphæroides*, which it separates from the *os coronale*, *os petrosum* and *os occipitis*. See F. *ib*.

The *zigmatick* futures derive their name from their situation in the *zigoma*; they are very small and separate the *os petrosum* from the cheek bones. See G. *ib*. They are short and slanting from above obliquely downwards and backwards to join the posterior process of the cheek bone to the process of the *os temporum*, which advanceth towards the face. Thus the two processes united form a kind of bridge

bridge or *jugum*, under which the temporal muscles pass.

It must be observed, says *Monro*, that the indentations of the futures do not appear on the inside of the *cranium*, near so strong as on the outside; but the bones seem almost joined in a straight line; and in some skulls the internal surface is found entire, though the futures are manifest without.

The principal *uses* of those *futures* are reduced to the following particulars. 1. For the adhesion of the ligaments, which tie the *dura mater*. 2. For a passage to the vessels, which go in and come out of the *diploe*. 3. To help perspiration; for where the futures of the *cranium* are too much closed, there the head is subject to intolerable pains; for want of a due perspiration. For further satisfaction consult *Monro's* anatomy of the bones, page 71.

The BONES of the CRANIUM are next to be considered and explained.

They are divided into *proper* and *common*.

The *proper bones* are the *os coronale*, or *frontis*, *os occipitis*, the two bones of the *sinciput*, and the two *parietal* bones.

The *common bones* are the *os sphenoides* and *os ethmoides*.

The *os coronale* or *frontis* takes its name from its situation. It is placed in the uppermost part of the face, and the foremost of the *cranium*, and makes the forehead or front: and it is bounded above by the coronal future, and below by the transverse. By the first it is joined with the bones of the *sinciput*, and by the second to those of the nose and cheek; as well as to the *sphenoides* by the *sphenoid* future.

This bone has some resemblance in its shape to the shell of a cockle; for the greatest part of it is convex externally and concave internally, with a ferrated circular edge; though the smaller part has processes and depressions, which make it of an irregular figure.

Its *external* surface is perfectly 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 two external; which from this situation may 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. Just above the internal extremity of those *superciliary* ridges is a protuberance in most skulls, where the bone is protruded to make a room for two large cavities. Between the internal regular processes rises a small process, which helps to form

the nose, and so is called *nasal*. From the under part of the *superciliary* ridges, the *os frontis* runs a great way backward, and hence those parts are termed *orbital* processes; and 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 the *glandula innominata Galeni*, or *lacrymalis*, is lodged.

Behind the internal angular processes a small pit may be remarked, where the cartilaginous pulley of the *musculus obliquus major* is fixed.

Between these two *orbital* processes a large discontinuation of the bone is to be seen, into which the cribriform part of the *os ethmoides* is incased, and the *frontal* bone, where it is joined to the *ethmoid* has frequently little caverns formed in it.

Behind the external angular processes the surface of the *frontal* bone is considerably depressed, where part of the temporal muscles are placed.

The *foramina* or holes observable on the external surface of the *os frontis* are three in each side.

One in each *superciliary* ridge, a little remove from its middle towards the nose; through which a twig of the *ophthalmick* branch of the fifth pair of nerves passes out of the orbit, with a small artery from the *carotid*, to be distributed to the teguments and muscles of the forehead.

In some subjects instead of a hole, only a notch is to be seen. And in others nothing of the hole is left: But in others both hole and notch are observed, when the nerve and artery run separate. Sometimes a hole is found on one side and a notch on the other: Again sometimes there are two holes; or one common hole without, and two distinct entries internally. Near the middle of the inside of each orbit, near or in the *transverse future* there is a small hole left for the passage of the *nasal* twig of the first branch of the fifth pair of nerves. This hole is sometimes entirely formed in the *os frontis*; sometimes the sides of it are composed of this last bone and the *os planum*; and it is commonly known by the name of *os orbitarium internum*, tho' *posterius*, says Dr. *Monro* should be added, because of the next which is generally omitted.

This which may be called *os orbitarium internum posterius* is like the former, only smaller, and about an inch deeper in the orbit. Through this a small branch of the internal *carotid* artery, sent off before it pierces the *dura mater*, passes to the nose.

Besides these six there are a great number of small holes observable on the outward surface of this bone, as on the eye brow; under which the *sinuses* are. But few of these penetrate further than the *sinuses*, or than the *diploe*, where the *sinuses*

es are wanting. Dr. *Monro* writes that he has seen the *os frontis* so perforated by a vast number of these small holes, that placed between the eye and a clear light, it appeared like a sieve; and he adds, that in the orbit of the generality of *skeltons*, we may observe, are two or more holes, which allow a passage to a hog's bristle through the scull; that their number is uncertain, and that 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 support the *anterior lobes* of the *brain*. This surface is not so smooth as the external.

The *sinuosities* from the luxuriant risings of the *brain* are often observed on its upper parts; and its lower or 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 frequently 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: therefore, on both these accounts chirurgical authors justly discharge the application of the *trepan* here. *Monro* is of opinion that this variety may be owing to the different times of a complete ossification of these parts in different subjects. (*ib.* 78.)

Immediately at the root of this ridge or furrow is a small hole, which sometimes pierces through the first table, and in other sculls opens into the superior *sinus* of the *ethmoid* bone within the nose. In this is lodged a little process of the *falx*, and a small artery, and sometimes a vein runs; and the superior longitudinal *sinus* begins here.

This hole however in some sculls is found with its lower part formed in the superior part of the base of the *crista galli*, which is a process of the *os ethmoides*.

The *diploe* is also exhausted in that part above the eye brows where the two tables of the bone separate by the external's being protruded outwards to form two large cavities, called *sinus frontales*, which are divided by a long perpendicular partition. But their capacities are seldom equal in the same subjects; and in different bones they sometimes are not to be found.

Each *sinus* commonly opens by a roundish small hole, at the inner and lower part of the internal angular processes, into a *sinus* form'd in the nose, at the upper and back part of the *os unguis*; near to which, according to *Cowper*, there are some other small *sinuses* of this same bone, the greater part of which open separately near the *septum narium*,

and often terminate in the same common channel with the large ones.

In a natural and sound state the cavities are of great advantage; by this enlargement of the organ of *smelling*, the effluvia of odoriferous bodies will with more difficulty escape it. Again, these and other cavities, which open into the nose increase the sound of the voice, and render it more melodious, by serving as so many vaults to resound the notes: and the want of these cavities is ordinarily the cause of a disagreeable voice.

This is sufficient to shew the danger of applying the *trepan* on this part of the scull; because instead of penetrating to the scull, it could reach only to the *sinusses*: besides other inconveniencies and dangers.

The upper circular part of the *os frontis* is joined to the *ossa parietalia* from one temple to the other, by the *coronal future*: and from the end of the *coronal future* to the external angular processes it is connected to the *sphænoïd* by the *sphænoïdal future*. At the external *canthi* of the eyes, its angular processes are joined by the *transverse future* 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 upon the internal sides, those orbital processes are connected to the *sphænoïdal* bone by that same future in most subjects.

On the inside of each orbit the orbital process is indented between the cribriform part of the *ethmoid* bone, and the *os planum* and *unguis*: the *transverse future* afterwards joins the *frontal* bone to the superior-nasal processes of the *ossa maxillaria superiora*, and to the *ossa nasi*. And finally, its *nasal process* is connected to the nasal lamella of the *ethmoid* bone.

The second bone of the CRANIUM is *OS OCCIPITIS*. This bone is opposite to the *os frontis* or *coronale*: and is the hardest in the scull. It is of an oblong figure, composed of five sides or two circular lines that terminate in a point; placed on and inclosing all the binder part of the head; bounded by the *lambdoid* and *sphænoïdal* futures; by which it is joined to the bones of the *sciput* and the *os sphænoïdes*.

The solid parts of this bone are two processes received into the *glanoid* cavities of the first *vertebra*, and join the head with the spine by *synarthrosis*.

The hollow parts are divided into two *common*, and five *proper* holes. The *common holes* are found, one on each side the *os petrosum*, and give passage to the *nervi vagi*, and to the internal jugular veins. The *proper holes* are, first, that single large hole through which the *medulla spinalis* passes, and also

the *vertebral arteries*, which slip into a little notch behind the *condyli* of the *os occipitis*, as they pierce the *dura mater*: two others give passage to the ninth pair of nerves, which distribute themselves wholly in the tongue; and the two last are an opening to let the vertebral veins come out.

The *os occipitis* hath four *pits*, two lower ones, which are the greatest, and serve to lodge the *cerebellum*; and two upper and smaller, and contains the posterior lobes of the *brain*, separated from the *cerebellum*, by a *transverse* inclosure, formed by the *dura mater*; to hinder the *cerebellum* from suffering compression.

The *third* and *fourth* bones of the *cranium*, are those of the *Sinciput*, and called *ossa parietalia*. from their being a kind of *wall* to the *head*; the sides whereof they possess entirely; they surpass in magnitude all the other bones of the head; are of a square figure, and joined together in their upper part, by the *sagittal* future; in their anterior part to the *os frontis*, by the coronal to the *os occipitis*; in their under part, by the *lambdaide*, and to the *os petrosum*, in their lower, by the *squamous* future.

These bones have their external surface very smooth; but their internal is unequal, by reason of the impressions that represent the upper side of a fig-leaf, and which have been made by a branch of the external *carotid*, which makes a kind of wrought-work on the *dura mater*, that covers all which lies under these bones. See *ib.* M. on the *scull*, and M on the *fig.* at the tip of the *jaw*.

They have each a little hole near the *sagittal* future, through which pass the branches of the external *jugular*, to receive the superfluous blood that could not be used in nourishing the teguments, and to dispose it into the longitudinal *sinus* of the *dura mater*.

The *fifth* and the *last* bones of the *cranium*, are those of the *temples*, (*NN* *ib.*) divided, by the *Anatomists*, into an upper part, which is semicircular; and an under part, which resembles a rock. They are placed on the side, and the lower part of the head, and circumscribed upward by a future, called *false* future, and thereby united to the bones of the *sinciput*; behind, to the *os occipitis*, by the *lambdaide* future; and forward and below, with the *os sphenoides*, by the *sphenoidal*. See the *fig.* of the *scull* and the *piece* marked N.

The parts of these bones are *prominent* and *hol-low*. The protuberant parts of the *os petrosum*, are their internal or external processes. The internal are two, one on each side like a great rock, in which are the *auditory* cavities, and the four little bones that belong to it. The external processes are three, the *mastoides*, the *apophysis styloides*, and the

*zigomatick* processes, which by advancing outwardly, and joining to the eminence of the *os malum*, form the *zigoma*.

The bone of the *temples* hath five holes, four external and one internal: This last is internal, and called the internal *auditory* hole. The first of the external holes, is the external *auditory*, otherwise the conduct of *bearing*. The second is called the oblique hole, it is large and of an oval figure, it opens obliquely into the canal or bony *sinus*. The third is a little hole found at the bottom of two processes, between the *apophyses mastoides*, and the *styloides*, through which comes forth the hard part of the *auditory* nerve; and the fourth of the external holes, is the canal of communication, which opens to the barrel of the *tympanum*.

The *pits* are likewise *internal* and *external*; the internal are two, and make the middle cavities of the *basis* of the brain. The *external*, which are two also, serve for the articulation of the lower *mandible*. The *Sinuses* are two; one in each of the *apophyses mastoides*.

In this rock which forms the *os petrosum*, there are four little bones, as you will find by the figure *ib.* marked O. P. Q. the *malleus*, (O) *incus* (P) *stapes* (Q) and the *os orbiculare*, which are thought as hard and as big at first, as ever they will be during the whole life; nevertheless they grow stronger with age, and are really harder at the end than they were at their first formation; though all of a *cartilaginous* nature.

In this rock there are three cavities, the *drum*, the *labyrinth*, and the *shell*. In the first of these cavities are placed those four little bones which are articulated together, so that the process of the *malleus* is tied to the *tympanum*, and articulated by its head in the cavity of the *incus*. The *incus* or anvil hath two legs, whereof the shortest is placed on the *tympanum*, and the longest on the *stapes* or stirrup. The *stapes*, whose two branches are placed on a large *basis*, receive the little tubercle of the *incus* by its sharp and external part. In infants is found a bone called *orbiculare*, (R in the piece under the foregoing *piece*.) It is circular like a ring, on which the *tympanum* or drum is stretched, as the skin of a drum is stretched on a barrel. This bone, discovered by *Silvius de la Boe*, is tied by a small ligament to the *lateral* and upper part of the *stapes*.

The *os sphenoides* (S in this *fig.* on the upper right hand corner) is the first of the two bones that are common to the *scalp* and the *face*. It is thick in its *basis*, and very thin in the cavity of the *temples*; it is sufficiently large and hard, and accounted but one bone, although in infants it may be divided into four. It is of such an extent that it touches

all the bones of the *head*, and many of the upper *mandible*, with which it is united by a part of its future. The *sphænoides* hath, like the other bones of the head, its holes, pits and *sinus*.

It hath six holes. The *optick* through which the optick nerve passes. The great cleft in the *orbit*, through which the nervous branches of the 3d, 4th, 5th and 6th pass, together with the blood-branches of the *carotide* and *jugular*. Its third hole is under the aforesaid cleft; it is round, and gives passage to some of the branches of the fifth pair of nerves, but they are its lower branches. The fourth is a bony channel dug into the *os petrosum*, which goes obliquely to the saddle of the *os sphænoides*. In this channel or bony *sinus* the internal *carotide* lies, which rises thence towards the saddle. The fifth hole is the oval cleft, that lets the great branch of the fifth pair of nerves, which is the hinder branch, come forth. The sixth hole is a little round one, through which passes a branch of the external *carotide*, that make the resemblance of a Fig-leaf on the *dura mater*, under the bone of the *sinus*.

Its pits are three in number, one internal on the saddle of the *os sphænoides*, and which serve as a basis for the *glandula pituitaria*; and two external placed in the *apophyses pterygoides*.

In the middle of the *os sphænoides*, under the saddle, are found two *sinuses* separated by a bony *lamina*, which open in the nose. These two *sinuses* are invested with a membrane altogether glandulous, and always covered with a *mucus*, because the little glands of this membrane separate from the blood a *serum*, which acquires consistence by its continuance in the *sinus*, and when they are full of it, this *mucus* is thrown out at the apertures into the hole, by mixing with the *snivel* it there meets.

The *Ethmoides* (T *ibid.*) is the last of the bones that are common to the scalp and face. It is the smallest of all the bones that compose the *cranium*, and is joined to the *os caronale* in its upper part by a common future called *ethmoidal*; and by the *sphænoidal* to the *sphænoides*. It is divided into three parts; the upper or sieve-like part, which hath abundance of little holes; the lower, which is spungy, and separates the cavity of the nostrils in two; and into lateral parts which are full and flat, and make part of the *orbit*.

This bone hath a prominence called *crista galli*; because it resembles the *comb of a cock*; it is very hard, and part of the *dura mater* is tied to this place called *falx*, which *falx* or *scythe* divides the *brain* into two parts.

From the BONES of the HEAD we proceed to those of the FACE.

The FACE consists of two *mandibles* or *jaws*, *viz.* the upper jaw which comprehends all from

the eye to the bottom of the upper lip; and the lower jaw which extends from the top of the under lip to the end of the chin.

The upper jaw hath no motion, the lower, on the contrary, is moveable, since mastication is its office.

There are eleven bones in the upper jaw, five on each side, and one in the middle, *viz.* the bone of the nose, the *os unguis*, the *pometta*, the jaw-bone, the bone of the palate or roof of the mouth, and the share-bone. These bones are separated from the *cranium* by common futures, and joined together by *harmonia*, which is the cause that they have no motion.

The bones of the nose, (A in the *head* at the feet of the *first Skeleton*, *ib.*) tho' they be very thin, are of a solid substance; they are very small, and of a pyramidal figure; they are placed on the upper part of the nose, and compose what is called its *bridge*. These bones are terminated above by the transverse future, whereby they are joined with the *os frontis*, and on the sides by two *harmonia's*, that is, one of those futures joins them together, and is in the middle of the nose; and the other unites them with the two jaw-bones. These bones are smoother in their outward surface than they are in the inward, and their lower part is unequal and in slits, that the cartilages may the better stick to them.

The *French* call *os unguis* (B *ibid.*) two bones of the bigness and figure of a nail, placed at the great corner of the eye; they are of a thin substance like a scale, and the smallest bones of the upper jaw. These bones touch four other bones, the *os frontis*, the bone of the nose, the jaw-bone, and that part of the *os ethmoides*, which forms the orbit of the eye, though they hold fast to neither of those bones, and are seldom found in a *skeleton*; being easily lost in the boiling.

The bones of the cheeks which are the fifth and sixth bones, are very large, and of a hard and solid substance; their figure is triangular, their middle part is a little prominent outwards, and round like an apple. These bones compose the cheek and the lower part of the *orbit*; and are fastened to the *os frontis*, the *sphænoides*, the jaw-bone, and the *os petrosum*. Each of them hath three processes, one forms an eminence, which, rising upwards, makes the little corner of the eye; another advancing toward the nose, makes the greatest part of the lower eyebrow of the *orbit*, and the third joining with a prominence of the *os petrosum*, helps towards the formation of the *zigoma*.

The jaw bones (D *ibid.*) are the greatest of all the bones of the face, and the most spungy. They make some part of the cheek, contribute to the formation of the inferior part of the orbit; com-

pose the greatest part of the palate, and articulate all the upper teeth. They are situated on the side, and under the bones of the *os mala*, possessing the inferior part of the upper jaw; and they touch the bones of the nose, the palate, the *os mala*, and those of the *orbita*.

These bones have also their holes, pits; and *sinus*. Their holes are internal and external; of the internal, which are four in number, two are called incisives, because directly under the teeth *incisores*; and the two others are placed on the lateral and posterior parts: the two external ones are called holes of the orbit, the nerves of the fifth pair pass through them, and are distributed into the face. There are sixteen pits in each jaw, which are the *alveoli*, in which sixteen teeth are fastened; and two *sinus* in each, situated along the extremities of the roots of the teeth.

The two bones of the *palate*, (E in the adjoining *fig.* of the internal structure of the face) which are the ninth and tenth bones of the upper jaw, are situated at the bottom of the palate, and make the deepest part of the roof of the mouth; they are joined together by the suture of the palate, which advancing forward near the *dentes incisores*, unite also the two jaw-bones: they are likewise fastened to the *apophyses, pterigoides*, by the *sphænoïdal* suture. Each of them hath a hole called *foramen gustavium*, through which passes a branch of the fifth pair of the nerves: these bones are very hard, but so small that they make but the least part of the palate; they are almost square, being a little bigger than they are long.

The bone which divides the nostrils into two, is called the *plough-bone* (F *ibid.*) from its resemblance to the coulter of the plough; it is the eleventh bone of the upper jaw, is placed in the middle, above the palate, is hard and small, is a single bone, and is joined with the *os ethmoides* and *sphænoïdes*, which have both some small eminences that are received in the cavities of the plough-bone, and which thereby strengthen in its position.

The ORBITS (GG in the *fig.* of the *outside*) of the eye, situated at the lower part of the forehead, appointed for a mansion to the eyes, and to defend them against all that may offer to hurt them; are of a pyramidal figure, and composed of six different bones, which, altogether, form their extent and depth. Of these bones there is one proper to the *orbit*, which is the orbitary-bone, situated in the great corner of the eye; and five common, as the *os frontis*, which forms the superior part of the *orbit*, and serves for an arch to it; the *ethmoides*, which makes the lateral part of it, towards the nose; and the *sphænoïdes*, which form the most inward part of it; these three bones belong to the

*cranium*. The bone *de la pomette*, makes that part which is near the little corner of the eye; and the jaw-bone, that which is next the great corner.

The ZIGOMA (HH in the *fig.* of the *inside face*) is a union or coalition of two prominences of bones, whereof one comes from the temporal-bone, and the other from the cheek-bone: these prominences are joined by a small oblique suture; these two bones form an arcade, which hath two very considerable uses; one is to give passage to the muscle *crotaphytes*, and to serve for a defence to it; and the other is to give rise to the muscle *masseter*, whose office is, with the *crotaphites*, to help the mastication.

The lower jaw (II in the *outside face* and the separate bone marked I.L.L.) consists of two bones until the seventh year of age, after which they turn into one, joining together in their anterior and middle part by *symphysis* without a medium. They serve for *basis* to sixteen teeth articulated into them; their substance is very hard, that they may be strong enough to bite and chew.

The TEETH (L *ibid.*) are defined small hard bones, white and smooth, articulated in the jaws by *Gomphosis*.

They have no *periosteum*, and therefore have no sense of pain, but only at their root where the nerve enters.

Although the *teeth* exceed all the bones of the body in point of hardness, they nevertheless consume by their continual action and friction against one another; for which, cautious nature has given them vessels to convey them a matter, to nourish and repair them.

The time is not certainly fixed by nature for the expulsion of the teeth; some infants have had some teeth from their birth, and some not till they are a year or two old. Neither do the teeth come forth all at a time. Nature expels them one or two at a time; if they come three or four together, it is always very dangerous.

The infants have commonly twenty teeth in twenty months, which is all they ought to have at that age, the rest not coming forth for some years after.

The twenty first *teeth* are called the *milk-teeth*; they commonly fall, toward the sixth or seventh year, and then four more appear behind the former: at fourteen there comes four more; and four more at twenty; which put together, make up the whole number of *thirty-two*.

All the *teeth* are ranged in order, one by another, although sometimes there will happen a double row of them, which is a vicious confirmation, because it is both a deformity, and inconvenient.

Every

Every tooth hath its cavity in the middle, where the nerve is inserted. In that cavity a certain acrimony is sometimes found, which corrodes and spoils the tooth; and not worms, as vulgarly supposed.

The *teeth* have three different uses; the first and chiefest is for mastication; the second, to distinguish the voice; and the third for ornament.

The **TEETH** are divided into *incisores*, *dog-teeth* and *grinders*.

The **INCISORES**, (MM in distinct pieces under the *small Skeleton A.*) so called, because they cut the meat like a knife, are eight; four in each jaw, placed before the rest outwardly, and in the middle of the others. Their outward surface is like an arch; and the anterior is hollow; they are sharper and shorter than the rest; and each hath but one single root which terminate in a point.

There are four **DOG-TEETH**, (N in the adjoining *fig.*) two in each jaw; they are called *dog-teeth*, because they break the hardest bodies. Their situation is next to the *incisores*, one on each side; they are thick, strong, and solid, fastened in their *alveoli*, by single roots, like the *incisores*, but deeper; for they exceed all the rest in length. The upper *dog-teeth* are called *eye-teeth*; because part of the nerve, which moves the eye, is ramified, or branched toward them.

There are twenty *grinders*, (OO *ibid.*) ten in each jaw, and five on each side; they are large and hard, and encrease in bulk, according to their deeper situation in the mouth; they have divers roots, which serve the better to fasten them in their *alveoli*. The lower *grinders* have but two or three roots, and the upper ones three or four; because those upper ones being in a hanging position above, have occasion of a greater quantity to keep them fixed and firm.

The *os hyoides*, (P in the single piece or bone marked P only) the last of the sixty bones of the head, is placed at the *basis* of the tongue, upon the *larynx*, and kept in its place by ten muscles. It touches no other bone, but is tied above by bones, called its superior *cornua*, to the two *apophyses styloides* of the bone of the temples, by small *ligaments*; and below, at its inferior *cornua*, it is joined unto the two wings of the *cartilage theorides* of the *larynx*, by ligaments of the same nature with those that tied its upper part, which is a true *synneurosis*. This bone is composed of five others, the greatest of which makes the *basis*. It resembles the *Greek*  $\psi$ ; and the *basis* is arched outwardly, and hollow within. Two other lesser bones are united to this, one on each side; and two very small ones are joined at the end of these last; which four bones makes the sides of the *os hyoides*, and what we call the *cornua*.

The principal use of this bone, is to facilitate the admittance of air into the *aspera arteria*, and the passage of meat and drink into the *œsophagus*, by keeping the *pharynx* in that just bigness it ought to have for the free passage of the nourishment.

### Of the TRUNK.

From the bones of the *cranium*, I descend gradually to those of the **SPINE**.

The **SPINE**, is a complex of many bones articulated together, to serve for habitation and rampire to the marrow. It is divided into five parts, the neck, the back, the loins, the *os sacrum*, and the *coccyx*. If the *spine* be considered before, or behind, it appears direct and strait; but if on either side, it falls inward, or outward, both for its better support, and to remove from, or to approach to the part of the *thorax*, and the *abdomen*.

The sharp end of the *spine*, at the neck, bends inwards, the better to sustain the head which is there placed, as on a *pivot*.

The *spine* (A in *fig.* of the *back-bone*) serves to support the body, for the insertion of several muscles, and for the conveyance of the marrow. The parts it is composed of are called *Vertebræ*, from *verto* to turn, because the body turns several ways by their means.

Each of the *vertebræ* hath its body in its internal part, wherewith they support one another. They have all a great *foramen*, through which the *medulla spinalis* passes; all three sorts of processes, four oblique, two transverse, and one acute; and all five *epiphyses*, or appendages, *viz.* two at their body, two at the extremities of their transverse processes, and one at the end of their acute process. They are likewise all pierced through on their sides, for the passage of the nerves, that come through them; *i. e.* that two *vertebræ* make a hole between them, but one half of the hole appearing in each of them, the other half being hidden in the cartilage, which ties two *vertebræ* together.

There are seven **VERTEBRÆ** in the *Neck* (B *ib.*) more solid and harder than those of the back, (because their office is to support the head, which is a very weighty part) though they are smaller, for were they as big as those of the back and loins, the neck had not been able to move so easily as it does.

The first of these seven *vertebræ* is called **ATLAS**, (C in the *fig.* adjoining marked C) because it supports the head, which being of a round figure resembles the world, which the ancient poets have feigned to be borne by Mount *Atlas*. This *vertebra* hath no acute process, because the head don't move upon it, but upon the second; and because

because it being obliged to turn as often as the head has a circular motion, an acute process would have discommoded the posterior muscles of the head, especially the two little right muscles which rise from the second *vertebra*, and are inserted in the *occiput*.

This differs from the other *vertebra*, in that it is of a more delicate, thinner, and harder substance, and that it receives at both its extremities while the others receive on one side, and are received on the other; for two prominences of the *occiput* enter into its two superior cavities, whereby it is articulated with the head; and, at the same time, two other prominences of the second *Vertebra* enter its two inferior cavities, which join them both.

The articulation of the head is made on the anterior part of this *vertebra*, not on its posterior, that it may be the better supported, and the better kept in its *æquilibrium*. This *atlas* giving passage to the *medulla spinalis*, as all the other *vertebræ* do, and receiving besides the tooth of the second, which passing thro' it, unites itself to the *os occipitis*; its aperture must be greater than that of the rest.

The head and the first *vertebra* turning upon the second as on a pivot, it is called for that reason the wheeling *vertebra*, (*see* the next *fig.* marked D) and from the process, which rises from the middle of its body, in the form of a tooth, *dentata*. This process would expose the *medulla spinalis* to some dangerous compression, was not the second *vertebra* invironed with a strong, solid and curious ligament; other particular ligaments join it with the first *vertebra*, and tie them both strongly to the head.

The third *vertebra* is called the *axis*, (*see* the next *fig.* marked E) because it begins to form a body, on which the two former *vertebræ* and the head are supported, as on an axle-tree. The four following have no particular name. There is only this to be observed, that the last hath no acute process forked like the others, and that it begins to assume the figure of the *back*, (F in *fig.* of the *Back Bone*) which is composed of twelve *vertebræ*, larger than those of the neck, and smaller than those of the loins; tho' they are not at all equal, becoming larger and stronger in proportion as they descend lower. They are all of a pyramidal figure; have their processes spiny, simple and acute, which rest upon one another; their transverse processes very large, for the articulation of the ribs fastened to them; for each *vertebra* of the back articulates two ribs, both by its body and its transverse processes.

The first of these *vertebræ* (G in *fig.* adjoining marked G) being higher than the rest is called *eminent*; the second *axillary*, from its being nearest to the arm-pit. The eight following, articulating those ribs inwardly invested with the *pleura*, are called both *costal* and *pleuretical*. The eleventh (H in the next *fig.* marked H) is called the *Direct*, because its acute process don't bend downwards to rest upon the next below; and the twelfth, *Girdler*, from its being situated in the place where girdles are worn.

The *vertebræ* of the *loins*, (I in the *fig.* of *Back Bone*) because they support all the rest, are thicker and larger than those of the back; have not their articulations so close and compact, that they may be free in their motions, and we able to stoop with more ease: have their processes longer and finer, which serve there instead of ribs, the first and fifth of them excepted, which have them shorter. Those processes are nine in number, the ascending ones which articulate them together being double. Their spines are also thicker and larger, the better to fasten them to the muscles and ligaments of the back.

The *reins* or *kidneys* being placed on the side of the first of these *vertebræ*; or because, perhaps it is in that place that the *nephretick* pain begins to be felt, is called *nephretick* (L in the next *fig.* marked L) or *Renal*. The three following next have no particular name; and the fifth, which is the prop and support of the whole spine, is called *ασφαλτίτις*.

If the *Os SACRUM* (M in *fig.* of *back bone*) derives its name from its being offered in sacrifice to the Pagan divinities, or from its bigness, or from its enclosing the *puenda*, is what must be very indifferent to us. The truth is, that the *os sacrum* is a great, large, and immoveable bone, which serves for a basis to the spine. Its figure is triangular; its being hollow within serves to form the *pelvis*, a cavity situated in the lower part of the *hypogastrium*; and, for the better insertion of the muscles, its posterior part is convex and unequal. This bone hath three different articulations; the first with the last *vertebra* of the loin, like that of the other *vertebra*; the second by *synchondrosis*, with the *coccyx*, and the third with the *ossa innominata* by an indenting.

The *Os Sacrum* (N in the separate adjoining *fig.* marked N) is divided into five *vertebræ* of a different bigness, the superior thereof is the biggest, and which in adults are so strongly united, that they make but one bone, the better to support the whole spine, and to articulate the *ossa innominata*.

The *Coccyx*, (P in the *fig.* of *Back-Bone*) so called,

called, because it resembles the beak of a cuckow, is the last extremity of the *spine*, it is composed of three bones, the greatest of which touch the *Os Sacrum*, the second is less than the former, and the third is very small, at the whole end is fastened a small cartilage; they are all three joined together by a very loose connection, which makes them pliant, and to draw back easily behind. In women they jet outward more than they do in men, because they want a greater cavity to inclose the *matrix*, and to contain the infant during their pregnancy. The end of these bones (Q, in the adjoining *fig.* marked Q.) always bends inwards, that it may be no inconvenience in setting, but they draw backwards a little, for the better extrusion of the excrements, as they do in women at the time of their delivery, (R *ib.*) to facilitate a passage to the infant.

From the *Coccyx* we come by a necessary retrogradation to the THORAX, or *Breast*, from ἀπὸ τοῦ Σοῦῶ, which is that part of the human body which forms the capacity of the *Breast*: Its figure is oval, especially when the *diaphragma* moves downwards, terminated above by the *clavicles*, before by the *Sternum*, behind by the *vertebræ* of the back; on the sides by four and twenty ribs; and below by the cartilages of the *costæ nothæ*, and the cartilage *xiphoides*.

The larger and deeper is the cavity of the *thorax*, the parts contained therein move with greater facility, and we are supposed to live longer. It is composed with the *sternum*, the ribs, and the *clavicles*.

The STERNUM (A see the *fig.* of the ribs, &c. under the face) is all that anterior part of the *thorax*, which, above, touches the *clavicles*, and ends below at the *cartilago xiphoides*, and laterally both on the right and left is joined to the ends of the ribs before. Its body proceeds forward, but bends towards the ribs, in order to form the round and oval figure of the *breast*, on which it appears, as if couched.

In Adults it consists of one single piece or bone, but in infants of several, according to the diversity of age; if we believe *Kirkringius*, it never exceeds six, though Mr. *Dionis* pretends he has found eight, in some infants, which, by growing together, are reduced to four, and commonly to three.

The first of those three bones (B) is the superior one, larger and thicker than the rest. It hath a *sinus* on each side of its upper part, which receives the head of the *clavicle*, to which it is joined by a cartilage; and the other sinous cavity found in the middle of its internal and superior part makes room

for the *trachea*. The second (C) is placed under the former, is straiter, and thinner, but longer, with divers *sinus*'s on both sides, which receive the cartilages of the ribs that articulate in them. The third (D) is still less in length, but thicker; it is placed under the two former, and ends at the *cartilago xiphoides*.

This CARTILAGE, (E) so called, because it ends like the point of a sword, is commonly triangular and oblong; sometimes it is round, and sometimes divided in two: whenever it sinks inwardly by some stroke or fall, it occasions vomiting, which ceases not until it is restored to its proper place. This cartilage serves to defend the stomach, to tie and fasten the *diaphragma*, and to support the liver before by a large ligament that's tied unto it. These three bones are joined together by cartilages, which serve instead of ligaments to them. They also form a cavity, which appears outwardly, and is called by the vulgar, *the pit of the heart*.

The *sternum* forms the anterior and middle part of the *breast*, joins and articulates the *costæ* and the *clavicles*, contains and defends the heart and the parts for respiration, and fastens all along its middle and internal part to the *mediastinum*, which is a membrane that divides the *breast* into two parts.

The COSTÆ or *Ribs* (FF *ibid.*) form the two sides of the *breast*. Their substance is partly bony and partly cartilaginous, which cartilages serve them instead of *epiphyses*. Their figure is concave within to form the capacity of the *breast*, and convex without to resist any accident. The further they are distanced from the *sternum*, they become narrower and round: flatten, and are larger the nearer they approach unto it. The upper *ribs* are shorter than the middle ones, and the lower very small, which difference is necessary to form the arch of the *breast*. The *ribs* are articulated at the extremities of their anterior part with the *sternum*, by *synchondrosis*, and by *anthrodia* at their posterior with the *vertebræ*.

There are twenty-four *ribs*; twelve on each side; and divided into *true* and *false ribs*. The *true ribs* are the seven upper, and the last five are the *false* ones. The *true ribs* touch the *sternum*, (H *ibid.*) with which they have a strong articulation, and the *false ones* below don't touch the *sternum*, and have but a very slack articulation, though they are fastened to the *vertebræ* behind; but, before, they terminate in long and soft cartilages.

The use of the *ribs* is to form the capacity of the *breast*, to defend the parts: they inclose, and to give origin and insertion to several muscles.

The two bones, which shut the superior part of the *thorax*, and fasten the *sternum* to the shoulders

ders, are called *CLAVICLES* (LL *ibid.*) There is one on each side, and they both have a transverse situation at the lower part of the neck, and upper part of the breast a little above the first rib. Their substance is thick but porous and fungous; whence it is that they are often fractured, and when fractured, sooner reunited than any other bone. Their figure is like an , convex outwardly towards the neck, and a little concave inwardly, that the vessels under them may not suffer compression. The *clavicles* help the different motions of the arms, which move easier backwards and forwards, because supported on these bones, as upon a basis; they are likewise of great use to hinder the arms from too great an extension forwards.

The *HIP-BONES*, (NN *ibid.*) or *Osfa innominata*, form the last part of the trunk of the body. There are two *hip-bones* one on each side, articulated at their posterior part by *ginglymus* with the *os sacrum*; and at their lateral with the *femur* by *enarthrosis*.

These bones have this common with all the other bones, that, like them, they serve for the insertion of the muscles, and for support to the whole body; with this difference that they serve also to tie the inferior extremities with the trunk, to support the spine, to help to form the capacity of the *abdomen*; and for a basis to the parts, and couch to the parts contained in the *hypogastrium*.

These bones consist of three different bones, which are the *os ilium*, *ischium*, and *os pubis*, joined together by cartilages, which remain such till about the tenth or twelfth year of age, but grow drier with time, till they become so bony that they seem to make but one bone with the others in adult persons.

The *OS ILIUM* (O see the *fig.* mark'd O, P, Q) so called, because it contains the intestine, *Ilium*, being the greatest of the three, offers itself first; it is articulated with the *os sacrum* by *ginglymus*, strengthened by a cartilage, and a very strong membranous ligament.—Its figure is semicircular, having two surfaces, the one internal, filled with one of the *musculi flexores femoris*; and the one external where the *musculi extensores femoris* are inserted.

The *costa* placed between these two surfaces is bordered with two *lips*, one whereof is likewise internal, and the other external. The two extremities of this *rib* end with two prominences called *spines*, of which the upper is much greater than the lower. Near to this last, which is placed before, is seen an indenting or notching that facilitates the passage of the tendons of the *musculi iliaci*

and *psaos*; of the crural veins and arteries, and of the spermatic vessels.—With its lower part it forms a part of the cavities, which receives the head of the *os femoris*.

This bone is larger in women than men, for the support of the infant in the *matrix*; and near this bone women with child often feel a pain, occasioned by the weight of the infant.

There are three parts to be considered in the *Os ISCHIUM* (P. *ibid.*) Its upper, which makes the greatest part of the *cotyla*; its anterior, which makes part of the *foramen ovale*; and the lower, in which two processes are observed, the one behind, called the *Spine Process*; and the other before, and below.—There is likewise seen a *sinus* or cleft, which gives passage to the *obturator internus*.

This bone is annexed to the *os sacrum* by a double ligament that rises from it; one is inserted in the acute process of the hip; and the other behind at its appendage, which supports the *rectum intestinum*.—Its extremity, called the tuberos part of the *ischium*, gives rise to the muscles of the *penis*, the *levatores ani*, and many of the *flexores femoris*.

The *OS PUBIS* (Q, *ibid.* and also in the *first Skeleton*) called also *Os Pelvina*, is situated at the middle and anterior part of the trunk. Its fore part is joined by means of a cartilage with its fellow; its back part forms one part of the *cotyla*. Between this part and the extremity of the *os ilium*, the *sinus* is placed, thro' which the tendons of the *musculi lumbares* and *iliaci* pass. The muscles of the *abdomen* are inserted in the upper part, otherwise called the *spine*; and the lower is joined with a prominence made by the tuberos part of the *ischium*, both which prominences make the *foramen ovale*; into which prominences there are many muscles inserted. The *musculi obturatores femoris*, which serve to move the thigh semicircularly inward or outward, are annexed to a strong, tendinous membrane, that shuts intirely this hole.

The *os pubis* are slenderer and larger in women than men; and those, who have them advanced more outwardly, undergo their labour the easier; the cartilage, which joins the two *os pubis* together, is of a pliable substance, and in hard and painful labours may be distended a little, but not to facilitate alone the delivery of the *Fœtus*.

#### Of the EXTREMITIES.

The extremities are upper and under, both the one and the other are like so many branches springing from the trunk, and growing to it; the first

are the hands, and the second the feet. We'll begin with the BONES of the HANDS.

The HANDS are divided into three parts, the arm, the cubit, and the hand.

The arm consists of one bone only; the cubit of two; and the hand of twenty seven.

But we must examine, first, the scapula, or shoulder-blades, comprehended in the number of the sixty-two bones that compose the arms.

The SCAPULA, (A see the fig. of the Arm and Hand) or shoulder-blade, is the bone that forms the shoulder, defined, a large and slender bone, especially in the middle, and thick in the processes: It is situated at the hind part of the upper ribs, where it serves instead of a buckler to them.

There are four things to be observed in it; its figure, connections, parts and uses.

The figure of the scapula (see the fig. B adjoining) is triangular; of which, two angles are posterior, and the third anterior. It is convex without, and concave within, both for its better apposition in the ribs, and for containing a muscle, of which I shall speak hereafter.

It hath three sorts of connections, one by *arthrodia*, with the *humerus*, having at its anterior angle, a glenoid cavity, which receives the head of the *humerus*. This cavity is covered over with a cartilage, that facilitates the motion, and it hath a ligamentous brim, which, by making the cavity deeper, and embracing the head of the *humerus*, strengthens its articulation. The other is made by *synchondrosis*, with the clavicle, by means of a cartilage, that unites this bone with the clavicle; and the third is made by *symparcosis*, with the *vertebræ* and the ribs; there being nothing but muscles in all the posterior part, that unite it with the adjoining bones.

There are a great many parts to be considered in this bone. First, its *basis*, which is in its hind part, ends next to the *vertebræ* of the back; this *basis*, and with two angles, the one upper, and the other lower. The parts coming from these angles towards the neck, are called the *costæ* of the scapula; of which there are also two, the one called the upper *costa*, which is the slenderest and shortest; and the other the lower *costa*, which is thicker and longer.

The two surfaces of this bone differ one from the other; the internal is hollow, to lodge the scapular muscle; the external is elevated, to form a considerable eminence, which from the bottom of the *basis*, rises straight upwards, called the spine of the shoulder-blade, the end thereof is called *acromium*, from its resemblance to an anchor.

On each side of this same spine, there are two pits, one above, called *fossa supra spinata*; and the

other underneath, called *fossa infra spinata*, greater than the former; because, besides the *musculi infra spinati*, it contains some other muscles, which serve for the motion of the arm; and in the middle of the spine, there is a crooked eminence, called the crest, or the wing of a batt, from its resemblance to it.

The process *caracoides*, placed at the superior part of the neck, and which advances above the head of the shoulder-bone, strengthens the articulation of the shoulder, and gives rise to one of the muscles of the arm, called also *caracoides*.

The two other cavities, one between the neck of the *acromium*, and the other between its superior *costa*, and the *apophysis caracoides*, serve for the passage of vessels; and that cavity which is at the end of the exterior angle, is called the glenoid cavity.

The uses of the shoulder-blade, are, 1. To give origin and insertion to the muscles, like all the other bones. 2. To fasten the arm to the body. 3. To support the arm, that it may more conveniently make its motions. And 4. To make the shoulder, and defend the internal parts, with its bulk and largeness.

The arm is composed only of the HUMERUS (C see fig. of the arm and hand.) This bone is articulated at both its ends; the upper end with the scapula, by *arthrodia*; and the lower part by *ginglymus*, with the *cubitus*; and by *arthrodia*, with the *radius*. The *humerus* is also joined with the *radius* by *arthrodia*, having a prominence at its end, which is received into the cavity placed at the end of the *radius*. — This articulation causes the motions of the *cubitus* inwards, and outwards.

The *humerus* is often divided into its body, (D) and its *extremities*; which are two, the one superior, the other inferior. — The body of the *humerus* is long and round; it hath an internal cavity all its length, which contains the marrow; its figure is not absolutely straight, but a little hollow on the inside, and raised on the outside, for the strengthening of it in its actions. The line observed in it, to descend and terminate in two *condyles*, serve to fasten more strongly, the muscles inserted in this bone. — The upper end of the *humerus* (E *ibid.*) is much larger, and more spongy than the lower; it contains a medullary juice, and is called the head of the *humerus*. A little from under this head, is the neck, which is a round, and somewhat straight part; and as the fore-part of this head appears a pretty long cleft, which goes to the middle part of the bone, and made like a gutter, to make room for one of the tendons of the muscle *biceps*. This head is not only invironed on all sides, with ligaments and membranes, which come from the

*glenoide* cavity of the *scapula*, but is likewise involved with four *aponeuroses* of the muscles that compass it.

The lower part of the *humerus* (F *ibid.*) is smaller, flatter, and harder, than the other; it is also bigger, because it is joined with the two bones of the *cubitus*, placed on the side of one another, and which have two different motions. In this place there are three processes and two cavities; the first called the superior process, is a round head, articulated with the *radius*. The second, which is the inferior, articulate with no bone, because it only serves for the origin of the *musculi flexores* of the hand. This is smaller than the former, and is called *apophysis condiloides*. In the middle of these two *condyli*, is a third process that is smooth, oblong, and made in the form of a pulley, round which the *cubitus* hath its motions. The two cavities are near this process, one internal and smaller; the other external and greater; they receive the *apophyses coronoides* of the *cubitus*, and the pulley is received into the cavity *sigmatoides* of the *cubitus*.

The *elbow* consists of two bones, which are not so long nor so big as the *humerus*, but both of them much of the same magnitude, though the *cubitus* is a little larger than the other; they are removed from one another in their middle, for the more convenient situation of their muscles, for the passage of the vessels, and especially for their easier motion; one is called the *cubitus*, and the other the *radius*.

The *CUBITUS*, (G, *ibid.*) or *bone of the elbow*, is articulated at both ends, at its upper end two ways; with the lower end of the *humerus*, by *ginglymus*, and with the upper part of the *radius*, by *arthrodia*. At its lower end, it is also joined two ways, by *arthrodia*; by its end with the *os carpi*, and with the lower part of the *radius*, by its lateral, or side-part.

The *cubitus* is divided into its superior, (H, *ibid.*) middle, (I, *ibid.*) and inferior part (K, *ibid.*) Its superior part has two processes, and two cavities; the smallest of these processes, which has no particular name, is situated before, and the other (called *olecranon*, and is larger than the former) behind. The *carpus* is supported on this process; it makes an acute angle, when the arm is bent, and hinders it from bending backwards. These two processes enter into the two cavities, situated on the lower end of the *humerus*. Of the two cavities, at the superior part of the *cubitus*, the greatest, called *sinus sigmatoides*, is placed between the two processes, and receives the end of the *humerus*. There is a line, or eminence in the middle of this cavity, which goes from one process to the other, and enters into the *sinus* of that part, which

is at the lower end of the *humerus*. The other cavity, situated on the lateral and internal part of the *cubitus*, (which is very small) by receiving the *radius*, joins them together.—There are three angles at the middle part of the *cubitus*, one internal, and very sharp, called the spine; two others not so keen, one before, and the other behind.

Two prominences, and a cavity are discovered at the inferior part: The first of these prominences situated at the lateral and inferior part, is received into the *glenoide* cavity of the *radius*; the second, called *styloides*, and placed externally at the end of this bone, serves to fortify the joint; and the cavity at the end of the bone helps to make an *arthrodia*, with the *carpus*.

The second bone of the elbow, called *RADIUS*, (L, *ibid.*) is articulated like the *cubitus* in its superior, and inferior part; in its superior part two ways, both by *arthrodia*, the one with the external *condylus* of the *humerus*, and the other with the *cubitus*; in its inferior part, either with the *os carpi*, or with the *cubitus*, and both ways by *arthrodia*.

The *radius* is also divided into three parts, the superior (M, *ibid.*) the middle (N, *ibid.*) and the inferior (O, *ibid.*) It has in its superior part, a head, a neck, and a tuberosity: the head is round and smooth, for its better motion, and over it a *glenoide* cavity, that receives the superior *condylus* of the *humerus*; the neck is very long for oblique motions; under this neck is situated the tuberosity or eminence, into which the *musculus profundus*, and one of the *flexores* of the thumb are inserted. There is an acute angle in its middle, called the spine, which grows still bigger, as it comes nearer to the wrist, contrary to the *cubitus*, that lessens according as it is elongated from the elbow.

There are many sinuosities and inequalities observed at its inferior part, made to avoid hurting the tendons, that go to the outward part of the hand. There are likewise two cavities, one at its extremity, which receives the bones of the *carpus*; and the other at its lateral and internal part; but smaller, for a prominence of the *cubitus*. The prominence at the external part of its extremity, form, with the *apophysis styloides*, a great cavity, which receives the bones of the *carpus*, and hinders their luxation.

The *HAND* is made up of the *carpus* or *wrist*, the *metacarpus*, and the *fingers*. It begins where the bones of the elbow end, and it terminates with the ends of the fingers.

The *carpus* (P, *ibid.*) or *wrist*, which is the first part of the hand, is a heap of bones, situated between the inferior articulation of the elbow, and the *metacarpus*. These bones are eight in number, placed in two rows, (Q, *ibid.*) four in each row.—

Of

Of the four bones of the first row, the two greatest are received into the cavity of the *radius*, by their upper part, for the motion of the hand; and touch the three first bones of the second rank, by their lower part. The third, next to this in bigness, is placed in the cavity, at the end of the *cubitus*, joining to its *apophyses styloides*; and united in its lower part, with the fourth bone of the second rank. The fourth bone of the first rank, (the smallest of them all) is situated upon the third, on the inside of the hand, making a prominence, like unto the crooked process of the fourth bone of the second rank.

The first bone of the second row, is placed more within the hand than without, that it may the better support the thumb, and answer to the crooked process of the fourth bone of the same rank. The second and the third, support the first and second bones of the *metacarpus*; and the fourth and last bone of the *carpus*, supports, by its two small glenoid cavities, the third and fourth bones of the *metacarpus*. — The figure of the bones of the *carpus*, joined together, is round, and raised on the outside, but it is unequal and hollow on the inside, for the facility of the motion.

There are three sorts of articulations in the bones of the *carpus*; the first, with the bones of the elbow, by the *arthrodia*; the second, with the bones of the *metacarpus*, by *amphiartrosis*; and the third by *syneurosis*, between themselves. — None of these articulations has a manifest motion but the first.

The METACARPUS, (R. *ibid.*) which is the second part of the hand, makes its palm, by its internal part; and its back, by its external. — The *metacarpus* is composed of four long, slender, and unequal bones, each of them having a cavity that contains a marrow. These four bones are joined with the *carpus*, by a strong connection, by means of many cartilaginous ligaments, which allows them but an obscure motion; and with the fingers, by *arthrodia*; each of them having a round head at their end, which enters into the glenoid cavity, placed at the end of the first bone of the fingers. — Besides these two articulations, they mutually touch, and are united together by their lateral part, very near the place where they are joined to the *carpus*, and this for their greater strength. — They afterwards separate towards the middle, in order to leave a convenient space to the *musculi interossei*.

The middle part of these bones is of a round figure, though a little convex outwardly, for strength sake; and a little hollow inwardly, for the better taking up things. — Their superior extremity, whereby they are united with the *car-*

*pus*, is their largest part; and their lower extremity, which ends with a head that joins them with the fingers, their smaller part. — These four bones are not equally large; that which supports the *index*, is larger than the others; the next to it is less; the next to that lesser; and the fourth the smallest of all. This last is the supporter of the little finger, and has a more apparent motion than the three others.

There are five FINGERS (S. *ibid.*) which differ from one another, both in bigness and length. — The first, (I. *ibid.*) called the *thumb*, is bigger and stronger than the others, and the only one opposite to the rest in the matter of apprehension. — The second is called the *index*, (V. *ibid.*) because we make use of it when we shew, or point at something; the third, the *middle finger*, (X. *ibid.*) by reason of its situation, and is the longest of them all; the fourth, *annularis*, (Y. *ibid.*) because the ring is worn upon it; and the fifth, (Z. *ibid.*) *auricularis*, because being little and pointed, some commonly use it to cleanse their ears of *sordes*. —

The bones of the fingers are fifteen, three in each finger, placed in three ranks, called *phalanxes*, from their resemblance to the ranks in battle-array.

— The first rank is of larger bones than the second, and the second than the third, which is the smallest; and whose extremities end in a semi-circle or crescent. The figure of these bones is hollow on the inside, for the convenience of flexion; convex on the outside, for strength sake, and a little flattened on the inside, that they might not hurt the tendons of the *flexores*, and for the better bending the fist. — They are joined together by *ginglymus*, all of them having both little bones, and little cavities, which reciprocally receive one another; their articulation with the *metacarpus*, is by *arthrodia*. — Each finger has likewise ligaments the whole length, on the inside; and these ligaments tie these bones mutually together.

We will conclude our *Osteology* with the BONES of the LOWER LIMBS, which are those of the *leg*, and comprehends all from the *os illium* unto the ends of the *toes*.

The *leg* is divided into the *thigh*, the *leg*, and the *foot*. See the figure of the *thigh*, *leg* and *foot*.

The FEMUR (A in that figure) or *thigh*, is made like the *humerus* of one bone only, the greatest and strongest of all the bones of a human body; and which alone bears the burthen or weight of the whole. — This bone has two strong articulations at both its ends; the first and upper, called *enarthrosis*, is made by the means of a very large head received into a great cavity. The head is at the

end of the *femur*, and the cavity at the lateral part of the *os ilium*; this cavity has a cartilaginous brim for the better inclosing this head, and to hinder it from luxation; which head is tied besides by a strong ligament to the bottom of the cavity.

— The second connection is made at its lower end by *ginglymus*, having two heads which are received into two cavities, situated at the upper and extreme part of the *tibia*. Between these two heads there is a cavity, which receives a prominence of the same *tibia*, and makes the *ginglymus*.

The *femur* is divided into an upper, middle, and lower part. See the *bone* marked B. C. D.

The upper has a *head*, *neck*, and two *processes*. The *head*, (B) which is large and round, is formed of that process which is inserted into the *cotila* of the hips, from the little pit that is in its middle rise, the ligament that ties it unto the *os illium*. The *neck*, for the support of this large head, is also very large, and long, inclining outwardly, not only for the convenient situation of the parts of the thigh, but for the stronger going. This neck is oblique, because the cavity of the *ischium* not being situated in a strait line, the head of the *femur* had not been able otherwise to enter well into it. Moreover this neck stretching thus outwardly, separates these two bones from one another, and causes the rest of the bones to descend in a strait line, and the body to be more conveniently and surely supported.

The two processes behind the neck of the *femur* are called *trochanters*, divided into the great and lesser *trochanter*. — The great *trochanter*, which is also the superior, gives insertion to the *musculi extensores* of the thigh, and for this reason its exterior part is rough and unequal, that they may insert the better; and at its internal part, which regards the neck, there is a cavity, over which there is found a kind of *sinus*. This bone has a great cavity, its whole length (C) which contains marrow; it is convex outwardly, and a little crooked or concave on the inside, insomuch that it serves for a buttress to our body, to hinder it from falling; and from inclining too much forward.

At the lower part of the *femur* (D) there are two processes called *condyli*, covered with a large cartilage, as all the other extremities of bones. — Between these *condyli*'s there is a cavity which receives the prominence of the *tibia*. Likewise at the upper part of the *femur*, there is a vacuity, which gives a passage to the vessels that go down to the leg. This vacuity is invested like all other cavities, as well as the processes, which serve for the connexion of the bones. They are plaistered over with a smooth and slippery cartilage, in the mass of which there are small glands, each of them having a *secretory*

*duct*, through which runs that slimy liquor, which serves to facilitate the motion of the joint.

The *KNEE*, placed at the lower end of the thigh, and at the upper part of the *leg*, has a round and large bone that lies at the articulation of the *femur* with the *tibia*, and called the *ROTULA*, (E. see *fig.* of the *leg*, &c.) or *knee-pan*. — Its substance in infants is cartilaginous for some time, afterwards it comes to be bony. Its figure is like the circular boss of a buckler, its middle part being thicker, and more prominent than its brims. The *rotula* is moveable, and articulated by a kind of *ginglymus*; it is covered with the *aponeuroses* of the four *extensores* of the leg, inserted at its external part and its brims. It is invested at its internal part with a slippery cartilage to facilitate its motion, and serves to strengthen the extensor muscles of the leg.

The *LEG*, which is the second part of the lower limbs, comprehends the whole space from the knee down to the foot, and has two bones, one whereof is very big, called the *Tibia*, and the other smaller, called the *Fibula*. — These two bones differ only in bigness, being of the same length; for if the *tibia* rises higher, the *fibula* descends the lower; both of them have a triangular figure, though that of the *fibula* is more irregular; they are united together at their end, but separated asunder in their middle to give room to the muscles, and a passage to the vessels. They also each of them make a *malleolus*, or ankle-bone, the *tibia* making the inward angle, and the *fibula* the outward.

The *TIBIA* (F, *ibid.*) is the largest bone of the leg, hollow within, its whole length (to contain the marrow) situated on the inside of the leg, articulated at both its ends by *ginglymus*, above with the *femur*, and below with one of the bones of the *tarsus*, called *astragalus*. It is also joined at both its ends, but laterally with the *fibula*, by *arthrodia*. — The *fibula* has a small cavity in its superior part that receives the *tibia*, and below a small prominence received into the *tibia*, which *tibia* has also three parts, the superior, middle, and inferior part.

The superior part of the *tibia* (G, see the bone G. I.) has a process in its middle, received into the cavity, which is at the end of the *femur*. There are on both sides of this process two small cavities, which receive the heads of the *femur*. Their depth is increased by a *cartilago lunata*, which is not deprived of motion, altho' it be fastened by ligaments. — The middle part of the *tibia* has three angles, the most remarkable thereof is the *shin*, being long and sharp before like the edge of a knife; whence it happens that blows received upon that part are very much felt, by reason that the

*periosteum*, which covers it, is often cut with the blow: According as this bone approaches to the foot, it lessens in bigness, but in recompence it grows harder as it descends.—The inferior part of the *tibia* (I, *ibid.*) terminates in two little cavities for the infertion of the prominences of the *astragalus*; and from the middle of these cavities there rises a small protuberance, inferted into the cavity found at the upper part of the *astragalus*; and from the side of this cavity there is a pretty large prominence which forms the internal ankle.

The FIBULA (K, see the fig. of the whole leg) is the least of the bones of the leg, situated at its external part, and articulated at both its ends by a kind of more compact *arthrodia*, fortified by a ligament both above and below it.—This bone has also three parts; an upper, middle, and lower part. See the bone marked L. M. N.—The upper (L) is a round head, which don't touch the knee, ending a little under it at the place where it is articulated with the *tibia*.—The middle (M) is slender and long, and of a triangular figure like the *tibia*, but a little more irregular.—And the lower part (N) has a *condylus*, which makes a process called the outward ankle. It is a little hollow within, for a free motion of the *astragalus*.—The lower end of this bone descends a little lower than that of the *tibia*.

The FOOT. (O, see the fig. of the whole leg,) which is all that's comprehended from the inferior articulation of the leg unto the end of the toes, is of an oblong figure; its superior and external part is convex, the better to form the cavity of its lower and internal one, called the *sole of the foot*. (P, see the fig. of the foot mark'd P.

The uses of this cavity are, besides that of contributing to the convenience of walking, and of standing firm, to leave a free passage to the tendons that go to the toes, and to lodge one of their *flexores*.

The first and largest part of the foot is the TARSUS, (Q, see the fig. of the whole leg,) composed of seven bones: (see the bones in separate pieces mark'd R. S. T. V. X. X. X. the first and superior is smooth, and made like a pully, upon which the great bone of the leg is placed; the second, which is anterior, is a large head that enters into the cavity of the *os naviculare*, with which the *astragalus* is strongly articulated; the third and posterior receives the head of the *calcaneum*, (S) with which it is strongly united; the fourth and inferior is rugged and unequal; the fifth and sixth surfaces of the *astragalus* are the two lateral, inclosed by the two *malleoli* or ankles.

The CALCANEUM, or heel-bone, is the second of the *tarsus*, the greatest and the most porous, and

situated at the posterior part of the foot.—In this bone the tendon *achilles*, the biggest and strongest of all the tendons is inferted.—It is doubly joined with the *astragalus*, and also by a flat head with the *os cuboides*.

The third is the OS SCAPHOIDES, (T) or *naviculare*, from its resemblance to a little boat; it has a pretty large cavity that goes from one of its ends to the other, for the infertion of the large head of the *astragalus*, which joins them both strongly together; and to the three protuberances found on the other side of this cavity, the three last bones of the *tarsus* are articulated.

The OS CUBOIDES (V) is the fourth bone of the *tarsus*, situated before the *calcaneum*, unto which it is joined by an unequal surface, and articulated with the seventh bone of the *tarsus*, whose fifth, sixth, and seventh bone are called *cuneiformia*, because they have the figure of a wedge, that cleaves wood.

These three bones, although the same in figure, differ moreover in magnitude; for one of them is greater than the rest, another of a middle size, and the other is the least of all.—They are all three articulated with the *os scaphoides* by one of their ends; and by the other end one of them supports one of the bones of the *metatarsus*, the two others being supported by the *os cuboides*.

The METATARSUS, (Y, see the fig. of the whole leg, &c.) or *insep.* consists of five bones, situated sideways to one another, for the sustaining each of them a toe. These bones are compactly joined together at that end where they are united with the *tarsus*; but they separate from one another in their middle for the infertion of the *musculi interossei*. They are convex outwardly and hollow within, for the better reception of the tendons of the muscles.—They are long and slender, and end with a little head, which entering the cavity at the end of the first phalanx of the toes, unite them together by *arthrodia*.—They differ in magnitude, like the bones of the *tarsus*, and have at their slenderest end a head covered with a little cartilage for the freer motion of the toes.

There are fourteen bones of the *toes*, (Z, *ibid.*) two to the great toe, and three for each of the four others, distributed into three *phalanxes*, or ranks, as those of the fingers: those of the first order or rank, are greater than those of the second; those of the second are less, and so of the rest.—They are of the same figure as those of the hand, convex without, and concave within; and are articulated with the *metatarsus*, by *arthrodia*, and by *ginglymus* with one another.

There are also found in the joints of the bones, of the hands and feet, some very small bones, of the

the bigness of a pea, flat on their inside, and round without, called *ossa sesamoidea*. Their number is uncertain, although we commonly count twelve of them in each hand, and the same in each foot; those bones, small as they are, not only serve to strengthen the joints, and hinder luxation, but their principal use is to serve for pulleys to the tendons of the muscles, which go to the fingers, in order to keep them in their due places, and hinder them from falling upon the joint.

#### OF SARCOLOGY.

*Sarcology* treats of the *flesh* and other soft and tender parts of the human body.

This is the *second* most essential and most curious part in *anatomy*, and is divided into (1) *Splanchnology*, (2) *Myology*, and (3) *Angiology*. The first treats of the internal parts especially the *viscera*. The second of the *muscles*. The third of the *vessels*, viz. *nerves*, *arteries*, and the *lymphatic vessels*.

For the more clear demonstration of these parts it is necessary to divide the human body into the *trunk* and *limbs*; and to subdivide the *trunk* into three principal regions, viz. the *head*, the *breast*, and the *venter* or *abdomen*, with which last we shall begin this treatise.

The *ABDOMEN* is all that cavity extending from the *diaphragma* to the *os pubis*; terminated on the sides by the *hip bones*, and behind by the *vertebræ* of the loins and the *os sacrum*; and it is of a soft and fleshy substance before, capable of great extension.

This region is subdivided into three parts (1) the *epigastric*, which begins at the *diaphragm* and *cartilago xiphoides*, and terminates about the breadth of two fingers above the *navel*. (2) The *umbilical*, which begins where the *epigastric* ends, and descends two fingers breadth below the *navel*. (3) The *hypogastric*; which reaches as low as the *os pubis*.

Each of these regions are again divided into a middle part called *epigastrium*, and two sides named *hypochondria*; distinguished by the name of the right, and left *hypochondrium*. See A A in the fig. at the bottom of the left side in the second *anatomical* plate, under the title *Sarcology*.

The *EPIGASTRIUM* incloses the small lobe of the liver and a part of the stomach, with its lower orifice, and also the middle of the *colon*.

The *HYPOCHONDRIUM*, on the right side contains the great lobe of the liver and the gall bladder; that on the left contains the greatest part of the stomach and spleen.

The *UMBILICAL* region (B B *ib.*) contains the navel in the middle of it; and its sides are the

two loins. The *navel* contains the greatest part of the *intestinum jejunum* and the *mesentery*. The right loin contains the right kidney, the *intestinum sacrum*, and part of the *jejunum* and *colon*; and the left loin incloses the left kidney and some part of the *colon* and *jejunum*.

The middle of the *hypogastric* region, (see C C *ib.*) is called the *hypogastrium*. Its sides are the *ilia* or flanks; and under it we find the *rectum*, the *bladder* and the *matrix* in women.

We divide the lower part of the *hypogastric* (D D *ib.*) into the middle or the region of the *pubis*; and into two lateral, or regions of the groins, which gives passage to the *spermatic vessels*.

The hind part of the *VENTER* extends from the last rib to the end of the *os sacrum*; and is divided into an upper part called the *loins*, and a lower region called the *nates* or buttocks; between which is the *anus* or hole for discharge of the grosser excrements from the guts.

The *venter* or belly is a cavity, which contains the parts for nourishment, and for generation, and is divided into the outward and inward *venter*. The outward is again divided into common and proper, the common parts containing are the teguments, as the *epidermis* or *cuticula*, the *cutis* or skin, and the *fat*, and the proper are the muscles of the *abdomen* and the *peritonæum*.

The *epidermis* (E E *ib.*) is a membrane as thin as the peel of an onion, and strongly fastened to the skin, which it covers; and is insensible, because it contains neither veins, arteries nor nerves; but is produced in the same manner as the other parts of the body. It is of the same figure with the skin; from which it separates in burns.

This is the part, which rises in large pustules when vesicatories are applied. It cannot be dissected. It regenerates without leaving a scar; and when it separates from the *cutis* without any outward cause, it shews the part to be disposed to mortify.

Its *uses* are to cover the skin and render it smooth and equal; to prevent the evacuation of humours from the extremity of vessels terminating to it; and to blunt that pain, which otherwise would always follow any impression on the fibres and nerves in the skin, if it was not for this natural cover.

The *SKIN* (F F *ib.*) is the second tegument and the greatest membrane of the body, and formed of fibres, intertwined like nets, which cover thousands of small glands. Its thickness is very unequal; very gross in the back, at the kidneys, and about the limbs; very thin in the face, but much more so upon the edges of the lips. A small branch of an artery enters every gland; and there passes from

from the gland a small vein and a lymphatic vessel through the nets, which terminate at the *epidermis*, or the superface of the *skin*.

Thus we account for the manner of *sweating*. The blood is conducted hither by as many arteries as there are glands, and is carried back by as many veins. But as it passes through the pores of the glands, a *serum* is filtrate from it, which passing through the excretory vessel furnisheth matter for *sweat*.

Besides this there is another evacuation through the *skin*, called insensible *transpiration*; which being made without intermission purifies and cools the blood, by an absolutely necessary dissipation thereof, and preserves both the *skin* and *epidermis* from growing scurfy and too dry.

The *skin* is of such a nature that it extends and contracts itself easily, as may be observed in pregnant, hydropical and fat subjects; and always adheres to the part it touches; and when it happens to be drawn from the flesh it never reunites without making a scar. Nature has in most subjects covered it with hair; but not alike in all parts, nor in every subject. Some men have their whole body; but most men have only certain parts covered with long hairs. The like is observed in female subjects.

There is also a great variety in the *colour* of the skin upon different subjects. For, though *white* is allowed to be the *natural colour*; yet it is evident that some are brown, others ruddy, others tawny, and again others quite black; owing chiefly to the temper of the body, some predominant humour, and to the soil, climate, and state of the creation.

The *uses* of the *skin* may be summed up in these particulars, *viz.* To cover all the parts of the body, to be the organ of touching; and to serve for an emunctory of these *humours*, which nature throws off by sweat and transpiration.

The *FAT* (G G *ib.*) or third common tegument is a white body of a middle consistence, formed of the unctuous and oily parts of the blood, condensed by a certain degree of heat, and inclosed in little bags called *cellulæ adiposæ*, adhering to the outward surface of the membrane *adiposa*, all over the body except on the forehead, eye-lids, *penis* and *scrotum*.

This tegument is vastly unlike in different subjects both as to substance and kind. Some bodies are covered with fat an inch thick; in others the *cellulæ* are almost flat; and in emaciated subjects we find nothing but the mere membrane of a transparent substance.

This sort of *fat* is termed *pinguedo*; but there is another sort of fat in the human composition of a

harder, whiter, more brittle nature, and not so easily liquified as the former.

The *uses* of *fat* are to preserve the body like a balsam; and by enveloping the salts, with which the blood and *serum* are highly saturated, to keep them from fretting and corroding the parts through which they pass. It also serves for a warm covering to the whole body, to keep the heart moist, and pliant in its motion; and the *pelvis* of the kidneys from being hurt by the salts of the urine; and that at the joints to facilitate their motion, by its lubricity. Therefore nature has provided the heart, the eyes, &c. where motion is quickest and most violent, with greater abundance of fat.

Where fat increases beyond its natural proportion, it not only becomes troublesome to the body, but it affects the animal spirits, induces heaviness drowfiness, and an unwillingness to move. Too much about the thorax in the cavities obstructs the expansion of the *diaphragm* and lungs, and produces a *dyspnœa*, or an *orthopnœa*; and may hinder the necessary secretions in the brain should the abundance of fatty particles return into the blood, and implicate the most subtle and active parts.

The *ABDOMEN*'s anterior parts are also covered by ten *muscles*, *viz.* Four oblique, two transverse two *recti*, two pyramidal; taking their names from their situation and from the order and disposition of their fibres. These muscles help the *abdomen* to expand and contract itself.

The *oblique* muscles are two descending and external; and two ascending and internal.

The oblique descending are (L *ib.*) what first appear after the raising of the teguments, and are so called from their fibres, which descend obliquely. They are called external to distinguish them from others placed below; and great, because they exceed the other obliques in size.

Their figure is triangular, proceeding by digitation from the *ferratus major*, on the 6th and 7th of the true ribs, all the bastard ribs, and from the transverse process of the *vertebræ* of the loins; are inserted into the external part of the *os ilium*, and *os pubis*, and end with a large and strong *aponeurosis* in the *linea alba*. These muscles are indented with the *ferrati majores*, which are muscles of the *thorax*, by five or six digitations: each whereof receives a nerve from the interstices of the ribs.

The *oblique* ascending muscles (M *ib.*) so called, because their fibres arise from below and ascend, are situate just under the former, and are a great deal less. They proceed from the upper part of the *os pubis*, and end with a large double *tendon* in the *linea alba*; the upper part whereof creeping over the *rectus*, and the other creeping under it, and

and joining together at the *linea alba*, do, as it were sheath the *rectus*.

The *transverse* muscles (N *ib.*) are placed under the *oblique* and upon the *peritonæum*, proceed from the processes of the *vertebræ* of the loins, are inserted in the internal part of the *os ilium*, and of the cartilage of the lower ribs, and, passing under the *rectus*, terminate in the *linea alba* by a strong *aponeurosis*. They are perforated in the middle to give a passage to the umbilical vessels; and at their lower part for the communication of the spermatick vessels with the testicles in men; and so in women the round ligaments of the *matrix*, which proceed to make their insertion in the thighs.

The four pair of muscles in the *abdomen* named *recti* (O) arise from the *sternum* and the extremity of the two last ribs, and proceed strait down to the fore part of the *abdomen*, and are inserted in the *os pubis*. These have three or more tendinous coarctations of their fleshy fibres, which make them appear as many distinct muscles.

In a female subject, whose *epigastric* is stopt by the compression of the pregnant *uterus*, the mamillary veins are supplied in the return of the blood by the veins and arteries of the *recti* or *rectus*, which creep along the inside from the mamillary and *epigastric* vessels, and communicate together.

The *pyramidal* vessels (P) of the *abdomen* lie upon the lower tendons of the *recti*, proceed from the upper and internal part of the *os pubis*, and terminate in a point on the *linea alba*; though sometimes they reach the navel.

Their uses are to raise the *peritonæum*, and to hinder a too great compression of the region of the bladder from the other muscles.

The *linea alba* (Q) is the meeting of all the *aponeuroses* of the muscles already mentioned, and takes its name from being like a *line* in its construction, and *white*, because it has no flesh in it.

This line extends from the *cartilago hipphoides* to the *os pubis*, being straiter below than above the navel; and dividing the muscles of the right side from those on the left.

The *PERITONÆUM* (aaa) is a thin soft membrane, covering and containing all the *viscera* of the *abdomen*. Its figure and size answer to those of the *abdomen*, which it lines. Its internal surface is smooth, and lined with an unctuous humour. Its external surface is fibrous and unequal, and fastened to the muscles of the *abdomen*, *linea alba*, *ossa pubis*, *ischium*, *ilium*, *sacrum*, and the *vertebræ lumbares*, and from the last whereof many suppose it to have its origin. It is also connected to the lower or convex surface of the liver, which it suspends by a strong ligament, called *suspensorium hepatis*.

The *PERITONÆUM* is double every where, but most apparently so from the navel to the *os pubis*, and near the *lumbar vertebræ*, as appears not only from its extraordinary thickness in both, but from its spontaneous parting in the latter, to receive the kidneys. It is perforated in the upper part to give passage to the *œsophagus*, *aorta*, and *cava*; in the lower part, for the fundament, the neck of the *matrix*, and the vessels that go to the thighs; and in the fore-part to give passage to the *umbilical* vessels.

Its exterior coat has two processes, which in men fall down into the *scrotum*, wrap up the *spermatick* vessels, and dilating make the *tunica vaginalis* of the testicles; in women they form a cover for the round ligament of the *womb*.

The *peritonæum* receives veins and arteries from the *mammaria*, *diaphragmatica*, *epigastricæ*, *sacra*, and *lumbares*.

The use of the *PERITONÆUM* is to contain and keep in their place the *viscera* of the *abdomen*; when it is injured the parts are apt to fall down, and to form those tumors called *hernias* or *ruptures*.

The *NAVEL*, (B) called *umbilius* from *umbo* the middle, *i. e.* of the *venter*, is a *nodus* formed by the reunion of the *umbilical* vessels, and cut as soon as the infant is born.

In a *fœtus* the *navel* is a *string* about  $\frac{3}{4}$  of a yard long, that goes from the *after-birth* to the *belly* of the *fœtus*, and then incloses four vessels, which are a vein, two arteries, and the *urachus*; and serves to conduct these vessels, which would have been too weak of themselves for so long a passage, and not been able to resist the motion of the infant. Its length is of use to the infant, that he may remove conveniently to and fro in the womb, and that both the infant and the *after-birth* may come away one after another in the delivery. But as soon as the infant is born, this string is to be tied within two fingers breadth of the belly, and cut above the ligature. Nature afterwards rids itself of what remains of it, so that there remains only the *nodus* or knot, above mentioned.

The four umbilical vessels are annexed to it; the vein ascends upwards, and the arteries and *urachus* descend; and are all four inserted between the muscles and the *peritonæum*.

The use of the *umbilical vessels* (CDD) is, that the arteries of the mother carry a certain quantity of blood into the *placenta*; which, being therein dispersed, is received by the branches of the *umbilical* vein, which carries it into the *vena porta*, to be filtrated through the substance of the liver in the *fœtus*, before it is to enter into the *vena cava*: that carries it into the right ventricle of the heart; from whence it passes into the left through the *foramen botalli*, in order to be distributed, afterwards, into

into all the parts of the body by means of the *arteries*. The superfluity of this blood is brought by the two *umbilical* arteries to the *after-birth*; where being dispersed, it is received by the veins of the mother spread therein, and which carries it into the great veins to circulate with the whole mass of blood: Thus there is made a continual circulation of the blood of the mother to the infant, and of that of the infant to the mother.

The *EPIPLOON* (FF) is a membrane situated under the *peritonæum*, which floats upon the intestines, and follows their sinuous windings. It extends from the bottom of the stomach unto the *navel*, where it commonly ends. But when it happens to descend unto the lower region of the *hypogastrium*, and even to lapse into the *scrotum*, then it causes the *hernia epiploecæ*; and when in women it happens to slip between the *matrix* and the bladder, it makes a compression on the orifice of the *uterus*, and thereby, says *Hippocrates*, hinders generation.

Its figure is like a fisher's net. It has a great cavity in its middle part, formed by two membranes, one external before, annexed to the bottom of the stomach, and to the spleen; and the other internal behind, annexed to the *colon*, and to the back, under the *diaphragm*. — The *epiploon* has small vessels of *fat*, which terminate in globules, and often melts in those, that have a *hectic fever*.

As the *epiploon*, when it comes to the air, corrupts soon; so in wounds of the *abdomen* we are obliged to cut off any such part of it, as has had any irruption outwards. There are likewise some distempers, which spoil and corrupt it, as it is easy to observe in *scorbutick*, *phthisical*, and *hypochondriacal* persons. — It has more vessels than any other membrane, in proportion to its magnitude; for it receives small nerves from the *intercostal* branches of the eighth pair, many arteries from the *cœliac*, and many veins which discharge themselves into the *porta*.

The uses attributed to the *epiploon* are, to warm the stomach, and thereby help the digestion; to cover the intestines, and to conduct the splenic branch, and the other vessels, which go to the stomach, the *duodenum*, or the *colon*.

From the mouth unto the *anus*; there is a continued and a very long body, whose beginning gives an entrance to the nourishment; the middle receives, and preserves it; and whose end gives a discharge to its excrements.

The part from the mouth unto the *diaphragm* is called *œsophagus*, or *gullet*; the next to it, *stomach*; and the next, *intestines*, or the *guts*; and the membrane, which retains them all, is the *mesentery*.

I'll begin with the *STOMACH*, (GG) which is an organical part, destined to receive the meats after deglutition, and the principal instrument of chylification, situated in the *epigastrium* immediately under the *diaphragm*, between the liver and the spleen, and of a round and oblong figure, resembling a bag-pipe, particularly when the *œsophagus* is left with it and a part of the *duodenum*. — Its external surface is smooth and whitish, and the internal wrinkled and reddish; it is annexed above to the *diaphragm*, below to the *epiploon*, on the right side to the *duodenum*, and on the left to the spleen.

The *stomach* consists of four membranes or coats; the first and inmost is formed of short fibres, which stand perpendicular upon the fibres of the next coat, and are plainly to be seen towards the *pylorus*. When the stomach is distended with meat, these fibres become thick and short, whilst they endeavour to restore themselves by their natural elasticity; they contract the cavity of the stomach for the attrition and expulsion of the aliments. — This coat is much larger than the rest, being full of plaits and wrinkles, and chiefly about the *pylorus*. These plaits retard the chyle, that it runs not out of the stomach before it be sufficiently digested. — In this coat there are also a great number of small glands, which separate a liquor, that besmears all the cavity of the *stomach*, and helps the concoction of the aliments; for which reason this coat is called the *tunica glandulosa*.

The second is much finer and thinner; it is altogether nervous; is of an exquisite sense, and is called *nervosa*.

The third is *muscular*, being made of straight and circular fibres: The straight run upon the upper part of the stomach, between its superior and inferior orifices; and the circular run obliquely from the upper part of the stomach to the bottom. — Of these the innermost descend towards the right side, and the outermost towards the left; so that by their action both ends of the stomach are drawn towards its middle, and the whole is equally contracted. By their contraction and continual motion, the attrition and digestion of the aliments is in great measure performed.

The fourth *tunic* is common, and comes from the *peritonæum*.

The *STOMACH* has two orifices, the one superior, and the other inferior; the superior (M) one, called the mouth of the stomach, is on the left side, and begins where the *œsophagus* ends; it is situated over against the eleventh *vertebra* of the back, and closely shut up by abundance of fleshy and circular fibres, at the time when it receives no nourishment, a thing very necessary, not only for the better concoction, but to hinder the aliments from being cut

up again into the mouth, and also hinder the fumes, caused by digestion, from being offensive.

The inferior (N) orifice, called *Pylorus*, is on the right side; which although called the inferior orifice, 'tis only with respect to the other placed a little higher, and not with respect to the fund or bottom of the stomach, since both orifices are almost equally removed from this. — The *pylorus* is a little bent, very narrow, because full of tranverse fibres, and is begirt with a thick circle or a *sphincter*, that shuts it.

The stomach sends veins to the *porta*, and branches the *gastroepiploica*, accompanied with others of the *cœliac*, all lying immediately under the fourth coat.

The eighth pair of nerves give two considerable branches to the *stomach* (PP) which are spread much about the upper orifice; by which it is rendered very sensible: whence also proceeds the great sympathy betwixt the stomach, head, and heart; on account whereof *Van Helmont* thought that the soul had its seat in the upper orifice of the stomach.

The use of the STOMACH is for the concoction of the aliments, and converts them into chyle. This concoction or digestion is performed in the following manner.

The internal coat of the *stomach*, being all over bedeck'd (as we have already observed) with glandules, which continually transmit into it an acid juice, the aliments, after having been pounded in the mouth, and penetrated with the *saliva*, which springs from the *parotide*, and *maxillary* glandules, are conducted through the *œsophagus* into the *stomach*, and either by the help of the acid juice, both of that they find in it, and of that which distils into it without intermission, they become more liquid: then this liquor, not being able to rise upwards through the *œsophagus*, by reason of its situation, and the *diaphragm* making compression upon the stomach, does gently run through the *pylorus* into the intestines, where it comes to greater perfection by the mixture of the *bilis*, and *pancreatic* juice.

The INTESTINES, (QQ) or *guts*, are long, round, hollow, and continued bodies from the *pylorus* unto the *anus*; situated under the *epiploon* in the *abdomen*, whose whole capacity they almost fill. — They are knit or annexed to the back by the *mesentery*, which ties them together; so that the *tenuia intestina* are in the middle of the *abdomen*, towards the *umbilical* region, and the *crassa* in the circumference.

The *intestines* seem to be nothing but a continuation of the *stomach*, as consisting of the same

number of coats, and fabricated in the same manner. They are, when separated from the *mesentery*, of a very great length; ordinarily about six times as long as the person's height, whose they were; and though they seem to be but one continued channel, or *fistula*, yet because in several parts, their magnitude, figure, and thickness are different, they are generally divided into the *thick* and *small*, and these again are each of them subdivided into three. The three small are called *duodenum*, *jejunum*, and *ilium*; and the thick, *cœcum*, *colon*, and *rectum*.

They have all of them in common, a kind of vermicular motion, which, beginning at the *stomach*, is propagated downwards, and is called the *paristaltick* motion; to facilitate which, they are generally lubricated with a great deal of fat, especially the thick ones, whose surface being somewhat uneven, and the contents less fluid than those of the small, they need somewhat more to make them slide easy.

The first of the *intestina tenuia*, or *small guts*, is called *duodenum*, and reaches from the right orifice of the stomach, as far as the *vertebræ* of the back, on the left side, where it ends, at the first angle made by the intestines, which is about twelve inches: from which measure, it seems to have taken its name. — Into this gut, the *meatus cholidocus*, and *ductus pancreaticus* are inserted; whereunto each of them discharges its juice, for the second preparation of the chyle.

The next *intestine* is the *jejunum*, so called, because it is generally found more empty than the rest; which may be occasioned, partly by the fluidity of the chyle, which is greater in this intestine, than in any of those that follow it; and partly by its capacity, being somewhat larger than that of the *duodenum*, and therefore gives a freer passage, and, perhaps also the irritation of this gut, through the acrimony of the bile discharged into the intestines, a little before the beginning of this gut, may contribute something towards accelerating the passage of the contents. — This intestine possesses, almost the whole *umbilical* region; its length being an ell and an half, *Paris* measure. *Dionis*.

The third of the small intestines, is the *ilium*; it possesses almost all below the navel, and extends by its circumvolutions, towards the *ilia* on both sides; from whence it takes its name. It begins immediately where the *jejunum* ends, and terminates at the *cœcum*. — It has fewer *venæ lacteæ* than the *jejunum*, and therefore is always fuller. — This gut not being so fast tied to the neighbouring parts, as the *colon*, and *cœcum*, often fall into the *scrotum*, and

and makes the *hernia enterocolis*. It is also in this gut, that the *miserere* happens, called *iliaca passio*, occasioned by its *antiperistaltic* motion.

The first of the *intestina crassa*, is called *cæcum*, which has a lateral infertion into the upper end of the *colon*, and is not perforated at its other extremity; but hangs to it, like the finger of a glove, and is about three or four inches long.—*Bartholin* pretends that the name of *cæcum* is given to it, because its use is but *blindly* known, and some late anatomists, not allowing this to be the *cæcum* of the ancients, which they imagined to be that thick globous part of the *colon*, immediately appended to the *ilium*, have given this part the name of *appendicula vermiformis*.

The next of the thick intestines, is the *colon*, the largest of them all; it begins at the end of the *cæcum* towards the right kidney, unto which it is annexed, and ascending up to the concave part of the liver, it touches the bladder of *bile*, which tinges it with its yellow colour in this place; from thence it passes along the inferior part of the stomach, and fastens to the spleen and to the left kidney; from whence it descends like an S, unto a little above the *os sacrum*, and terminates at the *rectum*, inasmuch that it encompasses all the *abdomen*.—At the entrance of the *ilium* into this gut, is placed a valve formed out of the production of the inward coat of the *ilium*, which, like the finger of a glove, when its extremity is cut off, hangs loose in the cavity of the *colon*; by which means it stops the return of the excrements, though sometimes, as in inversions of the *peristaltic* motion, it proves not sufficient for that use.—It has a great many *cellulae*, or, as it were, distinct cavities, framed by a coarctation of the gut by two ligaments or bundles of membranous fleshy fibres, about half a finger broad, each running on either side the gut opposite to each other, the whole length of it; and, as it were, girding it in at certain distances, thereby making it resemble a glass incorporator used in mixing oil and vinegar.

The last of the intestines is the *rectum*, which reaches from the *os sacrum* to the *anus*, and is plain, without cells. It is fast tied to the *ossa sacrum*, and *coccygis*, by means of the *peritonæum*: in men to the neck of the bladder of urine, and in women to the *vagina uteri*, to which it is strongly connected by a membranous substance. That substance of the *vagina* and intestine is hardly distinguishable from one another. The length of this gut is ordinarily about a hand's breadth and a half, and its capacity about the thickness of three fingers: its lower end, the *anus*, is furnished with three muscles, *viz.* the *sphincter ani*, and the two *levatori ani*.

The *sphincter ani*, is like a ring; its bigness is two fingers breadth, annexed, before, to the *penis* in men, and to the neck of the *matrix* in women; behind, it is fastened to the *coccyx*, and laterally, to the ligaments of the *os sacrum*, and to the *hips*: it serves to open and shut the *anus* according to our will.—The *levatori ani* proceed from the inferior and lateral part of the *os ischium*, and insert in the *sphincter* of the *anus* to lift it up again, after the evacuation of excrements is over.

The *intestines* in general are furnished with blood from the *mesenteric* arteries, which is returned by the *mesaraic* veins; but the *duodenum* receives a branch from the *cœliac*, which is called *duodena*; to which answers a vein of the same name, that likewise returns the blood to the *porta*—the *rectum* receives others called *hemorrhoids*; the internal from the lower *mesenteric*, and the external from the *hypogastric*, with veins corresponding of the same name, that also go to the *porta*.—These vessels spread the intestines with abundance of ramifications, and are frequently diversified in several subjects of the same species; much less are they to be depended upon, for an uniform appearance in animals of different kinds.—The nerves of the *intestines* come, some of them, from those of the stomach, and some from the great *mesenteric plexus*, which distributes branches to all the intestines.

THE MESENTERY (V) is a double membrane situated in the middle of the *abdomen*, and of an almost circular figure.—If the elongation of the *colon*, and the *rectum* be excepted in it, it has about four fingers breadth diameter, and three *Paris* ells, in its circumference, round about which the intestines are folded.—The *mesentery* contains a vast number of lateral veins, which carry the chyle from the intestines to the glands, which are abundantly more in number in its center, than in its circumference.—From these glandules the chyle goes by other *lacteal* veins, into the common receptacle, and from thence into the *ductus thoracicus*, in order to fall into the left *axillary* vein.—The other vessels of the *mesentery* are the *lymphaticks*, which distil their *limpha* into the receptacle, in order to make the chyle more fluid.

Fat is collected into the *mesentery* as in the *epiploon*, from an oily and sulphurous blood, which evaporates from the vessels, and retained there by the thickness of the membranes. This fat is to preserve the natural heat of these parts, and to moisten the *venæ lacteæ*, which having only a very thin membrane, and being filled only in the time of the distribution of the chyle, would otherwise grow dry.—The glandules (X) of the *mesentery*, have each of them a little artery, which bring blood to them, a little vein which carries back the

blood, and an excretory *ductus*, which discharges into the guts what has been filtrated through these glandules.

The use of the *mesentery* is to tie the intestines together unto the *vertebræ lumbares*, and to hinder any disorder, which could happen in their circulations; and its double membrane is to shelter from all dangers the vessels, which pass between them to the intestines.—The *mesentery* receives its nerves from the *vertebræ lumbares*, and from the intercostal branch. They are so interlaced together in the middle of the *mesentery*, that they form there a *plexus*, out of which come abundance of nervous ligaments, as fine as hairs, which overspread the membranes of the intestines.

The arteries inclosed in the duplicature of the membranes of the *mesentery*, come from the superior and inferior mesenterick arteries, which are two great branches that come from the trunk of the *aorta*, and terminate in all the intestines.—All the veins, which run through the *mesentery*, unite together as they approach its basis, and form larger veins, which larger veins form a trunk called the mesenterick vein, which joining with another, called the splenick, make together the *vena porta*, which has no other use than that which is common to all the veins of the body, and which is to carry back the blood to the heart.

We must observe in this place that the *VENÆ LACTEÆ*, (Y) mentioned already, were never discovered till the year 1622, by *Afellius*, which is the cause that the ancients have attributed part of their most essential functions to the *vena porta*.

There are two sorts of *venæ lacteæ*: the one called first lacteal, and the others secondary; the first bring the chyle from the intestines unto the glandules spread through the *mesentery*; and the secondary carry the chyle from these same glandules into the receptacle of *Pequet*, a famous physician, who in 1651 discovered that receptacle placed between the two origins of the diaphragm, in the place where the *lumbares* glandules are found. The two branches, which proceed from these glandules joining together, form the *ductus thoracicus*. This *ductus* ascends along with the *aorta*, between the ribs and the *pleura*, and terminates by one, two, or three branches in the left subclavian vein, near unto the axillary vein, from whence the chyle is carried into the right ventricle of the heart by the descending *vena cava*.—This canal, or *ductus*, and all the *venæ lacteæ* have *valvules* from place to place, which give admittance to the chyle, and hinder its ever returning.

*Bartholin* discovered in 1652 the *lymphatic vessels*, which some of the ancients had mistaken for the *venæ lacteæ*.

All these vessels are employed in the chylicification, which is perfected in the following manner.—After the vituals are by the digestion conveyed into the stomach, (as already observed) and have been penetrated with the *dissolvent*, so as to appear as an uniform liquor; that liquor being squeezed by the stomach equally on all sides, is forced through the *pylorus*, and so enters the intestines: there it meets with two others dissolvent, *viz.* the *bile*, and the *pancreatic* juice, which finish the liquefaction of the aliments. This done, it pursues its course through the intestines; and mean while the subtillest part of it enters the orifices of the first *venæ lacteæ*, and is carried unto the glands at the basis of the *mesentery*; then that same subtillest part taken up by the secondary *venæ lacteæ*, and conveyed to *Pequet's* receptacle, where we'll leave it till we conduct it to the heart through the *ductus thoracicus*.

The LIVER, (aa) which is the next part of the *abdomen*, which falls under our consideration, is a large glandulous viscus, of a red sanguine colour, situated immediately under the diaphragm in the right *hypochondrium*, which it almost fills; and then stretching itself over the right side of the stomach towards the left *hypochondrium*, reaches behind the *cartilago xiphoides*, growing gradually thinner and narrower.

The upper part of the liver is convex and perfectly smooth; the under concave, and somewhat more uneven, having four large fissures; one, through which the umbilical ligament passes; a second on the left side receiving the *pylorus*, and the beginning of the *duodenum*; a third on the right side, near the margin, in which the gall bladder is lodged; and the last in the upper part affording a passage to the *vena cava*.

Its figure is somewhat approaching round with thin edges, not altogether even, but notched in some places.—Its magnitude is various in different subjects, according to the proportion of the body; though in a *fœtus* it is always larger, in proportion, than in adults.—The liver is fastened by two ligaments, the first, which is the strongest and chief ligament, penetrates into the substance of the liver, and ties it up to the *diaphragm*.—This suspensory ligament proceeds from the common *capsula* of the *porta*, and gall duct.—The other ligament has its origin from the external coat of the liver, or, which amounts to the same, from the *peritonæum*, and terminates in the *cartilago xiphoides*.—These ligaments serve to keep it in its due situation.—Some authors give in the dry'd umbilical vein for a third ligament; which cannot be, since, thereby the liver and the midriff, to which

it is tied, would be drawn downward, and so would hinder its motion, especially in expiration.

The *liver* has a motion, not of itself, but depending on that of the *diaphragm*; to which being very firmly connected, it must needs obey its motion.—The substance of the liver is vascular and glandulous, which latter part is very soft and friable, and easily scraped off from the vessels, to which the glands every-way adhere, as it were, in bunches; which has made the Anatomists call the considerable ones, the internal lobes of the liver.

The glands adhering thus to the vessels, and constituting those lobes, are wrapped up together in proper membranes, whence this appearance of distinct lobes.—Every one of these glands, according to *Malpighi*, is composed of six unequal sides, or faces.—They are all cloathed with their proper membranes, and have each an excretory duct; several of which joining together form little trunks, which run all along with the branches of the *porta*; and these again uniting form larger trunks always full of *bile*, and which constitute the *porus bilarius*, which being distributed all over the *liver*, receives, in the foregoing manner, the *bile*, which is separated by these glands; and terminating in the *meatus hepaticus*, and in the *ductus communis*, at length discharges that *bile* into the *duodenum*.—Besides this discharge by the *porus bilarius* (supposed to be the great one) the *liver* delivers also part of its *bile* into the gall-bladder, by a duct, called the *cyst-hepatic duct*, first discovered by Dr. *Glisson*, and therefore called, also, *Glisson's capsula*, by means whereof there is an immediate communication, between the *porus bilarius*, and the gall bladder.

Besides these gall-vessels, peculiar to the liver, it has also *nerves*, *arteries*, *veins*, and *lymphatick* ones.

It receives two *nerves* from the eighth pair, one from the stomachic branch, and the other from the intercostal, which not piercing through its substance, but only being lost in its tunicles, is the reason why its sense is not so quick, as the other parts, which are better stock'd with nerves.

The *arteria cœliaca*, springing from the *aorta*, divides itself into two branches, one of which repairs to the *liver*, and the other to the *spleen*. The first, which is the least, detaches from it the gastrick, the two *cysticæ*, the epiploick, the intestinal, and the gastro-epiploick, before it enters the liver; where, at last, 'tis divided into almost as many small branches, as the *vena porta*, which is disseminated, with the *cava*, through its whole substance.—And here it is particularly remarkable of the *porta*, and the *cava*, that, contrary to the sentiment of some *Anatomists*, they are both equally dispersed through

the whole substance of the *liver*, with this single difference, that the branches of the *porta* arrive there, and those of the *cava* set out from thence.

The lymphatick vessels of the liver, proceed from the small conglobated glands found under the tunicle of its concave part, towards the entry of the *vena porta*, in the *capsula*.—These vessels serve to carry the lymph of these glands to *Poquet's cistern*.

Although the *liver* is not the organ of sanguification, as imagined by the ancients, it nevertheless contributes towards the refining of the blood, which is effected in this manner.—It is almost unquestionable, at present, that it performs the office of an artery, and supplies the *liver* with blood, by promoting the filtration performed in the glands, which opens into the extremities of the biliary vessels, the capillaries of the *vena cava*, and those of the arteries, which convey blood to them, as well as the *vena porta*. Now all this blood is filtrated in such a manner, that its particles, which are proportioned to the shoots of the extremities of the biliary vessels, flow perpetually into them; after which some of them are conveyed to the gall-bladder, and others to the *hepatick duct*, and from thence to the *duodenum*: whereas the other particles of blood, the figure and size of which is disproportioned to the above-mentioned orifices, are reconducted by the capillaries of the *vena cava*, into its large trunk, and at last to the right ventricle of the heart; which, the better to perform, nature has taken care to join the *hepatic* artery to the *vena porta*, that its continual pulsation may facilitate and augment the motion of the venous blood; and has also placed the *liver* under the diaphragm; and the muscles of the *abdomen*, that the concurrence of the blood may be quickened by their continual beating.

In the concave part of the liver, towards the lower margin, is the GALL-BLADDER (B), which is a membranous receptacle, in figure, somewhat like a pear, being about the bigness of a pullet's egg; though it is sometimes larger, especially in those of a bilious temperament.

The *gall-bladder* adheres to the liver, both by its vessels, which it receives from it; and by its membranes; whereas the external is common with that of the *liver*.—The lower part, which hangs out of the *liver*, rests on the *pylorus* of the stomach, which it dyes yellow, with the gall transfusing through its membranes.

Its membranes are five; an outer or common one, from the *peritonæum*: an inner one, from the *capsula* of the *porta*, and *porus bilarius*; and three proper ones.—The first, *vasculous*, consisting of white fibres, interwove with vessels. The second, *muscular*,

muscular, consisting of a double row of fleshy fibres, the one longitudinal, the other angular; the third or inner coat, glandulous, consisting of a great number of glands, like the *crusta villosa* of the stomach, which separates a mucus that lines the inside of the *gall-bladder*, and defends it from the acrimony of the bile.

The *bladder* is usually divided into two parts, the *fundus*, or bottom (C,) and the *collum*, or neck (D,) at the orifice of which latter, is placed a ring or circle of muscular fibres, which serve as a sphincter, to constrict it, and hinder the too liberal discharge of the bile.

The *Duct*, called *cholidachus* (E), is a long vessel, twice as broad as the neck of the *bladder*, which runs straight from the liver, through the common passage to the *duodenum*, and throws the gall directly into that intestine.

The *common duct* (F,) or passage of the bile, is formed by the union of the *cholidochus*, and *porus bilarius*. It terminates obliquely, in the end of the *duodenum*; and sometimes in the beginning of the *jejunum*, but very rarely in the ventricle. It runs between the coats of the intestine, and cuts through the outer coat two fingers breadth higher than the inner.—When any obstruction happens in this duct, the *bile* not having a free egress, flies back into the blood, and so occasions a jaundice, which oftentimes proves mortal.

There are two sorts of *BILE*, one is subtle and fine, being conveyed by the biliary vessel to the *bladder*, and from thence to the intestine; the other is of a grosser substance, and being strained out of the glands of the liver, in which the shoots of the *vena porta* terminate, is carried by small ducts to the *cholidochus*, and from thence to the common passage, where the two sorts meet; and so repair with joint forces to the intestines.

The *bile* being a potent dissolver, compleats in the first intestines, the breaking and mincing of such parts of the aliments, as were not entirely dissolved in the stomach: so that the *bile* is a necessary liquor, without which, the chyle would never attain to that degree of perfection, that is requisite for its sanguification.

Dr. *Quincy* thinks the principal use of both sorts of *bile*, called by the moderns, *cystic*, and *hepatic*, is to sheath and blunt the acids of the chyle, entangling them with its sulphur, so as to prevent their being sufficiently diluted by the *pancreatic* juice to enter the *laeteals*.

*Borelli* asserts, that part of the *bile* discharged into the intestines, re-enters the meseraic veins, and mixing with the blood of the *vena porta*, is again percolated through the liver; and *Boerhaave*

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seems of the same opinion: which, if true, the *bile* has its *circulation*, as well as the *blood*

The *bile* is a juice of great importance, with regard to the good or ill habitude of the animal.—Dr. *Woodward* has traced its effects throughout the body, very minutely, and makes no scruple to ascribe most of the diseases thereof, to some disorder of the *bile*. This he takes to be the chief spring in the animal machine, and from this accounts for most of the *phenomena* of a body, whether healthy or diseased.

Many, even among the modern Anatomists, from the small quantity of *bile* secreted, have been led into a mistake, that this secretion is not the sole end of so considerable a *viscus*, as the liver. Dr. *Keil* observes, that in a dog, whose common duct was near as big as that of a man, he gathered about two drams an hour; though in a human body, there is reason to think the quantity secreted to be greater. Mr. *Tauvry* observes, that the *bile* becomes one of the principal causes of thirst, by mixing with the salival juice.

Sometimes the *bile*, from yellow, becomes greenish, like verdigrease, and frequently pale, like the yolks of eggs, and that without any other apparent cause, than a little motion, a convulsion, or a violent passion of the mind.—This occasions many and terrible diseases, as nausea's, an abhorrence of food, anxiety, sighing, cardialgia's, wind, diarrhœa's, dysenteries, acute diseases, fevers, and convulsions.

Sometimes it becomes black, and takes the name of *choler*. In this case, it sometimes tastes like a very sharp vinegar; sometimes like putrified blood, gnawing, burning, dissolving, consuming, occasioning inflammations, gangrenes, mortifications, violent pains, and terrible fermentations.

Of *atra bilis*, or black *bile*, *Boerhaave* distinguishes three kinds. 1. The mildest, arising from the matter of the blood, put in too great a motion, which, hence, takes the name of *adust*. The 2d, is an aggravation of the first, arising from the same causes, only heightened. The 3d, is a corrupt, parched *bile*, which if it arose from a greenish, or palish sort, is still worse.

Too great an evacuation of the *bile*, either upwards or downwards, robs the chylefaction of its main instruments. Hence it prevents digestion, secretion, excretion of the *feces*, produces an acid temperature, coldness, weakness, paleness, &c.

The *SPLEEN* (GG,) (the next part to be considered in the *abdomen*) is a *viscus*, of a darkish red, or rather a livid colour, ordinarily resembling the figure of a tongue, though sometimes triangular and sometimes roundish.—It is situated in the left hypo-

hypochondrium, between the spurious ribs, and the stomach; is somewhat convex on the side towards the former, and concave towards the latter, Its ordinary length is six inches; breadth, three; and thickness, one.—It is connected to the *omentum*, and by means of that and the blood vessels, to the stomach, and left kidney, and sometimes to the diaphragm.

The *spleen* has but one membrane, which is very thick, its inward surface sends out hard fibres which run across it: all these fibres make a net, the interstices of which are of different figures. These fibres are fleshy, like those of the lungs.—The bulk of the *spleen* is composed of innumerable cells, or little bladders, which communicate with each other, and discharge themselves into the trunk of the splenic vein.—Their inside, according to *Malpighi*, is furnished with various minute glands adhering together; six, seven, or eight whereof form a kind of small conglomerate glands, wherein the arteries and veins seem to terminate.

Its blood vessels are the *splenic artery*, which furnishes it with blood from the *cœliaca*, and the splenic vein, which carries it thence, by the *porta* to the liver.—Its nerves come from the *plexus linearis*, near the bottom of the stomach.—The vessels are all, as soon as they enter the *spleen*, wrapt up in one common *capsula*, or membrane, and plentifully distributed together, throughout the substance of the *spleen*. Besides these, are lymphatics in abundance.—The *anastomoses* between the arteries, and veins of the *spleen*, are more apparent than any other part of the body; and this *viscus*, is observed to be furnished with a greater quantity of blood than any other part.

Some have imagined the *spleen* only served to make a balance in the weight of the body; others, that it was only intended for the sake of symmetry; others hold it an useless load, (since it appears from dissection, that animals from whom it has been cut, live very well without it) others a pit or common shore to discharge the *feces* of the blood into; others a fire, by the heat whereof the action of the stomach is animated. But Mr. *Cowper*, from the great quantity of blood, and the apparent inosculation of the *spleen*, takes the *spleen* to be a subordinate organ, ministering to the circulation; and thinks, that by this congress of the arterial and venal blood, an *impetus* is communicated to the latter; by which its progress through the ramifications of the *porta* to the *cava*, is promoted, which would otherwise be so broke by the double ramifications of the *porta*, as to want strength sufficient to carry to the heart.

This action or effect of the *spleen*, according to Dr. *Boerhaave*, is to receive the fresh arterial blood,

to prepare it in its glands, and pour it into its cells; to turn what blood is left from this action, to the little veins, and thence to the splenic vein; to mix the humour thus prepared with the nervous juice, and to prepare, attenuate, and more intimately unite them together into one humour.

*Malpighi* and Dr. *Keil* take the spleen to be a viscous assistant to the liver, in the secretion, &c. of the bile. Because the *moleculæ*, or little particles, should be already separated before they come to the strainer, and therefore those of the bile should be parted from those of the blood before they arrive at the glands of the liver.

The PANCREAS is a conglomerate gland, or a body composed of a great quantity of glands seated under the lower and back part of the stomach near the first *vertebra* of the loins; it reaches from the *duodenum* to the spleen, the principal part of it being in the left *hypochondrium*, 'tis tied very fast to the *peritonæum*, and weighs about five ounces; commonly it has ten fingers breadth in length, one in thickness, and two in breadth; furnished with a nerve from the intercostal, with arteries from the *cœliaca*, with veins leading to the splenic, and with lymphatick vessels, which run to the *receptaculum*.

Besides all these vessels it has a peculiar duct, called the *pancreatic*, discovered in 1642, by *Virtungus*, a celebrated anatomist at *Padua*.—This duct running along the middle of the *pancreas*, opens into the cavity of the *duodenum*, where its orifice is guarded by a valve, allowing an exit to the contained liquor, and opposing the entrance of the chyle and other liquors contained in the intestine. There is but one passage of this nature, though *De Graaf* observes that it is frequently double; and in its natural state it is no bigger than a small quill.

The *Pancreas* serves, by virtue of its glands, to separate and strain out a certain juice from the blood called the *pancreatic juice*.

This juice is not acid, as some authors have supposed; nor *alkaline*, as some others; but a little *saline*, and much resembling the *saliva* in its origin, vessels, and properties.—It is carried by the *pancreatic duct*, into the *duodenum*, where it serves to dilute the bile, to change its viscosity, bitterness, colour, &c. and make it mix with the chyle, in order to reduce the several tastes, odours, and properties of the several foods in an homogeneous one.

*De Graaf*, a Dutch physician, had found means to collect a quantity of it for experiments, and has published an express treatise *de succo pancreatico*.

*Brunner* relates, that the *pancreatic duct* having been

been tried in several dogs, and cut, they still continued to eat as usual, and performed all the other functions of life; one of them seemed to have the better stomach for it.

Before we proceed to the *kidneys*, we must take notice of two parts, called *capsulæ atrabiliaræ*; because there is found in their cavity, an humour resembling the *atrabilis*.

Those two *capsulæ* are placed sometimes above the *kidneys*, and sometimes between it and the great artery.—They are inclosed in a thin membrane, and entangled with fat, which occasions the difficulty of tracing them.—That on the right side is commonly less than the other. Each of them is as big as a walnut laid flat, and has a cavity large enough in proportion to its bigness.—In a *fœtus* they are generally as big as kidneys, from which they differ, in this, that their substance is softer and more flabby.

Their figure is as inconstant as their situation; for, in fact, they have no determined figure.—Their colour is sometimes red, sometimes the same with that of the fat they are wrapped in.—In their cavity they have small holes, which penetrate through their substance.—They have a nerve derived from the intercostal, which makes a *plexus* in this place; one or two branches detached from the emulgent artery, and sometimes from the *aorta*, and a small *duct* inserted into the upper part of the emulgent vein.—Their cavity has a valve, which opens towards the emulgent vein.

The *capsulæ atrabiliaræ*, are probably glands for the secretion of some humour from the blood, imported by the arteries, which humour is afterwards conducted by their small veins to the emulgent vein, and there mixed with the blood.

The parts, which purge the blood of the superfluous serum, called *Urine*, are of three sorts, *viz.* the *kidneys*, the *ureter*, and the *bladder*. The first make a secretion of the *serum*; the second convey it to the *bladder*, as soon as it is separated; and the *bladder* serves for a *cistern*, where it is kept for some time, and evacuated when it swells to a sufficient quantity.

The *KIDNEYS* are called *Renes*, from *Ren*, to flow, because the *urine* flows incessantly into the *pelvis*.—They are seated in the region of the loins under the *psœas* muscle, upon the sides of the *aorta*, and *vena cava*, without the *peritonæum*, one on the right side under the liver, and the other on the left under the spleen, at the distance of about four fingers breadth one from the other.

They are fastened to the *vena cava*, and the great artery, by the emulgent arteries and veins, and to the bladder by the *ureter*; the right *kidney* is knit to the intestine *cœcum*, and sometimes to

the liver; the left one is tied to the *colon*, and sometimes to the spleen.—Their figure resembles that of a half-moon or a bean; that side which faces the vessels is concave, the opposite side is *convex*. Commonly they are four or five fingers breadth long, three broad and two thick.—Their surface is smooth and soft, like that of the liver, and their natural colour a dark red.

The *kidneys* have a proper and very thin membrane, which keeps all their glands in their natural order; which membrane some imagine to be nothing else but a continuation of the tunicle of the vessels inserted in the kidneys, which by dilating themselves, line their inside; and then turning back upon the outside, cover that too.—They are covered, besides, with the *peritonæum*, and always with a great deal of fat.

Each of them receives *two nerves*, one from the *stomachic branch*, which spreads itself along the membrane; and the other from the neighbourhood of the *mesenteric*, which enters the concave part of the kidneys, and is lost in its substance; these nerves occasion the vomiting in the nephretick pains.—The trunk of the *aorta* sends out two large vessels to the kidneys, which, before they enter, divide themselves into three or four branches, and which passing through the substance of the kidney, by its concave part, are lost in an infinity of little glands, to which they convey the blood and its *serum* promiscuously mixed.

The blood imported by the arteries to the glands, which cannot pass through the orifices of these small pipes, is taken up by the branches of the emulgent vein, which conducts it to the *vena cava*.

The *pelvis*, or *basin*, is a cavity made of the upper end of the *ureters*, in the form of a funnel, the narrow part thereof marches out of the kidney, and makes the beginning of the *ureter*.—Its office is to receive the urine that distils from the nipples, which are small mamillary bodies, shooting out a little to a point where they are perforated, in order to let the urine fall into the basin, and to which repair the arteries distributed through the whole circumference of the *kidneys*.

The *URETERS*, (SS) are two canals of a peculiar form, which spring upon each side from the *pelvis* of the kidneys, are covered with the *peritonæum*, and terminate in the bladder not far from its neck.—They are furnished with annular fibres, to enable them to contract themselves, and thereby facilitate the course of the urine into the bladder. Their length is equal to the interval between the *kidney* and the *bladder*; they are no bigger than a writing-pen, except in the *nephretick*, when their cavities are sometimes so dilated as to receive one's

little

little finger, and resemble an S.—They receive nerves from the *intercostal* branch, which occasion their exquisite sense in the gravel, and arteries from the neighbouring parts, and return the small veins.

The *ureters* proceed from the *kidneys*, beginning at the end of the *pelvis*, and terminating in the bladder, which they perforate very artificially; for, having pierced through the outward membrane, they run for two fingers breadth between the two membranes, and then perforate the inner one, near the neck of the *bladder*. By this contrivance the urine having once entered the bladder, cannot return back, the orifice of one membrane being stopped by the other.—The *ureters* receive the urine from the *pelvis*, and convey it to the *bladder*.

The **BLADDER** (T) is a membranous part, which forms a considerable cavity fit to contain the urine and the solid bodies that are preternaturally bred in it; such as stones, &c.

The *bladder* is situated in the *pelvis* of the *abdomen*; in men, immediately on the *rectum*; in women on the *vagina uteri*. Its figure in human bodies, the lower part is almost on a level with the upper; and its orifice, or neck, placed side-ways, while the *fundus*, (V.) or bottom, which in a human *bladder* is very broad, rests either on the *rectum*, or the *vagina uteri*.—It is fastened to the navel by the *urachus*, degenerated into a ligament, its sides to the umbilical arteries, and its neck to the *intestinum rectum* in women.

The *bladder* is composed of three coats; the first a covering of the *peritonæum*; the second consists of muscular fibres, which run irregular several ways; and the third, which is full of wrinkles for facilitating its dilatation, is both glandulous and nervous. Its glands separate a viscous and slimy matter, which defends the *bladder* from the acrimony of the salts in the urine.—Around its neck there goes a small muscle, called *sphincter vesicæ*, which contracts the orifice of the *bladder*, to prevent the urine from dripping involuntarily, or till it thrusts open the passage by the contraction of the second coat of the *bladder*, called, therefore, *detrusor urinæ*.

Having already considered all the parts of the *abdomen* which contribute to the perfection of the blood, it will not be improper to consider in this place the *aorta*, or great artery, and the *vena cava*, which are two large vessels of the *abdomen*.

The **AORTA**, or *great artery*, (Y) rises directly out of the left ventricle of the heart, where it receives the blood, in order to disperse it all over the body.—We'll only examine in this place the arte-

ries it sends to the *abdomen* after its perforation of the *diaphragm*, which are seven.—The first is the *cœliaca*, which splits into two branches, one on the right side for the liver, and the other on the left for the spleen.—The second is the upper mesenterick, which visits the upper part of the mesentery.—The third are the emulgents, which run to the kidneys.—The fourth, the spermaticks, which repair to the parts calculated for generation.—The fifth, the lower mesenterick, which goes to the intestines, and the lower part of the mesentery.—The sixth, the *lumbares*, which serve the muscles of the loins.—And the seventh, the upper *musculares*, which are lost in the flesh.

When the *aorta* reaches the *os sacrum*, it gets over the *vena cava*, and divides itself into two large arteries, called the *iliacæ*. Each side has one of them, which subdivides itself into the internal and external.—The internal iliack artery detaches four other arteries, *viz.* the *sacra*, *muscularis inferior*, the *umbilicalis*, and the *hypogastric*. The external iliack, which is the larger of the two, sends out the *epigastrick* and the *pedenda*, and then marches to the thighs, where it changes its name, and assumes that of the *arteria cruralis*.

Where the *iliac* artery terminates, there's a vein of the same size, called the *iliaca externa*, which receives not only three other small veins, called *muscularis inferior*, *pedenda*, and *epigastrica*; but also the internal *iliac* branch, consisting of two veins, *viz.* the *hypogastrica*, and the *muscularis media*.—These two *iliac* veins upon one side, and the other two on the opposite, begin about the *os sacrum* to form a very large vein, called the ascending *vena cava*, further enlarged by the accession of the *sacra*, and *muscularis superior*.

I call it *ascendens*, since its office is to convey the blood from the inferior parts to the heart.—It begins to assume the name of *vena cava* upon the *os sacrum*, where the four *iliacæ* join. As it rises higher, it is joined by four sorts of veins, *viz.* the *lumbares*, which come from the muscles of the loins; the *spermatica*, springing from the instruments of generation; the emulgents from the kidneys; and the *adiposa* from the *membrana adiposa* of the reins. This done, the *vena cava ascendens* strikes through the *diaphragm* into the breast, and terminates in the right ventricle of the heart.

The last parts to be considered in the *abdomen*, are those calculated for **GENERATION**, which nature has formed to perpetuate itself, by producing new creatures to supply the place of those who are gone.

The *organs for generation* are either common or proper; the common are met with in both sexes,

such as are the *spermatic* vessels, the testicles, and the *vasa differentia*. The proper parts are peculiar either to a man, as the *parailata*, the seminal vesicles, the prostates, and the yard or *penis*; or the womb to a woman.

We must consider first the parts of a man, not only those peculiar to his sex, but likewise those which are common to both sexes, that we may observe wherein they differ.

The parts of a man, which fall first under our consideration, are the *spermatick* vessels, which are four in number, *viz.* two arteries, and two veins.—The two *spermatick* (AA) arteries rising from the trunk of the *aorta*, run obliquely upon the *ureters*, and along the muscle *psaos*, till they arrive at the groin, where they are received by a production of the *peritonæum*, and so conducted to the testicles, by passing through the rings of the *aponeuroses* of the muscles of the *abdomen*.—The two *spermatick* veins (BB) march out from the testicles towards the *vena cava*; the right runs strait to the trunk of the *cava*; but the left one terminates in the emulgent vein.—In their progress they are joined by small veins from the *peritonæum*, and the neighbouring muscles loaded with the superfluous blood of their parts, in order to lodge it in the *cava*.

The artery in its ascent, and the vein in its descent, on each side approach to one another, and are covered with the *peritonæum*.—The various branches of the vein form in their progress (without the assistance of the artery) what we call *corpus varicosum*, or *pyramidal*; but the artery descends almost in a straight line, without dividing itself, unless it be at the place of its insertion, where it splits into two branches, the least whereof terminates under the *epidymis*; and the other in the testicle.

The *spermatick* vessels are larger in men than in women, and in both the arteries are always larger than the veins.—They don't perforate the *peritonæum*, as in dogs, but a production of that membrane conducts them along, together with some branches of the *intercostal* nerves, and some from the one and twentieth pair of the *spine*, which supply the testicles with animal spirits, and not with the matter of the seed, as some have imagined, since they have not a sufficient cavity to contain such liquor.

The reason why the less *spermatick* vein terminates in the emulgent, and not in the *cava*, is, that its bulk in passing over the emulgent artery, would have hindered the reflux of the blood to the *cava*.

The preparation of the seed is not commenced

in the spermatic vessels, as falsely supposed by the ancients; for if the two arteries penetrate the substance of the testicles, 'tis only to procure a more exact separation of the seminal particles that accompany the arterious blood since the remains of that blood are carried back by the spermatic veins to the *vena cava*, and the arteries have no *anastomosis* with the veins, either in this place, or any other part of the body.

Therefore the use of the *spermatick* vessels, is to have the blood conveyed by the arteries, to the upper part of each testicle, where the seminal particles are separated, and the remains of the blood carried back, by the branches of the veins to the *cava*.

The TESTICLES, are so called from the *Latin* word *testes*, witnesses; as giving testimony of virility; they are what we properly call *genitalia*.—The *Greeks* call them *dydimi*, or twins, because men have but two.

The testicles (DD) are soft, white bodies of an oval figure, and about the size of a pigeon's egg; they have been thought to be of a glandulous substance; and according to the present doctrine of the glands they may be allowed to be so still.

They are formed of a convolution of divers kinds of vessels, particularly of the *spermatick* veins and arteries, the latter of which bring the blood; whence the particles of the seed are to be secreted in the meanders of the testicles, and the former return it back again, after the secretion made.

The rest of the testicles is made up of seed-vessels, which, indeed, are but one continued series, intricately convoluted, and wound up, as it were, into a bottom; but adhering so laxly, that it is easily drawn out into length, and in rats shaken from its close contexture.—These seminal vesicles terminate in the *parastata*.

They are seated, in men, without the *abdomen*, at the root of the yard, wrapped up in five coats, two of which are common, *viz.* the *scrotum*, and the *dartos*; and three proper, *viz.* the *eritroides*, the *elitroides*, and the *albuginea*.

The first of the common sort is the SCROTUM, or purse, composed of a scarf skin, and a true skin, which is here thinner and tenderer than in any other part of the body: it is soft, wrinkled, and void of fat, divided into the right and left halves by a line, or future, which commences at the *anus*; passes through the *perinæum*, and terminates in the *glans*, or nut.

DARTOS, is a cutaneous muscle, consisting of a texture of many fleshy fibres, by virtue whereof, the *scrotum* contracts and furls itself. It receives several vessels from the *arteriæ pudendæ*, and  
not

not only covers the two testicles, like the *scrotum*; but runs in between them, and keeps them from grating one upon another.

The ERITROIDES (E), is the first of the proper class; it is interlaced with fleshy fibres, which makes it appear red; and is produced by the *cremaster*, a muscle, which holds up the *testicles*.

The ELITROIDES (F), called also *vaginalis*, is a dilatation of a production of the *peritonæum*. — Its internal surface is even and smooth, and the external rough and unequal, whereby it sticks very close to the *eritroides*.

The ALBUGINEA (G), so called from its *whiteness*, is the immediate cover of the *testicles*, and impresses them with a figure answerable to its own. — It proceeds from the coat, in which the *spermatick* vessels are wrapped.

The *testicles* are suspended by two muscles, called *cremasteres* (H), or *suspensores*, which are inserted in the *os pubis*, at the end of the transverse muscle of the *abdomen*, and surround the *testicles* like a membrane, which if they happen to be stronger than ordinary, move the *testicles* of themselves, pulling them up, and letting them fall at pleasure.

The PARASTATÆ (LL), or *epididymida*, are two tuberos, varicose bodies, lying upon, and adhering to the upper part of the *testicles*, whereof they properly appear to be a part; though different from the rest in form and consistence.

The *parastatæ* consist, like the *testicles*, of a convolution of seminal *tubuli*, mixed with bloody vessels; the difference between them lying only in this, that the *parastatæ*, and the *tubuli*, are united into one; the various convolutions of which being more firmly bound together, by a strong membrane, arising from the *tunica albuginea*, it feels more compact than the *testicles*.

The use of the *parastatæ*, is to receive the seed separated in the *testicles*, and pour it into the trunk of the *vas deferens*, to which it is contiguous.

The VASA DEFERENTIA (M), are white and nervous vessels, of a round figure, and of the bigness of a quill, seated partly in the *scrotum*, and partly in the *abdomen*. — They are rooted in the testicle; from one end of which they proceed, and march upwards, in the same process of the *peritonæum*, that covers the *spermatick* vessels. — They turn about, upon their arrival at the upper part of the *pubis*, and climb over the *uterus*; and then, approaching to one another, run under the upper part of the bladder, where they have a communication with the seminal vessels. — The two extremities of the *vasa deferentia*, being arrived between the bladder and the *rectum*, dilate themselves, and form the *vesiculæ seminales*. —

They resemble a bunch of grapes; and their cells, the cavities of pomegranate kernels; though not separated by a membrane, like grapes, for their cells communicate with one another. — Their broadest part is about an inch over, they have one side thicker and larger than the other, and their cavities are unequal, some being greater than others. — They are seated between the bladder and *rectum*, near the *prostatæ*, and serve for a cistern to the seed.

From these vesicles, proceed two small ducts, called EJACULATORY VESSELS, because in the heat of action, they really throw the seed of the vesicles into the *urethra*. — These ducts are broad near the vesicles from whence they proceed; but dwindle as they approach the *urethra*, which they perforate; and on its inside, at the place of their entry, form a small caruncle or tuft, called *verumontanum*, which is a sort of small valve, keeping the urine out of the two ducts, in its passage to the *urethra*; and obliging the seed to turn towards the *penis*, and not towards the bladder.

The PROSTATÆ (OO), are two white, spongy, glandulous bodies, situated at the root of the *penis*, or just below the neck of the bladder, and about the size of walnuts.

Authors ascribe two kinds of substance to the *prostatæ*, the one glandulous, the other spongy, or porous; which last seems nothing but a congeries of minute vessels, and cells, through the middle of which pass the *vesiculæ seminales*, without any communication therewith.

The *prostatæ* have many excretory ducts of their own: *De Graaf* does not remember to have known them fewer than ten in the *prostatæ* of men. — Out of these issues a whitish slimy humour, secreted in the glandular parts of the *prostatæ*, and conveyed into the cavity of the *urethra*.

The use of this humour is to line and lubricate the cavity of the *urethra*, and prevent it from being annoyed by the acrimony of the urine, in its passage through it, and to serve as a vehicle to the seed, in the time of ejaculation.

*Boerhaave* thinks that this humour may serve to nourish the animalculæ, during the first moments after coition. — This humour, he adds, remains after castration, but is not prolific.

The same author, from the memoirs of the *French academy*, makes the *prostatæ*, to consist of an aggregate of twelve glands, each of which terminates by its excretory duct, in a little bag, into which it discharges its humour. — These twelve bags open by as many excretory ducts, into the cavity of the *urethra*, so as to encompass the exit of the *vesiculæ*; whence the seed and the humour of the *prostatæ* are the more accurately mixed.

'Tis alledged, that this place is the ordinary seat of a *clap*, upon the plea, that some volatile salts fastening there, occasion ulcers that corrode the caruncles; and upon that, the orifices of the heretofore mentioned ducts, throw out their slimy liquor, the flux of which is sometimes never cured.

The PENIS (PP), which is the instrument appointed by nature to convey the *seed* to the womb, for the formation of *man*, is placed at the lower and external part of the *abdomen*, and fastened to the *os pubis*.

Its body consists of the two *corpora cavernosa*, viz. the *corpus cavernosum urethrae*, and the *urethra* itself.

The *corpora cavernosa* of the *penis* have two distinct origins in the *os pubis*, whence they proceed, growing both in bulk and thickness, till they meet the *corpus cavernosum* of the *urethra*, where they join; leaving an interstice or channel, for its passage along them; and thus continue their progress connected together by a membranous body called the *septum*, and terminating at length in the *glans*.

The cavernous body of the *urethra*, includes the *urethra*, or urinary passage. — Its form, contrary to that of the other cavernous bodies, is largest at the two extremes, and smallest in the middle. — That part included between the two origins of the cavernous bodies of the *penis*, Mr. *Cowper* calls the *bulb of the urethra*: Its other extremity being dilated, forms the *glans*.

The *penis* receives arteries (QQ) from the internal iliac branches, and umbilical arteries, from the capillary extremities whereof arise so many veins, in whose channels are apertures, corresponding to so many cells, which communicating with each other empty themselves into larger venous ducts, running on the superior surface of the *penis*; some whereof join the vein of the prepuce; others make one large trunk, called *vena penis*, which marching on the *dorsum penis* to the *prostatæ*; there divides and enters the internal iliac on either side.

The *penis* has nerves from a trunk, composed of a coalescence of the third of the *os sacrum*, and a branch of the great crural: These ascending the cavernous bodies, expand themselves over the upper surface thereof, and are thence distributed to all parts of the *penis*.

It has a great number of *lymphatick* ducts, on its surface under the skin, which discharge themselves into the *glandulae inguinales*.

The *penis* has two pair of muscles, and an odd one; the odd muscle is called *accelerator urinæ*: Its upper part, which covers the bulb, serves to streighten the veins passing through it, from the *corpus cavernosum* of the *urethra*, and thus hinders

the reflux of the blood in erection, and, by repeated contractions, drives the blood into the bulb towards the *glans*. — Its elongation serves to compress the channel of the *urethra*, and to force out the contained *seed*, or urine.

The first pair of muscles is called the *erectores penis* (RR). By their action the *penis* is sustained and drawn towards the *pubes*; and by the assistance of the suspensory ligament of the *penis*, the *vena penis*, is applied to the transverse ligament of the *os pubis*, and the reflux blood hindered from passing that way, whereby the *corpora cavernosa* become distended.

The last pair of muscles are the *transversalis penis* (SS), which vary in various subjects, and are sometimes wanting; their use is to dilate that part of the cavernous body of the *urethra*, to which they are fastened.

The *penis* has also three glands (TT), first discovered by Mr. *Cowper*; these all empty themselves into the *urethra*, and from the tenacity of the liquor they separate, are called the *mucous glands*.

The whole compages of the *penis*, is invested with a cellulous membrane, of admirable texture; which, again, is covered with a firm nervous coat; and that with a *cuticula*, and *cutis*; the duplication of the *cutis* on the *glans* makes the *prepuce*.

The PREPUCE (V), is tied to the lower part of the *glans*, by a ligament, called *frænum*. — By another ligament, called *suspensorium*, the *penis* is tied to the *os pubis*.

The URETHRA (Y) is a nervous passage reaching from the neck of the bladder to the end of the *penis*, seated underneath, and between the nervous bodies. — 'Tis composed of two membranes; the outermost fleshy and uneven, with transverse fibres; the inner one thin and nervous.

The *urethra* descends from the bladder, and passes under the share-bone, after which it ascends and accompanies the *penis* to its end, where it terminates; therefore its figure resembles an S (which should be minded by surgeons when they probe the bladder).

The use of the *urethra* is to be a common passage to the seed and urine.

Having thus examined with all possible care and attention the parts calculated for *generation* in a *man*, we must proceed to another historical account of the same organs in a *woman*.

To observe the same order I have followed in the description of the parts of a *man*, I'll begin with the *spermatick* vessels. — A *woman* has four *spermatick vessels*, viz. an *artery* (AA) and a *vein* (BB) on each side, as 'tis in a *man*. — In both the arteries proceed, in the same manner from the fore

fore part of the *aorta*, but have in both a different infertion; for, in a woman, they divide themselves half-way into two branches, the greatest of which after several circumvolutions marches to the testicles; and the least to the *matrix*, where it splits into several twigs, some of which repair to the sides of the *tubæ*, and neck of the womb, and others to the upper part of its bottom.

This ramification of the *arteries* is accompanied with an equal number of branches of veins, which wind up again from the womb and the testicles, and joining together make two considerable veins: of which that on the right side terminates in the *cava*, and that on the left in the emulgent vein.

These *spermatick* vessels differ from those of men in two points; 1. They are not so long as in men: since the women's testicles, or *ovaria*, being lodged within the *abdomen*, whereas those of men, hang out in the *scrotum*, consequently the passage from the *aorta* to the testicles, and from the testicles to the *vena cava* must be much shorter in a woman than in a man.

Women have two testicles (CC) as well as men, but differ in their situation, magnitude, figure, connexion, covers and substance. — They are seated in the *abdomen* upon the sides of the bottom of the womb, at the distance of two fingers breadth from it, by reason that their commerce and alliance with the *matrix* requires that they should not lie at a great distance. — They are connected to the *uterus* by a strong ligament, which the ancients improperly called *vas deferens*, (for it is not at all hollow) and in some measure by the *fallopian tubes*, and the broad ligament about the region of the *ilium*. — They are fastened to the *peritonæum* by the spermatick vessels, by which means they are kept suspended about the same height with the *fundus uteri*.

Their *figure* is semi-oval; their surface somewhat uneven, and their size different in the different stages of life. At the time of puberty, when largest, they usually weigh a drachm and half.

They are covered with a common membrane from the *peritonæum*; their substance is whitish, composed of a number of little thin membranous and slender fibres, interwoven with arteries, veins and nerves.

Among these fibres and vessels are interspersed a number of little round bodies, like bladders; full of a limpid substance, and called *ova* or eggs, which include the sperm that contains the *fœtus*.

On each side of the *fundus uteri* are discovered two ducts arising from it, called *tubæ fallopianæ* (D) or trumpets, in respect of their form: for that in their rise or opening into the womb, they are exceeding small, but in their progress towards

the *ovary* they grow much bigger, and at length are capable to receive the finger; from whence they contract again, and at the extremity next the ovaries are expanded into a sort of flanch or foliage, fringed round with innumerate little fibres, bearing some resemblance to the flanch of a trumpet.

The FALLOPIAN TUBES are four or five inches long; they consist of a double membrane, derived from the outer and inner membrane of the *uterus*.

— The extremity next the *ovary*, at the time of impregnation, at which time the whole tube is expanded, reaches to, and embraces the *ovary*; tho', at other times, it seems to fall a little short of it, and is only slightly tied by the fringe to the under side of the ovary.

The use of the *tubes* is to convey the *seed*, or rather *ova* of women, from the testicles, or ovaries into the *uterus* or *womb*.

Their inner substance is composed, in good measure, of ramifications of veins and arteries, which form a kind of reticular or cavernous body, not unlike that of the *clitoris*. This structure makes them capable of dilatation and contraction, according to the quantity and stop of the blood; and consequently of being, as it were, erected in *coitu*, and of embracing the *ovary* at that time, which in their state of flaccidity they did not.

They take their denomination *fallopian* from *Gabriel Fallopius*, a *Modenese*, who died in 1562, commonly reputed their first discoverer, though we find them described long before in *Rufus* of *Ephesus*.

The *ova*, or *embryos*, are sometimes detained in the *tubæ fallopianæ*, and cannot make their way into the womb. — *Abraham Cyprianus*, a celebrated physician of *Amsterdam*, in a letter to Sir *Thomas Millington*, describes the manner in which he drew a *fœtus* twenty-one months old out of the *tuba* of a living woman, who lived and had several children after the operation.

TWINS spring always from two *eggs* disengaged from the *ovarium* at one and the same time. The *egg* has two membranes strew'd with vessels, which at first are very small and fine, but grows larger after it has been fecundated by the more volatile part of the *seed* of man carried to the *ovarium*, through the *tubæ fallopianæ*.

The MATRIX (E) *uterus*, or *womb*, is the principal organ of *generation*. 'Tis placed in the lower part of the *hypogastrium*, between the *rectum* and the bladder; lodged in a cavity called *pelvis*, so large as to give the womb liberty to distend itself upon impregnation. It is surrounded and defended by mighty bones; before by the *os pubis*, behind by the *sacrum*; on each side by the *ilium* and *ischium*. It is in figure somewhat like a flat flask, or dried pear.

pear. In women with child, it expands and receives different forms, according to the different times and circumstances of gestation.—It has several coats, arteries, veins, nerves, and ligaments, and is interwoven with several kind of fibres.

Anatomists divide the *matrix* into the *fundus* and *cervix*; a broad part, and a neck.—It is in extent from the extremity of the one to that of the other, about three inches in length; its breadth at the *fundus* is about two and a half, and its thickness two inches.—It has but one cavity, unless we distinguish between the cavity of the *uterus*, and that of its neck. That of the *cervix* is very small, scarce sufficient to contain a garden bean. At the bottom or neck towards the *fundus*, it grows very narrow in virgins; the extremity of it is called the *osculum internum*; in pregnant women it opens, more especially towards the time of delivery.—The other and lower orifice of the neck towards the *vagina*, called *osculum externum*, is a little prominent, resembling, in some measure, the glans of the virile organ.

The substance of the *matrix* is membranous, which enables it to receive the *seed*; to stretch and spread itself for the growth of the child; to contract itself for the egress of the child, and after-birth, and at last to reinstate itself in its natural posture.

The *matrix* is tied fast at the bottom and at the neck. The neck, which is covered with the *peritonæum*, is knit before to the bladder and the *share-bone*, and behind to the *rectum* and the *os sacrum*. The bottom is more at liberty, in order to move, dilate, and contract itself upon occasion, though equipped with four ligaments; two upper ones (FF,) which are nothing else but the productions of the *peritonæum*, which proceed from the loins, and are inserted in the sides of the bottom of the womb, to prevent its falling down upon the neck; and two inferiors (GG) which rise from the sides of the bottom of the womb, towards its horns, and passing through the reins in the *aponuroses*, or tendons of the muscles of the *abdomen*, march to the groins, where they divide themselves into several branches, some of which are inserted into the *share-bone*, and others in the thighs, from whence proceed the pains which pregnant women feel in those parts, which increase as the belly rises.

From the *nerves* dispersed over the bottom of the womb, as well as its neck, and which proceed, some from the *intercostal* branch, and some from those that pass through the *os sacrum*, the *matrix* receives its exquisite sense of pain, or pleasure; and are the occasion of its sympathy with all the parts of the body.

The womb is sprinkled all over with blood imported, part by the *spermatick* arteries, mentioned above; and part by other arteries, which spring from the *hypogastrick* ones.

These *arteries* not only furnish the womb with blood for its nourishment, but likewise pour in blood through an infinity of small branches upon the whole body of the *placenta*, in order to be sent through the *navel-string* to the *fœtus*.—When a woman is not with child, the same blood slips away through several passages that open into the circumference of the bottom of the womb, and falls into its cavity, from whence it makes its *exit* through the *vagina* every month; and this is what we call *menstrual* blood.

There are some of these *arteries*, that supply the inner orifice with blood, which is sometimes let out in pregnant women, especially when the person has more than is necessary for the nourishment of the child: so that we must not be surprized upon seeing some women visited by their *terms* several times during their being with child, who nevertheless go their full time; since in that case the flux comes from the vessels of the neck of the womb, and not from the bottom: for, if from the bottom, it would occasion a miscarriage; but no otherwise.

The *hypogastrick* and *spermatick* are the two principal veins of the *matrix*, which consists of an infinity of branches, springing from all the parts of the womb, and exporting the blood to the trunk of the *vena cava*.

Since we have already compared the *matrix* to a flask, we must believe that it has a bottom, a neck, and orifices: and in fact it has two orifices, the one internal, and the other external.

The *external orifice* (H) called PUDENDUM, is composed of several parts, some of which are obvious, as the *pubes*, the *mons veneris*, the lips, and the great slit. But the others are only descri'd after the deduction of the lips, such are the *nymphæ*, the *clitoris*, *urinary passage*, and the *caruncles*.

The PUBES (I) is seated on the forepart of the *share-bone*, and immediately above the *pudendum*. It consists of fat, which serves as a little cushion to hinder the hardness of the bones from being hurtful in amorous embraces.

MONS VENERIS (K) is seated a little lower than *pubes*, above the great lips.

The great LABIA (LL) descend from this hill, one on the right and the other on the left, and meet in the *perinæum*.—They consist of the skin doubled, and spongy flesh and fat, which renders them pretty thick.—In girls they are firmer than in those who have received man, and in those who have bore many children they are soft and flabby.

—The space between the two lips is called the great cleft, or slit; and reaches from the *mons veneris* to the *perinæum*.

Upon spreading the thighs, and drawing aside the *two lips*, are two fleshy soft and spongy excrescences, called

NYMPHÆ (MM) which descend from the tip of the *clitoris* to the sides of the urinary passage; thus reaching to about the middle of the orifice of the *vagina*, where they grow less and less till they disappear.

Their breadth is uncertain, usually in maids half a finger; some times they are larger, and capable of being distended to a great degree; so as to hang a good way out of the body, and in such cases are often extirpated.

The use of the *nymphæ* is, by swelling in act of coition, to embrace the *penis*, and by their sensibility to affect the woman, and mutually invite to procreation.

Their substance is very spongy, composed of membranes, and vessels loosely cohering, and therefore easily distensible.

Within the great cleft above the *nymphæ*, there is a long round and glandulous body, which encreases towards the extremity, called

CLITORIS (NN) which some call *ostreum veneris*, from its exquisite sensation, for all *Physicians* as well as *Anatomists* agree in this, that the *clitoris* is the principal seat of pleasure.

Its appearance commences in virgins about the fourteenth year of their age; after which it enlarges as the years advance, or in proportion to the greater or lesser salaciousness of the person.—In the ardour of enjoyment it swells and becomes hard, just as the yard swells in the time of erection, and by the same cause.—In some women 'tis very large, and shoots without the lips; in others it has the size of a man's yard, and serves for an instrument to abuse other women, as seen in the *hermaphrodites*.

The *clitoris* is composed of the same parts with those of the *penis*; it has, like it, two cavernous or spongy bodies, and a *glans* (O,) at the extremity, covered with a *præputium* (P,) but not perforated like the *penis*.

It has two muscles (RR) which erect it in coition, on which occasion it swells and grows hard.

The spongy bodies of the *clitoris*, arise distinctly from the lower part of the *os pubis*, and approaching one another, unite and form the body of the *clitoris*; before their union they are called *crura clitoridis*, and are twice as long as the body of the *clitoris*.

Its muscles arise from the protuberance of the *ischium*, and are inserted into its spongy bodies;

it has veins and arteries from the hæmorrhoidal vessels and *pudenda*; and nerves from the intercostal, which serve not only to raise and stiffen the *clitoris*, but likewise to contract and straiten the orifice of the *vagina*; for when they swell themselves, they oblige the *labia* to draw close to one another; by which means the yard is extremely squeezed in the amorous approaches.

The *arteriæ pudendæ* furnish the *clitoris* with blood; and the *venæ pudendæ* carry it back into the *cava*.

Under the *clitoris* appears the urinary passage, surrounded with a *sphincter*, which serves to imprison or release the urine at pleasure; and this passage being larger and shorter in women, than in men; their urine being thereby provided with more dispatch, sweeps off the small stones, sand, and gravel, which oftentimes remain in the bottom of a man's bladder: so that women are less subject to the stone.

*Graaf* calls *lacunæ* a glandulous body, of about a finger's breadth thick, situated between the fleshy fibres of the *urethra*, and the membrane of the *vagina*, and which spreads itself along and round the bladder.—Those conduits terminate in the lower part of the *vulva*, and there throw out a slimy matter that mixes with the male seed.

The CARUNCLES MYRTIFORMES (VVVV) come next, placed, as it were, in the four corners of a quadrangle, and in the midst of a long cavity called *fossa navicularis*.—They are made of the fleshy wrinkles of the *vagina*, which render the passage so much the straiter, especially in virgins, in whom they are joined side-ways to one another by some small membranes, which make them resemble a rose-bud half blown; but when those membranes are once broken, by the ingress of the *penis*, or the egress of a child, they are separated, and never rejoin.—These *caruncles* serve for two uses, one is to heighten the mutual pleasure of enjoyment, by clinging round and locking up the yard; the other is to facilitate the egress of the child, by extending themselves.

*Qu.* May not the union of these two *caruncles*, be the sole mark of virginity in a woman?

Having thus carefully examined the parts calculated for generation, both in men and women; it will not be improper to give here, some account of the generation itself.

To proceed with some order in this discovery, we must consider, that an animal cannot be produced without a couple, *i. e.* a male and a female, each of which acts its respective part in the admirable work of generation.

Let us therefore inquire first into the man's part. The whole of his action may be reduced to two heads,

heads, *viz.* the producing of seed, and the conveying it into the womb.

The SEED, *femen*, is a white liquid matter, the thickest of any in the body, separated from the blood in the testicles, and reserved in proper vessels to be the means of *generation*.

The parts concerned in the preparation of the seed are the spermatick arteries, which bring the blood to be secreted into the testicles; the testicles and *parastatæ*, where the secretion is chiefly effected; the *vasa deferentia*, which convey the secreted matter out of the testicles; and the *vesiculæ seminales*, which receive and preserve it to be emitted in coition.

The *feminal* liquor emitted for use, is a mixture of several fluids, poured at the same time into the common canal of the *urethra*, either from the glands, that have secreted them, or from the reservoirs, that have kept them.

The several feminal particles being separated from the blood by the natural disposition of the testicles, are received by an infinite number of the small roots of the *epididymus*, which convey them to these glandulous bodies; from whence they repair to the *vasa deferentia*; and are by them conducted by drops to the feminal vesicles. — In these vesicles all these particles being joined make a prolifick liquor, called *seed*, laid up for a reserve in these little bags.

This liquor must have an egress, and be transferred to a place that's qualified for the production of man. This place is the *womb*; and the action which transfers the *seed* is called *copulation*.

COPULATION is the joining of a male to a female; in the action the male gives, and the female receives; there are three necessary circumstances in performing the act of *copulation*; the first is the erection of the *penis*; the second its being lodged in the neck of the womb; and the third is the ejection of the *seed*.

The *erection of the penis*, consists in a distention of its *corpora cavernosa*, by an extraordinary quantity of blood pent up therein; and which is effected in the following manner.

The EJACULATION, or EJECTION which ought to follow the lodging of the yard in the neck of the womb, is thus performed. The seed taking leave of the feminal vesicles, passes through the ejaculatory vessels, and enters the *urethra*, from whence it is squirted out with a jirk, by virtue of the convulsions that then seize the yard. The quantity of seed thus emitted cannot be determined; some squirt out more than others; and no more is necessary than what can keep up its conveyance to the *ovarium*.

We'll now take a view of the woman's part in

the act of *generation*; but before we proceed further we must make some remarks upon the *testicles* of women. 1. That the testicles of women are glands which filtrate the seed; and that each of them has an excretory vessel, which conveys the filtrated seed to the vesicles. 2. That in women each of these vesicles is separated from its neighbouring vesicle, as one grape is from another in the same bunch. 3. That in each vesicle there is a seed which is capable to form a child, just as a hen's egg contains all the necessary particles for producing a chick; and, 4. That each vesicle may disengage itself from the testicle, and be transported to the bottom of the womb. — Upon this principle we call the vesicles, *eggs*, and change the name of testicles into that of *ovarium*.

The MATRIX, or womb, is the proper and peculiar organ of generation. 'Tis certain that the *fætus* is formed within it out of the seed that it foment; but we are at a loss to know in what manner it is formed.

There are two principal theories or methods of accounting for the generation of animals: The one supposes the *embryo* or *fætus* to be originally in the seed of the male; the other in the *ovum* or egg of the female.

The *first* supposes animalcules in the male seed to be the first rudiments of the *fætus*; and that the female only furnishes a proper *nidus* and nutriment to bring them forwards.

The *second* supposes the first rudiments of the animal to be in the *ova*; and that the male seed only serves to warm, cherish, and ripen the *ova*, 'till they fall off out of the *ovary* into the womb; which is chiefly supported (say the retainers to that system) from the conformation in rabbits, cows, &c. where the *vagina* of the womb is so long and sinuous, that it is scarce possible the male-seed should ever arrive within the body of the *uterus*, especially in cows, whose *vagina* is filled with a thick, viscid ichor, and the inner orifice of the womb exactly closed — They add to this that it is highly improbable that the animalcules (mentioned by Mr. *Leeuwenhoek* and others) should contain the rudiments of a future body; since their large number would produce too plentiful an offspring; in so much that it would be necessary for 999 parts of them to be in vain and perish, which is contrary to the œconomy of nature in other things.

*Analogy* is likewise urged in favour of this system: That all plants are maintained to arise from eggs; seeds being no other than eggs under another denomination. All *oviparus* animals do unexceptionably arise from eggs; which the female casts forth; and it is highly probable, that the females lay and hatch their eggs within themselves.

Against this hypothesis it is urged, that what are usually called *ova*, or eggs, in women, are no other than little cells or bladders, full of a certain liquor: And how can a drop of liquor pass for an egg? And that these imaginary eggs have no proper membrane belonging to them, nor any covering but that of the cell; which seems so inseparable therefrom, that when they are discharged, it is hard to conceive how they should take it with them. And beside, how should they make themselves a passage through the common membrane, wherewith the *ovary* is invested, which is of so close a texture, that it must seem absolutely impenetrable, by a round body of so soft a consistence, as one of these vesicles. — Lastly, *vesiculæ*, in all respects perfectly like *ova*, have been found in other parts of the body, where it is apparent they could not serve for any purposes of generation. *Mem. de l'Academ. Royal des Scien. An. 1708, 1709.*

To this it is answered, that *ova*, or *vesiculæ*, have been actually found in dissections, detached and separated from the *ovary*, and the ruptures in the membranes in the *ovary*, through which they had passed, still visible.

Mr. *Littre* even observed some of these separated *ova*, spread with blood vessels, like those in the yolks of birds eggs. — Nay more, the same author is positive, that he saw an *embryo* in one of the *ova* not yet separated; could discern its head, mouth, nose, trunk, and *funiculus umbilicalis*, whereby it adhered to the membranes of the *ovary*.

Sir *John Floyer* starts a difficulty, which seems to press equally against each system, taken singly: It is fetched from monsters; in a mule, for instance, which is the production of a *venereal copula*, between an ass and a mare, the bulk of the body partakes of the form of the dam; and the feet, tail, and ears of that of the sire; hence it is argued, that the rudiments of the greater part of the *fœtus*, are laid in the *ovum*; and that the impregnation, either conveys or changes the extremities. If the male supplied the *animalcula*, the *fœtus* should always be of the same species as the male: If the female supply it, it should be of her kind; whereas monsters are of both.

But notwithstanding this objection, all Anatomists agree, at present, that the *fœtus* is certainly lodged in an egg; and that the process of generation, on the part of the female, is thus,

The *clitoris* being erected, after the like manner as the *penis* in man; and the neighbouring parts all distended with blood, they more adequately embrace the *penis* in coitu; and by their intumescence, press out a liquor from the glands about the neck of the

womb, to facilitate the passage of the *penis*. — At the same time the fibres of the womb contracting, open its mouth, (which at other times is extremely close) for the reception of the finer part of the seed.

Thus the seed, pregnant with *animalculæ*, is conveyed with some impetus, into the *uterus*; where, being retained by the convulsive constriction of the inner membrane thereof, and further heated and agitated therein, it is prepared to impregnate the *ovum*.

During the act of coition the *fallopian tubes* growing stiff, embrace the ovaries with their strong muscular edges, like fingers, and compress them; till their mouth being dilated, and expanded by this embrace, force the egg, now ripened, into their cavities, and gradually drive it forwards, by their vermicular motion, till at last they protrude it into the cavity of the womb, to meet the seed; some of the *animalcules* whereof, entering the dilated pores of the glandulous membrane of the egg, are there retained, nourished, grow to its navel, and suffocate the rest of the less lively *animalculæ*.

Thus speak the asserters of that system.

They who set aside the *animalcules*, as unconcerned in generation, account for it thus: The seed containing oily, volatile, and saline parts (as appears from its fetid smell, oleaginous substance, &c.) being lodged in the womb, and there further digested and exalted, grows yet more volatile, fetid, pungent, and stimulating; and thus adding to the heat occasioned by coition, vellicates the nervous fibres of that part, and occasions a fermentation; and by that means an extraordinary flux of humours to that and the adjacent parts.

By this means the *tubæ* become rigid, and fit to grasp the *ovaries*, which are also heated by the *effluvia* of the *semen*, and the warmth of the parts surrounding: till at length, some of them at least, by such greater supply of nourishment, increase in bulk; and as those grasped by the edges of the *tubæ*, will be kept warmest, and the greatest flux be made thereto, they will soonest be ripened, fall off, and be received by the *tubæ*, and conveyed to the womb; where growing after the manner of the seed of plants, the *placenta*, at length, lays hold of, and adheres to the *uterus*; from which time the *embryo* begins to be nourished after a different manner.

From the *abdomen* we proceed to the region of the *thorax*.

The THORAX or *breast* (see A on the fig. of the *ribs*, &c. in the centre of the plate of *Osteology*) is the cavity that reaches from the *claviculæ*, or channel bones to the midriff, terminated by

the *sternum* before; the ribs on the sides and the *vertebræ* of the back behind. Its figure is almost oval; flat behind, and broad and arched before. It is composed of bone and flesh; but not of the same size in all subjects.

It is divided into parts *containing* and *contained*. And the containing parts are either common or proper. The common parts are already described in the account of the *abdomen* (see page 73.) To which add that the fat of the *thorax*, (except in the breasts) is but a small quantity. The proper containing parts are; some glandulous, as the breasts; some cartilaginous, and bony, as the breast bone, ribs, channel bone, shoulder blades, and the *vertebræ* of the back; some fleshy, as the pectoral, intercostal and other muscles; and some membranous, as the *pleura* and the *mediastinum*.

The parts containing are the *viscera* and the vessels.

The *viscera* are the *heart* and its *pericardium*; and the *lungs*, and part of the *wind pipe* and *gullet*.

The *vessels* are several *nerves*; the *great artery*, *vena cava*, and the *thoracick duct*.

The most apparent of these parts are the breasts, a prominent fleshy part on the outside of the *thorax* laterally, serving to separate the milk. Their shape represents a large section of a globe. In the middle of each there is a protuberance, terminating in a blunt point, called the *papilla* or *nipple*; whose extremity is perforated with many holes through which the lacteal tubes discharge themselves, in women, whose breasts are more perfect, conspicuous and useful than in men. They differ in their size not only according to the difference of the sex; but likewise in different female subjects; and even in the same women at different times; being always biggest in times of pregnancy and giving suck.

The *papilla* or nipple is of a fungous and spongy substance; by which means it droops or raises itself, when sucked or handled; and it is possessed with an exquisite sense, so as to give the woman pleasure by a certain titillation, occasioned by the sucking of the child. This nipple varies according to the age and condition of subjects. In virgins it is small and red; in nurses, and those past child-bearing it is large and livid. In virgins it is encircled with a pale coloured *areola*; which is brown in pregnant women, and nurses; but black in old people.

The internal substance of the *breasts* is of an oval figure composed of a great many different sized glands, mixed with globules and vessels of fat. Their excretory ducts, as they approach the nipple, join and unite together, and form seven or more

pipes, called *tubuli lactiferi*, which communicate also with each other by cross canals to prevent casual obstructions. These *tubuli* are in some parts more dilated than in others, so as to form cells, to hinder the spontaneous efflux and create a necessity to draw out the milk by sucking; and the substance of the *papilla* is in some measure formed by the concurrence of these *tubuli*; and they are preserved from passing too close on each other by an intermediate glandulous substance, intermixed with abundance of fibres derived from the external tegument of the *papilla*. By which the lacteal tubes are constricted, and the motion of the milk is modified.

Here also we find abundance of fatty globules called *ductus adiposi*, which, according to *Drake* and *Malpighi*, contribute to the composition of the milk.

These tubes, which compose the glands of the breasts in virgins, contract so closely, that they admit no blood to enter them; but when the womb grows big with the *fœtus*, and compresses the descending trunk of the great artery, the blood increases and is accelerated so much through the arteries of the breasts, that it forces a passage into the glands. By this secretion of the *blood*, or a thick *chyle* circulating with it, there at first appears only a thin water; but as the woman advances in her pregnancy and the womb enlarges, the glands grow wider and admit a thick *serum*; which after her delivery coagulates into a thick milk; because that blood, which before flowed to the *fœtus* by the *uterus* begins then to stop and no longer dilates the mamillary glands.

The *nerves* of the *breasts*, derived from the fifth pair of the *vertebræ*, are dispersed through the whole substance of the breast, and, terminating in the *nipple*, give it every sensible feeling.

The *arteries* of the *breasts* are internal and external.

The *internal arteries*, which visit the inner part, are named *mammariæ*, spring from the *subclavia*, and lend a branch to each of the oval glands, that compose the breast.

The *external arteries* run along the outward surface, are named the upper *thoraciæ*, and spring from the *axillares*.

The oval glands give rise to several sprigs of veins, which form the *venæ mammariæ* and unload in the *subclaviæ*.

In like manner the external part of the breast sends out several branches, which are the trunks of the *thoraciæ superiores* and repair to the *axillares*.

The other arteries import blood for the nourishment of the breasts, and the inner ones feed all the glands

glands. And that blood is exported by the veins *mammariæ* and the *thoraciæ superiores*, into the *subclaviæ* and *axillares*.

As to the MILK obtained through the nipple of the breast, various have been the conjectures about its formation. The ancients took it for granted that nature had endowed the glands of the breasts with a certain concocting virtue capable of turning that blood into *milk* for the nourishment of the child when born; which had fed the *fœtus* in the womb; and that this concoction received its *whiteness* by a certain assimilating faculty in the glands.

This opinion is exploded by the moderns, who teach that *milk* is produced from *chyle*, through the arteries, and like urine through the reins, is filtrated through the glands without undergoing any considerable change. But *Leuwenhoeck* says, that by experiments he has found *milk* to consist of globules swimming in a clear, transparent liquor, called *serum* or *whcy*.

This premised; I am of opinion that MILK is composed of butyrous, caseous and serous parts.

The *butyrous* part is the cream or oil that swims on its surface.

The *caseous* is the grosser part, which coagulates, or curdles like cheese.

The *serous* is that part called *lymphæ*, or a sort of *whcy*.

MILK is the *chyle* conveyed by the *thoracick* duct to the *subclavian* vein, near the *axillary*; from whence running to the *cava* and to the right ventricle of the heart, it there joins with the blood and accompanies it into the great artery, which injects it into all the other arteries of the body; the most serous part thereof being dropt into the reins by the emulgent arteries; and the most milky carried up to the small branches of the *mammariæ* to all the glands of the *breasts*, which completes its secretion and filtration for use; to be deposited by those glands in the cistern of the *milk* till pressed out by the child or some other means; and if kept there too long proves not only very troublesome, but hurtful to the woman; and induceth a disease, called the *milk fever*, occasioned by its fermentation, for want of proper vent.

It will be necessary here to remark, that some men have been found with milk in their breasts; and that authors give us a case of a girl of eight years old, who voided milk in abundance through one of her thighs, and continued for several years so to do, which confirms the doctrine of the *milk's* production from *chyle*, or that it is a thick *chyle*.

Nurses should never give a child the breast so as to load its stomach; for though such a practice, which is too common in good mothers, is allowed to fatten the child, as cramming does turkies; it

often enflames the constitution and carries the baby off with a continual fever.

Great attention also should be given to children, who live much upon milk, who contract several diseases by the corruption of the wholesome nourishment of *milk*, occasioned by a bad digestion. In such a case we are directed by *Celsus* and *Dobél* the *Dane*, to give the patient only a glass of water with a little salt in it, which will throw up the corrupt matter.

The next parts of the *thorax* are muscular and cartilaginous or bony. The muscular will be treated of hereafter. The cartilaginous and bony parts have been described (see page 49.) Therefore we'll proceed to that class of the containing parts of the *breast*, called *membranous*, viz. the *pleura* and the *mediastinum*.

The PLEURA is a membrane of the substance of the *peritonæum*, the figure and extent of the *thorax*, lines the whole inside of the cavity of the *breast*, and incloses all its contents. It is double; yet very fine and thin. It rises from, and is fastened to the ligaments of the *vertebræ*; and is thickest about the back. Its other fastenings are to the *periosteum* of the *costæ*, to the intercostal muscles and to the inner and fore part of the *sternum*.

Its duplicature is in the middle of the *thorax* and forms the *mediastinum* (G). It contains several holes; those above make way for the great artery, the *vena cava*, the gullet, the wind pipe, and to the nerves of the eighth pair. There are other holes below for the passage of the *vena cava* also, and for the gullet.

There are several nerves, arteries and veins; which render the wounds in this part both painful and dangerous. The nerves branch from the *vertebræ* of the back, and from the eighth pair. The arteries spring from the intercostal and great artery; and the veins flow to the *intercostalis superior*, and the *ægygos*.

The use of the *plura* is to defend the inside of the *thorax*, and to make it smooth; which otherwise might injure the lungs in their motion.

The MEDIASTINUM is a double membrane, as above; divides the *thorax* from the lungs, and sustains the *viscera*, to prevent their falling from one side of the *thorax* to the other.

It rises in the *sternum*, and passing, downwards through the middle of the *thorax* to the *vertebræ*, divides its cavity into two parts longitudinally, so that one lobe of the lungs may officiate, should the other on the other side be hindered by any accident.

It contains the heart between its two *lamellæ*; and gives a passage to the *vena cava*, the *œsophagus*, and to the stomachic nerves.

The membranes of the *mediastinum* are thinner than the *pleura*, and have a little fat. Betwixt its membranes immediately under the *sternum* there is matter sometimes lodged; which may occasion the tapping of this part.

It is spread with nerves, arteries and veins. The *nerves* come from the *stomachic*, and some from the *lymphatic*, which open into the *thoracic duct*. The *arteries* and *veins* are branches from the *manillary* and *diaphragmatic* arteries; but one of them is particularly named the *vena mediastina*.

The PERICARDIUM is a membranous pouch or bag, consisting of a double membrane; the inner rising from the coats of the vessels of the heart; the outer from the *mediastinum*. Its figure is *conoidal*, like the heart, including the heart, which it embraces loosely, allowing space for its pulsation; and it is connected either immediately, or by *vesiculae*, emitted from it to the *sternum*, back, *jugulum*, and to the tendinous parts of the diaphragm; being situate in the middle and lower part of the *thorax* between the two lobes of the lungs.

This membrane, when expanded upon the finger discovers a great number of *foramina*, or little holes.

Its arteries and veins are branches from those of the *mediastinum* and *diaphragm*; and its nerves are also derived from the *diaphragmatics*. But its *lymphatics* all run to the *thoracic duct*.

The uses of this *pericardium* are, 1. To support the heart in a pendulous state, especially when we lie down. 2. To defend the heart from the cold air taken in at the lungs. 3. To preserve it from being injured by water, by matter, or any other extraneous fluid in the cavity of the *thorax*, And, 4. To contain the liquor of the *pericardium*, as it is called, which serves to facilitate the motions of the heart.

The liquor of the *pericardium* is a fluid resembling in appearance water, in which raw flesh had been washed. The *anatomical* writers, in general, deduce this fluid from certain glands situated either in the *pericardium*, or in the *heart* itself; but as these glands are not to be found, HEISTER thinks it more rational to suppose that it is expressed out of the *auricles* of the heart in its *systole*.

The *pericardium* is found sometimes in long *beetles*, to cohere with the substance of the *heart*; and there are accounts of its having been wholly wanting.

Dr. KEIL in his treatise of animal secretion attempts to shew, that the liquor in the *pericardium* must be the most fluid of any separated from the blood, because its particles uniting first, will have the greatest attractive force; consequently their particles must be the most spherical and most solid;

and therefore their contact the least of any; and therefore the most fluid. Yet *M. de Mortale's* account published in the memoirs of the *French academy*, says, that the liquor contained therein has been found congealed into a consistence, two square fingers thick about the heart, and fit to be cut with a knife.

The HEART, (L) which is the first and best seat of life, (for it no sooner moves than the *fœtus* begins to live; and the cessation of its motion dissolves the whole machine) is a muscular body, included in the *pericardium*, and situated nearly in the middle of the breast, between the lobes of the lungs; being the primary organ of the circulation of the blood, and consequently of life.

Its figure is nearly *conic*, the larger end being called its *base*, and the smaller end its *apex*. Its lower part is plane, and the upper part convex. Its situation is nearly transverse, or horizontal; so that its *base* is in the right, and its *apex*, with the greatest part of its bulk, is in the left side of the *thorax*; and consequently, it is there that the pulsation is felt.

The plane surface of the *heart* lies on the *diaphragm*; the convex one is turned upwards. The *heart* is connected, 1st, by the intervention of the *pericardium* with the *mediastinum*, and with a large part of the middle of the *diaphragm*: this is contrived by nature, to prevent its being displaced, inverted, or turned too rudely about, in consequence of the various motions of the body. 2. Its *base* is connected to its common vessels; but its *apex* is free, and is received into a kind of cavity in the left lobe of the lungs.

The length of the *human heart* is about six fingers breadth: its breadth at the *base*, is about five fingers; and its circumference about thirteen. It is, both externally and internally, surrounded with a smooth membrane (M). There is a quantity of fat about it, which covers its *base* and its *apex*, and serves for lubricating it, and for facilitating its motions.

The substance of the *heart* is carnos and resembles that of other muscles; but it is harder at the tip end, and its motions are involuntary. It consists of an outer and inner fleshy *fibre*; both of which have their origin and insertion in the *basis* of the *heart*; the *outer* descending from the *basis* in a spiral line, from the right to the left, towards the tip, where they cast a semi-circle, and reascending in a spiral line from the left to the right towards the *basis*: the *inner fibres* depending in a straight line from the *basis* to the tip, and then ascending directly from the tip to the *basis*, where they terminate. By these inner fibres are formed the little fleshy columns of the ventricles.

The *fibres* of the HEART (L) generally pass for a real muscle. Though some authors chuse rather to make the *heart* a double muscle, or two muscles tied together. And certainly the two ventricles and their auricles are two distinct bodies, vessels, or cavities; which may be separated, and yet remain vessels; the *septum* consisting of fibres derived from them both.

The *Nerves* of the HEART are small, and arise from the *par vagum*, or *plexus cardiacus*, and the intercostals.

The *arteries* of the HEART (N) are called *pulmonary* and *aorta*, or only *coronaria*, because they gird its *basis* like a *crown*. They proceed from the great artery, as it arises from the *heart*, before it passes the *pericardium*. So that here the *heart* distributes the first portion of the blood just perfected in its *ventricles*.—Here is also a *vein* called *coronaria*, which pervades along the outer part, and consists of several branches flowing from all parts of the *heart*. This vein deposits the superfluous blood in the *cava*, which passes from the *arteria coronaria*.

The HEART is also provided with *lymphatic ducts*, which empty themselves in the *thoracic duct*.

In the HEART are two great cavities called VENTRICLES. They are two several muscles united together by the *septum*, and several plans of fibres, arising from the outward *base* of the *heart*, and meeting at the apex, which entering the left ventricle line the *parietes* or sides.

The seat of these *ventricles* is in the middle of those fibres: and their orifice and valves are made by the dilatation of their tendons.

The right *ventricle* is the largest, and big enough to contain two, and sometimes three ounces of blood.

They are divided by a fleshy substance, also composed of the muscular fibres, called the *septum*, or partition; concave to the left *ventricle*, and convex to the right. The only communication between the *ventricles* is the passage for the blood into each other.

The left *paries*, or side, is much thicker and stronger than the right; because its orifice is destined to force the blood through all the parts of the body; but the right only drives it with the aid of other vessels, through the lungs; which accounts for the want of this ventricle in animals, which have no lungs.

The *ventricles* enclose certain little muscles, called *columnæ carneæ*, or *lacertuli*: which are derived from the *parietes*, and connected by tendons to the valves of the *heart*: and from the concourse

of the tendinous fibres of these in the heart, there are formed peculiar membranes situated at the orifices of the *auricles* of the heart: and there are also other columns of this kind, which run transversely from one side of the *ventricles* to the other: these serve partly to assist the contraction of the heart in its *systole*, and partly to prevent its too great dilatation in its *diastole*.

The ventricles are capped, each with an *auricle* (OO) which is a production or appendage made of a duplicate of the membranes of the vessels in which they are placed.

The right *auricle* is the extremity of the *vena cava*; and the left of the *pulmonary vein*: To which they adhere in such a manner, as to seem to make but one body with these vessels; so that they agree in size with them.

These *auricles*, as they receive the blood from the veins, serve for a measure to the *heart*, and to prevent a too large eruption, or precipitant course of the blood into the *ventricles*; which might suffocate the animal. Any stoppage in those caps, either by passion, or accident, creates a difficulty of breathing, a rough and quick pulse, and a continual palpitation of the heart.

The Use of the HEART, and its appendant *auricles*, is to circulate the blood through the whole body: in order to which, they have an alternate motion of *contraction* and *dilatation*. By the *dilatation*, called the DIASTOLE, their cavity is opened, and their internal dimensions enlarged, to receive the reflux blood from the veins: and by their *contraction*, called the SYSTOLE, their cavity is shrunk, and their dimensions lessened, to expel the blood again into the *arteries*.

It must be observed that these alternate motions of the *heart* and *auricles* are opposite in time to each other; the *auricles* being dilated whilst the heart is contracted again; and contracted whilst it is dilated to drive the blood into it.

The blood being driven through the *pulmonary vein*, by the right ventricle, into the *pulmonary artery*, it is returned to the left *ventricle*; from which, by the *aorta*, it is distributed all over the rest of the body, and thence returned to the right *ventricle* by the *vena cava*; making an entire circulation through the whole body.

The principle of *motion* in the *heart*, or the power, from which its alternate contraction and dilatation arises, has been greatly controverted among the late *Physicians* and *Anatomists*.

The *motive power*, it is certain, must surmount the *resistance* made to it; and according to *Borelli's* computation, the resistance made to the motion of the blood through the arteries, is equal to 180000 pounds,

pounds, which therefore are to be removed by the *heart*, or else the circulation must cease.

Now, whence comes the machine of the heart to have such a power? And after the expulsion, what other power is it that surmounts the former, and restores its part to the dilatation, to produce a reciprocal *astus*?

*Des Cartes* alledges, that in each ventricle, there are some remains of the blood, which missing of an *exit*, when the heart was contracted, turn sour, and become a ferment, qualified to ferment with the fresh blood, just as oil of tartar does with spirit of vitriol. Upon this foundation he accounts for the motion of the heart in the following manner.

When a gross drop of *blood* falls by its own weight into either *ventricle*, it presently swells, and rarifies, because of its mixing with the ferment it meets with.—The drop thus fermented, taking up more room in the heart than before, removes its *prietes* from one another, enlarges it, and obliges the point or *tip* to approach to the *basis*.—At last, when the heart admits of no farther dilatation, this *drop* tending still to take up more room, forms the *signoides* valves, and repairs to the arteries.—But when its ebullition ceases, and the blood thus rarified has lost its great motion, as being condensed; the heart, by virtue of its *elastic* spring, lengthens itself, and removes its point from the *basis*; upon which a fresh drop of blood, repairing to each ventricle (because nothing then shuts the *tricuspides* valves) is fermented by the ferment, or sharp remains of the preceding blood; and after separating the walls of the *ventricles*, passes into the arteries, as above.

Some believe this *hypothesis* contrary to reason, and say, 'tis more probable that the *pulsation of the heart* is owing to the animal spirits; for if you cut or tie a ligature upon the *intercostal* nerve, and the eighth pair, it ceases in the space of twenty-four hours. But this pulsation depends likewise on the blood; for, if you tie a ligature upon the vessels, the *vena cava* for instance, the pulsation ceases, and recommences when the ligature is taken off, which recommencement is owing to the heat of the blood.

They come nearest to the truth, who attribute this motion to the weight of the blood; for the heart being without an antagonist muscle, would never dilate itself after contraction, if the weight and impetuosity of the blood was not to force it to a dilatation. Thus in dying animals, five pulsations of the *vena cava* answer only to one of the right *auricle*, and two of the *auricles* correspond to one of the heart; which in human bodies is in

some measure promoted by the motion of the *midriff*; the point of the *pericardium* being fastened to it.

To shew how, and in what manner this motion is compassed, let us consider the double *spiral* formed by the *fibres* of the *heart*, and how these fibres cross one another upon the inner surface of the *ventricles*.—As often as these fibres act, they endeavour, by all their parts, to describe a strait line, the consequence thereof is, that the spiral must be shortened, and tend to the form of a double ring; so that the middle of the heart will be enlarged, and its *tip* approach to the *basis*, in order to make an exact and forcible expression of what is contained in the *ventricles*, which is what we call the *systole*, in which the heart beats against our left breast.—But when the *fibres* unbind, they tend to disengage themselves, and to re-assume their first natural state; being assisted therein by the impulse and weight of the blood flowing from the veins, and the motion of the *midriff*, which draws the *tip* of the *heart* towards it; so that the heart is lengthened, and the blood fills the *ventricles*, which we call *Diastole*.

The *auricles* of the *heart* have likewise their *diastole* and *systole*, but different from those of the *heart*; for when the *auricles* empty themselves, the *heart* fills, and as often as the heart squeezes the blood out of its *ventricles*, the *auricles* swell; because the *auricles* are the cisterns of the heart.

At the *basis* of the *heart* we meet with four large vessels, *viz.* the *vena cava*, the *arteria pulmonaris*, the *vena pulmonaris*, and the *arteria*; of which the two former are inserted in the right *ventricle*, and the other two in the left.

The *VENA CAVA* (S) is the biggest of all the four vessels, and terminates in the left *ventricle* of the *heart*, to which it is knit so fast, that it cannot be separated.—It opens into that ventricle by a wide mouth, and pours into it the blood that it has received from the several branches of veins.—Its membrane, which is thin every where else, is very thick, and full of fleshy fibres at its mouth; and that prevents its being rent by the continual motion of the heart, as well as its being over-extended by a large quantity of blood.

The three *triangular* and *membranous* VALVES, (T) called *Tricuspides*, placed at the mouth of the *cava*, are formed of a dilatation of the tendons of the muscles, of which the heart consists, open from without inwards; and are so disposed as to favour the passage of the blood from the *cava* to the heart, and oppose its retreat.

The *vena cava* serves to receive the blood from the branches of the veins in all the parts of the body, and to pour it into the cavity of the *auricle*,  
from

from which it falls into the right *ventricle* of the *heart*.

The *arteria pulmonaris*, or *vena arteriosa*, rises from the right *ventricle* of the *heart*, but its mouth is less than that of the *cava*.—This artery is divided into two great branches, which after a subdivision into several small shoots are dispersed upon the right and left, through the whole substance of the lungs.—The three valves (called *sigmoides* from their resemblance to the Greek *sigma*) are placed at the entrance of the *arteria pulmonaris*.—These valves are little membranes, seated by one another in a different manner from those of the *cava*; for they open from within outwards, to afford a passage for the blood from the right *ventricle* into the artery, and oppose its retreat.

The *arteria pulmonaris* serves to receive the blood from the right *ventricle* of the *heart*, and disperse it in the substance of the lungs.

The VENA PULMONARIS, (X) or *arteria venosa*, proceeds from the lungs by an infinity of small shoots, which, after uniting into one trunk, march out of the substance of the lungs, and empty themselves into the left *ventricle* of the *heart*.

At the entrance of this vein are placed two valves (called *Mitrales*, from their resemblance to a *bishop's mitre*) their situation is like that of the *tricuspides*, for they open from without inwards, to favour the blood's entry into the left *ventricle*, and oppose its return to the veins.—The capillary branches of the *vena pulmonaris*, being dispersed through the substance of the lungs, takes up the blood imported by the *arteria pulmonaris*, and convey it to the left auricle of the *heart*.—Together with the blood this vein imports likewise, the subtlest parts of the air, which passes from the extremity of the *trachea* into its trunk.

The GREAT ARTERY, (Y) called *aorta*, is the trunk and source of all the other arteries of the body, those of the lungs excepted, which are the branches of the artery of the right *ventricle*.—It has several hard and thick coats, and proceeds from the left *ventricle* of the *heart*; at which part it seems to be cartilaginous, being thereby kept always open, and ready to receive the blood, which flows with great impetuosity from the *ventricle*.

The head of the *aorta* (Z) is provided with three valves, or membranous appendages.—They look from within outwards, in order to let the blood pass from the left *ventricle* to the *aorta*; and prevents its reflux from the *aorta* to the *ventricle*.

The *aorta* distributes the blood that flows into it from the *heart*, to all the parts of the body, which is effused in the following manner:

The blood falling out with an impetuous force from the left *ventricle*, is thrown into the *aorta* by the contraction of the *heart*. The subtlest part of this blood mounts upwards through the upper trunk of the *aorta*, and is distributed into the arms by the axillary arteries, and into the head by the *arteriæ carotides*, and *cervicales*.—On the other hand the coarser sort of blood falls downwards through the lower branch of the same artery; and is dispersed to all the parts that lie below the *heart*, by the arteries called *celiac*, *mesenterick*, *emulgent*, *spermatick*, *iliac*, and an infinity of other branches.

In this *circulation* the several liquors contained in the mass of the blood are separated from it in several parts, by virtue of the configuration of the pores of the parts through which it passes, *viz.* The animal juice is separated in the brain; the secretion of the *saliva* is performed in the *parotides*, and the glands of the jaws; that of the acid liquor in the glands of the *œsophagus*, and the stomach; the *pancreatic juice* in the *pancreas*, or sweet-bread; the choler in the liver; the urine in the kidneys; the seed in the testicles; the milk in the breasts, and several other liquors in an infinity of other parts.

The blood being conveyed by the two trunks of the *aorta*, to all the parts of the body both above and below; marches out of the extremities of the capillary arteries, in order to nourish the parts: and for as much as the whole mass thus extravasated, is not quite consumed, the surplusage re-enters the orifices of the capillary veins, by the impulse of the fresh blood, which ounces without intermission from the little arteries, and obliges its fore-runners to return through the small veins to those of a larger size; by which means the blood sent to the head, returns by the jugular veins, and that to the arms by the axillary, and both these terminate in the subclavian, which leads to the upper trunk of the *cava*, and so to the *heart*: In like manner, the blood dispensed to the lower parts, returns to the *heart* by the *iliac*, and all the other veins of the *abdomen*, which unload in the lower and ascending trunk of the *cava*, and with joint forces falls into the right auricle; where the disposition of the *tricuspides* valves, and the contraction of the *heart*, forward it to the *arteria pulmonaris*.

The *arteria pulmonaris* having received the blood, conveys it to the lungs, and disperses it through their whole substance, from whence being accompanied

panied with the subtilest part of the air that joins it from the extremities of the *trachæ*, it passes to the branches of the *vena pulmonaria*, from thence to the left *auricle* of the *heart*, and so it enters the *ventricle* of that side.—In that part the disposition of the *valves* prevents its reflux; upon which, by the contraction of the *heart*, it flies out impetuously into the great artery, and this artery dispenses it to all the parts of the body.—From all these parts it returns by the *capillary* veins to the great ones, and from thence to the upper and lower trunk of the *cava*, in order to renew the incessant *circulation*, the cessation of which, for one moment, would put a period to the animal life.

Mr. *Robault* supposes that it is very easy to discover, by the pulsation of the *heart*, in what space of time the circulation of the blood can be accomplished.—He presupposes that a certain quantity of blood enters the *aorta*, at each pulsation of the *heart*, which he believes cannot be less than a drachm. This presupposed, he begins his calculation thus.

He finds by his pulse, that there happen, sixty-four pulsations of his heart in the space of a minute; whence it follows, that his heart beat 3840 times in the space of an hour; and consequently, that 92160 drachms, or 11520 ounces, or 720 pounds of blood, pass every day through the heart; so that if it could be reasonably supposed, that there is so much blood in a human body, there would be in twenty-four hours but one circulation of the whole mass of blood. But as in Mr. *Robault's* opinion, there is scarce more than ten pounds of blood in a human body; and he believes that the whole mass passes 702 times through the heart in twenty-four hours; consequently, there happens *three circulations* of the whole blood in the space of an hour.

Several ingenious persons have, from time to time, attempted to make estimates of the *force of the blood in the heart, and arteries*. According to Dr. *Keil's* estimate, the left *ventricle* of a man's heart throw out in each *systole* an ounce, or 1.638 cubic inch of blood, and the area of the orifice

of the *aorta* be  $\approx 0.4187$ : then dividing the former by this, the quotient 3.9 is the length of the cylinder of blood, which is formed in passing thro' the *aorta* in each *systole* of the *ventricle*; and in the seventy-five pulses of a minute, a cylinder of 292.5 inches in length will pass; this is at the rate of 1462 feet in an hour. But the *systole* of the heart being performed in one third of this time, the velocity of the blood in that instant will be thrice as much, *viz.* at the rate of 4386 feet in an hour, or 73 feet in a minute. And if the *ventricle* throws out one ounce in a pulse; then in the seventy-five pulses of a minute, the quantity of blood will be equal to 4.4lb. 11 oz. and in thirty-four minutes a quantity equal to a middle-sized man, *viz.* 158lb. will pass through the heart. But if with Dr. *Harvey*, and Dr. *Lower*, we suppose two ounces of blood, that is, 3,276 cubic inches to be thrown out at each *systole* of the *ventricle*, then the velocity of the blood in entering the orifice of the *aorta*, will be double the former, *viz.* at the rate of 146 feet in a minute, and a quantity of blood equal to the weight of a man's body, will pass in half the time, *viz.* 17 minutes.

If we suppose what is probable, that the blood would rise  $7 + \frac{1}{2}$  feet high in a tube fixed to the *carotide* artery of a man, and that the inward area of the left *ventricle* of his heart, is equal to fifteen square inches; these multiplied into  $7 + \frac{1}{2}$  feet give 1350 cubic inches of blood, which presses on that ventricle, when first it begins to contract, a weight equal to 51.5 pounds.

What the doctor thus calculates from supposition with regard to mankind, he actually experimented upon horses, dogs, fallow does, &c. by fixing tubes, in orifices opened in their veins and arteries; by observing the several heights, to which the blood rose in these tubes, as they lay on the ground; and by measuring the capacities of the *ventricles* of the heart, and orifices of the arteries. And that the reader may the more readily compare the said estimates together, he has given a table of them, ranged in the following order.

The

The several animals.	Weight of each.		Height of the blood in the tube from the jugular vein.	Height of the blood in tubes fixed to arteries.	Capacity of the left ventricle of the heart.	Area of the orifice of the aorta.	Velocity of the blood in the aorta.	Quantities of blood equal to the wt. of the animal in what time.	How much in a minute	Weight of the blood sustained by the left ventricle contracting.	Number of pulses in a minute.	Area of the transverse section of the descending aorta.	Area of the transverse section of ascending aorta.
	Pounds.	Ounces.											
Man	160		On straining.	7 6	1.659	0.4187	56.55	34.18	4.38	51.5	75		
Horse 1ft 2d.				8 3	3.318		113.3	17.6	9.36				
Ox	825	1600	12 52	9 6	10	1.036	86.85	60	13.75	113.22	36	0.677	0.369
Sheep	91		5 1/2	9 6	1.85	0.172	174.5	20	4.593	36 56	65	0.094	0.07
Doc				4 2	9	0.476						0.38	0.246
Dogs 1ft.	52	0		6 8	1.172	0.106	144.77	11.9	4.34	33.61	97	0.106	0.041
2d.	24	5		7 2	8	1	0.185	130.9	6.48	3.7		0.102	0.031
3d.	18	5		4 8		0.633	0.118	130	7.8	2.3		0.07	0.022
4th.	12	8	4	3 3	0.5	0.101	120	6.7	1.85	11.1		0.061	0.015

Dr. Jurin likewise deduces the force of the heart from the laws of hydraulics, in the following manner. He supposes  $p$  = to the weight of the left ventricle, or a quantity of blood equal to the same weight;  $S$  = the internal surface of the same;  $l$  = the mean length of the filaments of blood issuing from the same;  $s$  = the section of the aorta;  $q$  = the quantity of blood contained in the left ventricle;  $t$  = the time in which the blood would be expelled from the heart, taking away the resistance of the arteries, and of the blood going before;  $v$  = the variable velocity with which the blood issuing from the heart would flow through the aorta, abstracting from the resistance;  $x$  = the variable length of the aorta, described by the blood gushing from the heart;  $z$  = the time in which the length  $x$  is described.

Hence the mean variable velocity of the blood contiguous to the ventricle, or the mean velocity of the ventricle itself, is  $= \frac{sv}{S}$ ; the motion of the ventricle  $= p \times \frac{sv}{S}$ ; the motion of the issuing of the blood  $= sv \times l + x$ ; the sum of these, or the power of the ventricle  $= sv \times \frac{p}{x} + l + x$ .

But it is  $v = \frac{x}{z}$ . Whence by Newton's inverse

method of fluxions, the power of the ventricle

will be found  $\frac{sv}{z} \times \frac{p}{S} + \frac{x}{z} + l$ . Now, since  $z = t$ , it will be  $sv = q$ . Hence the power of the ven-

tricle  $= \frac{q}{t} \times \frac{p}{S} + \frac{q}{z} + l$ . In the same manner the power of the right ventricle will be found =

$\frac{q}{t} \times \frac{\pi}{S} + \frac{q}{z} + l$ . Here the same things are signified by the Greek letters in the right ventricle, as by the Italic letters in the left. Hence the whole

power of the heart  $= \frac{q}{t} \times \frac{p}{S} + \frac{\pi}{S} + \frac{q}{z} + \frac{q}{z} + l + \lambda$ .

Q. E. I.

If we suppose  $p = 8$  ounces avoirdupois = 13.128 cubic inches;  $\pi = 4 = 6.564$ ;  $8 = 10$  square inches,  $S = 10$ ;  $l = 2$  inches;  $\lambda = 1 \frac{1}{2}$ ;  $q = 2$  ounces avoirdupois = 3.282 cubic inches;  $s = 0.4185$  square inches;  $\sigma = 0.583$ ;  $t = 0.1$ . The power of the ventricles will be equal to the motion of the underwritten weights, that is,

	lb. oz.
Of the left ventricle	9 1
Of the right ventricle	6 3
Of the whole heart	15 4

Of which weights the velocity will be such, as that a line of an inch long might be described by the same in a second.

In a *fœtus*, the apparatus for circulation is somewhat different from that above described. — The *septum* which separates the two auricles of the heart, is pierced through with an aperture, called the *foramen ovale*; and the trunk of the pulmonary artery, a little after it has left the heart, sends out a tube in the descending *aorta*, called the *communicating canal*.

The *fœtus* being born, the *foramen ovale* closes, by degrees, and the canal of communication dries up, and becomes a simple ligament.

This mechanism once known, it is easy to perceive its use. — For, while the *fœtus* is inclosed in the *uterus*, it receives no air but that little, furnished by the umbilical vein: Its lungs therefore cannot swell and subside as they do after the birth, and after the free admission of the air. They continue almost at rest and without any motion; their vessels are, as it were full of themselves, and do not allow the blood to circulate either in abundance, or with ease.

Nature, therefore, has excused the lungs from the passage of the greatest part of the blood; and has contrived the *foramen ovale*, by which part of the blood of the *vena cava*, received into the right *auricle*, passes into the left *auricle*, at the mouth of the *pulmonary* veins; and by this means is found as far in its journey, as if it had passed the lungs.

But this is not all; for the blood of the *cava*, which missing the *foramen ovale*, passes from the right *auricle*, into the right *ventricle*; being still in too great quantity to pass by the lungs, whither it is driven through the *pulmonary* artery; the communicant canal intercepts part of it in the way, and pours it immediately into the descending *aorta*.

This is the doctrine of *Harvey*, *Lower*, and most other Anatomists. But Mr. *Mery*, of the royal academy, has made an innovation in it.

He assigns another use for the *foramen ovale*; and maintains that the whole mass of blood, brought from the *cava* to the right *ventricle*, passes, as in adults, into the *pulmonary* artery, whence part of it is conveyed by the communicant canal, into the *aorta*; and the rest brought from the lungs by the *pulmonary* veins into the left *auricle*, where it is divided into two parts, the one passing through the *foramen ovale*, into the right *ventricle*, without circulating through the *aorta*, and the rest of the body; the other part pushed, as in adults, by the contraction of the left *ventricle*, into the *aorta*, and the whole body of the *fœtus*.

Mr. *Du Verney* asserts, on the contrary, that the

*foramen ovale*, has a valve so disposed, as to be opened by the blood driving into the right *ventricle*, but shut the more firmly, by its pushing into the left. Mr. *Mery* denies the existence of any such valve.

According to the common opinion, the *aorta* receiving more blood than the *pulmonary*, should be bigger. — According to the opinion of Mr. *Mery*, the *pulmonary* artery should be the biggest, as being esteemed to receive a large quantity of blood.

Therefore, to judge of the two systems; it should seem there needed nothing, but to determine which of the two vessels were the biggest in the *fœtus*.

Mr. *Mery* always found the *pulmonary* artery half as big again as the *aorta*; and, on the other hand, Mr. *Tauroy*, who seconded Mr. *Du Verney*, produces cases where the *pulmonary* is less than the *aorta*. The facts on both sides were examined by the *French* royal academy.

Mr. *Tauroy* adds, that though the *pulmonary* artery should be greater than the *aorta*; yet this does not prove, that more blood passes the first, than the second; since it may be accounted for, from the blood's pressing more slowly towards the lungs, which it finds some difficulty to penetrate, and accordingly swells and is driven back.

Mr. *Littre*, upon dissecting an adult, in whom the *foramen ovale* was still open, and measuring the capacities of the vessel on each side, declares for Mr. *Mery*.

For the source of the circulation in the *fœtus*, *Anatomists* are again divided. — The popular opinion is, that during gestation, the arteries of the *uterus* convey their blood into the *placenta*, which is nourished by it, and the surplus conveyed into the root of the *umbilical* vein, which makes part of the navel-string: Thence it is carried to the liver of the *fœtus*, where it enters the *vena cava*, and is thence conveyed to the right *ventricle* of the heart, and distributed as before.

Again, the blood brought from the *iliac* arteries of the *fœtus*, enters the navel string, by the *umbilical* arteries; thence passes into the *placenta*, where it is returned by the veins of the *uterus*, which carry it back again to the mother; and perhaps also, by the roots of the *umbilical* veins, which mix it afresh with the blood of the mother.

Therefore, according to this system, it is the blood of the mother that supplies the child, which is here only regarded as a distinct member, or part of her frame.

The beating of her heart sends it a portion of her blood; and so much of the impulse is preserved,

as suffices to maintain that languid circulation, which a *fœtus* enjoys: And in all probability, gives that feeble pulsation observed in the heart.

Other *Anatomists* maintain, that the *fœtus* is only supplied with chyle, from the glands of the *uterus*: which is further elaborated, and turned into blood, in the vessels of the *fœtus*; and circulates therein, without any further communication with the mother. — These allow of no reciprocal circulation, excepting between the *placenta* and the *fœtus*.

But the former opinion is best supported; for the *placenta* being separated from the *uterus*, during the time of gestation, neither yields any chyle, nor any thing but blood.

The circulation of the blood has been generally allowed to have been first discovered in *England*, in the year 1628, by the celebrated *Dr. Harvey*, though there are several authors, who have attempted in vain to prove the contrary.

The LUNGS (AA) which are the next part we are to observe in the *thorax*, are a collection of little membranous vesicles heaped one above another, and interlaced with branches of arteries and veins.

(BB) Those bladders are formed of the extremities of the inner coat of the *trachæa*, or wind-pipe, and all wrapt up in a membrane. — Their outside is convex, and raised upon the sides, where they touch the ribs, but their inside is concave, whereby they can embrace the heart with greater facility.

The LUNGS are connected above to the *fauces*, by means of the *trachæa*; and below to the *vertebræ* of the *thorax*; and to the *sternum* and *diaphragma* by means of the *pleura*, to which they sometimes adhere, even from the first conformation of those parts.

(CC) They are divided into two great lobes by the *mediastinum*, and those again subdivided into several other lobes or lobules; the right sometimes into three or four, by means of some fissures running from the fore to the back edge. — The great lobes, when inflated, resemble each of them a horse's hoof in figure, but together they are like an ox's inverted.

The whole substance of the lungs is covered with a common membrane, which is divisible into two coats; the outer, thin, smooth, and nervous; the inner, somewhat thicker and rougher, consisting mostly of the extremities of vessels and vesicles, through the impression of which it is pitted, and resembles, in some measure, a honey-comb.

The vessels of the lungs are the *bronchiæ*, the pulmonary and bronchial arteries and veins, nerves; and lymphatics. — Of these vessels some are pro-

per, and some common; the common are the *bronchiæ*, the pulmonary artery and vein, the nerves and lymphatics; the proper are the bronchial artery and vein.

(EF) Before we inquire into the use of the lungs, it is proper to observe, that the *trachæa*, or wind-pipe, is a passage, which reaches from the mouth to the lungs. — 'Tis placed upon the *œsophagus*, or gullet, which it accompanies to the fourth *vertebra* of the breast, and there splits into two branches, which enter the lungs, one on each side. These branches are afterwards divided into as many twigs, as there are lobes; and the twigs are again subdivided into a number of smaller shoots, answerable to that of the lobules in each lobe; so that all the small vesicles in each little lobule are furnished with branches.

The branches of the artery and pulmonary vein, are constant companions of those of the *trachæa*, and they jointly terminate in the lobes and lobules; so that we may justly apprehend, that each lobule being composed of several little round vesicles, is a sort of little lungs.

The constituent parts of the *trachæa* are several cartilages, ligaments, and two membranes. — The cartilages are semicircular before, and upon the sides they are hard, and sometimes ossified; but their backside is membranous, which give them the form of an half moon. — They are ranged one above another, and grow smaller as they approach to the lungs. They are so contrived, that by entering into one another, like the shells of a crab's tail, they lengthen themselves in inspiration, and shorten in expiration and expectoration.

They are all fastened to one another by ligaments, which run between them, and which some have mistaken for muscles.

The *trachæa* has two membranes; a very strong outer one, which ties the cartilages together, and hinders their dilatation; and the inner membrane, which is but a continuation of the palate of the mouth, and serves to line its inside in the *larynx*, or entrance of the *trachæa*. This coat is very thick, indifferent in the middle, and very thin in the branches inserted in the lungs. — Its sense is so exquisite that it can suffer nothing; for when any portion of food, or drink falls into its cavity, we never cease coughing till we have dislodged it again. — 'Tis liquored over with a fat humour that keeps it always supple, in order to form the voice, and prevent its being dry'd or injured by the sharp and fuliginous excrements that pass through the wind-pipe. The abundance of this humour causes a hoarseness; but its excessive redundancy occasions the loss of one's voice, which retrieves so soon as the humour is consumed.

The *trachæa* receives branches of nerves, from the recurrent branches of the eighth pair; arteries from the *carotides*; and its veins unload in the external *jugulares*. Its nerves being dispersed through its whole inner membrane, cause its exquisite sense.

The *trachæa* and its *bronchia* serve to conduct the air into the *lungs*, in the *inspiration*, and to return it again in the time of *expiration*.

The *INSPIRATION* is the ingress of the air, ensuing upon the dilatation of the *thorax*, and the *lungs*; and the *EXPIRATION*, the egress of the air; together with a vaporous *lympa*, procured by the contraction of the same parts.

This ingress or admission of the air depends immediately on its springs, or elasticity, at the time when the cavity of the breast is enlarged, by the elevation of the *thorax* and *abdomen*, and particularly the motion of the *diaphragm* downwards: So that the air does not enter the *lungs*, because they are dilated: but those dilate, because the air enters within them. Nor is it the dilatation of the breast, which draws in the air, as is commonly thought, but an actual intrusion of the air into the *lungs*.

*EXPIRATION* is performed by a contraction of the cavity of the breast, and the parts employed in the inspiration, re-assuming their first station.

*Inspiration* and *expiration*, form together what we call *respiration*.

But for a clearer explanation of this subject, and of the manner wherein *respiration* is performed, we must observe, that the *lungs*, when suspended in the open air, by the contractive power of the muscular fibres which tie together the squamous parts, the *bronchia* are reduced to less space, than they possessed, while in the cavity of the *thorax*; and when thus contracted, if a quantity of new air be injected through the *glottis*, they again become distended, so as to possess an equal, nay, a greater space, than that assigned them in the *thorax*.

Hence it appears, that the *lungs*, by their proper force, are always endeavouring to contract themselves into less compass than they possess when inclosed in the *thorax*; and that therefore they are always in a state of violent dilatation, while the man lives. — For the air that encompasses them in the *thorax*, shut up betwixt their external membrane, and the *pleura*, is not of equal density with common air.

In effect, the ingress of the air, through the *glottis*, into the *lungs*, is always free; but that on the outside, wherewith they are compressed, is impeded by the *diaphragm*, so as it cannot enter the *thorax* in a quantity sufficient to make an equilibrium.

Since then in *inspiration*, the air enters the *lungs* in greater quantity than it did before; it will dilate them more, and overcome their natural force. — The *lungs* therefore are wholly passive in the matter: What it is that acts must be learnt from the *phenomena*.

1. Then it is observed, that in *inspiration*, the nine upper ribs, articulated to the *vertebræ*, and the *sternum*, rise archwise towards the *clavicles*; and the three lower are turned downwards; and the eighth, ninth, and tenth are drawn inwards. 2. That the *abdomen* is dilated. And, 3. The *thorax* enlarged. 4. The *diaphragm* is brought from its convex, and sinuous position to a flat figure.

Now as these are the only visible actions in *inspiration*, the cause of the operation must be referred to them; or rather to the muscles of these parts, which are the intercostal, the subclavian, &c.

The capacity of the *thorax*, being enlarged by the action of these muscles on the ribs, &c. a space is left between the *pleura* and the surface of the *lungs*; so that the air entering the *glottis*, inflates them till such times, as they become contiguous to the *pleura* and *diaphragm*. — In this case now the air presses the *lungs* as much as the *thorax* resists them; and hence the *lungs* become at rest; the blood passes less freely, and is forced in less quantity into the left ventricle of the heart, and so less comes into the *cerebellum*, and its nerves, and the arterial blood acts less on the intercostal muscles, and *diaphragm*.

The causes, therefore, which at first dilated the *thorax*, grow weaker; and consequently the ribs become depressed, the distended fibres of the muscles of the *abdomen*, restore themselves, the *viscera* thrust the *diaphragm* up again into the *thorax*, the space whereof being thus contracted, the air is drove out of the *lungs*; and thus is *expiration* performed.

Immediately the blood being quickened in its motion, begins to flow stronger, and more plentifully to the *cerebellum* and muscles; and thus the causes of the contraction of the *intercostals*, and *diaphragm* being renewed, *inspiration* is repeated. — Such is the true, immediate, adequate manner of vital *respiration*.

The uses and effects of *RESPIRATION* are greatly disputed among *Anatomists*. — *Boerhaave* takes the principal uses thereof to be the farther preparation of the chyle, its more accurate mixture with the blood, and its conversion into a nutritious juice proper to repair the decays of the body.

*Borelli* takes the great uses of *respiration*, to be the admission, and mixture of air with the blood in the *lungs*, in order to form those *elastick* globules.

it consists of; to give its red florid colour: and to prepare it for many of the uses of the animal economy: But how such admission should be effected is hard to say.

Other authors, as *Sykeus, Etmuller, &c.* take the great uses of *respiration*, to be by the neighbourhood of the cold, nitrous air, to cool the blood coming reeking hot out of the right ventricle of the heart, through the *lungs*; and to act as a refrigeratory.

*Mayow* and others, assert one grand use of *respiration* to be, to throw off the fuliginous vapours of the blood along with the expelled air; and for *inspiration*, he asserts, that it conveys a nitro-aerial ferment to the blood, to which the animal spirits, and all muscular motions are owing.

But *Dr. Thurstow* rejects all these, from being principal uses of *respiration*, which he shews to be, to move or pass the blood, from the right to the left ventricle of the heart, and so to effect the *circulation*.

He instances an experiment made by *Dr. Croon* before the Royal Society, who by strangling a pullet, so as not the least sign of life appeared; yet by blowing into the *lungs*, through the *trachæa*, and so setting them a playing, he brought the bird to life again. — Another experiment of the same kind is that of *Dr. Hook*, who after hanging a dog, cut away the ribs, diaphragm, and pericardium, and also the top of the wind-pipe, that he might tie it on to the nose of a pair of bellows; and thus by blowing into the *lungs*, he restored the dog to life; and then ceasing to blow, the dog would soon fall into dying fits, but recover again by blowing, and thus alternately, as long as he pleased.

The **NECK**, (which being nothing else but an extension of the *thorax*, we'll examine in this place) commences at the *atlas*, which is the first *vertebra*, next to the *head*, and terminates at the first *vertebra* of the *thorax*. — It has the length of seven *vertebræ*, and is not so broad as it is long. — Its forepart is called the *throat*, and the back part the *nucha*, or nape. — 'Tis divided into the *containing* parts, which are the same with those of the whole body; and the *contained*, among which the *trachæa*, the *larynx*, and the *œsophagus* are of the greatest note.

The **LARYNX** (HH) is the principal organ of the *Voice*, and the upper part of the *trachæa*, placed on the fore-side of the neck, directly in the middle. — Its figure is circular. — It rises before, and is flat behind, to prevent its hurting the *œsophagus* just placed under it. — This rising is called *Adam's* bit, upon the ridiculous opinion, that the forbidden fruit stuck in his throat, and so occasioned a bunch.

The magnitude of the *larynx* varies according to the difference of ages. In young persons 'tis strait, and renders the voice shrill; in persons of riper years 'tis larger, and renders the voice strong. — 'Tis bigger in men than in women, or it does not appear so visibly in women, as in men; because the glands of the lower part of the *larynx* are larger in women, and thereby their neck becomes rounder, and their throat fuller. — It moves in deglutition, for when the *œsophagus* lowers itself, to receive the food, the *larynx* rises to press it down.

The *larynx* consists of cartilages, muscles, membranes, vessels and glands.

The whole body of the *larynx* is formed of five cartilages, viz. the *thyreoides*, *cricoides*, *arythænoides*, the *glottis* and *epiglottis*.

The *Thyreoides* is hollow within, and convex without, and divided in the middle by a line, which give occasion to say, 'twas double, though 'tis very rarely found to be such. — The *larynx* is square, and each of its angles has a production. — The two upper productions are the longest, and are tied to the sides of the *os hyoides* by a ligament; and by the two lower productions to the *cricoides* cartilages.

The *Cricoides* resembles a ring, and goes round the whole *trachæa*. — 'Tis narrow before, but broad and thick behind. — It serves for a basis to all the other cartilages, and joins them all to the *trachæa*, and for that reason is immoveable.

The *Arythænoides*, (L) which is the third cartilage, is placed in the *thyreoides*, and supported by the annular cartilage. — It forms the back part of the *larynx*.

The *Glottis* (M) forms the upper and back part of the *larynx*, where 'tis narrowest, and renders the voice either shrill or strong, according as it contracts or dilates itself.

The *Epiglottis* serves for a cover to the *glottis*, resembles an ivy-leaf, and has a softer substance, than any of the other cartilages; which qualifies it to rise, or lower itself commodiously. — 'Tis fastened to the concave and upper part of the *thyreoides*. — The *orifice* of the *larynx* stands always open for *respiration*, except when the *epiglottis* shuts it. Now the weight of the aliment makes the *epiglottis* fall down upon it, lest any thing should fall into the *trachæa*; but as soon as the aliment is passed the *œsophagus*, or gullet, the *epiglottis* recovers itself by a natural rebound, to afford a passage to the air.

The *larynx* is provided with fourteen muscles; seven on each side, which dilate or contract the wind-pipe, or *trachæa*; four of these are *common*, and ten are *proper*.

(OO) The two first *common* proceed from the upper and lower part of the first bone of the *sternum*, and mount along the cartilages of the *trachea*, till they arrive at the lateral part of the *thyreoides*; —where they are inserted.

The two other common muscles proceed from the fore-part of the *hyoides* bone, and are inserted in the outer and lower part of the *thyreoides*. — They serve to raise the *larynx*, by contracting the upper, and dilating the lower part of the *thyreoides*.

The first pair of the *proper* muscles proceed from the lateral and fore-part of the *cricoides*; are inserted in the lower part of the wing of the *thyreoides*, and therefore placed in the fore and lateral part of the wind-pipe.

Of the remaining four pair, two serve to open the *larynx*, and two shut it.

The first pair employed in opening the *larynx* proceed from the lower and back part of the *cricoides* cartilage; and are inserted into the upper and hinder part of the *arythænoïdes*.

The next couple for the same use, take their origin from the edge of the lateral and upper part of the *cricoides*, and their insertion from the lateral and upper part of the *arythænoïdes*.

The first pair that serve to shut the *larynx* spring from the hinder and lower part of the *arythænoïdes*, and have an oblique insertion in the same cartilage.

The second couple, for that use, proceed from the hollow and inner part of the *thyreoides*, and terminate in the fore-part of the *arythænoïdes*.

The *larynx* has two membranes; an outer one, which is continuous with the outer cover of the *trachea*; and an inner one, which is the same with that of the palate, for it lines the whole mouth, and descends as an inner coat through the *pharynx*, the *larynx* and the *trachea*.

It receives two branches of nerves from the recurrents; and is moistened by four large glands, two situate above, called *tonsils*, and two underneath, called *thyroïdæ*.

The *tonsils* are of a spongy substance, seated on each side the *uvula*, near the root of the tongue. The common coat of the mouth is their cover. Their nerves are derived from the fourth pair; their arteries from the *carotides*; and their veins unload in the jugular.

These glands serve to make a secretion of the blood imported by the *carotides*. This *serum* they unload in the bottom of the mouth, in order to keep the wind-pipe moist, and part of it trickles down the *trachea*.

The two lower glands called *thyroïdæ*, are placed under the *larynx*, by the annular cartilage, and the first ring of the *trachea*; one on each side; they have the figure of a little pear. Their sub-

stance is more solid, viscous, and inclining to a muscular consistence than that of the other glands. — Their nerves are from the recurrent branches; their arteries from the *carotides*; their veins run to the jugular, and their lymphatick vessels unload in the thoracic duct.

These glands make a secretion of a viscous Humour, with which the *larynx* is done over, in order to facilitate the motion of its cartilages, to qualify the acrimony of the *saliva*, and to soften the voice.

The *larynx* is of a very considerable use, not only in modulating and softening the voice, by the different apertures of its *rima*, or chink, but also in compressing the *lungs* to a greater or less degree by the air; for if the internal diameter of the *larynx* had been equal to that of the *trachea*, the lungs could have undergone little or no compression at all; nor consequently without the *larynx* could we have reaped the advantage from breathing, in regard the air would not have resisted that force wherewith it is driven out in expiration, nor consequently could the compression have been made in the lungs, which is found necessary for the communication of the globules of the blood; and the mixing of the two fluids, air and blood together.

2. Behind the *larynx* there is a very large cavity, called the PHARYNX, which is only the orifice of the *œsophagus*, dilated to a great extent. — This made like a funnel, and some call it *gula*, or gullet, in which the action of digestion commences, and where it is chiefly performed.

It is assisted by three pair of muscles, which chiefly compose the *pharynx*. — The first, called the *stylopharyngæus*, serves to draw up and dilate the *pharynx*. The second, *pterygopharyngæus*, serves to constrict it; the third, which is called the *œsophagus*, serves to close it.

The office of the *pharynx* consists in receiving the aliment into its widest part, and conveying through its narrower passage into the *œsophagus*, which conducts it to the ventricle; and which is performed in the following manner. When the muscles heretofore mentioned have widened the *pharynx*, then the *œsophagus* contracting itself, raises the *larynx*, and presses down the *pharynx*, which clings round the aliment on all sides, and obliges it to descend through the *œsophagus* into the *ventricle*.

The OESOPHAGUS, or *gullet*, is a membranous pipe or passage, whereby our food and drink is conveyed from the mouth to the stomach.

The *œsophagus* descends from the *fauces* to the stomach, between the *aspera arteria* and the *vertebræ* of the neck and back, in a strait line, excepting for a little deflexion about the fifth *vertebra* of the

the *thorax*, where it turns a little to the right to make way for the great artery, which runs along with it to the ninth; where turning again towards the last, it crosses the artery, and piercing the diaphragm, ends at the left orifice of the stomach.

It consists of three membranes, which qualify it for an easy dilatation upon the swallowing of a bone, or an ill chewed morsel.—Of these three membranes the outer one is a continuation of that, which invests the stomach.

The first proper or middle one is carnos, thick, and soft like a muscle, and is possessed of round and oblique fibres, which effect the motion of the *oesophagus*.

The second proper is nervous, and contiguous with that, which invests the mouth and lips, by which means it comes to pass that the lips tremble, when a vomiting approaches. This coat has long and strait fibres, and like that of the stomach, is strewed with an infinity of glandules, which strain out an acid humour into the *oesophagus*; and this humour gliding to the bottom of the stomach, affects it with the sense of *hunger*.

Mr. *Duncan* observes, that when any acid vapours proceeding from the stomach, irritate the nervous membrane of the *oesophagus*, by provoking the spirits to crowd particularly on that part, it never misses to make us *yawn*, and therefore this membrane is the true seat of yawning; for in that case, the nervous fibres of the inner membrane swell by the irritation; and by dilating the *oesophagus*, oblige the mouth to answer their motion, it being lined with the same membrane.

The *oesophagus* receives nerves from the *par vagum*; arteries from the *aorta*, and *celiaca*; and two sorts of veins, one above, which runs to the *azygos*, and another below, which terminates in the stomachick *coronaria*.

The glands placed at the hinder part of the *oesophagus* serve to separate the viscous humour with which its cavity is moistened, and rendered more slippery in order to facilitate the descent of the aliment

The action of the *oesophagus* belongs to the animal class, and not to the natural, for it is effected by the means of the muscles: and swallowing is known to be a voluntary action.—Its motion is of undulation, like that of the intestines, and is performed by the oblique and circular fibres of its fleshy membrane.—When this motion tends from above downwards, 'tis called *peristaltick*, and the reverse of that *antiperistaltick*.

From the *neck* we proceed to the parts contained in the *head*. For the parts containing see page 40, &c.

The first part that offers itself to our view after

the lifting up of the *skull*, is the *DURA MATER*, which consists of a double plan of fibres, that cross one another a thousand different ways; though sometimes one may divide it into two, very easily.—'Tis much thicker in young persons, and sticks very close to the skull, by a great many little vessels, which nourish the inner part of the *cranium*; of which this membrane is thought by many authors to be a continuation.

Arteries and veins rise above the outer surface of the *dura mater*, and so contrived that the arteries are always covered with veins to prevent any injury accruing to the *cranium* from the continual pulsation of the artery.—The arteries of the brain proceed from the inner *carotides*; and those of the *cerebellum* from the *vertebrales*.—The veins of the brain empty themselves into the inner jugular veins, and those of the *cerebellum* into the vertebral.—In these vessels there are mutual *anastomoses* of arteries with arteries, and veins with veins, to the end that the blood being stopt on one side, the brain may be sufficiently supplied on the other.

To prevent the compression of the vessels, nature has run the vertebral artery through a bony gutter, digged out of the transversal processes of the neck, and conducted the same artery to the *cranium*, by the *foramen* of the *occiput*, where it is defended from pressure by being laid in a hollow cut of the first *vertebræ* of the neck.

'Tis to be observed, that some arteries run off obliquely, after they have gone some rounds upon the *dura mater*, to mitigate the boiling of the blood, which otherwise would occasion grievous *head-achs*.—These arteries unload in the longitudinal *sinus* of the *dura mater*, which does not happen in any other part of the body; for the blood of the arteries never mingles elsewhere with that of the veins, without passing first through some glands, or the fibres of some parts.—In effect the *veins* have no immediate communication with the *arteries* in any other part of the body.

The *DURA MATER* invests the whole substance of the brain and *cerebellum*; serves, 1. To keep the brain from rattling against the *skull* in the great commotion of the head; 2. To let in the more volatile parts, which are perpetually evaporated from the brain; 3. To fill up and stop the holes of the *skull*, through which the sanguine and nervous vessels pass; and, 4. For a cover to the nerves: and defends them from being annoyed by the hardness and roughness of the skull in passing through its perforations.

This membrane is endowed with an exquisite sense, independent from the brain, for if the brain is stript of the *dura mater*, it might be cut without pain.—This sense proceeds from its immediate contact

contact and union with the nerves, to which it is a cover, and from some threads it receives of the fifth pair of nerves, at the place of its perforation.

In that part, which runs out in length under the *sagittal future*, the *dura mater* is double, and by a gradual diminution enters the substance of the brain. This duplicature contracting itself, marches from the *cerebellum* to the fore-part of the head, and is fastened to the hollow part of the *coronal bone* above the *crista galli*.

(D) This duplicature is called *FALX*, from the resemblance of a *sickle*.—This membrane has another duplicature towards the *lamboides future*, where it is four times thicker, than in other places, the better to part the brain from the *cerebellum*; and to keep one side from pressing the other (when one lies on one side of the head;) to keep up the second longitudinal *sinus*, and to hinder the corruption of one side to be imparted to the other.

The second duplicature of the *dura mater* serves to guard the *cerebellum*, from the pressure of the two hinder lobes of the brain, and to keep up the two lateral *sinus's* in savage animals.—In this place called the *torcular*, or *profs*, there stands a bony protuberance, which fortifies the last use of the duplicature.

The *dura mater* presents us with ten *sinus's* or cavities, *viz.* (E) the superior longitudinal; (FE) the two lateral; (G) the straight; (H) the inferior longitudinal; one at the *crist* of the *os occipitis*, and two upon the stony process, (one above and the other below) which communicate with one another towards the *fella* of the wedge-like bone, and after that communicate with those of the other side towards the hinder *clinoides processus*.

The upper longitudinal *sinus* runs upon the *falx*, along the *sagittal future*, and terminates together with the *falx* above the *crista galli*. The lateral cavities commence towards the *lamboides future*, where the *falx* and the back longitudinal *sinus* take their rise. The straight *sinus* commences towards the union of the lateral, or the division of the upper longitudinal, and marches straight to the *glandula pinealis*.—The lower longitudinal runs along the extremity of the *falx*, and terminates the straight *sinus*.

The cavity that lies by the *crist* of the *os occipitis*, extends no further than the *crist*, and disembogues in the lateral *sinus's*; the other cavities in the base of the *cranium*, empty themselves into the lateral *sinus's*; some higher, and some lower, and commonly at that place, where they wind in the form of a Roman S; and then unload in the jugular and internal vertebral veins.

These ten cavities serve to contain the blood in the brain, for some time, in order to heat it, by

their moderate and cherishing heat, for the generation of animal spirits, and to check its rapid course, they serve also to receive the residue of the blood from the capillary veins of the brain, and convey it to the jugular and vertebral veins, in order to circulation.

The *dura mater* has a motion of *diastole*, and *systole*, which is caused by the arteries, which enter the *skull*.

(I) The *PIA MATER* lies immediately under the *dura mater*, and is a fine, thin membrane, which covers the brain so intimately, that it can scarcely be separated from it: it accompanies the brain in all its circumvolutions, and conducts all the vessels that either enter its substance, or depart from it.

Dr. *Willis* observes, that it is filled with a great many little glands, which serve to separate a watery humour that moistens the two membranes.—'Tis alledged that this *pia mater* is extream sensible, and the seat of the head-ach.

(M) Under the *meninges* appears a large, soft, whitish mass, wherein all the organs of sense terminate, called *BRAIN*.

Its figure is the same with that of the bones that contain it, *viz.* roundish, oblong, and flat on the sides; and is divided into three principal parts, *viz.* the *cerebrum*, or *brain*, strictly so called, the *cerebellum*, and the *medulla oblongata*.

The *BRAIN* is divided by the *falx*, into two equal parts, called right and left *hemispheres*. It is also separated from the *cerebellum*, by another duplicature of the *dura mater*.

(N) It consists of two kinds of substance; the outward one is *cineritious*, or *ash-coloured*, soft and moist, called the *cortex*, or cortical part of the brain, is about half an inch thick. The other or inner substance is white, more solid and dry than the *cortex*, and is called the *marrow*, or *medullary*, and sometimes the *fibrous* part.

The *cortex*, according to *Malpighi*, is formed from the minute branches of the *carotides* and vertebral arteries; which being woven together in the *pia mater*, sends from each point thereof, as from a *basis*, little branches, which being twisted together into the form of a gland, inclose the *medulla*, ordinarily to the thickness of half an inch. These little branches make circumvolutions like the intestines; each of which may be resolved into other innumerable minute glands, contiguous to each other, destined for the secretion of animal spirits from the blood, brought hither by the *carotides*, &c. and likewise to filtrate the *nervous juice*, which is an oily, and very subtil liquor, affording a vehicle to the animal spirits, and assisting the blood, in the nourishing of the parts.

(O) The inner or *medullary* part of the BRAIN, consists of infinitely fine fibres, arising from the minutest branches or filaments of the glands of the *cortex*; these receive the fluid separated and subtilized from the glands of the *cortex*; and by means of the nerves, which are no more than productions of this part, distribute it all over the body.

*Ruyfch*, and *Leeuwenhoek*, deny any thing like glands in it; and allow nothing but little *cryptæ*, or sinks, opening laterally to the arteries; and thence receiving a juice already secreted from the blood, and transmitting it to the *medulla*.

In the space between the two *hemispheres* of the brain, under the *falx*, or rather under the longitudinal *sinus* of the *dura mater*, is a white substance, of a texture, more compact than the *medulla* of the brain, called *corpus callosum*, which runs along the whole tract of the *falx*, and receives from each side the terminations of the *medulla*, interspersed between the several windings of the *cortex*, and supposed by some to be a kind of base, or support to it.

(QQ) Under the CORPUS CALLOSUM, there are two great cavities, called by some, the upper, or front *ventricles*, and by others, lateral; tho' they have one besides, on each side of them. Both these cavities are of the same magnitude and figure; and their situation and uses are likewise the same. They are seated in the middle of the brain; begin from a narrow point towards the root of the nose; and enlarging by degrees, form each of them a great cavity towards the end.

These two *ventricles* are parted by a very fine portion of the medullary substance, enclosed between two membranes, or continuations of the *pia mater* (wherewith the inside of these two *ventricles* is lined) called, from its transparency, *septum lucidum*.

(RR) The CORPORA STRIATA (called thus from their streaks or furrows) are two considerable eminences, of a browner colour than the rest: there is one in each *ventricle*.

(S) The INFUNDIBULUM, which is a cavity in form of a *funnel*, descends to the *basis* of the brain, and terminates with a point in the *glandula pituitaria*, is formed of the *pia mater*, and placed in the middle of these *ventricles*.

The ancient Anatomists pretended, that these *ventricles* were nothing else but cisterns, from whence the animal spirits were sent by the nerves to all the parts of the body: but the moderns will have it that these *ventricles* are rather cisterns for the superfluous moisture of the brain.

*Monsieur de la Cambre* is of opinion that these *ventricles* were formed only to facilitate the motion of the brain; which could not perform its functions,

if its whole body was full and solid; since it is like bellows, which can never enlarge their cavity without a *vacuum* in their sides.

(T) That which appears red in each of these *ventricles*, is part of the *plexus choroides*; of which hereafter.

The FORNIX is a production of the *medulla*; which at its extremities next the *cerebellum*, sends out two processes, by whose juncture is formed a kind of arch, thence called *fornix*, which separates the third *ventricle*, from the two upper ones.—At the bottom of the *fornix* are two holes, by which the third *ventricle* has communication with the others; that before, is called *vulva*, and that behind, *anus*.

(V) The THIRD VENTRICLE, or *rima*, which is in the *medulla oblongata*, has likewise two apertures; the one is the orifice of the *infundibulum* or funnel; the other is a duct, whereby the third *ventricle* communicates with the fourth, in the *medulla oblongata*, under the *cerebellum*.—The whole cavity of the third *ventricle* is filled with the *plexus choroides*, which is an assemblage of minute veins and arteries; and with four eminences; the first the *corpora striata*; the others the *thalami nervorum opticorum*.—Some believe this assemblage or texture, to be like a water-bath to the brain, which by its gentle heat, preserves the motion of the spirits in the *corpus callosum*.—Others alledge, that the heat of this texture, keeps up the liquidness of the *serum* in the *ventricle*, which without the warm influence of its numerous vessels would thicken and condensate; so that it hinders the humours from stagnating, and causing obstructions in the *infundibulum*.

(X) At the entrance of the canal, reaching from the third *ventricle* to the fourth, is situated the PINEAL gland; so called from the figure of a *pine-apple*, which it resembles.—This gland *D. s. Cartes* supposes to be the seat of the soul; but I am of opinion that the soul is not confined to any part, but the soul is *tota in toto*, and *tota in quâlibet parte*, or it is entire in the whole body, and entire in each part.

The use of the *glandula pinealis*, is to separate liquor to be thrown into the *ventricles* of the brain.

Behind the *pineal gland* are four eminences; two upper and greater, called *nates*; and two smaller, and lower called *testes*.

(YY) The CEREBELLUM is the hind part of the brain, and esteemed a kind of little brain by itself. It is placed in the hinder and lower part of the *skull*, underneath the hind part of the brain or *cerebrum*: it lies open to the *cerebrum* at bottom; but is separated from it at the top by a duplicature

of the *dura mater*. Its figure somewhat resembles a flat bowl, broader than long; it is formed by two branches, which setting out from the sides of the trunk of the *medulla oblongata*, make a sort of cradle, by joining in the middle, and leaving between them a cavity, called the *fourth ventricle*.

Its substance is harder, drier, and more solid than that of the *brain*, but of the same nature and kind, being composed, like it, of a *cortical*, or *glandulous* and a *medullary* part; the branches of which last, when opened, resemble those of a tree, meeting in the middle, and forming a kind of stem, which runs quite through it. Its colour is yellowish; that of the brain whiter.

Its surface is unequal, and furrowed, but not so much as that of the *cerebrum*; appearing rather as if laminated, like some shells; the middle circles being the largest, and deepest. Between the *laminæ* are duplicatures of the *pia mater*. The fore and hind parts of the *cerebellum* are terminated by *apophyses*, called *vermiformes*, from the resemblance they bear to *worms*. It is joined to the *medulla oblongata*, by two processes, called by *Willis* *PEDUNCULI*.

Here are two or three more medullary processes, which, passing across the *medulla oblongata*, form an arch, called *pons Varolii*.

*N. B.* Those who took the animal spirits to be formed in the *ventricles* of the *brain*, gave this part the title of *noble*; upon the apprehension that it raised the spirits to the last degree of perfection, and dispersed them through the whole body, by means of the spinal marrow.

The blood vessels of the *cerebellum* are the same with those of the *cerebrum*, and their use the same, *viz.* to separate the nervous juice from the blood, and convey it through the several parts of the body.

*Dr. Willis*, however, distinguishes between the functions of the *cerebrum* and *cerebellum*, making the first the principle of voluntary motions, and actions; and the last the principle of involuntary ones, *viz.* that of respiration, the motion of the heart, &c.

It is commonly asserted that a wound, either in the *cortex*, or the *medulla* of the *cerebellum* is mortal.

By turning up the *brain*, the origins of the nerves proceeding from it are distinctly seen; these are in number ten pair, *viz.* the *olfactory*, *optic* movers of eyes, *pathetic*; the fifth pair and sixth pair, called also the *gutturariae*, the *auditory* nerves, the *par vagum*, and the ninth and tenth pair.

The *OLFACTORY NERVES* proceed from the *basis* of the *corpora striata*, by a medullary fibre,

which is largest in that place, where they fetch a winding turn near the *optic* nerves.

The *OPTIC NERVES* rise from the extremity of the *corpora striata*, and the medullary part, called *thalami nervorum opticorum*. They unite above the *fella* of the wedge-like bone; and divide into two strings, which stretch to the eyes.

These nerves are surrounded with small branches of the *motores*. As the *carotide* arteries enter the *brain*, they run along the trunk of the *optic nerves*; whence *Dr. Willis* infers, that, after eating, these arteries, being then fullest of blood, cause sleep by pressing down the *optic nerves*.

The *MOTORES*, or movers of the eyes, proceed from the *basis* of the *medulla oblongata*, near the *infundibulum*, pass through a hole under the *optic nerves*, divide into four branches, which are distributed to the muscles of the eyes, and the eye-lids, and oftentimes disperse likewise a branch to the *crotaphites* muscle, which occasions its communication with the eyes.—The *carotide* arteries, and the *infundibulum*, lie between these muscles.

The *PATHETIC* rises from the lower part of the *medulla oblongata*; behind the *nates* and the *testes*. They divide into four branches, one of which visits the great oblique muscle; the second the upper lip, the nose, and the gums; the third, the membrane of the nostrils; and the fourth, the *crotaphites*.

The *FIFTH PAIR*, which is bigger than all the rest, commences from the sides of the annular protuberance behind the *pathetici*, and divides into three branches, *viz.* the *ophthalmic*, the *maxillaris superior*, and the *maxillaris inferior*.

The *OPHTHALMIC*, so called from its repairing to the eyes, after detaching several threads, which surround the optic nerves, and are distributed to the *carotides*, divides into two branches; the biggest of which is subdivided into two, *viz.* one that marches out by a hole, called the outer *orbital*, and another which passes through the hole of the *eye-brows*, and is lost in the muscles of the *forehead*, the great *orbicular* muscle of the eye-lids, the *lachrymal* gland, and the nose-bag. The last branch passing through the *orbital foramen*, is lost in the membranes of the bony *laminæ* of the nose. The upper *maxillary* nerve is distributed to the upper part of the teeth, as the lower *maxillary* to their lower part.

The *SIXTH PAIR*, improperly called *gutturaria* (since it does not run to the tongue but to the eyes, as well as the *motores*, *pathetici*, &c.) rises by the last pair, in the lower part of the *annular* eminence, marches out of the *skull* by the same hole with the third and fourth pair, and is distributed upon the muscle of the eye, called *indignatorius*; after

after having sent out a small branch, which, together with two branches of the fifth pair, forms the *intercostal* nerves.

The INTERCOSTAL is bestowed upon the *heart*, the *breasts*, and the *privy parts*. By this mutual communication Dr. Willis explains several *phenomena*, viz. the mutual pleasure that affects lovers in their caresses and reciprocal kisses. Sometimes the *intercostal* is formed only by the *sixth pair*.

The *intercostal* receives in its first *plexus* the *tenth pair*, with a branch from the first vertebral nerve of the neck, that's united with the *tenth pair*; and another branch from the second vertebral of the neck; at last there springs from this *plexus*, a branch that serves the head of the *trachæa*. As soon as it arrives under the channel-bone it forms a second *plexus*, which sends out two twigs, which embrace the axillary arteries in the form of a ring; from whence proceeds a third *plexus*, formed by the junction of the *intercostal*, with several branches of the *bronchiales*, and *dorsales*, that descend along the *vertebræ*.

Of the productions of this nerve in conjunction with others from the *eighth pair*, are formed the *nervi cardiaci*, and those of the lungs; and of three other productions, which join together in one trunk, before they enter the *abdomen*, are formed likewise, the *hepatic plexus* on the right, and the *splenic* on the left side.

From the *hepatic plexus* there spring several branches, some of which cross over the *duodenum*, and the *vena porta*, and repair to the liver: some run to the *pancreas*, and to the right side of the *stomach*; and others to *Glosson's capsula*; and two larger than the former, pass over the emulgent artery, and run to the right kidney.

The *splenic plexus* furnishes several branches to the left side of the *stomach* and *pancreas*, some to the spleen, and the left *capsula atrabiliaria*, and two very considerable branches to the left kidney.

From the several branches, both from the *hepatic* and *splenic*, is formed the *mesenterick plexus*, which serves as a cover to the *mesenterick* arteries, and accompanies them through their whole distribution.

Further, there is a trunk on each side formed out of several branches, both from the *hepatic* and *splenic plexus*, which descending along the *aorta*, continues its course, accompanied with the twigs of the *intercostal*, to the division of that vein. This done, 'tis dispersed through all the parts of the *hypogastrium*, particularly the *rectum*, or strait gut, the bladder, the womb and the *vagina* (in women) and the male seminal vesicles and *prostates*.

At last the trunk of the *intercostal* descending

along the *vertebræ*, is lost in *capillaries* dispersed thro' all the parts of the *hypogastrium*, particularly the bladder, the *anus*, the *rectum*, and the genitals.

The AUDITORY NERVE, proceeds from the lower part of the *annular* rising, and passes through the perforation of the stony process of the temple-bone. This nerve is composed of two branches, one soft, which serves the immediate organ of hearing, and forms the nervous membrane which cover the *cochlea*, and the inner side of the semi-circular passages; and the other hard, which marches out through a hole that lies between the *mastoides* and *styloides* processes, and goes to unite with the third branch of the *fifth pair*.

The PAR VAGUM, so called from its serving so many different parts, proceeds from the sides of the *medulla oblongata*, and lies behind the *acustici*.—To this is joined another nerve, rising from the spinal marrow, called *accessory* by Dr. Willis.—These two nerves march out with joint forces thro' the perforation of the *os occipitis*, but as soon as they are out of the skull, the spinal separates from the *eighth pair*, and is quite spent upon the *trapezium* muscle.

The *eighth pair* it no sooner departed from the skull, but it forms a *plexus*, as well to supply the *larynx* and *pharynx* with its branches, as to produce the recurrent nerve: the right branch whereof encompasses the axillary artery, as the left does the *aorta*.—These two nerves return upwards by the sides of the *aspera arteria*, and send forth shoots to the *fibres* that fasten the *annulli*.

The *cardiaci* and the *pneumatici*, are also formed from the several shoots which the *intercostal* and *eighth pair* send to the *pericardium*, the *heart*, the lungs, and the *cava*.

The NINTH PAIR (9) proceeds from several fibres of the *eighth*, receives two branches from the first vertebral, and one from the second, in its passage through the muscles of the bone *hyoides*; one of these branches is dispersed through the muscles *sterno-thyracoides*, and the other spent upon the muscles of the bone *hyoides*.—Its trunk furnishes the *basis* of the tongue with several branches, and comes to a period.

The TENTH and last PAIR (10) proceeds likewise from several threads, and descends along the pith of the back-bone; marches between the first vertebral of the neck, and the *os occipitis*, sends branches to the oblique muscles of the head, and in its progress to the *plexus* of the *intercostal*, receives one from the first vertebral pair.

Though all the *nerves* proceed from the *brain*; yet it may be said to have no nerves, since not

one of them is inserted in it; so that the proper substance of the *brain*, which dispenses sense to the whole body, is of itself insensible.

(14) The BASIS of the *brain* has six great prominences lodged in the six great pits of the *cranium*; the four first and anterior are formed by the *brain*; two of them are lodged in the cavities of the *os frontis*, and the other two in those of the *ossa petrosa*; the two last and posterior risings, are placed in the cavities of the *os occipitis*, and formed by the *cerebellum*.

The *blood* (aa, bb) is conveyed into the brains by the *carotides*, and *servical* arteries; which, at their entrance, form one great trunk at the *basis* of the *brain*; from whence they send an infinity of arteries throughout its whole substance.

The Union of these arteries (c) serves to mingle the arterious blood, before its distribution to the *brain*, and to check its rapidity.

MEDULLA OBLONGATA (Z) is the medullary part of the *brain* and *cerebellum*, joined in one, the fore-part of it coming from the *brain*, and the hinder-part from the *cerebellum*. It lies on the *basis* of the *skull*, and is continued through the long perforation thereof into the hollow of the *vertebræ* of the neck, back, and loins, though only so much of it retains the name of *oblongata*, as is included in the *skull*.

The substance of the *medulla oblongata* is harder than that of the *brain*, and it rises by four roots; of which the two greatest spring from the *brain*, and the other two from the *cerebellum*.—These parts uniting afterwards, are again divided into two, by the *pia mater*; whence it happens, that one side may be *paralytick*, while the other is found.

MEDULLA SPINALIS, or the *spinal marrow*, is a continuation of the *medulla oblongata*, or *medullary* part of the *brain*, without the *skull*. It consists, as the *brain* does, of two parts, a white, or *medullary*, and a cineritious or glandulous; the former without and the other within.—The substance of the exterior part is much the same with that of the *corpus callosum*, only somewhat tougher, and more fibrous; which difference becomes more apparent as it descends the lower, by reason of the streightness of the cavity, which growing gradually more narrow, presses the medullary fibres closer together, and renders them more compact, and gathers them into more distinct *fasciculi*, till having descended the whole tract of the *spina*, they end in the *caula equina*. It is the origin of most of the nerves of the trunk of the body, and sends out thirty pair, on each side, to the limbs, the great cavities, and other parts; which are nothing but

*fasciculi*, of medullary fibres, covered with their proper membranes.

The *spinal marrow* is covered with four coats; the first, or external one, is a strong nervous ligament, which ties the *vertebræ* together, to the inside of which it firmly adheres. The second is a production of the *dura mater*; it is exceedingly strong, and serves to defend the *spinal marrow* from any hurt, from the flexures of the *vertebræ*.

The third is a production of the *arythænoïdes*, and is a thin pellucid membrane, lying between the *dura* and *pia mater*, or the second and fourth membrane of the *medulla*.—This membrane gives a coat to the nerves that go out of the *spina*, which is the inner membrane of the nerves, as the *dura mater* gives the outer.—The fourth coat is a continuation of the *pia mater*, and is an extremely thin, fine, transparent *membrane*; strictly embracing the whole substance of the *medulla*, dividing it in the middle into two tracts, and making, as it were, two columns of it.

The use of the *medulla oblongata*, as well as that of the *spinalis*, is to give an origin to all the nerves; for of forty pair of nerves, which march through the whole machine, ten proceed from the *medulla oblongata*, and thirty from the *spinalis*.

The FACE, which is the next to be examined, in the *superior venter* or *head*, is divided into two parts, one above called *forehead*; and another below, extending from the eye-brows to the chin.

The FOREHEAD is also called *Front*, from the Latin *Frons*, and from the Geeek  $\varphi\rho\nu\nu\sigma$ , to think, perceive; of  $\varphi\rho\nu$ , *Mens*, the Mind.

The motions of the *Forehead* (A) are performed by the means of two muscles called *Frontales*, one on each side the *forehead*, which spring from the upper part of the head, near the crown; or rather it appears that the *frontal*, or *occipital muscles*, are only one continued *digastric* muscle, on each side, moving the scalp, and skin of the forehead and eye-brows.

The *frontales* begin to be thus denominated, after they have begun to pass the coronal future, with fibres passing obliquely to the eye-brows, where they terminate, and in the lower part of the skin of the forehead.

They have each two appendages; the superior, or external, is commonly fixed to the bone of the nose; the lower is fixed to the *os frontis*, and is, by *Volcberus Coiter*, made a distinct muscle, and called *corrugator*, from its use in drawing the eye-brows to each other.

The face is divided, as well as the breast and the abdomen, into the *containing* and *contained* parts.

The former are either common or proper. The common are the teguments, which are the same with those of the other parts of the body. The proper are the muscles and bones. The contained parts are the organs of four senses, *viz. seeing, hearing, smelling, and tasting*; for the sense of the *tact.* reaches all over the body.

The skin of the face resembles that of the other parts. In children and women, 'tis smooth and and fine; but in men, it is covered with hair round the chin, after the age of maturity.

The *seed* and the *beard* appearing both about the same time, is a convincing proof that there is some correspondence between them. In effect, they are both formed of the same matter, with this difference, that the subtilest parts are strained out by the testicle, form the body of the *seed*, and the coarser being conveyed to the skin, produce the *beard*. — 'Tis upon this account, that those who have the greatest stock of seed, are always roughest; and that eunuchs are without a beard, as well as without seed. This opinion is confirmed by what happens to women; for we see they have hairs in the arm-pits, and the *pubes*, at the same time when they begin to have seed. 'Tis true, they have no beard upon the chin, as men have, and that must proceed from the evacuation of the matter in the menstrual *flux*, which attends the arrival of the seed: And for a further proof of this matter, it is to be observed, that some women have had beards upon a suppression of the *terms*.

The EYE is, without dispute, the handsomest, and most wonderful part of the body. — 'Tis seated below the forehead, in a cavity, called the *orbita* or socket, which is all over bony. — If we consider only its globe or ball, its figure is round; but if invested with its muscles, 'tis oblong, and pyramidal, throwing its base outwards, and its point inwards.

The magnitude of the *eye* varies in different persons. — A large *bulging-eye*, is the handsomest; little eyes are more serviceable.

Men and horses, are the only animals that have eyes of different colours; they are sometimes *grey, black, or blue*; and this diversity depends upon the different colours that appear in the *iris*.

The eyes are divided into external and internal parts; the former cover and guard it, and such are the *eye-brows*, and *eye-lids*: The latter are lodged within the socket, and are the constituent parts of the globe of the *eye*.

The EYE-BROWS, are hairs, ranged in the form of a crescent; the point next the nose, is called the head; the other towards the temples, the tail of the *supercilia*.

The *eye-brows* consist of four parts. 1. A membrane, which by its thickness forms a rising eminence, and by its hardness, keeps the hairs fast. 2. Muscular parts, which serve to raise them. 3. The hairs to prevent sweat, and other nuances, falling down into the *eyes*. 4. Fat, which serves for nourishment to the hairs.

The *eyes* are also covered and defended with the *palpebræ*, or *eye-lids*; whose motion is so quick, in human bodies, that nothing is reckoned so short as the twinkling of an *eye*.

The PALPEBRÆ, or *eye-lids*, consist of a thin, muscular membrane, covered on the outside with a strong, flexible skin; and lined within with a production of the *pericranium*. — Their edges are fortified with a strong cartilage, to enable them to close the better.

Out of these cartilages, grows a palisade of stiff hairs, called *cilia*; of great use to warn the eye of the approach of danger, either in sleeping or waking; to keep off motes, flies, &c. and break the too fierce impression of the rays of light.

These hairs, it is observed, only grow to a certain convenient length, and never need cutting, as most others do; add to this, that their points stand out of the way; those of the upper *eye-lid* being bent upwards, as those of the lower downwards.

At the joining of the upper and under *eye-lids*, are formed two angles called *canti*.

(G) In the inner of these, is placed the *glandula lachrymalis*, which is furnished with arteries that spring from the *carotides*, veins that unload in the *jugular*; nerves derived from the fifth and sixth pair; and excretory vessels, which perforate the inner coat of the *eye-lids*, near the *cilia*. — This gland filtrates a viscous serosity, which it throws in between the body of the eye, and the *palpebræ*, in order to facilitate their motion.

Near the other angle is a gland, called *innominata*, which helping by several branches to irrigate the *eye*, the overplus is carried to the greater angle, and transmitted to the nose, through the *puncta lachrymalia*, which are orifices of a little membranous bag, whose ulceration occasions a *fistula lachrymalis*, and hinders the transfusion of tears into the nostrils.

The *eye-lids* are both moveable: especially the upper, which has two muscles to raise, and depress it, called *attollens* and *deprimens*, or *orbicularis*.

(H) The *attollens* springs from the bottom of the *orbita*, above the perforation of the optick nerve, and is inserted with a broad tendon in the edge of the upper *palpebra*.

(I) The *deprimens* proceeds from the great, or inner corner of the *eye*, and passing above the upper

per *eye-lid*, marches to its insertion in the little or outer corner. — When this muscle is employed, it draws down the upper *eye-lid*, and covers the eye; and in order to a more exact shutting of the eye, one part of it passes through the lower *eye-lid*, and is inserted in the little corner; for by the two parts it shuts the eye very nicely.

Animals that have hard *eye-lids*, as lobsters, and the generality of fishes, have no *palpebræ*; as being sufficiently secured without.

In the generality of brutes, is a kind of third *Eye-lid*, which is drawn like a curtain, to wipe off the humidity, which might incommode the eyes; it is called the *nictitating membrane*.

We now shall examine the inner parts of the eye. — The EYE, properly so called, is of a globular figure, and consists of tunics, humours and vessels. — In some parts it is lined with fat, (as in the cavity of the *orbita*) and is moved with six muscles; four of which are strait, and two obliques.

(III) The *streights* come from several points of the bottom of the orbit, and run immediately between the *sclerotica* and *adnata*; they derive their several denominations from their several offices, *viz.* *attollens*, or *superbus*, which draws the eye upwards: *Deprimens*, or *humilis*, which casts it down; *adducens*, or *potator*, which draws the eye towards the nose: And *abducens*, or *indignator*, which draws it the other way towards the lesser angle.

(K) The two *obliques* are the upper, called *rotator*, which proceeds from the inner part of the *orbita*, ascends along the bone to the upper part of the great corner, where its tendon passes through a little annular cartilage, called *trochlea*, and afterwards terminates in company with the *obliquus minor*, near the lesser corner.

(L) The under *oblique* sets out from the lower and outer part of the *orbita*, above the union of the two bones of the upper jaw, and is inserted in the lower part of the *cornea*, near the lesser angle. — These two muscles move the eye obliquely, and wind it round.

When the muscles of the eyes have not acquired an habit of acting in concert, (which falls out very often in children) they render the person *squintey'd*.

The nerves of the eye are the *optic pair*, which issuing through a perforation in the skull, behind the orbit, enter the ball of the eyes, deface and lose themselves therein: Besides which the *motorii pathetici*, the first branch of the fifth pair called *opthalmicks*, and the sixth pair are bestowed on the muscles of the eye.

The eyes receive arteries both from the internal

and external *carotides*, and return the blood by veins that go to the jugular.

The eye has six membranes; four of which are common, *viz.* the *conjunctiva*, *cornea*, *uvea*, and *retina*: and two proper, *viz.* the *vitrea*, that contains the *vitreous* humour, and the *arachnoides*, in which is the *crystalline* humour.

(M) The CONJUNCTIVA is smooth, polished, and of an alabaster white colour, in a sound state, and is fastened by some ligaments to the *periernium*. It terminates upon the edge of the *cornea*; and is strewed with millions of arteries and veins.

(N) The CORNEA proceeds from that part of the *dura mater*, in which the optick nerve is wrapped, and, passing under the *conjunctiva*, becomes conspicuous in the gap, which that coat leaves in the fore-part of the eye. — This membrane being transparent on the fore-side, bears the name of *cornea* in that part; but being thick and opaque at the bottom, where the *conjunctiva* covers it, that part of it is therefore called *sclerotis*, *i. e.* hard.

(O) The third coat is the UVEA, called also *choroides*, from its resemblance to the *chorion*. It proceeds from the *pia mater*, which covers the *optic* nerve. Of the duplicature of this part, is formed a striped, variegated circle, called the *iris*. In its middle is an aperture, called the *pupil*, or *apple of the eye*, about which the *iris* forms a ring. From the inside of this *tunic* spring certain fibres, which spreading round the *chrystalline* humour, form the *ligamentum ciliare*.

(P) The RETINA, so called, from its being drawn up in the form of a *net* behind the humours, consists of a dilatation of the *optic* nerve, and receives the impression of objects; for, of all the tunics of the eye, this alone is opaque; so that the *species* of objects, after passing through the other membranes and humours, reflect upon the *retina*, which represents them to the *brain*, according as it receives them.

(Q) The VITREA, from its *glassy* humour is the 5th coat, and the first of the proper ones; it spreads out through the whole substance of the humour, small filaments, which hinder it from slipping out of its place; but when the coat, which is very thin, is broken, the humour melts, and turns all into water.

(R) The second of the proper coat is entitled *arachnoides*, from its being thin, like a *cobweb*. This tunic serves for an immediate cover to the *crystalline* humour, and is transparent that the images of objects might appear in it as in a looking glass.

The humours of the eye, enclosed within these tunics, are three, *viz.*

I. The

I. The AQUEOUS, a limpid, transparent humour, situate in the fore-part of the *eye* immediately under the *cornea*, and occasioning its protuberance.

(S) 2. The CRYSTALLINE is situated immediately under the aqueous, behind the *uvæa*, opposite to the *pupil*.

(T) 3. The VITREOUS, or glassy humour, which fills all the part of the cavity of the globe; and is that, which gives the spherical figure to the *eye*.

The whole structure and apparatus of the *eye* tends to this, that there be produced a distinct and vivid collection in the bottom of the *eye*, directly under the *pupil*, of all the rays, which proceeding from any point of an object, and entering the *eye*, penetrate the crystalline humour; and that so many points being painted in the bottom of the *eye*, as are conspicuous in an object, that so a small image like thereto, may be represented in the *retina*.

The noblest and most excellent sense next to *seeing* is that of HEARING; therefore let us examine the admirable structure of the parts employed in this sense.

The EAR is the organ of *hearing*, or that part whereby animals receive the impression of sounds.

The *ear* is divided into the outer and inner part. The former is that, which appears upon the external surface; the latter consists of several particles and cavities within the *ossa petrosa*.

(X) The outer part, or *auricle*, is a semicircular, and contains divers sinuosities. — Its upper part, which is the broadest, is called *ala*, or wing; and the latter, which is narrow, soft, and pendulous, the *lobe*, or *fibra*, being that, to which ear-rings, &c. are hung.

The outer *area*, or extent of the *auricle* is called the *helix*, and the inner, opposite thereto, the *anthelix*; the little protuberance of the side next the face, is called the *tragus*, or *tircus*; and the ridge just above, and opposite to it, an *antitragus*: And the cavity, leading to the beginning of the *meatus*, the *concha*.

The *auricula*, or the outer part of the *ear*, consists of a thin cartilage covered with a skin, ligaments, nerves, arteries, veins, and muscles. — The cartilage is not divided in men, as it is in other animals. — The ligament fastening the ear to the *os petrosum* is strong, and proceeds from the *petricranium*. — The nerves spring from the second *vertebra* of the neck; the arteries from the *carotides*; and the veins repair to the *jugulares*.

Though the *auricula* has no manifest motion, yet

'tis provided with four muscles; one superior and three posteriors.

(Y) The *superior* proceeds from the *musculus frontalis*, it being part thereof, and is inserted in the *auricle*, which it pulls upwards. The other three, which make but one fleshy body, rise from the *os occipitis*, and the mamillary processes, and is inserted behind, at the root of the *ear*. — It serves to pull the ear backwards and downwards. (ZZZ)

The external *ear* is not the principal organ of hearing, though, at the same time, it contributes very much to the perfection of that sense, in receiving the sounds, and introducing them to the *meatus* of the internal *ear*; since those, whose ears are cropt or cut off, have but a confused way of hearing, and are obliged either to form a cavity round the ear with their own hands, or else to make use of a horn, and apply the end of it to the inner cavity of the *ear*, in order to receive the agitated air.

Under the *ears* we meet with big conglomerated glands, for the secretion of the *saliva*, called *parotides*.

The inner part of the external *ear* is possessed by the *meatus auditorius*, or auditory passage, which commences from the bottom of the *concha*, called the *alvearium*, and is continued in a winding direction, turning sometimes this way, and sometimes that, to the *membrana tympani*. — The *meatus* is dug out of the *os temporis*, and lined with a membrane, furnished with divers little glands that separate a thick, yellow, glutinous humour, called *cerumen*, or ear-wax, serving to defend the *ear* from the ingress of vermin, and other extraneous bodies. — The external *ear* is separated from the internal by a thin, dry, round, and transparent membrane, called, improperly *tympanum*, or *drum*, and placed at the further end of the *meatus*.

Behind this membrane is a cavity, called the *barrel of the drum*, being three or four lines deep, and five or six broad. — In this cavity are three little bones, *viz.* the *malcus*, *incus*, and *stapes*, *i. e.* the hammer, the anvil, and the stirrop, which we have seen in the *Osteology*. — Their articulation is such, that the *malleus* is fastened to the *tympanum*, which communicates to them that which it receives from the air.

To give motion to these bones is the office of a muscle placed in the barrel of the *drum*, which produces a tendon, that fastens it to the process, which the handle of the hammer obliges to approach to its head. — The action of this consists in pulling the handle of the hammer inwards, and in stretching

stretching the membrane of the *drum*, which afterwards unbends when the muscle ceases to pull; for the little bones are so articulated, and mutually joined by ligaments, that they make a sort of elastic spring, which in conjunction with that of the drum, serves for an antagonist to the muscle.

Two *meatus* are situate at the side of the cavity, one opening into the palate, called *aqueduct*, which is partly cartilaginous, and partly membranous, and the other shorter and bigger, opening into the *sinus* in the mamillary process.

We come next to two gaps, or apertures, called *Fenestræ tympani*, which are placed in the surface of the *os petrosum*, which is opposite to the membrane of the *tympanum*. The first, called *fenestra ovalis*, is situate a little higher than the other, and receives the *basis* of the *stapes*; the other *rotunda*, notwithstanding its figure is oval like the former, and closed by a thin, dry, transparent membrane, resembling that of the *tympanum*.

There is a *small chord*, which lies in the cavity of the *tympanum*, and runs over the inner surface of the membrane, called *chorda tympani*. It is a branch of the fifth pair of nerves, which meets the *portio dura*.

The two *fenestræ*, or *windows*, open into a cavity dug out of the *os petrosum*, which for its meanders, is called the *labyrinth*. But the pipes whereof the *labyrinth* consists, are called by different names.

The beginning of the cavity is called *vestibulum*, as leading into the other two. It has nine apertures. From the *vestible* there set out three semicircular *meatus's*, which return to it by another road. All these surround the *forinx* of the *vestible*. One of them is called *horizontal*, and the other two *vertical*.

*N. B.* In the *labyrinth* is supposed to be contained the innate air.

The *COCHLEA*, *snail* or *shell*, is the last cavity, and consists of a spiral, semi-oval canal, and of a *lamina* formed into a *spiral* flight. The canal makes two turns and a half round a *newel*, or *axis*, still growing less as it ascends. The *spiral lamina* divides this cavity into two, being fastened by its base to this *axis*, and by its other extremity, to the surface of the canal, opposite to the *axis*, by a very fine membrane.—The cavity of the *cochlea*, thus divided, forms, as it were, two stair-cases, both on the same *newel*, one cover the other; but without any communication between them.

The *aqueduct* is the *auditory nerve*, which consists of two parts; the one soft, called *portio mollis*; and the other harder, *portio dura*. The first part is spent on the organ of hearing, being divided

into five branches, which form a delicate web, that lines the *vestibulum*, *cochlea*, &c. The hard part, passing out of the *cranium*, is distributed among the parts of the external ear.

The *sense of hearing* is performed in the following manner.

The external air being tossed by very quick and nimble concussions, enters the first *meatus*, and strikes upon the drum; and that membrane being thus *connected*, shakes the small string behind it, and the three little bones that are knit to it; and by that means conveys the external motion to the internal air: upon which this air subtilizes itself, and fortifies its agitation in the windings of the *labyrinth*, and by entering into the spiral *cochlea*, as advancing from a broader to a narrower space; the air thus subtilized, communicates itself to the nerve, which conveys it to the common *sensorium*. So that these different modifications of the air, move the imagination, to form the sensation, called *sound*. For *hearing* is no action; but only the reception of the impression of the air into the nerves, that visit the *ear*.

*Martial* ranks large *ears* among the number of deformities.

The next sense, which offers itself to our consideration, is that of *SMELLING*, and the *nose* is the organ thereof.

The *NOSE* is divided into the root or upper part, which lies between the two *eyes*; the lower or *dorsum*; the *spina* or pointed part, which is yet lower; the cartilaginous moveable tip; the little globe; the lateral parts; the *alæ* or wings; and the *columna* or pillar, which is the fleshy part that advances in the middle, and separates the two nostrils.—These are called its *external parts*.

The teguments of the *nose* are common to the rest of the face. Under these are the seven muscles of the *nose*, *viz.* one common, and six proper. Of the last sort, four dilate it, and the other two contract it.

The *common* muscle is a part of the orbicular muscle of the lips; it draws the *nose* downwards, to bring the upper lip towards the lower.

3. The *pyramidales* or *triangulares*, which are the two first of the proper class, proceed from the suture of the *forehead*, and are inserted with a broad tendon in the *alæ* of the *nose*; which they serve to draw asunder.

4. The *dilatantes*, which serve to widen the external apertures of the nostrils, resemble a *myrtle-leaf*, proceed from the bone of the *nose*, near the *alæ*, and terminate in the round place of the same wing.

5. The *constringents*, which draw the wings of the

the nose downwards, and at the same time the upper lip also downwards, are hidden under the coat that invests the nostrils; spring from the inner part of the bone of the nose, and are inserted in the internal *alæ* of the nostrils.

The upper part of the nose being bony, there are five cartilages under these muscles, which form the lower part. The two superior cartilages, are broad upwards, but soften and grow narrow in their descent, and adhere to the bones of the nose: the other two, which form the *alæ*, are fastened to the extremities of the upper ones, by membranous ligaments; and the fifth is placed in the middle for a partition between the two nostrils.

The membrane of the nose is furnished with large arteries from the *carotides*, and veins which empty themselves into the jugular; and nerves from the fifth pair, as well as the olfactory nerve.

In this membrane is a great number of small glands, which filtrate a white viscous liquor, called *snot*.—Besides these two kinds, there are some others that convey a liquor like the former into the nostrils, which keeps the membrane soft, defends it from the injuries of the air; which must pass this way, when the mouth is shut.

The first of the excretory ducts is the *canalis nasal*, formed by the coition of the two *lachrymal* points, that pass through the *foramen* of the *os unguis*.—Through this passage, part of the humour that waters the eye, distils into the nose.—The second is the two holes of the *sinus frontales*, which unload in the nose, a *snot* filtrated by the glands of their membrane.—The third is the two holes of the *sinus's* of the *os spheroides*, there being one on each side.—The fourth is the two orifices of the *maxillary* cavities.—The fifth is the *aqueduct*, some part whereof is invested with the glandulous membrane of the nostrils.

The NOSTRILS are the two apertures at the basis of the nose, or the commencement of two cavities, which afford a continual ingress and egress to the air.—Each of these cavities divides afterwards into two others; one of which ascends towards the sieve-like bone: and the other descends to the palate, to empty itself in the bottom of the mouth, and the throat.

There are two other conduits, which run from the nostrils to the mouth. They commence at the bottom of each nostril, and, passing over the palate, perforate it under the fore teeth, where they end.

The whole inner capacity of the nose is lined with a pretty thick coat, which is a continuation of the *dura mater*, at the lower part whereof generally grow some hairs, visible at the entry of the nose.

The internal nose is filled with several cartilaginous plates separated from one another, whose extremities terminate at the root of the nose, and which serve to support its inner coat, which having a very long extent, is therefore folded into the little cavities of the nose, runs quite round these *laminae*, and covers their surface exactly.

In this inner tunicle of the nose, the olfactory nerves are diffused, and rendered capable of the perception of *odoriferous effluvia*, which is effected in the following manner.

The little atoms that exhale from *odoriferous* bodies, are carried along with the air to the nose; where, by striking upon its inner membrane, they jog the small pipes of the olfactory nerves, immediately the subtle matter with which they are filled, partakes of this commotion, which, by virtue of the continuity, flies in a moment to the *corpora striata*, from whence these nerves proceed, and whereof our imagination, sensible of the different undulations, which each object can occasion in the spirits, perceives that this is the impression of an odoriferous body; whence proceeds the sensation, called *smelling*, which is not an action, but a passive quality of the olfactory nerve.

The matter in animals, vegetables, fossils, &c. which chiefly affects the sense of smelling, BOERHAAVE observes, is that subtle substance inherent in the oily parts thereof, called *spirit*; for that, when this is taken away from the most fragrant bodies, what remains has scarce any smell at all; but this, poured on the most inodorous bodies, gives them a fragrancy.

WILLIS observes, that brutes have, generally, the sense of smelling in much greater perfection than man; and by this alone, they distinguish the virtues and qualities of bodies unknown before; hunt out their food at a great distance, as *bounds*, and *birds of prey*; or hid among other matters, as *ducks*, &c. Man having other means of judging of his food, &c. did not need so much sagacity in his nose; yet have we instances of a great deal, even in man. In the *Histoire des Antilles*, we are assured, there are negroes who, by smelling alone, can distinguish between the footsteps of a Frenchman and a negro.

The chemists teach, that sulphur is the principle of all smells, and that those are more or less strong, as the sulphur in the odorous body is more or less dried or exalted. Sulphur, they say, is the foundation of odours, as salt is of flavours, and mercury of colours.

Smell, like taste, consists altogether in the arrangement, composition, and figure of the parts, as appears from the following experiments of Mr. BOYLE. 1. From a mixture of two bodies, each

whereof is of itself void of smell, a very *urinous* smell may be drawn, that is, by grinding of quicklime with *sal ammoniac*. 2. By the admixture of common water, which, of itself, is void of all smell, and inodorous; another inodorous body may be made to emit a very rank smell. Thus *camphire*, dissolved in oil of *vitriol*, is inodorous, yet, mixed with water, immediately exhales a very strong smell. 3. Compound bodies may emit smells which have no similitude to the smell of the simples they consist of. Thus oil of *turpentine*, mixed with a double quantity of oil of *vitriol*, and distilled; after distillation, there is no smell but of *sulphur*, and what is left behind, the retort being again urged by a more violent fire, yields a smell like oil of wax. 4. Several smells are only to be drawn forth by motion and agitation. Thus *glass*, *stones*, &c. which even when heated yield no smell, yet, when rubbed and agitated in a peculiar manner, emit a strong smell; particularly *beech-wood*, in turning, yields a kind of rosy smell. 5. A body that has a strong smell, by being mixed with an inodorous one, may cease to have any smell at all. Thus if *aqua fortis*, not well dephlegmated, be poured on salt of *tartar*, till it ceases to ferment, the liquor when evaporated will yield inodorous crystals, much resembling salt of *nitre*; yet when burnt, will yield a most noisome smell. 6. From a mixture of two bodies, one whereof smells extremely ill, and the other not well, a very pleasant *aromatic* odour may be gained, *viz.* by a mixture of *aqua fortis*, or spirit of *nitre*, with an inflammable spirit of wine. 7. Spirits of *wine*, by mixing with an almost inodorous body, may gain a very pleasant *aromatic* smell. Thus inflammable spirits of *wine*, and oil of *Dantzic vitriol*, mixed in equal portions, then digested, and at last distilled, yield a spirit of a very fragrant smell. 8. A most fragrant body may degenerate into a *foetid* one, without the admixture of any other body. Thus, if the spirit mentioned in the former experiment be kept in a well closed receiver, it will soon turn to the rankness of *garlic*. 9. From two bodies, one whereof is inodorous and the other *foetid*, a very pleasant smell may arise, much resembling musk, &c. by putting *pearls* into spirit of *vitriol*; for, when dissolved, they yield a very agreeable smell.

The uses of the NOSE (besides giving us the sense of smelling) is its serving in the great office of *respiration*, and in modelling the voice; in receiving the abundant humours from the eyes, and in adding to the beauty of the face. It is certain, that there is no passage to the brain for the air, much less for the powders snuffed up the nostrils.

Wounds of the nose are generally cured by the dry future; but where the wound divides the *car-*

*tilage*, and penetrates so deep, that its lips cannot be kept in contact, by the application of sticking plasters, the true future must be made through the skin, on each side of the wound. ROONHUYTS, in his *Observ. Chirurg.* xxiv. gives an instance of a nose slit down longitudinally, and cured by future. M. BLEGNY, in *Zod. Med. Gall.* speaks of a soldier, whose nose was cut off by a scymeter, and afterwards sewed on again so well by the surgeon, that the scar could scarcely be perceived; and M. GARENGEOT, in tom. iii. p. 55. of his surgery, gives an account of a nose that was conjoined again by future, after it was bit off. When the nasal bones are fractured, it is usual to place small tubes, of silver or lead, under them, for some time, to prevent the passage of the nose being stopped by the shooting out of the new flesh. Externally, some vulnerary balsam or glutinous powder is to be used, and covered with sticking plasters, which must be kept on with the four-headed bandage.

In the NOSE, both the *bone* and *cartilages* are subject to *fractures*; and if the injury is very great, they can never be so perfectly cured, but that some deformity will remain; besides, the vicinity of this part to the brain, which is frequently injured at the same time, renders cases of this kind often dangerous: a *caries* also, or a *polypus*, are no uncommon attendants on this disorder. In order to restore the bones of the nose to their proper situation, the patient is to be placed in a seat opposite to the light, and his head is to be held back, while the surgeon raises the depressed part with a *spatula*, a *probe*, or a *quill*, applying externally the thumb of one hand, and the fore-finger of the other. If the bones are fractured on both sides, they are to be raised on each in this manner, and the cavity of the nostrils is to be filled up with long dossils, to prevent the bones from collapsing; covering the part also, for this end, with a plaster, applying first the dressings common to recent wounds. If the bone be fractured into several splinters, they are to be reduced into their proper places, by the fingers; but if a splinter is so entirely separated from the bone, that it will not easily unite with it again, it is to be taken out with the forceps. If no *caries*, or abscess intervene, the bones will unite in about fourteen days. If the bone should require a stronger support than what has hitherto been mentioned, one may be formed out of strong paper, either single or double; adapted to each side of the nose, and supported by bolsters, and the whole must be kept in its place by a four-headed bandage, not tied too tight. When the fracture of this part is accompanied with an external wound, after the bones are replaced, dress the wound first with dry lint, covering it with a vulnerary plaster, afterwards

terwards use balsamic medicines; but all those that are oily or greasy, are to be carefully avoided, both here, and in all other cases where the bones are injured.

When the *bones* are separated from each other, or *distorted* out of their places, they are to be replaced by a probe, or quill, thrust up the nostrils, guiding the parts thus raised up, with the other hand, into their proper places, as above described, under *fractures*; after which there is scarce any thing to be done, but to let a piece of sticking plaister lie upon the nose for some time.

Another disorder, to which the nose is liable, is that of the *preternatural closing of the nostrils*, which is sometimes owing to careless treatment in the *small-pox*, in the bad sort of which the nostrils have been known to close, and adhere so strongly to the upper lip, which is turned back at the same time, as to leave no possibility of shutting the mouth. In this unhappy case, the only relief is by the knife, separating the lip from the nose, and then opening a passage through each of the nostrils, which are to be kept open with leaden pipes, and the lip pressed down into its natural position by a compress and bandage, and this continued till the wounds are cicatrized.

The diseases of the nose are a *coryza*, *ozæna*, *polypus*, *sarcæna*, *noli me tangere*, *sneezing*, and the *loss of smelling*.

The figure and magnitude of the nose cannot be nicely adjusted, because some have bigger noses than others. But a great hawk nose is preferable to a flat one; upon the account of the convenience of respiration, as well as beauty.

We proceed to the TONGUE, which is the organ of TASTE. But first let us premise an account of the mouth, which contains it.

The MOUTH has an upper and an under lip made of a fungous flesh, and covered with a very thin coat.

These LIPS have several glands placed under the coat that covers them, and which are furnished with little arteries from the *carotides*, and veins which carry back the blood to the external jugulars. Besides they have eight proper muscles and five common. Of the proper, four belong to the upper, and four to the lower lips: of the common, two are allotted to each lip; the other is an odd one.

(7) The first of the proper, proceeding from the upper jaw-bone, where the fore-teeth *incisores* are placed, is called *incisivus*, and inserted in the upper lip, which it pulls upwards.

(8) The second, called *triangularis*, springs from the lateral and external part of the *basis* of the

lower jaw-bone; is inserted near the corner of the mouth in the upper lip, and pulls it down.

(9) The third, called *montanus*, allotted to the lower lip, proceeds from the fore and lower part of the chin, and from the root of the fore teeth of the lower jaw; and terminates in the brim of the lower lip; which it draws down.

(10) The fourth is called *caninus*, from its proceeding from the upper jaw-bone above the *eye-teeth*; is inserted in the lower lip, near the corner of the mouth, and serves to draw up this lip.

(11) The *zigmaticus*, proceeds from the *zygoma*, is the fifth muscle, and the first of the common sort, is inserted in the corner of the mouth, and draws it towards the ears.

(12) The sixth rises from the roots of the *grinders* of both jaws, and terminates in the circumference of the lips. 'Tis called the *buccinator*, from its action in swelling and enlarging the cheek, when we sound a trumpet.

(13) The *odd muscle*, called *orbicularis*, is the flesh that encompasses the two lips, like a *sphincter*, and shuts the mouth, by drawing them together.

The nerves of the lips come from the fifth, sixth, and eighth pair of the head, and some from the *par accessorium*.

When the mouth is well made, with ruby lips, it contributes much to a beautiful face. A little mouth is always handsome.

Under the eyes, between the nose and ears, lies a round prominence called the *POMUM*, stiled *the seat of shame*; because it reddens or grows pale in the recess of that passion; the loose part under it is called the *cheek*, or *bucca*; the upper part of the upper lip, *myrtax*; the slit between the two lips, *mouth*; the prominent parts of the lips, *prolabia*; the lower part of the under-lip, *chin*; and the fleshy part under the chin, *buccula*.

Within the mouth are contained the *gums*, the *palate*, the *uvula*, and the *tongue*.

The GUMS serve to keep the teeth fast in their sockets, and consist of a hard and solid sort of flesh, that possesses the upper part of those sockets or *alveoli*.

The PALATE, called the roof of the mouth, from being its upper part, is formed by the *maxillary bones*, and the bones of the *palate*, and covered with a thick, shrivelled membrane.

The substance of this *tunicle*, is strewed all over with conglomerate glands, which are continued to the *tonsilæ* or almonds,——These glands separate a sort of serosity, which they discharge into the mouth by an infinity of little pipes like a sieve.

The UVULA is a small pyramidal prominence, which hangs down from the palate upon the root of the *tongue*.——It is formed by the union of two

little round muscles, that spring from the *septum* of the nose. These muscles serve to raise it: and when the action ceases, it falls by its own weight.—Upon the sides of the *uvula*, are two arches, called *rimæ nasales*, which consist of semi-circular fibres, covered with a thin skin, upon which are dispersed little glandulous grains. When the semi-circular arches stretch themselves lengthwise, they become strait, and serve to confine the air within the mouth; when we blow or heave up the cheeks, they likewise stop the entry of the *larynx*, and so hinder the air to spring from the *aspera arteria*, when we breathe, in performing the same action.

(15, 15) The motions of the *uvula* are very manifest in some persons, and are performed by four muscles, two called *peristaphylini externi*, and two *peristaphylini interni*. The two first proceed from the upper jaw under the last grinder; and terminate by a slight *tendon* in the *uvula*.

(16, 16) The *peristaphylini interni* rise from the inner wing of the *pterigoides* process, where there stands a little moveable *cartilage*, that ministers to their motion. Then they mount along the wing of the process, and are inserted in the *uvula*. These four muscles serve to advance, and draw back the *uvula*, when we swallow victuals.—When the *uvula* is swelled and inflamed, the vulgar call it the falling of the roof of the mouth. Sometimes it runs out to such a length, that it is necessary to cut off its tip.

(17, 17) Upon each side of the *uvula*, betwixt the *larynx* and the muscles of the *os hyoides*, stand the *tonsillæ* or *amigdalæ*, the conglomerate glands, mentioned with the *larynx*. They are furnished with all sorts of vessels, and strain out the *serum* that moistens the tongue, the *larynx*, and the *œsophagus*.

The TONGUE, which is the organ of TASTE, and the principal instrument of *speech* and *deglutition*, is seated in the *mouth* under the arch of the palate.

The tongue is fastened to the *os hyoides*, the *larynx*, and the *fauces*, by the *frenum*, a membranous ligament, running about half way along the lower side of it.

It is generally proportioned to the size of the mouth: when it is too short we cannot shoot it out; when too thick, it makes us stammer; and when too flabby and moist, as in children, we can't well articulate our words.

The main body of the tongue is made up of muscles, covered on the upper part with a papillary nervous substance, over which is spread a pretty strong membrane, instead of the *epidermis*, and

full of *papillæ* of a pyramidal figure, especially towards the tip: which *papillæ* stand pointing towards the root of the tongue in a bending posture, which make their figure to be *concavo-convex*.—These *apices* or *papillæ* are so very minute and slender in men, that they make the coat appear on the upper part to be viscous; especially as they approach towards the root. The figure of the *papillæ* in human tongues, is not so plainly discernable to the naked eye, as not to need the *microscope*.

Under this lies a soft reticular sort of coat, full of holes like a sieve, and always lined with a thick yellowish *mucus*. This membrane on the upper side next the outward, appears white with a cast towards yellow, but black on the side next the tongue.

The greatest part of the body of the tongue is muscular, consisting of plans of fibres in different directions: the first or external plan, consists of strait fibres, which cover the tongue from one extreme to the other; when these contract they shorten it. Under this are several other plans running from the under to the upper side, which serve to make it broad and thin. These two kinds of fibres lie *stratum super stratum*, a plate of the one, and then a plate of the other.—'Tis by the means of these fibres that the tongue moves itself, and turns like an eel in the mouth.

It is also furnished with eight muscles for the performance of its great motions.

(23, 23) The first pair is the GENYOGLOSSI, which proceed from the lower part of the chin, and are inserted in the anterior and interior part of the tongue; which muscles pull the tongue forwards, and put it out of the mouth.

(24, 24) The second is the STYLOGLOSSI, which spring from the *styloides* process, and terminate in the lateral and upper part of the tongue, to pull it up.

(25, 25) The BASIOGLOSSI, which move the tongue towards the bottom of the mouth, are the third, proceed from the upper part of the *basis* of the *os hyoides*, and are inserted in the root of the tongue.

(26, 26) The fourth pair is the CERATOGLOSSI, which rise from the upper part of the *cornu* of the *os hyoides*, and are inserted in the sides of the tongue, which they pull aside and backwards. When these four muscles on each side act successively, they move the tongue round.

Mr. Cowper allows no more than three genuine pair of muscles to the tongue, viz. the *genioglossum*, *ceratoglossum*, and *styloglossum*.

Down the middle of the tongue, length-wise, runs a seam, called *linea mediana*, which divides it

to the bottom into two equal parts, but not so effectually, but that the blood vessels of one side communicate with those of the other. These vessels are arteries from the *carotides*, and veins called *ranulae*, and are very conspicuous about the *frænum* under the *tongue*, serving to re-convey the blood to the external jugulars.—These veins are frequently opened in the *angina*, and are the last resort of old women in this case. — The nerves of the *tongue* come from the fifth, sixth, and ninth pair, the two first of which have been called *gutturarii*, and the latter *motorii lingue*.

The TONGUE serves for four *uses*. 1. To assist the *chewing* faculty, by turning the morsels in the mouth. 2. To promote *deglutition*. 3. To join with the lips in *articulating* the voice; for it is by their joint-motion that the air springing from the lungs is formed into words. 4. To be the principal organ of *taste*.

The TASTE consists in the fluttering of the spirits of the *tongue*, caused by the salts of the aliment, which strike upon the nerves, in which they are contained; which salts grating against the papillary prominences, occasion undulations with them, which in the same moment are imparted to the spirit contained in the nerves, and by them transmitted to the *corpora striata*, with which they are continuous, and which represent to the imagination such impressions as they receive.

We will conclude SPLANCHNOLOGY with a demonstration of the four *salivary vessels*: Two upper, which proceed from the *parotides*, and two under, which rise out of the *maxillary glands*.

(29) The *parotides* are large conglomerate glands placed behind the ears, and fill all the space between the hinder corner of the lower jaw and the *mastoides* process. — They receive arteries from the *parotides*, which reach within their substance; and their veins run to the jugulars. The *saliva* is secreted from the blood, which passes through their substance; which *saliva* is received by two vessels, called *salivares*, and formed out of several little branches, which unite upon their departure from the glands, and marching along the cheeks, make a breach through the middle of them, in order to terminate in the mouth.

3. The MAXILLARY GLANDS (also of a conglomerate nature) are placed under the lower *maxilla*, between the *larynx* and the *os hyoides*. Their arteries, veins, and *ductus salivares*, are formed by the joint-union of several branches under the *digestrick* muscle. — The *saliva*, filtrated through these glands, is taken up by those salivary ducts, which unload it in the mouth, under the tip of the *tongue* upon the two sides of the *frænum*, by

the lower fore-teeth.—This *saliva* acts the part of the first dissolver of the aliment.

The next subject of enquiry in the dissection of the *human body*, after this historical demonstration upon the TRUNK and all its parts, is a plain description of the EXTREMITIES comprised in the *four limbs*. But as their parts, except such as have been particularly demonstrated in *Osteology* (see page 50.) are almost entirely *muscular*, such description will be most properly conceived under that part of ANATOMY called *Myology*. So that we shall proceed with a general history of the *muscles* and of their motions.

### OF MYOLOGY.

MYOLOGY (Gr. *μυς, μυος* a *muscle*, and *λογος* *trattise*) is a description of the *muscles*.

The MUSCLE contains many thin parallel plates, divided into a great number of *fasciculi*, or little *muscles*, each inclosed in its proper membrane; from the internal surface whereof, pass an infinite number of transverse filaments, intersecting the muscles into several distinct *areas*, filled with their respective *fasciculi* or fibres.

A *muscle* is usually divided into *head* and *tail*, two *tendons*, at the two extremes of the *muscle*; the first fixed to the stable part; the latter to the part intended to be moved.

And into the *venter*, or *belly*, which is the body of the *muscle* or a thick fleshy part, into which are inserted arteries and nerves; and out of which issue veins and *lymphatick* ducts.

All these parts of a *muscle*, the *belly*, and the *tendons* are composed of the same fibres; their only difference consists in this, that the fibres of the *tendons* are more closely and firmly bound together than those of the *belly*, which are more loose. Hence in the *belly* there is room for a sufficient quantity of blood to give them an appearance of redness; and the whiteness of the *tendons* only proceeds from the blood being in some measure excluded from the tightness of their contexture.

As the *muscles* act by having their belly inflated or swelled. All the difficulty then, in muscular motion, is, to assign their fabrick and the cause of their swelling.

Every single *muscle* may be divided into others similar, though less, to a degree of subtilty. The last, therefore, being similar to the first, must, in like manner, have its *belly* and *tendons*; which is called a *muscular fibre*; in an assembly of several whereof a *muscle* properly consists.

Dr. Boerhaave, is of opinion that the *muscular fibres* are nothing else but extremely slender expansions of the nerves stript of their integuments, hollow within, and of the figure of a *muscle*, and full of a spirit communicated by the nerve from its origin in the *cerebellum*, by the continual action of the heart.

Of these *fibres* united are formed *fasciculi*, or bundles; which again have their several membranes wherein they are involved, and kept distinct from others. This membrane is extremely slender and porous within, full of oil, which is accumulated in time of rest, and spent in motion, furnished by the arteries; and this oil, in conjunction, with a smooth mucous juice, secreted by small mucilaginous glands, interspersed among these *fasciculi*, serves to lubricate the parts, and preserve the *fasciculi* from fretting on each other.

There are arteries also carried into the *muscles*, in such abundance, and of such contexture, as to create a belief that the whole body of the *muscles* is composed of them.

A *MUSCLE* has two sorts of motion, *viz.* contraction and extension; in the first it shortens, and lengthens itself in the second. Hence arise all the different *motions* of the body.

The *motions* are either simple or compound. Those, which tend directly upwards, downwards, forwards, backwards, to the right, or the left, are called *simple*; as performed by one sort of *muscle*; but the motion is compound when several *muscles* act jointly and successively, as when the arm moves quite round.

It is generally believed that the cause of their *motion* proceeds from the *brain*. But we must not think that the animal juice is conveyed from the *brain* to the *muscles*, at the same time, that the soul wills the motion; for the motion follows so close upon the resolution of the will, that the juice cannot go so far in that time. But the case lies here; the *nerves* are so many conduits full of animal juice; and when the soul resolves to move any *muscle*, the *fibres* of the *brain* press gently upon the *extremity* of the *nerves*; this compression forwards the animal juice, with which the *nerve* is filled, and obliges it to march through the *muscles*; where mixing with the blood, never wanting in such places, it makes an ebullition, which is followed by an intumescence or swelling.

Dr. Boerhaave finding all that's requisite in the nervous juice, for the motion of the *muscles*, makes no scruple to attribute the whole business to it alone; for says he,

Suppose the *spirit* from any cause to be moved more swiftly from the origin of some one nerve than through the rest; the *influx* will be here greater into the *muscular fibre* open to this nerve

†

than into another: This will therefore be more dilated; and the other *phenomena*, mentioned above, will succeed. The same cause continuing, the effect will be increased, so that in a moment the whole will be swelled up; and while the same determination lasts, will remain contracted; and this obtaining in an infinite number of *fibrillæ* at once, the whole *muscle* will be inflated.

Hence it necessarily follows, that as the celerity is increased in one nerve, the motion will be less in another; this therefore being relaxed, the effort in contraction will be stronger; for which reason all the *turgid fibres* of a *muscle* will compress the intermediate place and blood, with a great force; whence the veins will be emptied, and the arteries, being compressed, will repel the grosser, that is the red parts of the blood, but will drive the more subtle parts, by the force of the heart, and their own into the most minute canals; thus the *cruur* being expelled, the whole body of the *muscle* will be found to act by a subtle humour, concurring from the nerves and arteries.

All the *phenomena* are accounted for in this manner without any other assumption than an *accelerating force* in the origin of the nerves; which is common to all *hypotheses*, and cannot be traced any further.

Dr. Lower and Mr. Cowper, and after them Dr. Morgan and others of the latest authors on that subject, setting aside all adventitious fluids, account for *muscular motion*, from the *intrinsic elasticity* of the nervous *fibrillæ*, contracting and restoring themselves against the stretching force of the circulating blood.

All the *muscles* employed in the same motion are called *congeneres*; and those which perform opposite motion *antagonistæ*.

From the definition of a *muscle* it appears that nothing can be more difficult than to ascertain the number of the muscular parts in the human body: it may be proper to mention nevertheless, that some writers have aimed at their numeration: and some have fixed the number at 529. But it is not fit for us to attempt to circumscribe a division, which may be divided into similars to a degree of subtility that exceeds all imagination. Let it therefore suffice to be acquainted with the parts or muscles contained in the following *Analysis*.

The *MUSCLES* of the LOWER JAW, with which we shall enter upon this demonstration, are

1st, The *Crotaphites* (A) which proceed from the *coronal*, *parietal* and *petrosum*, and is inserted by a nervous tendon in the *corona* of the lower jaw.

N. B. Its nerves come from the 3d and 5th pair: the

the arteries from the *carotides*, and the veins empty themselves into the *jugulares*.

2. The *Pterygoides exterior* (B) which proceeds from the *pterygoides* process, and are inserted in the interstice betwixt the head and *corona* of the lower jaw.

3. The *Masseter* (D) which proceeds from the cheek-bone, and the lower part of the *zygoma*, and is inserted in the external corner and middle of the jaw.

4. The *Pterygoides interior* (C) which proceeds from the inner part of the *Pterygoides* process to the internal part of the corner of the lower jaw.

5. The *Cutaneus* (F) proceeding from the upper part of the *sternum*, *clavicula* and *acromium*, is inserted in the external part of the basis of the lower jaw. And

6. The *Digastricus* (G) which proceeds from a *fissure*, between the *os occipitis* and the *mastoides* process, and fixes in the lower and inner part of the chin.

*N. B.* Each of these muscles have somewhat remarkable.—The *crotophites* is knit to the outside of the *corona*; and when wounded brings on convulsions and sometimes death. — The *pterygoides exterior* is knit to the inside: — The *masseter* to the outside corner of the jaw, and the *pterygoides interior* to the inside.

These four muscles assist jointly in the action of chewing, by drawing the jaws together. And it is the office of the *cutaneus* and *digastricus* to open or pull down the lower jaw.

The MUSCLES of the OS HYOIDES are

1. The *Geniohyoideus* (AA) proceeding from the lower and inner part of the chin, to be inserted in the upper part of the *basis* of the *os hyoides*: which it pulls down.

2. The *Mylohyoideus* (BB) which proceeds from the inner part of the side of the lower jaw near the grinders, is inserted in the lateral part of the *os hyoides*, which it pulls both upwards and sideways.

3. The *Stylohyoideus* (CC) proceeding from the extremity of the *stylohyoides* process, to be inserted in its *cornu*, which it draws aside.

4. The *Carcophyoideus* (DD) which proceeds from the *carocoides* process of the shoulder blade, and is inserted in the lower and lateral part of the basis of the *hyoides*, which it draws obliquely downwards.

5. The *Sternohyoideus* (EE) which proceeds from the inner part of the first bone of the *sternum* to the *basis* of the *os hyoides*, which it pulls down.

*N. B.* There are five of these muscles on each side of the *os hyoides*. They keep it secure in its situation, and facilitate the action of *swallowing*.

The MUSCLES of the HEAD are,

1. The *Sterno-Clinomastoideus* (F) proceeding from the upper and lateral part of the first bone of the *sternum* and middle of the *clavicula*, and inserted in the upper part of the process *mastoides*. By this we bow the head, and make what is called a *nod*.

2. The *Splenicus* (G) proceeding from the tops of the spinal processes of the five uppermost *vertebræ* of the back and three lowermost of the neck, and inserted in the back and lateral part of the *occiput*.

3. The *Complexus* (H) passes from the transverse processes of the *vertebræ* to the hinder and middle part of the *occiput*. *N. B.* This and the *splenicus* cross each other.

4. The *Rectus major* (I) proceeds from the extremity of the acute process of the 2d *vertebra* of the neck, and is inserted in the *occiput*.

5. The *Rectus minor* (K) passes from the 1st *vertebra* of the neck into the *occiput*.

6. The *obliquus major* (L) rises in the spine of the 2d *vertebra* of the neck, and ends obliquely in the transverse process of the first.

7. The *obliquus minor* (M) proceeds from the *occiput*, and is inserted obliquely in the transverse process of the first *vertebra*, at the same place with the former.

*Observ:* There are these seven muscles on each side of the head: four of which are employed to raise the head: and only one to pull it down. Which disparity is occasioned by the backward situation of the *vertebræ* of the neck. This serving as an *axis* or pivot for the head to turn upon, the head falls naturally forward by its own weight; one muscle is sufficient to bow it: but it is work enough for four to hold it upright. *Note* also, that, as the head moves, not on the first, but upon the second *vertebra*, which has a tooth-like process, round which the first *vertebra* turns, as a wheel round its *axis*, the two *oblique* muscles make the head perform a semicircular motion.

The MUSCLES of the NECK are,

1. The *Scalenus* (N) from the upper part of the first rib, and the *clavicula*, to the extremities of the transverse processes of the three and four uppermost *vertebræ* of the neck.

2. The *Longus* or *Rectus* (O) from the lateral part of the body of the four upper *vertebræ* of the back

back to the body of the upper *vertebra* of the neck or to the *occiput*.

3. The *Spinofus* (P) from the *spinofus* processes of the fourth and fifth uppermost *vertebrae* of the back to all the spines of the six *vertebrae* of the neck, which this impulse serves to extend.

4. The *Transversus* (Q) from the transverse processes of the five upper *vertebrae* of the back to the extremity of the third and fourth uppermost *vertebrae* of the neck, which it extends.

Where *Note*, that these four muscles are so many on each side of the neck: that two of these muscles serve to bend, and two to stretch the neck: that when they all act together, they keep the neck strait and steady: and that the head is bent to one shoulder by an *inflexor* and an *extensor*, acting in concert.

In the interstices of the muscles are fourteen glands united by membranes and vessels, resembling the *maxillares* in substance: whose office is to separate the lymph carried off by the lymphatic vessels of all the muscles.

The MUSCLES of the SHOULDER-BLADE are,

1. The *Trapezium* (P) from the hard part of the *occiput* from the *spinæ* of the six lower *vertebrae* of the neck, and the nine uppermost of the back, to the whole *spine* of the *shoulder-blade*, and to the external part of the *claviculae*.

2. The *Rhomboides* (Q) from the *spine* of the three lower *vertebrae* of the neck, and the three upper *vertebrae* of the back, to the whole basis of the *scapula*: which it pulls back.

3. The *Levator proprius* (R) proceeds, by different heads, from the transverse process of the four upper *vertebrae* of the neck, to the upper angle of the *scapula*; which it draws up.

4. The *Pectoralis minor* (S) proceeds by way of digitation, from the second, third and fourth upper ribs of the *thorax*, to the *carocoides* process of the *scapula*: which it pulls forward.

Besides you are to take notice that the *shoulder-blade* is assisted in its motion, in some degree, by the muscles *latissimus* and *profundus*: for, though it is manifest, that nature designed them for the arm, they are fastened, in their passage, upon the *shoulder-blade*.

The SUPERIOR LIMB is divided into the arm, *cubitus* and *hand*.

The ARM, which is the part between the *shoulder* and the *elbow*, is clothed with these muscles.

1. The *Deltoides* (I) so called from its resemblance to a Greek  $\Delta$ , proceeding from the *cla-*

*vicula*, the *acromium* and the whole *spine* of the *shoulder-blade*, is inserted with a strong tendon almost in the middle of the arm; and compounded of twelve simple muscles.

2. The *Supraspinatus* (V) from the external part of the *base* of the *shoulder-blade*, and is inserted under the neck of the *shoulder-bone*. It encompasses the arm with a broad tendon, and moves upwards.

3. The *Latissimus* (X) proceeding from the three of the four lower *vertebrae* of the loins, from the *spine* of the *os sacrum*, the hinder part of the *os ilium*, and the outward part of the lower short rib; is inserted in the upper and inward part of the *shoulder-bone*, which it pulls downwards.

4. The *Rotundus major* (Y) proceeds from the outward part of the lower angle of the *scapula*, and is inserted with the *latissimus* for the same use.

5. The *Pectoralis major* (Z) proceeds from the middle of the *clavicula* upon the side that faces the *sternum*, and from the lateral and middle part of the *sternum*, is inserted by a short tendon in the upper and fore part of the *shoulder-bone*, and moves the arm forward.

6. The *Carocoides* (1) from the *carocoides* process of the *scapula*; is inserted in the middle and inner part of the *shoulder-bone*; moves the arm forwards, and is perforated to give way to the nerves that repair to the muscles of the *cubitus*.

7. The *Subspinatus* (2) from the outer part of the *base* of the *scapula* to the upper back part of the *shoulder-bone*, which it draws back.

8. The *Rotundus minor* (3) proceeding from the lower side of the *scapula*, near to the foremost corner to the hinder and upper part of the *shoulder-bone*, which it moves backwards.

9. The *Subscapularis* (4) proceeding from the inner *labium* of the *base* of the *scapula*, is inserted in the inner and upper part of the *shoulder-bone*, which it draws close up to the ribs.

Where *Note*, that the *arm* performs five sorts of motions: *viz.* two muscles draw it upwards; two downwards; two forwards; two backwards: the *scapularis* draws it into the side of the body: and it moves round by the alternate actions of the other eight muscles.

The CUBITUS is divided into the *ulna* and *radius*.

The ULNA is moved by the following muscles, *viz.*

1. The *Biceps* (4) which proceeds from the *Carocoides* process, and from the upper part of the cartilaginous edge of the *glenoides* cavity of the *scapula*, is inserted by one tendon in a knob at the upper and inner part of the *radius*, and moves the elbow.

2. The

2. The *Brachæus internus* (5) from the inner and upper part of the shoulder-bone, is inserted in the upper and inner part of the *ulna*, and together with the *biceps* bows the *cubitus*.

3. The *Longus* (6) from the upper part of the *scapula*, near its neck, is inserted by a strong tendon in the *olecranon*.

4. The *Brevis* (7) from the upper and hinder parts of the *humerus* to the *olecranon*.

5. The *Brachæus externus* (8) from the hinder part of the *humerus*, and is inserted in the same place and manner as the two last named muscles.

6. The *Anconæus* (9) proceeds from the lower part of the *condylus*, and is inserted by a tendon in the lateral part and back of the *ulna*, about two or three fingers breadth under the elbow.

Observe, that the *ulna* has only an extending motion and a *bending* motion. The first kind is effected by the means of the four latter muscles: the second by the two first muscles.

The RADIUS is moved by four muscles, *viz.*

1. The *Rotundus* (10) which proceeds by a carnosus head from the internal process of the shoulder-bone, and is inserted obliquely by a membranous tendon upon the outside of the *radius*, a little below the middle.

2. The *Quadratus* (11) from the lower and almost external part of the *ulna*, is inserted in the lower and external part of the *radius*.

3. The *Longus* (12) proceeds from about three or four fingers breadth above the outer process of the shoulder-bone to the inner part of its lower process.

4. The *Brevis* (13) from the lower part of the lower and external *condylus* of the shoulder-bone, is inserted in the upper and fore part of the *radius*.

Observe, that the first and second are named *pronatores*, whereby the palm of the hand is moved downwards: and that the third and fourth are named *supinatores*, because they turn it upwards.

The HAND is the *third* part of the upper limb or extremity. It begins at the articulation of the *wrist*, and terminates at the finger-ends. — Its inner part is called the *palm*: the outward is called the *back* of the hand; and it is divided into the *carpus*, *metacarpus* and *digiti*.

The CARPUS or *wrist* contains six muscles, *viz.*

1. The *Cubitus externus* (14) proceeding from the lower and inner *condylus* of the shoulder-bone,

is inserted by a thick tendon in the small bone of the *carpus*, that lies above the rest.

2. The *Radialis internus* (15) proceeding from the lower and inner *condylus* of the shoulder-bone, is inserted in the first bone of the *carpus* that supports the *thumb*.

3. The *Palmaris* (16) proceeding from the same place is inserted in the skin of the *palm* of the hand.

4. The *Cubitus externus* (17) proceeding from the hind part of the *ulna* is inserted in the upper and external part of the bone of the *metacarpus*, that supports the *little finger*.

5. The *Longus* (18) proceeding from the inner part of the shoulder-bone, is inserted in that bone of the *carpus*, which supports the *fore-finger*.

6. The *Brevis* (19) proceeds from the lowest part of the shoulder-bone, and is inserted in the bone of the *carpus*, which supports the *middle finger*.

Note, Here also are two distinct motions performed: the three first muscles are named *flexores*, because they serve to bend: and the other three called *extenders*, because they serve to extend the *wrist*.

Here also is a ligament called *annular*, which bracing the wrist joins the two bones of the *cubitus*, and keeps fast all the tendons of the muscles, and prevents their slipping out of their place, when in action.

At the root of the hand, under the *mons veneris*, is a square muscular lump of flesh, which begins at the *thenar* and ends in the eighth bone of the *carpus*, and is said to serve to make the hollow of the hand, by drawing the fleshy part that lies under the little finger towards the *thenar*.

The FINGERS contain *three and twenty* muscles; of which thirteen are *common*, so called because they serve *all the fingers*, *viz.*

1. The *Sublimis* (20) which proceeds from the inner part of the lower and inner *condylus* of the shoulder-bone; is inserted in the second row of the four fingers, being fastened in its passage to those of the first, and is divided into four tendons.

2. The *Profundus* (21) proceeding from the upper and inner part of the *ulna* and *radius*, is inserted in the third row of the bones of the fingers, and divides also into four tendons.

3. The *extensor communis major* (22) proceeding from the hinder of the outward and lower *condylus* of the shoulder-bone, is inserted in the second and third phalanx, and before it arrives at the wrist, divides into four flat membranous tendons.

4, 5, 6 and 7. The four *Lumbricales* proceeding from the tendons of the *profundus*, and the *annular*

ligament, are inserted in the second articulation of the fingers, to pull them down.

8, 9, 10. The three *offici interni* proceeding from the upper part of the interstices between the four bones of the *metacarpus*, are inserted in the lateral part of the bones of the fingers to move them downwards, and join their tendons with the *lumbricales*.

11, 12, 13. The *offici externi* proceeding from the same place are inserted in the last articulation of the finger-bones.

Observe, that the true action of the hand is performed by the *sublimis* and the *profundus*, which is the reason of their great strength. Besides the tendons of the *sublimis* are perforated by those of the *rotundus*, to give a strong and circular flexion to the fingers.

Those tendons are inclosed in a long, strong membranous sheath, which prevents their flying off in any motion, and contains an oily fat humour to moisten them.

The tendons of the *extensor communis major* are flat to prevent any disproportion in the back of the hand, thro' which they pass. And there is but one *extensor* for two *branders*; because the strength of the hand consists in its flexion.

The other muscles are called *proper*, because they are peculiarly adapted part to the *thumb*, part to the *foic-finger*, and part to the *little-finger*.

The THUMB has five peculiar muscles, viz.

1. The *flexens proprius* (23) proceeding from the upper and inner part of the *radius*, is inserted in the first and second bone of the *thumb*, which it bends.

2. The *Longus* (24) proceeding from the upper and outer part of the *ulna*, is inserted in the second bone of the *thumb*, which it stretches by a forked tendon.

3. The *Brevis* (25) proceeding from the same place is inserted in the third bone of the *thumb* for the same use.

4. The *Thenar* (26) proceeding from the first bone of the *wrist* and the *annular* ligament, is inserted in the second articulation of the *thumb*, and moves it from the other fingers.

5. The *Antithenar* (27) proceeding from the bone of the *metacarpus*, that supports the middle finger, is inserted in the first bone of the *thumb*, and pulls it towards the fingers.

The FOREFINGER has three muscles, viz.

1. The *indicator* (28) proceeding from the middle and hinder-part of the *ulna*, is inserted in the

second phalanx of the *index* or *forefinger*, and in the tendons of the *extensor major* by a double tendon.

2. The *inducis adductor* proceeding from the fore part of the first bone of the *thumb*, is inserted in the first bone of the *fore finger*, to draw it towards the *thumb*.

3. The *inducis abductor* proceeding from the outward and middle part of the *ulna*, is inserted in the lateral and outer part of the bones of the *index*, to bend it towards the other fingers.

The LITTLE-FINGER has two muscles, viz.

1. The *extensor proprius* (29) proceeding from the lower part of the outward *condylus* of the shoulder bone, is inserted by a double tendon in the second articulation of the *little finger*, to assist the *extensor communis* in the stretching out of the *little finger*.

2. The *hypothenar* proceeding from the little bone of the *carpus*, that lies above the rest, is inserted on the outside of the first bone of the little finger, which it pulls away from the rest.

The next subject to be examined is the ARM, in regard to the nerves, arteries, and veins it contains.

We have observed already, that the nerves proceed from the *medulla oblongata*, and the *medulla spinalis*. The *first* sends forth ten pair of nerves, which we have seen; and the *second* thirty more, which we are to see.

Of the thirty pair which proceed from the *spinal* marrow, seven belong to the neck, twelve to the back, five to the loins, and six to the *os sacrum*.

The first pair of the *cervical nerves* arise between the first and second *vertebra* of the *neck*, and contrary to the rest comes out before and behind; whereas the other six pair come out laterally from the junctures of the *vertebrae*, thro' particular perforations near the transverse *processes*. — They go to the muscles of the head and ears.

The second pair contributes the main branch towards the formation of the *diaphragmatick-nerves*, which, spring only from the fourth and sixth pair.

The three last pair of the *neck*, joining with the two first of the *dorsum*, or *thorax*, make the *brachial nerves*.

These *brachial nerves* are six, which range all over the arm to the very fingers ends.

(32) The first, which is the uppermost, and least, is spent upon the *deltoides* muscles and the skin of the arm.

(33) The second is larger, and passes through the middle of the arm. It detaches branches to the *biceps* and the *supinator*; and, when it arrives at the cubit, divides it into three branches, the first of which marches by the outer part of the arm to the *thumb*; the second descends obliquely to the *wrist*; and the third keeping company with the *basilica*, runs to its period in the skin of the *cubitus* and the *hand*.

(34) The third joins the second under the *biceps*, furnish the muscles called *brachiales*, with some of its branches, the *thumb*, *fore-finger*, and *middle-finger*, with small twigs, and is spent upon the benders of the fingers.

(35) The fourth, which is the greatest of all, lies very deep in the *arm*, and accompanies the artery and vein, called the *basilica*. It dispenses shoots to the external muscle of the *cubitus*, and the skin of the inside of the *arm*; but as soon as it arrives at the elbow, it splits into two branches, one of which glides along the *radius*, and the other the *ulna*. — The first of these sends out five branches, two of which repair to the *thumb*, two to the *fore-finger*, and the fifth to the *middle-finger*. — The other branch dispatches twigs to the extenders of the fingers, and then is lost in the wrist.

(36) The fifth joins in with the fourth, and descending along the inner part of the arm, distributes branches upon the *ulna*; thence it comes to pass, that when one leans upon any of these branches, the arm is benumbed.

Then it is divided into two branches, one of which visits the benders of the fingers and the wrists, and looses the remainder in the same quarter with the former; the other creeps along the inner and lateral side of the *arm*, in order to send two branches to the *little-finger*, two to the *ring-finger*, and one to the *middle-finger*.

(37) The sixth, almost all over cutaneous, descends along the inner part of the *arm*, in company with the *basilica*, and is lost in the skin of the elbow, and *cubitus*.

The *arms* are also provided with arteries and veins. — The *arteries* have their origin from the ascending great artery, which divides itself into the right and left *subclavian*, which passing through the chink that lies between the two heads of the *scalenum* muscle, proceeds to the *arm*; and at the arm-pits, is called *axillary artery*, which passing under the head of the shoulder-bone, is lost between the two extenders of the *cubitus*.

The trunk itself continuing its descent along the inner part of the *arm*, dispenses branches to the *biceps*, and the *brachius internus* and *externus*, and above the bending of the elbow sends out a

twig, which is lost in the inner, and back part of inner and lower part of the arm.

(40) At the bending of the elbow this arterious trunk splits into two branches, one *internal*, and the other *external*.

(41) The *external* creeps along the *radius*, and shoots forth a branch, which re-ascends, and comes to a period between the *supinator longus* and *brachius internus*. In its descent it distributes branches to the benders of the wrist and fingers. At the wrist it affords a branch to the head of the *thenar*; which is the artery we meet with when we feel the pulse. After that it slides under the tendon of the extender of the thumb, and having bestowed branches on the outside of the *hand*, terminates into two shoots, one of which runs to the thumb, and the other to the fore-finger.

We must trace the *veins* in a different manner from the *arteries*; for as the *arteries* import the blood from the heart to the circumference, so the *veins* export it from the circumference to the heart; therefore they have both a different origin: The *arteries* of the *arm* proceeding like those of the other parts from the heart; and the *veins* of the *arm* from the extremities of the fingers, like the roots of a tree, which by their smallest strings receive the sap, in order to convey it to the bigger roots, and from thence to the trunk itself.

The *cephalica*, *basilica* and *mediana*, are the three considerable veins of the *arm*, formed from several branches of *veins* proceeding from the five fingers.

(44) The CEPHALICK consists of some small branches, which form a vein between the little and the ring-finger, called *salvatella*. It lies between the skin and the muscles, and is divided into two branches, *external* and *internal*. The external goes down to the wrist, where it joins the *basilica*, and turns up to the back of the hand. The internal branch, together with a sprig of the *basilica*, makes the *mediana*.

N. B. It is thus called, in regard the ancients used to open it in the disorders of the *head*; from a mistaken notion, that it had a nearer concern with the *head* than any of the other veins.

(45) All the little veins which spring from the five fingers to the *hand*, form that great vein which runs the whole length of the arm, and is called BASILICA, from its being seated almost on its *basis*. — The *basilica* is divided into three great branches, one of which is usually opened when we are bled in the arm, as being the more superficial and apparent. — The other is deeper, and consists of two branches, one directing its course to the inner part of the hand, and the other to the outer. — The third is the *cubitalis*, which

lies nearest the *os cubiti*. — These three branches ascend towards the arm, and in the way receive a vein from the *median*, after which they slip under the tendon of the *pectoral* muscle, and unload in the *axillary* vein.

From a branch, which arises between the *thumb* and the *fore-finger*, joined to another that springs between the *middle* and the *ring-finger*, is formed a large vein, which ascends along the middle of the arm to the bending of the *elbow*, called the *MEDIANA*, which afterwards divides itself into two branches in the form of an *Y*, one of which terminates in the *cephalica* and the *basilica*, where it is lost; while the *cephalica* and *basilica* continue their course to the *axillary*, where they unload themselves; the *axillary* into the *subclavian*, and the *subclavian* into the *cava*.

THE THORAX or BREAST also has its peculiar muscles; *thirty* serve to dilate it, and *twenty-six* to contract it.

The dilating muscles are *fifteen* on each side, and known by the names of

1. The *subclavian* (AA) which proceeds from the inner and lower part of *clavicula*, is inserted in the upper part of the first rib, which it pulls upwards and outwards.

2. The *ferratus major* (BB) proceeding from the inner base of the shoulder-blade, is inserted by digitation in the five lowermost long ribs, and the two uppermost short ribs, to pull them out and dilate the breast.

3. The *ferratus posterior* and *superior* (CC) proceeding in a broad tendon from the acute processes of the lowermost *vertebræ* of the neck, and from the first of the *loins*, is inserted in four points in the lowermost ribs, to pull them down and outward.

4. The *intercostales externi* (EE) proceeding from the lower and outer part of each upper rib, is inserted obliquely from behind forwards in the upper and outward part of each of the lower ribs, which they pull backwards and outwards, to promote the dilatation,

5. The *triangularis* (F) proceeding from the lower part of the *sternum*, on which it lies is inserted in the cartilages of the upper rib, reaching to the twelfth, to draw the ribs downwards, and to contract the breast.

6. The *sacro lumbaris* (GG) proceeding from the outer part of the *os sacrum*, and the *spinæ* of the *vertebræ* of the loins, is inserted in the back parts of the ribs, near the root, gives two tendons to each rib, one on the outside, the other on the inside, by which it contracts the breast.

Note, That there are two *ferrati posteriores*,

eleven *intercostales externi*, and eleven *intercostales interni*.

Besides we are to include the diaphragm, which being employed indifferently in both motions makes the fifty-seventh muscle in the *thorax*.

Some modern anatomists are of opinion that the internal and external *intercostals*; make but one muscle, which has two plans of fibres with contrary directions.

The action of these muscles is effected in this manner. When the internal air is pressed by the external, the diaphragm, being forced thereby to dilate itself, the dilating muscles are also in action; and when that air, after having passed through the lungs, is forced to fall out, the diaphragm contracts itself, as well as the muscles *antagonists* to those that acted before; though some of our modern Anatomists believe, that it is not the air that causes the dilatation, or contraction of the muscles of the *thorax*, but the dilatation and contraction of those muscles that procure the ingress and egress of the air, into or out of the breast.

(H) The *diaphragm*, which is the principal organ of the respiration, also called *septum transversum*, is a nervous muscle, separating the breast or *thorax* from the *abdomen*, or lower venter, and serving as a partition between the natural and vital parts. — Its figure is round, resembling a ray or thornback. — It consists of two circles, the one membranous, the other fleshy. Though others will have both of them muscular.

The first, or superior circle arises from the *sternum*, and the ends of the last ribs; the second or inferior comes from the *vertebræ* of the loins. The upper is covered a-top with a membrane derived from the *pleura*; and the lower lined at bottom with another from the *peritonæum* (I).

Its situation is oblique, being extended from the cartilage *xiphoides*, by the extremes of the ribs, to the region of the loins.

(L) It is pierced in the middle for the passage of the *vena cava*; and in its lower part for the *œsophagus*; and between the productions of the inferior circle pass the *aorta*, *thoracic duct*, and *vena azygos*.

(MM) It receives two sorts of nerves, one from the *par vagum*, and the other from the interstices of the four lowermost *vertebræ* of the neck. Both the one and the other pass through the cavity of the *thorax*, and being supported by the *mediastinum*, are dispersed in three or four branches all over its substance.

It receives likewise two arteries, called *phrenicæ*, which spring from the trunk of the *aorta*; and two veins of the same name, which march to the trunk of the *cava*.

The *diaphragm*, in its natural disposition, is convex on the upper side towards the breast, and concave on the lower, towards the *abdomen*. Hence it has two motions, the one of *contraction*, and the other of *relaxation*.

By the *contraction*, or swelling of the fibres, the *diaphragm* becomes flat on each side: the consequence of which is, that the cavity of the *breast* is enlarged to give liberty for the lungs to receive the air in inspiration; and the cavity of the *abdomen* lessened, and consequently the *stomach* and *intestines* pressed, for the distribution of the *chyle*. — In its *relaxation*, whereby it resumes its natural situation, the cavity of the *breast* is diminished, and the *lungs* pressed, for the expulsion of the air in expiration.

On the *diaphragm* also, in great measure, depends the action of *coughing*, *sneezing*, *yawning*, *laughing*, the *hiccups*, &c.

The BACK and LOINS contain the following muscles in common with each other.

1. The *sacer* (P) proceeding from the back part of the *os sacrum*, and the back part and upper edge of the *os ilium*, is inserted in the spines of the *vertebræ* of the back.

2. The *semi-spinatus* (Q) proceeding from the spines of the *os sacrum*, and from those of the *vertebræ* of the *loins*, is inserted obliquely in the transverse processes of the *vertebræ* of the back, reaching to the neck.

3. The *triangularis* (R) proceeding from the back part of the *costa* of the *os ilium*, and the lateral and internal part of the *os sacrum*, is inserted in the last of the short ribs, and in all the transverse processes of the *vertebræ* of the *loins* with its fellow, to bend the back bone forward.

Observe, that these muscles are double, one on each side to serve for the extension, flexion, and bending sideways of the *back* and *loins*, and these are the muscles that give a genteel carriage to the body both of men and women: and when these muscles are injured either by disease, accidents, or bad habit or custom of bending the body forwards, people grown round shouldered, and sometimes *bunch-backed*.

The *lower limb* is divided into the *thigh*, the *leg*, and the *foot*.

The THIGH is divided into the forepart, backpart, inside and outside. The forepart of the lower end is called the *knee*, and the backpart of the *knee* is called the *ham*. In this part of the lower limb are included the following muscles.

1. The *psaos* (S) proceeding from the transverse

processes of the lowermost *vertebra* of the *back*, and the uppermost part of the *loins*, is inserted by a strong and round tendon in the lesser *trochanter*, seated in the *abdomen*.

2. The *iliacus* (T) proceeding from the whole edge of the inner cavity of the *os ilium* is inserted in the same manner and place.

3. The *pectineus* (V) proceeding from the first part of the *os pubis* is inserted in the forepart of the *thigh-bone* under the little *trochanter*.

N. B. These three muscles make the *thigh* to bend.

4. The *glutæus major* (X) proceeding from the lateral part of the *os sacrum*, and from the back and outer part of the hip of the *os ilium* is inserted in the bone of the *thigh*, about the breadth of four fingers under the great *trochanter*.

5. The *glutæus intermedius* (Y) proceeding from the backpart of the tip of the *os ilium* is inserted about three fingers breadth under the great *trochanter*.

6. The *glutæus minor* (Z) proceeding from the deepest and hollowest part of the external cavity of the *os ilium*, is inserted in a little cavity at the root of the great *trochanter*.

N. B. These three stretch out the *thigh*.

7. The *triceps superior* (1) proceeding from the upper and outer part of the *os pubis*, is inserted in the upper part of a line that runs along the inside of the *thigh*.

8. The *triceps medius* (2) proceeding from the middle of the *os pubis* is inserted in the middle of the line last mentioned.

9. The *triceps inferior* (3) proceeding from the lower part of the *os pubis* and the lower part of the *os ischium* is inserted in the lower part of the same line.

10. The *pyramidales* (4) proceeding from the upper and lateral part of the *os sacrum* and the lateral part of the *os ilium*, is inserted in a small cavity at the root of the great *trochanter*.

11. The *quadratus* (4) proceeding from the outer and lateral part of the rising of the *os ischium*, is inserted in the back and outward part of the great *trochanter*.

12 and 13. The *gemi* proceeding from two little processes in the hinder part of the *os ischium* are inserted in a small cavity at the root of the great *trochanter*, separated by the tendon of the *obturator internus*, and joining with the *quadratus* in opening the *thigh*.

14. The *obturator internus* proceeding from the whole circumference of the oval foramen of the *os ischium*, is inserted by a tendon in a small cavity at the root of the great *trochanter*.

15. The

15. The *obturator externus* proceeds from the outward circumference of the same hole, and is inserted in the same place and manner.

*N. B.* These two muscles serve for the turning the thighs round.

The **TIBIA** or **LEG** begins at the knee and ends at its articulations with the *foot*; whose prominent sides are called *malleoli* or *ankles*.

In this part of its lower limb are found the following muscles, *viz.* 1. The *rectus* (5) proceeding from the fore and lower part of the *os ilium*, is inserted in the upper and fore part of the *leg*, comes from a tendon and covers the whole part of the *kneecap* or *retula*.

2. The *vastus internus* (6) proceeding from the inner and upper part of the *femur*, a little below lesser *trochanter*, is inserted in the upper and inner part of the *tibia*, marching in a broad tendon.

3. The *vastus externus* (7) proceeding from the upper and fore-part of the *thigh-bone*, marches and is inserted with the foregoing muscle.

4. The *cruralis* (8) proceeding from the fore-most and upper part of the *thigh* between the *trochanters*, is inserted as the two last mentioned.

*N. B.* These four muscles *stretch out the leg* by pulling it forward.

5. The *Biceps* (9) proceeding from the lower part of the knob of the *os ischium*, and the outer and middle part of the *thigh*, is inserted in the upper and back part of the upper appendage of the *perone*.

6, 7. The *seminervosi* (10) proceeding from the knob of the *os ischium*, are inserted in the hinder part of the upper *epiphysis* of the *tibia*.

*N. B.* These three muscles *bend the leg* by pulling it backwards.

8. The *longus* (12) proceeding from the upper and fore-part of the spine of the *os ischium*, is inserted obliquely in the internal and upper part of the *tibia*, and pulls it in.

9, 10. The *graciles* (13) proceeding from the lower and fore-part of the *os pubis*, are inserted in the upper and inner part of the *tibia*; and serve to draw the leg inwards.

11. The *membranosus* (14) proceeding from the external and lateral part of the lip of the *os ilium*, is inserted by a broad membrane in the upper and outer part of the *fibula*.

12. The *popliteus* (15) proceeding from the outer and lower knob of the *femur*, is obliquely inserted in the upper and inner part of the *tibia*.

*N. B.* These two muscles form the abduction of the *leg*, by drawing it to the outside.

The **FOOT** is that part of the *lower limb*, which extends from the *ankles* to the end of the *toes*. Its

upper part is called the *cubitus* or *instep*, and the under part is the *sole of the foot*. Besides, it is divided, as has been noted under *Osteology*, into the *tarfus*, *metatarfus*, and *toes*. Each of which parts is assisted in their motions by several *muscles*.

In the **FOOT** are those *muscles*, *viz.*

1. The *crureus anterior* (16) proceeding from the upper and fore-part of the *tibia*, is inserted by two tendons, one to the first wedge-like bone, and the other to the bone of the *metatarfus*, that supports the *great toe*.

2. The *peroneus anterior* (17) proceeding from the outer and middle part of the *perone*, is inserted on the fore-side in the bone of the *metatarfus* that supports the *little toe*.

*N. B.* The two muscles bend the leg by pulling it forwards.

3, and 4. The *gemelli* (18) proceeding from behind the two lower *condyli* of the thigh-bone, are inserted by one tendon, and the two following muscles, in the back and upper part of the *heel-bone*.

*N. B.* These, with the two following, form the *calf of the leg*.

5. The *soleus* (19) proceeding from the back and upper part of the *tibia* and *fibula*, is inserted by a tendon in the *heel-bone*.

6. The *plantaris*, proceeding from the outer knob of the bone of the thigh, is inserted by a slender tendon in the same place with the three last mentioned muscles.

7. The *crureus posterior* (20) proceeding from the back part of the *tibia*, is inserted in the inner part of the *scaptrioides* or *navicular bone*.

*N. B.* This is called the tendon of *Achilles*: because it is said, this warrior died of a wound in that part; which is always very dangerous.

8, and 9. The *peronei posteriores* (21), the first of which proceeds from the upper and very near the fore-part of the *perone*, and is inserted in the upper and near the external part of the *metatarfus* that supports the *great toe*.—The other proceeds from the lowermost part of the *perone*, and is inserted in the bone of the *metatarfus*, that supports the *little toe*. They both stretch out the foot by pulling it backwards.

*Observe*, that here are but *two flexores* or benders; but there are *seven extensores*. For which disparity it is alledged, that the great number of *extensores* or muscles that draw the foot back were necessary to counterpoise the center of gravity, and to keep the body from falling; whereas two are sufficient to bend the *foot*, which rarely bends too much.

The **TOES** make the extremity of the *lower limb*, and have *sixteen common* and *six proper* muscles.

The

The *common* muscles are those, which serve to the motion of the toes in general, and are,

1. The *extensor communis* (22) proceeding from the upper and fore-part of the *tibia*, where it joins to the *fibula*, and is inserted by four tendons in the four articulations of the four *toes*, which it extends.

2. The *pidieus* (23) proceeding from the lower part of the *fibula* and *annular* ligament, and being divided with four tendons, is inserted in the outer part of the first articulation of the four *toes*, to perform their extension.

3. The *sublimis* (24) proceeding from the lower and inner part of the *heel-bone*, and divided into four perforated tendons, is inserted in the uppermost of the first rank of the bones of the four *toes*, to bend them.

4. The *profundus* (23) proceeding from the upper and back part of the *tibia*, and the *fibula*, and divided into four tendons, is inserted in the last row of the bones of the *toes*.

*N. B.* All these *muscles* bend the four *least* *toes*.

5, 6, 7, 8. The *lumbricales*, proceeding from the tendons of the *profundus*, are inserted in the lateral and inner part of the first bones of the four *toes*, and form the *sole* of the *foot*.

9, 10, 11, 12. The *interossei interni*, proceeding from the bones of the *tarsus*, and the intervals of those of the *metatarsus*, along with the *lumbricales*, are inserted in the upper and inner part of the bones of the first articulation of the four lesser *toes*, which move towards the *great toe*.

13, 14, 15, 16. The *interossei externi*, proceeding from the upper part of the interstices of the bone of the *instep*, are inserted in the lateral and external part of the first bones of the *toes*, which they move from one another by abduction.

The *proper* muscles are those peculiar to the motions of particular *toes*.

Thus the GREAT TOE has,

1. The *Flexor proprius* (26) which, proceeding from the upper and back part of the *perone*, is inserted in the bone of the first phalanx, retaining and bending the *great toe*.

2. The *extensor proprius* (27) which, proceeding from the fore and upper part of the *perone* between the bone and the *fibia*, is inserted in the upper part of the first bone of the *great toe*, and bends it.

3. The *Thenar* (28) which, proceeding from the lateral and internal part of the *heel-bone*, the *navicular-bone* and the *ossa innominata*, is inserted in the upper part of the second bone of the *great toe*, and pulls it in.

4. The *Antithenar* (29) which, proceeding from the bone of the *metatarsus*, that sustains the *little toe*, is inserted in the inner part of the first joint of the *great toe*, which it pulls outwards towards the other *toes*.

The SECOND TOE has only the *abductor* of the *Index* (30) proper to it, which proceeding from the inner part of the first bone of the *great toe*, is inserted in the bones of the *second toe*, to pull it towards the *great toe*.

The LITTLE TOE also has only one muscle, the *hypothenar*, whose course is from the outer part of the bone of the *metatarsus*, which sustains the *little toe*, to its insertion in the upper and outer part of the bones of the *little toe*, which it draws off from the rest.

Here ends the *historically mechanical* account of the *muscles*; in which are described their situation, natures, uses, process and number, *viz.*

M U S C L E S

In the forehead	2	The ulna	12
The occiput	2	The radii	8
The eye-lids	6	The carpi, or wrists	12
The eyes	12	The fingers	48
The nose	7	Respiration	57
The external ears	8	The loins	6
The internal ears	4	The abdomen	10
The lips	13	The testicles	2
The tongue	8	The bladder	1
The uvula	4	The yard	4
The larynx	14	The anus	3
The pharynx	7	The thighs	30
The os hyoides	10	The legs	22
The lower-jaw	12	The feet	18
The head	14	The toes	44
The neck	8		
The shoulder-blades	8		
The arms or shoulder-bones	18		
		In all	434

To render this treatise of *Anatomy* a perfect one, we shall finish with *ANGIOLOGY*; which is a description of the *nerves*, *arteries*, and *veins* of the *inferior extremity* of the body.

We have seen, already, seven of the thirty pair of *nerves*, which march out from the spinal marrow, through the holes of the *vertebrae*, and belong to the *neck*: now we must discover those that belong to the *back*, *loins*, and *os sacrum*.

The twelve pair of *nerves*, which come from the *vertebrae* of the neck, extend no further than the circumference of the *Thorax*; each of which divide into two branches; the larger whereof are placed before, and the lesser behind.

The

The *fore branches* are distributed into the internal and external *intercostal* muscles, in each of the *interstices* of the ribs; send shoots to the muscles of the *breast*, and to the oblique descending of the *abdomen*.—The *hinder branches* bend back, and are lost in the muscles of the back, and in those, which adhere to the *vertebræ*.

Each of the five pair, which proceed from the *vertebræ* of the loins, is likewise divided into a *fore*, and a *hind* branch; distributed partly in the muscles of the *loins* and the *hypogastrium*, and partly in the *thigh*.

Of the six pair of the *os sacrum* (that pair between it and the *vertebræ* of the loins included) none, but the first, marches out by its lateral part; the other five make their way before, and behind; because the articulation of its lateral parts, with the bones of the *ilia*, obstruct its perforation in those places; but it has ten *foramina* before, and ten behind; and of these, five on each side; which give an egress to as many nerves.

The *spinal marrow* terminates in a *nerve*, which is distributed in the skin between the *buttock* and the *anus*, and sends branches to the muscles of the *thighs*, both on the right and left side.

The biggest branches of the three lowermost pair of the *loins*, and those of the four uppermost of the *os sacrum*, joining together in their descent, form four branches of nerves; two of which are no lower than the *thighs*: a third terminates in the *leg*, and a fourth reaches to the *foot*.

The first pair of the nerves of the *thighs* (33) is formed of the third and fourth pair of the *lumbares*; and, passing near the lesser *trochanter*, it is distributed in the skin and muscles of the *thigh*, and in some of those, which move the *leg*.—'Tis quite spent above the *knee*.

The second (34) which springs from the same source, and accompanies the *crural* artery and vein, is distributed to the fore muscle, the skin of the thigh, and the circumference of the knee, and sends out a branch to accompany the *saphana* to the inner angle, where it sinks.

The third (35) which rises between the fourth and fifth *vertebræ* of the loins, and passes through the *foramen* at the end of the *pubes*, is dispersed in the muscles of the upper part of the *thigh*, the *puenda*, and the *triceps*, and lost in the skin of the *groin*.

The fourth (36) is formed of the four upper nerves of the *os sacrum*, which together form the *cruralis*; and descends, in an entire body, to the ham, after having passed near the prominence of the *os ischium*.—At the *ham* it divides again into two branches, the outermost thereof runs from the outside of the foot to the muscles of the *perone*, and

then turns back to the outer angle, where it terminates.——The inner branch descends along the *leg* to the muscles of the foot, and after spreading itself upon the inner angle, is spent upon the sole of the foot, and all the toes; to each of which it dispenses two branches.

As to the *arteries* and *veins* in the *lower limb*; let it be observed that an *ARTERY* is a hollow fistulous canal, appointed to receive the blood from the ventricles of the heart, and distribute it to all parts of the body, for the maintenance of heat and life, and the conveyance of the necessary nutriment.

The *arteries* are ordinarily composed of three; the first or outermost, is nervous or tendinous, being a thread of fine blood-vessels, with nerves for nourishing the other coats. The second is *muscular*, and made up of spiral fibres; of which there are more, or fewer *strata*, according to the bigness of the *artery*. These fibres have a strong *elasticity*, by which they contract themselves with force, when the power, by which they have been stretched out, ceases.——The third, and innermost coat is a fine, dense, transparent membrane, which keeps the blood within its channels, which otherwise, upon the dilatation of an *artery*, would easily separate the spiral fibres from one another.—As the arteries grow smaller, these coats grow thinner.

All the *arteries* are conical. They begin with a trunk, and growing less and narrower, end in branches so minute, that they escape the sight, unless assisted with microscopes.

The *coats* of the *arteries* are of a very dense, close, contexture; and the blood not being visible through them, they generally appear white.—The blood proceeding in the vessels from a greater capacity to a less, is thereby somewhat obstructed in its passage; but being forced on by the motion of the heart, it distends the coats, and thereby occasions a *saliant* motion, called the *pulse*.——By this thickness and whiteness of the *arteries*, with the pulsation observed therein, *arteries* are distinguished from *Veins*.

The *pulse* of the *arteries*, as that of the heart, consists of two reciprocal motions, a *sysstole*, or contraction, and a *diastole*, or dilatation; but they keep opposite times; the *sysstole* of the one answering to the *aiastole* of the other.

All the *arteries* of the body arise in two large trunks from the two ventricles of the heart, *viz.* the *pulmonary artery* from the right ventricle, and the *aorta* from the left.

The *AORTA*, or *great artery*, after it leaves the heart, divides itself into two large trunks, called the *ascending*, or upper; or *descending*, or lower *trunks*.

The *descending trunk* (for we have already described the ascending one) or *aorta descendens*, carries the blood to the trunk and the lower parts of the body.

Out of this arise the *bronchial, intercostal, celiac, phrenic, mesenteric, emulgent, spermatic, iliac, umbilical, epigastric, hypogastric, crural, &c.* with their several ramifications.

The *ARTERIA ILIACA*, (37) which is one of those great branches of the *aorta descendens*, changes its name, at its egress out of the *abdomen* into that of *arteria cruralis*, upon its arrival into the *thigh*; where it produces three or four branches, which are spent upon the skin, and muscles of the upper and fore part of the *thigh*; but at the distance of three or four fingers breadth, under the groin, it produces,

I. The *MUSCULARIS INTERNA* (38) so called from its situation in the inner muscles of the thigh, which sends out four sprigs, one to the *abductor* of the thigh, and to the *triceps, biceps, and semi-nervosi*, and the *semi-membranosus*; one to the upper part of the *triceps*; the two others to the body of the *triceps*, and to the *gracilis*.—After this, the trunk of the same *artery* divides into three branches: the first of which passing by the end of the third of the *tricipites*, is lost in the *semi-membranosus*; the second passing under the thigh-bone, is spent in the *vastus externus*; and the third moving downwards, sends out branches at the end of the third of the *tricipites*, and is lost in the *semi-nervosus*, and the head of the *biceps*.

The *MUSCULARIS EXTERNA* (39) is the second which runs to the outer part of the thigh, and passing under the *sartorius* and the *gracilis rectus*, sends out branches at the end of the *iliacus*, to the *vastus externus*, the *cruralis*, and the *membranosus*.

The third springs from the *cruralis* (40) detaches branches to the *cruralis* and *vastus externus*, and is lost in the membranes and fat of the thigh.

The *cruralis* (41) in its farther progress to the *lower limbs*, furnishes the adjacent muscles with several branches, passes near the tendons of the *triceps*, and at its arrival at the ham, sends out little branches to the tail of the muscles of the hinder part of the thigh, which are lost in the fat. — Below the ham it produces the two *popliteæ*, which embrace the knee, one on the inside, and the other on the outside; and a little lower the *surales*, which direct their course to the *gemelli*; the *soleus*, the *plantaris*, and the *popliteus*; and encompass the bones of the leg by several branches, that terminate there.

Here the *cruralis anterior*, and the *posterior* (42) begin. The former runs across the membrane that joins the bones of the leg, and continuing its course, dispenses branches to the *tibæus externus*, and *extensores* of the *toes*.

The *cruralis posterior* (43) which is the largest of the two, divides itself into the *primus possicus*, which dispenses branches to the *soleus, peroneus posterior*, and the bender of the *great toe*, ascending by the outer ankle, is lost in the upper part of the foot; and the *secundus possicus*, which in its descent sends out sprigs to the *soleus*, the benders of the *toes*, and the *curvus possicus*; and then passing through the cavity of the *fibula*, is divided into two branches, one that passes under the *thenar* to the great toes, and another between the *brevis*, and the *hypothenar*, under the sole of the foot, and is spent upon the four other toes.

The *VEINS* are vessels or canals, which receive the blood from the divers parts of the body, to which the arteries had conveyed it from the heart. They are only a continuation of the capillary arteries, reflected back again towards the heart; and in their progress uniting their channels, as they approach the heart, they at last form three large veins, or trunks, *viz.* the *vena cava descendens*, which brings the blood back from all the parts above the heart:—The *ascendens*, which brings the blood back from all the parts below the heart:—And the *porta*, which carries the blood to the liver.

The *anastomosis*, or inosculation of the *veins* and *arteries*, was first seen by the microscope, in the feet, tail, &c. of frogs, and other amphibious animals, by *Leeuwenhoek*; but has since been observed in other animals, particularly the *omentum* of a cat, by Mr. *Cowper*.

The *coats* of the *veins* are four, the same with those of the arteries; only the muscular coat is thin in all the *veins*, as it is in the *capillary* arteries; the pressure of the blood against the sides of the *veins*, being less than against the sides of the arteries; because the force of the heart is much broke in the *capillaries*.

In the *veins* there is no *pulse*, because the blood is thrown into them with a continual stream; and because it moves from a narrow channel into a wider; but they have a *peristaltick* motion, which depends on their muscular coat.

The *capillary veins* unite with one another, as has been said of the capillary arteries, only their course is directly opposite; for instead of a trunk distributed into branches and capillaries, a *vein* is a trunk, formed out of a concourse of capillaries.

In all the *veins*, which are perpendicular to the horizon, excepting those of the *uterus*, and the *porta*, there are one or more small membranes or *valves*, like so many half thimbles, stuck to the sides of the *veins*, with their mouth towards the heart, which in the motion of the blood towards the heart, are pressed close to the sides of the *vein*; but shut the *veins* against any reflux of the blood

by that way from the heart, and thereby sustain the weight thereof in the great trunks.

The VEINS are distinguished into *upper and under descending*, and *ascending*; *right*, as the *mesenterick*; and *left*, as the *splenic* branch; *internal*, as the *basilica*; and *external* as the *humeral*, &c. according to their situation.

One of the principal among the ASCENDING veins, is the *cruralis*, formed by six branches of other veins, inserted in that part; the first whereof is,

The ISCHIADICA MAJOR (45) which proceeds from ten sprigs of veins; two whereof come from each *toe*, and form a branch which is joined by another that comes from the *fibula*, and the *heel-bone*; and both *ascending* by the muscles of the *calf* of the leg, unload, by a joint stream, in the *cruralis*.

The SURALIS (46) is the second, formed by almost all the veins that creep along the *foot*, and by those that come from the *calf* of the leg.

The third is the POPLITEA (47) produced by the sprigs of the *heel*, and part of those of the neck of the *foot*; from whence it *ascends*, passes by the *ham*, and terminates in the *cruralis*.

The MUSCULAR (48) is the fourth, and comprehends the *muscular external*, which proceeds from the *external* muscles of the thigh; and the *internal* from the *internal* muscles.—These two branches enter the *cruralis* opposite to one another.

The ISCHIADICA MINOR (49) and least, the fifth, is produced by several ramifications from the *skin*, and the *muscles* that surround the jointing of the *thigh*.

The longest and biggest of all the *fix*, is the SAPHENA (50) which begins at some branches from the *great toe*, and by *ascending* by the inner ancle along the leg, and the inner part of the thigh, between the *skin* and the *fleshy membrane*, terminates in the *cruralis*; which mounting upwards, and having passed the *groin*, empties itself into the *iliaca*; the *iliaca* into the *cava*, and the *cava* into the *right ventricle* of the *heart*.

ANGIOLOGY treats likewise of the *lymphatick* vessels; which are small pipes, consisting of a very thin coat, full of *valves*, that open, like those of the *veins*, towards the heart, and shut upon the reverse.—They have no common cistern, for some of them unload in the *thoracick* duct, and others immediately in the *veins*.—Some proceed from the *viscera*, and others from the glands dispersed all over the body.—Those that spring from the conglobate glands, convey their lymph to the *veins*; and those from the conglomerate disemboque into particular cavities, as the *eyes*, *mouth*, *duodenum*, &c.

The number of these vessels is infinite; but not

to be all discerned with the eyes.—Their *lymph* proceeds from the serosities of the blood filtrated in the glands. It is generally clear and transparent; but it changes its colour, in proportion to the tinctures it receives from the *chyle*, the *bile*, and the other humours contained in the blood.—Of itself it is insipid; but sometimes it has been found, acid, bitter, or brackish.—It fixes and congeals by the mixture of humours, and the dissolution of salts, as well as the *serum* of the blood.

I shall conclude this treatise on ANATOMY with a few observations on the *nails* and *hair* of the *human body*. The NAILS are hard, round, white and transparent bodies, seated at the ends of the *fingers* and *toes*: and are nothing more but the covers, or sheaths of the *papillæ pyramidales* of the *skin*, on the extremities of the *fingers* and *toes*, which dry, harden, and lie upon one another.

Their use is to strengthen, and defend the end of the *fingers*, in handling any hard and rugged bodies; that part being extremely sensible, by reason of the great number of nerves, which terminate here, for the sensation of feeling.

The *nails* are formed, and grow after the same manner as the rest of the body; their nourishment they receive from their roots. The HAIRS, according to *Malpighi* have roots that resemble those of the bulbous heads of tulips; and these roots are nourished by *blood-vessels*, accompanied with *nerves*; so that the *hairs* grow, and sometimes become so big, that they are carnos and sensible of pain, and bleed plentifully when they are cut.

Tho' the *hairs* ordinarily appear round and cylindrical; yet the *microscope* discovers triangular and square ones; which diversity of figures arises from that of the pores, to which the *hairs* always accommodate themselves. Their length depends on the quantity of the proper humour to feed them; and their colour, on the quality of that humour; whence at different stages of life the colour usually differs.

The antient writers of ANATOMY, *Hippocrates*, *Democritus*, *Aristotle*, *Galen*, and others, look upon this as the most important part of physick, and that without which, the uses of the parts of an human fabrick, and consequently the causes of diseases incident thereto, could no way be discovered. And yet this art, useful as it is, was intirely discontinued for several ages; till in the sixteenth century, it began to flourish afresh.—The dissection of an human body was looked upon as sacrilege before that time; and we have seen a consultation which the Emperor *Charles V.* appointed to be held by the divines of *Salamanca*, in order to be satisfied whether or no it were lawful in point of conscience to dissect

diseñt a dead carcase. — We may add, that to this day the use of *Anatomy*, and skeletons is forbid in *Museory*; the first as inhuman, the latter as subservient to witchcraft; and *Olearius* assures us, that one *Quirin*, a *German* surgeon, being found with a skeleton hardly escaped with his life; and the skeleton, after being solemnly dragged about the streets, was burnt in form.

ANATOMY is sometimes used to denote the sub-

ject to be anatomized. Thus (by 32 *Hen. VIII. cap. 42.*) the company of *Barbers* and *Surgeons* may have and take yearly, four persons condemned, adjudged, and put to death for felony, for *Anatomies*; and to make incision of the same dead bodies. And by a late act of King *George II.* since the *Surgeons* have been separated and made a distinct company from the *Barbers*, they are intitled to all the bodies executed at *LONDON* for *murder*.

Of ANTIQ U I T I E S.

IT is not to be expected that we shall be able to give a minute collection of antique pieces. Our province is to treat this study as a *science*, and to form our treatise in such a manner, as to render it useful to the curious searcher into *Antiquities*, and entertaining to our readers in general.

For this purpose this subject shall be considered under these heads; *temples*; *obelisks*; *pyramids*; *columns* and *pillars*; *amphitheatres*; *circus's* and *squares*; *mausoleums* or *tombs*; *statues*; *sculptures*; *paintings*; *inscriptions*; *hieroglyphics*; *manuscripts*; *medals*; *urns* and *mummies*, in particular; and, in general, other curious pieces that may afford any light into *Antiquity*.

A TEMPLE, the derivative of the *Latin*, *templum*, from *templare*, to contemplate or meditate, is a place set apart for the public worship of the true *GOD*, or of the *deities* of the heathens.

Authors differ in their opinions about the first institution of temples. *Apolonius* pays the first compliment of this kind of building to *Ducalion*, in *Greece*. *Herodotus* and *Strabo*, with more credit, lay the first foundation of temples in *Egypt*; and that they were built for the reception of certain *quadrupeds*, *reptiles*, or *insects* and *fishes*, worshipped by the *Egyptians*. And *Clemens Alexandrinus* and *Eusebius* refer us to the sepulchres built for the dead, for the origin of those places of prayer or worship.

Whatever gave rise to these edifices, it is not very material. But authors of the greatest reputation inform us, that they were very early propagated throughout the known world: and that it became a part of the grandeur of civilized nations to excel in those structures.

Some writers are for confining the name *temple* to places of pagan worship and superstition. But they must forget that the house built for the worship and presence of the *LIVING GOD* at *Jerusalem*, is an exception to their opinion. Tho' it

must be granted that this name has almost universally amongst *Christians* yielded to that of *church*.

In our enquiries on this subject, the first object in view is that very temple at *Jerusalem* built by *Solomon*, by the direction of the *CREATOR* of the universe, and for the residence of his divine *Shechinah*: and which exceeded all other buildings of the kind, as much in its magnificence, furniture, and ministry, as in the object of their worship.

To enter into particulars relating to this temple would be only copying from the *HOLY BIBLE*, which is in every body's hands to peruse at leisure. See *1 KINGS*, chap. v. vi. vii. viii. ix. and *1 CHRONICLES*, chap. xvii. xxii. xxiii. xxiv. xxv. xxvi. xxviii. *2 CHRON.* chap. ii. iii. iv. v. vi. vii. where you have an account of a building of sixty cubits, or 105 feet long; twenty cubits, or 35 feet broad; thirty cubits, or 52 feet high; with a porch twenty cubits long and ten wide in the fore front or west end of the temple; and three stories with stairs up to them round the outside of the temple.

There was also a gate on the right side. The roof was raised five cubits; and all the timber-work was cedar furnished by *HIRAM*, king of *Tyre*. The walls were of square stones waincoted from top to bottom with cedar also: and a cedar partition separated the *sanctuary* from the rest of the temple, adorned with carving, and at the distance of twenty cubits from the end of the building.

The inside of the sanctuary was covered with plates of gold. The ark stood in the midst of the sanctuary; over which spread the wings of two cherubims of olive wood covered with gold, ten cubits high, with wings five cubits long. There were two doors to enter by into this sanctuary.

The porch was adorned with a brass pillar, *JACHIN* and *BOAZ*, eighteen cubits high. In the court was a large brass basin five cubits high and ten cubits in diameter, which stood upon twelve brass oxen resting on ten bases, each of which had

four wheels : this bafon was called the *brazen fea*. Befides which there were ten lavers of brafs, four cubits high, each ftanding on ten bafes.

The altar for facrifices was twenty cubits long, twenty broad, and ten high. The table for fhew-bread was mafly gold, on which ftood five gold candlefticks; as were all the cenfers, veffels, and instruments for facrificing. But the kettles, caldrons and bafons were of brafs.

All the work of the temple was made under the infpection of mafter HIRAM, the widow's fon, and a moft skilful architect, born at Tyre.

This temple was rivalled by another erected on mount Garezim, by the Samaritan or *fehifmatical Jews*, who erected an altar there in oppofition to the temple at *Jerufalem*; and is the firft instance of a *difsenting* congregation in the church of GOD. This temple was destroyed by *Hyrchanus* the *Af-monean*.

The temple at *Jerufalem*, which was built by SOLOMON in the year of the world 2993, before CHRIST 1012, flourifhed till the invasion of *Judea* and its destruction by *Nebuchadnezzar*, king of *Babylon*, who in the year of the world 3398, before CHRIST 606, burnt both this temple and the city.

This temple of the true GOD remained in ruins till *Cyrus* and his fucceffor *Artaxerxes Longomannus* gave the *Jews* leave to rebuild it; and it was reftored accordingly in the year 454 before CHRIST.

HEROD the Great (in whose reign the MESSIAH was fent to abrogate the law of facrifices, and to eftablifh a fpiritual worfhip and intercourse with heaven) found this *fecond* temple fo decay'd in its materials, that he pulled it down and rebuilt it in a magnificent manner.

In this temple JESUS CHRIST was prefented by his parents according to the rites of the *Levitical* law. This is the temple, over which JESUS wept and prophesy'd that it fhould be fo destroy'd; that one ftone fhould not remain upon another; and this is the temple, which was rent from top to bottom by the violent concuffion of the earth, when the fun was darkened and the graves opened at the crucifixion of CHRIST.

TIRUS, the *Roman* general, in the year 70, after the birth of CHRIST, put an end both to this temple and to the *Jewish* nation. The temple was burnt to the ground in this general catastrophe of an abandoned people: and when JULIAN the apoftate, in defiance to the prophecy of JESUS againft them and their temple, attempted to reftore the *Jewish* ftate, to rebuild *Jerufalem*, and the temple on its former fcite, heaven interpoled, and drove the adventurers and labourers from the work, by throwing fire out of the bowels of the earth, from

whence they had dug up every ftone of the ancient foundation. By which the prophecy of JESUS was fully accomplifhed.

This temple ftood due east and west, with the feat of devotion in the east, and the chief entrance on the west. And from this accident arofe the custom amongft the worfhippers of the true GOD, always to build their churches, chapels, and temples in the fame direktion; a few modern examples excepted.

The *Grecians* boasted much of their temple of *Diana* at *Ephesus*, and of *Apollo* at *Delphos*. But we muft travel to *Rome* for number and variety.

The *Romans* built temples not only to their fupreme deities, but to their virtues, their difeafes, their blessings, their wants, and to their heroes and emperors, and to fome of them in their life-time; as may be collected, of *Auguftus*, from thefe verfes of *Horace*.

*Presenti tibi maturos largimur honores;  
Jurandasque tuum nomen, ponimus aras.*

Epift. ad Auguft.

Some remains of thefe ancient edifices are ftill feen.

1. In the *Pantheon*, which till about a year ago, when it fell a facifice to time, was the moft celebrated, compleat and perfect of them all.

This temple is faid to have laid the foundation of its body, during the time of the *Roman* republic, and to have been finifhed with a portico by *Marcus Agrippa*, about fourteen years after the death of CHRIST.

It was dedicated to JUPITER and all the gods; and thence called the PANTHEON; and was of the *Corinthian* order, both within and without. On the frieze of the beautiful portico was this infcription.

M. AGRIPPA L. F. CÆS. III. FECIT.

In this temple was placed, amongft other ftatues of their deities, the celebrated ivory ftatue of MINERVA, by *Phidias*, and the ftatue of VENUS, with a pearl in her ear valued at 250,000 ducats: the half of that fame pearl, which *Cleopatra* had diffolved and drank at fupper to out-do the liberality of *Mark Anthony*.

This PANTHEON fuffered much by age, and was repaired by the emperors *Septimius Severus* and *Marcus Aurelius*. It was firft confecrated for *Chriftian* worfhip by Pope *Boniface*; who dedicated it to the Virgin MARY, and from thence known by the name of *St. Mary Rotunda*, alluding to its circular form.

It received all its light from an opening at top. And the height, from the floor to that opening, was the diameter of its breadth from one wall to another.

Near

Near the trophies of *Marius* stands another circular temple erected with a noble portico by *Augustus*, in memory of his grand-children *Caius* and *Lucius*. It is commonly called *La Galluce*.

This temple was built of brick. The nave is perfectly circular and divided into ten parts, in each of which is a chapel situated within the thickness of the wall.

St. MARY'S is the ancient temple built by *SERVIVS TULLIVS* to *Fortuna Virilis*, whose statue, which was of gilded wood, is said to have resisted the flames, and was preserved when the temple was on fire. This piece of great antiquity is built of *peperino* covered with *stuc*.

St. STEPHEN'S is the remains of the temple of *VESTA*, built by *NUMA POMPILIUS*. It is also circular; and built in the *Corinthian* order.

Near the church of *Santa Maria nova* are to be seen the ruins of the temple of *PEACE*. It was begun by the emperor *CLAUDIAN*, upon the site of the *Curia* of *Romulus* and *Hostilius*, the house of *Melius*, the *Basilica Portia* and the house of *Cæsar* demolished by *Augustus*.

*VESPASIAN* (after his return with the trophies of victory taken in the sacking of *Jerusalem* and its temple) finished this foundation, so as to make it excel all the other temples at *Rome* in magnificence and riches. Here he deposited all the decorations and vessels of the temple of *Jerusalem*; after he had exposed them in his triumph to public view. And tho' this magnificent structure was destroyed by fire in the reign of *COMMODUS*, the strength of its walls has transmitted to us a strong idea of its pristine grandeur.

*AUGUSTUS* erected a temple to *MARS* the *Avenger*, in memory of the victory obtained by him and *Mark Anthony* at *Philippi* over *Brutus* and *Cassius*, in revenge of the treacherous murder of *Julius Cæsar*.

The situation of this temple added greatly to its magnificence. It had the *Forum* just before; into which, they who were honoured with a triumph carried the trophies of their enemies, and other marks of their victories. And their statues were also dedicated by *Augustus* in its two portico's.

Without, it was a most beautiful and stupendous fabric. Within, it was particularly adorned with two exquisite paintings of a *battle*, and of a *triumph*: and with two altars drawn by *Apelles*; the one representing *Castor* and *Pollux*; the other, the gods *Victory* and *Alexander the Great*.

The remains of this beautiful temple is still to be seen near *Torre de Conti*.

*AUGUSTUS* erected another temple at the foot of the capitol, to *Jupiter the Thunderer*, in memory of his deliverance from death by an arrow

that passed thro' his litter, and killed a slave before him; as he was pursuing the *Cantabrian* war in the night.

Between the *Capitol* and mount *Palatin*, stood the temple of *Vulcan*, near the *Forum*; on the place where are now three columns of the *Corinthian* order: but those columns are controverted; some being of opinion that they are part of a temple dedicated to *Romulus*: others say that both those and the columns below the capitol, are part of the bridge made by *Caligula's* direction, for passing the mount to the capitol.

*FURIUS CAMILLUS* built a temple to *CONCORD* near to the arch of *Septimius*, at the entrance of the *Forum*, the columns of whose portico are still to be seen.

This was erected for the debates of public affairs, which were frequently held here. And amongst other pieces of furniture there was the image of *Latona*, with her children *Apollo* and *Diana* in her arms; the statue of *Æsculapius*, with his daughter *Hyginia* or *Health*: the statues of *Mars*, *Minerva*, *Ceres*, *Mercury*, and that of *Victory*, placed in the front of the portico, and destroyed by thunder and lightning in the consulship of *Marcus Marcellus* and *Marcus Valerius*.

It was afterwards destroyed by fire, and rebuilt at the expence of the public: as appears by the following inscription still to be read on the frieze.

S. P. Q. R. INCENDIO CONSUMPTUM RESTITUIT.

I shall not trouble you with a description of any *Christian* temples or churches; because Architects never allow any of them to be considered as pieces of Antiquity. But perhaps I may be admitted to place *Stone Henge*, that wonderful pile of huge stones, on the plain, about six miles from *Salisbury*, in the number of ancient temples.

This monument of antiquity, which baffles all our conjectures, consists of the remains of four ranks of rough stones, ranged one within another: some of them, especially in the outermost and third rank, being twenty feet high and seven broad, and sustaining others laid across their heads and fastened by mortises, which shews that they originally did hang together.

Some have considered this to be a temple of the *Druids*: others ascribe it to the *Romans*, and dedicate it to *Celus*; because it was open at top: while a third party won't allow its antiquity to ascend higher than the coming in of the *Saxons*; thinking it to be a monument in memory of *Hengist*, their first general in *England*; or a funeral monument to the memory of the *British* prince *Aurelius Ambrosius*. *Inigo Jones*, who has given a fine scheme of this piece of antiquity, endeavours to

to fix it to a *Roman* epocha. But Doctor *Langwisch*, after examining this scheme upon the spot, declares that tho' he could not reconcile the measures with the scheme; he is of opinion that it was a temple dedicated to the *sun* and *moon*.

OBELISKS and PYRAMIDS were raised by the antients both for ornament and for preserving the memory of some person, thing, or event, by inscriptions carved or cut upon some part of them.

A PYRAMID, takes its name from *πύρις*, and is a solid massive building, which forms a square, triangular or other base, and rises to a *vertex* or point.

*Pyramids* are sometimes used to preserve the memory of singular events; and sometimes to transmit to posterity the glory and magnificence of princes. But as they are esteemed a symbol of immortality, they are most commonly used as funeral monuments. Such is that of *Cestius* at *Rome*, and those other celebrated ones of *Egypt*, as famous for the enormity of their size, as their antiquity. These are situated on the west side of the *Nile* almost opposite to *Grand Cairo*; the base of the largest covers more than ten acres of ground, and is, according to some, near seven hundred feet high, tho' others make it six hundred, and some but little more than five hundred.

The *pyramid* is said to have been, among the *Egyptians*, a symbol of human life; the beginning of which is represented by the base, and the end by the *apex*; on which account it was, that they used to erect them over sepulchres.

An OBELISK in *Greek* signifies a *broach*, spindle or spit; and is a triangular *pyramid*, very slender and high. It differs from a *pyramid* only in being cut out of a single stone, whereas a *pyramid* is built up with many.

*F. Kircher* reckons up 14 *obelisks*, celebrated above the rest; *viz.* that of *Alexandria*, that of the *Barberini*, those of *Constantinople*, of the *Mons Esquilinus*, of the *Campus Flaminius* of *Florence*, of *Heliopolis*, of *Ludoviso*, of *St. Mabut*, of the *Medici*, of the *Vatican*, of *Marcus Cælius*, and that of *Pamphilia*. — The first *obelisk* we know of, was that raised by *Rameses*, King of *Egypt*, in the time of the *Trojan* war. It was 40 cubits high, and according to *Herodotus*, employed 20,000 men in the building. — *Pbicus*, another King of *Egypt*, raised one of 45 cubits; and *Ptolemy Philadelphus* another of 88 cubits, in memory of *Arfinoë*. — These three *obelisks* are of *porphyry*, and still standing. — *Augustus* erected an *obelisk* at *Rome*, in the *Campus Martius*, which served to mark the hours on an horizontal dial, drawn on the pavement.

This kind of monument, which is very antient, was first made use of, we are told, to transmit to

posterity the principal precepts of philosophy, which were engraven in hieroglyphical characters thereon. In after times they were used to immortalise the actions of heroes, and the memory of persons beloved.

Some of the antients have confined the use of COLUMNS and PILLARS to transmit histories and sciences to posterity; and mention the documents of husbandry engraven by *Pisistratus* on stone pillars. But this was only one sort: for we have an account of the historical, chronological, funeral, instructive, itinerary, lactary, legal, limitrophous or boundary, manubiary, memorial, menian, miliary, military, statuary, symbolical, triumphal and zoophorick *columns*.

The *historical columns* were those whose shafts were adorned with a *basso relievo*, running in a spiral line its whole length; and containing the history of some great personage. Of these kind are the *Trajan* and *Antonine columns* to be seen still at *Rome*.

That of *Trajan* is of the *Tuscan* order, though somewhat irregular; its height is eight diameters, and its pedestal *Corinthian*; it was built in the *forum Romanum*, or *Roman square*. — Its base consists of twelve stones of an enormous size, and it is raised on a socle, or foot of eight steps. Within-side is a stair-case illuminated with forty-four windows. It is 140 foot high, which is 35 foot short of the *Antonine* column; but the workmanship of the former is much more valued. It is adorned from top to bottom with *basso relievo's*, representing the great actions of that emperor.

The *Antonine* column has 199 steps, with 56 windows; and each of these is divided by tambours of white marble.

At *Athens* there were *chronological columns*, containing the whole history of *Greece*, digested into *Olympiads*.

The *funeral columns* had sometimes their shafts overspread with *tears* or *flames*, symbols of *grief*, and of *immortality*; and were erected to support an *urn*, inclosing the ashes of a deceased hero.

We do not learn from historians that there were ever more than two *instructive columns*, one, which *Josephus*, lib. i. cap. 3. pretends to have been erected by the sons of *Adam*, whereon were engraven the principles of Arts and Sciences; and that by *Pisistratus*, abovementioned.

*Festus* informs us, that at *Rome*, in the herb-market, now the place *Montanara*, was erected a column called *lactary*, which had a cavity in its pedestal, wherein young children, abandoned by their parents, out of poverty or inhumanity, were exposed to be brought up at the publick expence.

None

None but the *Lacedæmonians* have ever erected *legal columns*, whereon were engraven the fundamental laws of their state; and those columns were always erected in publick places, for the better instruction of the people.

*Alexander*, according to *Pliny*, erected a *limitrophous* or *boundary column* at the extremities of the *Indies*; to shew the limits of his conquests; and the *Romans* afterwards followed his example.

The *Romans* were very industrious in erecting *manubriary columns*, built in imitation of trees, and adorned with trophies, whereon they hung the spoils of the enemies.

*Suctonius* and *Ascanius* refer to one *Menias* for the origin of the *Menian column*, who having sold his house to *Cato* and *Flaccus*, consuls, to be converted into a publick edifice, reserved to himself the right of raising a column without side, to bear a balcony, whence he might see the shews.

*Augustus* had a column of white marble (the same with that which is now seen on the balustrade of the *Perron* of the capitol at *Rome*) erected in the middle of the *Roman forum*, which was called *milliary*, and from whence, as a centre, the distances of the several cities, &c. of the empire, were reckoned by other *milliary columns*, disposed at equal distances on all the grand roads. This column was called *milliarium aureum*, as having been gilt, at least the ball, by order of *Augustus*. — Its proportion is massive, being a short cylinder, the symbol of the globe of the earth. — It was restored by the emperors *Vespasian* and *Adrian*; as appears by the inscriptions.

The *Romans* had two sorts of *military columns*, one whereon was engraven a list of the forces of the *Roman* army, ranged by legions in their proper order; with design to preserve the memory of the number of soldiers, and of the order observed in any military expedition. — And another called *columna bellica*, standing before the temple of *Fanus*, (whose gates were always open in time of war, and shut in time of peace) at the foot whereof the consul declared war, by throwing a javelin towards the enemy's country.

The *columns* adorned with the beaks or prows of ships and galleys, with anchors and graplers, erected either in memory of a naval victory, as the *Tuscan column* in the capitol, or in honour of some admiral, were called *rostral columns*.

There was dug up in the temple of *peace*, a flat-topped column of the *Corinthian order*, whose shaft is a single block of white marble, 49 foot and a half high, and five foot eight inches diameter; which *Paul V.* pope, caused to be erected on a pedestal, before the church of *St. Maria major*, at *Rome*, to support a statue, of gilt brass, of the *virgin Mary*,

from whence it is called a *statuary column*, as are all other columns which support a statue.

The *caryatides* and *termini* were also a sort of statuary columns. — The *caryatides* were, and are still, a kind of order of columns or pilasters, under the figures of women, dressed in long robes, serving to support entablatures. — *Vitruvius* pretends, that the origin of *caryatides* is owing to the *Greeks* having taken the city of *Caria*, led away their women captives; and to perpetuate their servitude, represented them in their buildings, as charged with burdens, such as those supported by columns.

*Termes*, or *termini*, (from the *Roman* god *Terminus*, the protector of land-marks) was a statue made without hands or feet (that he might not change his place) planted at the bounds of lands to separate them.

The two famous statues of *Pasquin* and *Marforio* at *Rome*, might be ranked among these sorts of statues, since otherwise, I do not know where else to place those two great satyrists, who for several centuries have, by their witty *repartees*, diverted all *Europe*.

*Pasquin* is a mutilated statue at *Rome*, in a corner of the palace *Ursini*. — It takes its name from a Cobler of that city, called *Pasquin*, famous for his sneers and gibes; and whose shop was the resort of a number of idle people, who diverted themselves with bantering folks as they passed by. — After *Pasquin's* death, as they were digging up the pavement before his shop, they found a statue of an antient gladiator, well cut, but maimed, and half-spoiled. This they set up in the place where it was found, at the corner of the deceased master *Pasquin's* shop; and by consent, called it by the name of the defunct. — From that time all satires and lampoons are ascribed to this figure, are put in its mouth, or passed against it; as if they came from *Pasquin Redivivus*.

*Pasquin* usually addresses himself to *Marforio*, another statue in *Rome*; or *Marforio* to *Pasquin*, whom they made reply. — The answers are usually very short, poignant, and unlucky: When *Marforio* is attacked, *Pasquin* comes to his assistance; and *Pasquin* is assisted by *Marforio* in his turn, *i. e.* the people make the statues speak just what they please. — The dialogues between these two statues are called *Pasquinades*.

There was another kind of *statuary columns*, called *zoophoric*, whereon was placed a figure of some animal, as that at *Sienna*, which bears the wolf which suckled *Romulus* and *Remus*; and one of the two columns (though not a piece of antiquity) whereon is the lion of *St. Mark*, and the arms of the republick.

The *symbolical columns* represented some particular country, by the attributes proper thereto, as the *Corvinian column*, on which was a crow, erected to *Valerius Maximus*, surnamed *Corvinus*, in memory of his defeating a giant in the army of the *Gauls*, by the assistance of a crow.

The *triumphal columns* were erected by the antients in honour of a hero; the joints of the stones, or courses whereof, were covered with as many crowns as he had made different military expeditions. — Each crown had its particular name; as *Vallaris*, which was beset with spikes, in memory of having forced a pallisade. *Muralis*, adorned with little turrets, or battlements (which sort of crowns have place at present in our *blazon*) for having mounted an assault. *Navalis*, of prows and beaks of vessels, for having overcome at sea. *Obsidionalis*, or *graminalis* of grass; for having raised a siege. *Ovans*, of *myrtle*, which expressed an ovation or little triumph; and *triumphalis*, of laurel, for a grand triumph. — *Procopius* tells us of a *column* of this kind erected in the place, called *Augusteum*, before the imperial palace at *Constantinople*, supporting an equestrian statue of the emperor *Justinian*.

The AMPHITHEATRES, from the *Greek*, *αμφι*, about; and *θεατρον* *theatre*, are another kind of antient publick edifices, of which there are still some standing at *Rome*, *Pola*, *Nismes*, *Douay* &c.

The *amphitheatres* were a spacious building of an oval figure, having its *area* or *arena*, encompassed with rows of seats, rising gradually one above another; with portico's both within and without side.

The *amphitheatres* were appointed for the exhibiting of spectacles or shews to the people: As the combats of *gladiators*, and those of wild beasts; and as the *theatres* of the antients were built in form of a semi-circle, only exceeding by one fourth part of the diameter; the *amphitheatres* were nothing else but a double *theatre*, or two *theatres* joined together; so that the longest diameter of the *amphitheatre*, was the shortest, as  $1 \frac{1}{2}$  to 1.

The *amphitheatre* at *Pola*, an antient republick of *Istria*, is very intire, consists of two orders of *Tuscan* pillars, one above the other. — The lower has pedestals, which is extraordinary; this order having scarce ever more than bases to support them.

The *amphitheatre* of *Titus* is computed to have been capable of holding 85000 spectators.

That of *Verona*, is one of the best preserved; the best stones of the outside are picked out, yet the great vault, on which the rows of the seats are laid, is entire: The rows also, (which are forty-

four in number) are entire. Every row is a foot and a half high, and as much in breadth; so that a man sits conveniently in them; and allowing for a seat a foot and a half, the whole will hold 23000 persons.

The most entire of all those, now standing, is that of *Douay*, a small town, upon the confines of the provinces of *Anjou*, and *Poitou*, in *France*; it don't want so much as a stone, and could contain, by supputation, 25000 spectators.

There is also, a very magnificent *amphitheatre* at *Nismes* in *Languedoc*; and some remains of *amphitheatres* at *Arles*, *Bordeaux*, &c.

The *Roman* gladiators were at first only slaves, who fought of necessity; or captives appointed to fight with each other, and do their best to save their own life, by killing their adversary.

*Junius Brutus*, who expelled the *Tarquins*, is said to have been the first, who honoured the funeral of his father with these inhuman diversions. — They were at first performed near the sepulchre of the deceased, or about the funeral pile (they being first instituted instead of the sacrifices of captives, or prisoners of war, offered at first to the *manes* of the great men who had died in an engagement) but were afterwards removed to the *circus* and *amphitheatres*, and became ordinary amusements.

The emperor *Claudius* restrained them to certain occasions; but he soon afterwards annulled what he had decreed, and private persons began to exhibit them, at pleasure as usual; and some carried the brutal satisfaction so far, as to have them at their ordinary feasts; and not slaves only, but other persons would hire themselves to that infamous office.

The master of the gladiators made them first swear that they would fight to death; and if they failed therein, they were put to death, either by fire, swords, clubs, whips, or the like.

It was a crime for the wretches to complain when they were wounded, or to ask for death, or seek to avoid it when overcome; but it was usual for the emperor, or the people, to grant them life, when they gave no signs of fear, but waited the fatal stroke with courage and intrepidity. *Augustus* decreed that it should always be granted them.

From slaves and freed men, the wanton sport spread to people of rank and condition; and *Nero* is related to have brought upwards of four hundred senators, and six hundred *Roman* knights upon the *Arena*; though *Lipsius* takes both these numbers to be falsified, and not without reason, reduces them to forty senators and sixty knights; yet *Domitian*, that other monster of cruelty, refined upon *Nero*, exhibiting combats of women in the night time.

The

The combats of *gladiators* were first forbidden in the east by *Constantine the Great*, who, by an order to the *praefectus praetorii*, dated at *Berytus* in *Phœnicia*, the 1st of *October*, 325, and still extant, condemned the criminals employed therein to the mines.

The practice was not entirely abolished in the west before *Theodoric*, king of the *Ostrogoths*; though the emperor *Honorius* had first forbidden them at *Rome*; but that prohibition does not seem to have been executed 'till the year 500, when it was entirely abolished by the said *Theodoric*.

*Programma's*, or bills, were distributed among the people, some time before the day of battle, by the persons, who gave the shews, containing the names of the *gladiators*, and the marks whereby they were to be distinguished; for each had his several badge, which was most commonly a peacock's feather, as appears from the scholiast of *Juvenal*, on the 158th verse of the third satyr. — They also gave notice what time the shews would last, and how many couples of *gladiators* there were; and it even appears from the 52d verse of the seventh satyr of the second book of *Horace*, that they sometimes made representations of these things in painting; as is practised among us by those, who have any thing to shew at fairs.

The day being come, they began the entertainment by bringing two kinds of weapons; the first were staves, or wooden foils, called *rudes*; and the second effective weapons, as swords, poniards, &c. — The first were called *arma lusoria*, arms for diversion; the second *decretoria*, as being given by decree, or sentence of the *praetor*; or of him at whose expence the spectacle was exhibited. — They began to fence or shirmish with the first, which was to be the prelude to the battle; from these, when well warmed, they advanced to the second with which they fought naked. — The first part of the engagement was called *ventilare, præludere*, to prelude; and the second *dimicare ad certum, or versis armis pugnare*; and some authors think, with much probability, that it is to these two kinds of combats, that *St. Paul* alludes in the passage *1 Cor. ix. 26; 27.* 'I fight not as one that beateth the air; but I keep under my body, and bring it under subjection.'

If the vanquished surrendered his arms, it was not in the victor's power to grant him life; it was the people during the time of the republick, and the prince or people during the time of the empire that were alone empowered to grant the boon.

The reward of the conqueror was a branch of palm-tree, and a sum of money; sometimes they gave him his *congé*, or dismissed him; by putting

one of the wooden foils or *rudes* in his hand; and sometimes they even gave him his freedom.

The sign or indication whereby the spectators shewed that they had granted the favour, was, to fall the thumb, or clench it between the other fingers; and when they would have the combat finished, and the vanquished slain, they raised the thumb, and directed it towards the combatants; which we learn from *Juvenal*, *sat. iii. 36.*

The *gladiators* challenged or defied each other by shewing the little-finger; and by extending this, or some other during the combat, they owned themselves vanquished, and begged mercy from the people.

There were divers kinds of *gladiators*, distinguished by their weapons, manner of fighting, &c. as the *Catervati*, who fought in troops or companies, number against number. — *Cubicularii*, who fought in private houses during feasts.

— The *Dimachaë*, who fought armed with two poniards or swords, or with sword and dagger.

— The *Essedarii*, who fought in cars; called also in an inscription, lately discovered at *Lyons*, *Affedarii*.

— The *Fiscales* or *Cæsariani*, who belonged to the emperor's company, and who being more robust and dexterous than the rest, were frequently called for; and therefore named *Postulatiui*. — The other kinds were, the *Hoplomachi*, *Meridiani*, *Mirmillones*, *Ordinarii provocatores*, *Retiarii*, *Rudarii*, *Secutores*, *Spelatores* and *Thracei*.

There was another kind of building, in Antiquity, for the exhibiting shews to the people, called *CIRCUS*, from the *Latin, circuitus*, or from *Circe*, to whom *Tertullian* attributes the invention.

The *Roman circus* was a large oblong edifice, arched at one end, encompassed with portico's, and furnished with rows of seats, placed ascending over each other. — In the middle was a kind of foot-bank or eminence, with obelisks, statues, and posts at each end. This served them for the courses of their *bigæ* and *quadrigæ*. — *Bigæ* were chariots drawn by two horses a-breast; *trigæ*, by three; *quadrigæ*, by four, &c.

There were no less than ten *circus's* at *Rome*; the largest was that built by the elder *Tarquin*, called *circus maximus*, between the *Avantine* and *Palatine* mounts. *Pliny* says it was enlarged by *Julius Cæsar*, so as to take in no less than three *stadia* in length, and one in width.

The most magnificent *circus's* were those of *Augustus* and *Nero*. — There are still some remains of the *circus's*, both at *Rome*, at *Nismes*, and other places; but as they used to encompass a

too large spot of ground, and were not built for so long duration, time has defaced them.

The *games of the circus*, which some call **CIRCEŒSEAN GAMES**, were combats celebrated in the *circus*, in honour of *Consus* the god of councils and thence also called *Consualia*. — They were also called *Roman games*, either on account of their antiquity, as being coeval with the *Roman* people, or because established by the *Romans*.

These games were instituted by *Evander*, and re-established by *Romulus*; the pomp or procession, called *pompa circensis*, was only part of the games, making the prelude thereof, and consisting of a simple cavalcade of chariots. — Till the time of the elder *Tarquinius*, they were held in an island of the *Tiber*; and were called *Roman games*: After that prince had built the *circus*, they took their name therefrom, as being constantly held there.

There were six kinds of exercises in the *circus*; the first wrestling, fighting with swords, staves, and pikes; the second was racing; the third *saltatio* dancing; the fourth dices, or quoits, arrows, and *cestus*: all which were on foot; the fifth was horse-coursing; the sixth courses of chariots, whether with two horses or with four; each bearing the names of the colours they wore. — At first there was only white and red; then green was added, and blue. *Domitian* added two more colours, but they did not hold. — It was *OEnomaus* who first invented this method of distinguishing the quadrils by colours. The green was for those who represented the earth; the blue for the sea, &c.

The great games, called *ludi magni*, were held in honour of the god *Neptune*, who was the *Roman consus*, and not of the *Jun*.

Other antient edifices were the **AGORA'S** or squares of the *Greeks*, and the *forums* of the *Romans*. — The *Roman forums* differed from the *Grecian agora's*, and were of a square form, surrounded with spacious and double porticoes and thick columns. — These porticoes or piazza's were as broad as the columns were long; so that by their being double, the place for walking was as spacious, as twice the length of a column, which made it very commodious. — Over the first columns, were others a fourth part less than the first; these had under them a *corridor* of such height, as was most convenient; because these upper porticoes were appointed likewise for walking and discoursing, and for persons to stand commodiously therein, to be spectators of any shews that might be exhibited in the square, either out of pleasure or devotion. — All these porticoes must of course have been embellished with niches and statues, since the *Greeks* used to be highly delighted with such

fort of ornaments. — Near to these squares were the *basilica*, the senate-house, the prisons, &c.

But the *Roman forums*, or squares, were somewhat longer than they were broad; so that dividing the length into three parts, two made the breadth; because the *gladiators* exerting their skill publicly in these places, this form was more commodious for their purpose than a perfect square; for which reason likewise the intercolumnation of the porticoes, that went round the square, was made of two diameters and quarter of a column, or even of two diameters, that the sight of the people might not be intercepted by the thickness of the columns. — The porticoes were as broad as the columns were high, and under them were the bankers and goldsmiths shops. — The upper columns were a fourth part less than the under ones; because all pieces below should be stronger than those above, considering the weight they bear. — In the part fronting the warmest region of heaven were the *basilicas*. — On that side which fronted the north, stood the senate-house, a square and a half in length. This *curia*, or senate-house, was the place where the senate assembled to consult about state affairs.

Of these *forums* there were several at *Rome*; at first only three, *viz.* *Romanum Julianum*, and *Augustum*; but that number was afterwards increased to six, by the addition of the *transitorium*, called also *palladium*; the *Trajanum* and *Sallustii forum*. — The first and most eminent of these was the *forum Romanum*, called also *forum vetus*, the old square; and absolutely *forum* or the *forum*. — In this was an apartment called the *rostra*, where the lawyers pleaded; the officers harangued; funeral orations were delivered, &c. — This *rostra* was adorned with the beaks of ships taken from the people of *Antium*, in a naval engagement: whence comes the name.

The ancient *funeral monuments*, are to be collected from the customs of the several nations. The *Romans* were not so extravagant in building places for their interment, as they were in all their other edifices; though besides the usual *sepulchres* for the interment of the whole body, or of the ashes of the body burnt, they had a particular kind, called *cenotaphia*, which were empty *sepulchres*, made in honour of some person, who perhaps had no burial at all; from a superstitious opinion, that the souls of those who wanted burial, wandered a hundred years, ere they were admitted to pass into the *Elysian Fields*.

Among the *Romans*, none but the Emperors, vestals, and persons signalized by great actions, were allowed to have *sepulchres* in the cities; the rest were all in the country, near the high roads; whence

whence come those common words, *Siste, & abi, viator*, which are still improperly retained in the inscriptions of monuments in churches, &c.

*Strabo* informs us, *Georg. l. 14.* that at *Anchiale*, was antiently seen the tomb of *Sardanapalus*, with this inscription in verse; *Sardanapalus built Anchiale and Tarsus in one day; go passenger, eat, drink, and be merry; the rest is nothing.*

The CATACOMBS, are a vast assemblage of subterraneous *sepulchres* chiefly about three miles from *Rome*, in the *Via Appia*, supposed by *Mr. Moura*, in the *philosophical transactions*, to have been originally the common sepulchres of the first *Romans*; and dug in consequence of these two opinions, that shades hate the light; and that they love to hover about the places where the bodies are laid. But most of the *Roman* catholicks suppose them to be the sepulchres of the martyrs, and visit them accordingly out of devotion; and relics thence taken, are dispersed throughout the catholick countries after they have been baptized by the Pope, *i. e.* After those relics being brought to him, and he calls them by the name of what saint he pleases.

Each *catacomb* is three foot broad, and eight or ten high; running in form of an alley or gallery, and communicating with others: in many places they extend within a league of *Rome*.—There is no masonry or vaulting therein, but each supports itself: the two sides, which we may look on as walls, were the places where the dead were deposited; which were laid lengthwise, three or four rows over one another, in the same *catacomb*, parallel to the alley.—They were commonly closed with large thick tiles, and sometimes pieces of marble, cemented in a manner inimitable by the moderns.—Sometimes, though very rarely, the name of the deceased is found on the tile: frequently a palm is seen, painted or engraven, or the cypher Xp. which is commonly read, *pro Christo, i. e.* dead for Christ, or for the Christian religion.

Antiently, the word *catacomb* was only understood of the tombs of *St. Peter* and *St. Paul*.

The greatest pieces of *antiquity* we have of the sepulchre-kind in being, are the famous PYRAMIDS, erected for *sepulchres* of the *Egyptian* Kings and Queens, which time, the seasons, and the different revolutions, that have happened in so long a course of centuries, have till now left untouched.

This manner of erecting stately monuments for the dead, was invented by *Artemisia*, who first had a most sumptuous one erected to MAUSOLEUS her husband, King of *Caria*; from whence monuments of the same kind, are called MAUSOLEUMS.

*England* surpasses all other nations in funeral edifices; as witness the monuments in *Westminster-Abbey*.

Almost all the public edifices of the antients, were adorned with inscriptions, which have always very much tickled the curiosity of *antiquaries*.—*Sanchoniathon*, *Gideon's* contemporary, drew most of the memoirs, whereof his history is composed, from inscriptions, which he found in temples, and on columns, both among the *Heathens* and the *Hebrews*.

*Pliny* assures us, that the first publick monuments were made of plates of lead; and the treaties of confederacy, concluded between the *Romans* and the *Jews*, were written upon plates of brass; that, says he, the *Jews* might have something to put them in mind of the peace and confederacy concluded with the *Romans*.—The *Greeks*, and the *Romans* were great admirers of inscriptions, and extremely fond of being mentioned in them: and hence it is that we find so many, in those countries of antient learning, that large volumes have been composed of them; as the collection of *Greter*, &c.

The *Egyptian* inscriptions were all in *Hieroglyphicks*, which were symbols, or mystick figures used among them, to cover or conceal the secrets of their theology.—*Hermes Trismegistus*, is commonly esteemed the inventor of those symbols, which according to *Clemens Alexandrinus*, are a kind of real characters, which do not only denote, but in some measure express the things.—Thus a lion is the hieroglyphick of strength and fortitude; a bullock of agriculture; a horse of liberty; a Sphinx of subtilty, &c.—The religious rites of the *Egyptians*, are mostly involved in such figures of animals, to be seen still on the pyramids of *Egypt*, and on the mummies brought from thence.

The *sepulchres* or *tombs* have always had a sort of *inscription*, different from the rest, called EPITAPH, which is an inscription engraven or cut on a *tomb*, to mark out the time of a person's decease, his name, family, and usually some eulogy of his virtues, or good qualities.

The style of *epitaphs*, especially those composed in *Latin*, is singular. *Cicero* has prescribed the rules of it; *Accedat, oportet oratio varia, vehemens, plena spiritus, omnium sententiarum gravitate, omnium verborum ponderibus est utendum*. The discourse must be diversified with incidents, strong and full of spirit; all the thoughts must be noble and grave; and all the expressions weighty.—An *epitaph* is commonly neither prose nor verse; but a *medium* between both.

At *Sparta*, *epitaphs* were only allowed to people, who died in battle.—*Boethornius* has made a collection of *epitaphs*, not very ample, but exceedingly well chosen. *Father L'Abbé* has likewise given a collection of the like kind in *French*, en-

titled *Treſor des Epitaphes*.—Camden and Weaver have done ſomething in the ſame way in our *Engliſh epitaphs*.

The *antient STATUES* are divided by *Antiquaries* into *Greek* and *Roman Statues*, and theſe again ſubdivided into *Divine*, *Heroes*, and *Auguſt*.

The *Greek ſtatues* were naked figures; being in this manner they repreſented their *Deities*, *Athletæ* of the Olympic games, and heroes; the reaſon of this nudity was, that thoſe who exerciſed wreſtling, wherein the *Grecian* youth placed their chief glory, always performed naked.—The *Greeks* ſucceeded in their ſtatues beyond the *Romans*; both the workmanſhip and the fancy of the *Roman* ſtatues were inferior to the *Grecian*: indeed we have very few remaining that have eſcaped the injuries of time.

The *Roman ſtatues* differed in this from the *Grecians*, that they were cloathed; thoſe of the Emperors, with long gowns over their armour, and hence were called *Statuæ Paludatæ*; thoſe of captains and cavaliers, with coats of arms, *Thoracatæ*; thoſe of ſoldiers with cuiraffes, *Loricatæ*; thoſe of ſenators and augurs, *Trabcatæ*; thoſe of magiſtrates with long robes, *Togatæ*; thoſe of the people with a plain *Tunica*, *Tunicatæ*; and, laſtly, thoſe of women with long trains, *Stolatæ*.—Their other diviſion of ſtatues is that I have already mentioned into *divine*, which were thoſe conſecrated to the *Gods*, as *Jupiter*, *Mars*, *Apollo*, &c. *Heroes*, which were thoſe of the *demi-gods*; as *Hercules*, &c. and *Auguſti*, which were thoſe of the Emperors; as thoſe two of *Cæſar* and *Auguſtus*, under the portico of the capitol.

The other kinds of edifices, which the antients uſed to adorn or embellish their cities or towns with, were *triumphal arches*, *baths* and *bridges*.

The *TRIUMPHAL ARCHES* were gates or paſſages into a city, built of ſtone or marble, ſculpture, inſcriptions, &c. ſerving not only to adorn a triumph, at the return from a victorious expedition, but alſo to preſerve the memory of the triumph to poſterity.—The moſt celebrated triumphal arches now remaining of antiquity are that of *Titus*, of *Septimus Severus*, and of *Conſtantine* at *Rome*.—One of the gates of *Orange* (the chief city of that principality belonging antiently to the illuſtrious houſe of *Naffau*, but at preſent in the King of *France*'s poſſeſſion) is a triumphal arch of *Caius Marius*.—The gate, *Peyro*, at *Montpelier*, is alſo a triumphal arch; and the gates of *St. Denis*, *St. Martin*, and *St. Antoine* at *Paris*, though modern pieces, deſerve that name.

*BATHS* were large and pompous buildings, which made part of the antient *Gymnaſia*, and which, though erected for the ſake of bathing, were frequented more for the ſake of pleaſure, than health.

The moſt magnificent *baths* were thoſe of *Titus*, *Paulus Æmilius*, and *Diocleſian*; of which there are ſome ruins ſtill remaining.—It is ſaid that at *Rome* there were 856 public *baths*. *Fabricius* adds, that the exceſſive luxury of the *Romans* appeared in nothing more viſible than in their *baths*. *Seneca* complains that the *baths* of *plebeians* were filled from ſilver pumps; and that the freed-men trod on gems. *Macrobius* tells us of one *Sergius Oratus*, a voluptuary, who had pendant *baths* hanging in the air.

Since I have hinted here at *GYMNASIUM* I am obliged to inform the reader, that it was a publick edifice of the antients, erected for performing exerciſes of the body, where people were taught, and regularly diſciplined therein.

The *Romans* borrowed the *Gymnaſia* from the *Athenians*, and the *Athenians* from the *Lacedæmonians*; ſince *Solon*, in *Lucian's Anacharſis*, and *Cicero de erat. l. 2.* are both of opinion, that the *Greeks* were the firſt that had *Gymnaſia*.

There were three principal *Gymnaſia* at *Athens*; the *Academy*, where *Plato* taught; the *Lyceum*, noted for *Ariſtotle's* lectures; and the *Cynofarges*, allotted for the populace.

Mr. *Burette*, after *Vitruvius*, aſſerts, that the *Gymnaſia* conſiſted of twelve members or apartments, viz. 1. The exterior portico's, where the philoſophers, phyſicians, mathematicians, rhetoricians, and other virtuoſo's read publick lectures, diſputed, and recited their performances. 2. The *Ephebeum*, where the youth aſſembled very early, to learn their exerciſes in private, without any ſpectators. 3. The *Coryceum*, *Apoditerion*, or *Gymnaſterion*, a kind of wardrobe where they ſtrip, either to bathe or exerciſe. 4. The *Elæothefium*, *Alipterion*, or *Unctuarium*, appointed for the uncti- ons, which either preceded or followed the uſe of the bath, wreſtling, *Pancraſia*, &c. 5. The *Coiniſterium*, or *Coniſtra*, in which they covered themſelves with ſand or duſt, to dry up the oil or ſweat. 6. The *Palæſtra*, properly ſo called, where they practiſed wreſtling, the pugilate, *Pancraſia*, and divers other exerciſes. 7. The *Sphæriſterium* or tennis-court, reſerved for exerciſes, wherein they uſed balls. 8. Large unpaved alleys, which comprehended the ſpace between the portico's and the walls, wherewith the edifice was ſurrounded. 9. The *Xiſti*, which were portico's for the wreſtlers

lers in winter or bad weather. 10. Other *Xisti's* or open alleys, allotted for summer and fine weather; some of which were quite open, and others planted with trees. 11. The *balbs*, consisting of several different apartments. 12. The *Stadium*, a large place of a semicircular form, covered with sand, and surrounded with seats for the spectators.

There were several officers for the administration of the *Gymnasia*. 1. A director and superintendent of the whole, called the *Gymnasiarcha*. 2. The *Xistarcha*, who presided in the *Xistus* or *Stadium*. 3. The *Gymnasia* or master of the exercises, who understood their different effects, and would accommodate them to the different complexions of the *Athletæ*. 4. The *Pedotriba*, whose business was mechanically to teach the exercises, without understanding their theory or use. — Under these four officers were a number of subalterns, whose names distinguish their different functions.

The exercises learned under those different masters, were either for defence, health, or diversion. — Those for defence were called military, as the exercise of the javelin, gladiators, wrestling, boxing, running, leaping, throwing the *discus*, drawing the bow, &c. in all which exercises, there were prizes proposed for the conqueror, thereby to animate youths, to combats of divers kinds, that they might be capable, when occasion required, to repel the insults of their neighbours. — Those for health, were walking, vociferation, shouting, holding one's breath, &c. Though this kind of exercise is not co-eval with the rest; since it is *Plato's* sentiment, that they were first introduced into the *Gymnasium*, by one *Herodicus*, prior a little to *Hippocrates*, and not before luxury and idleness had reduced men to the absolute necessity of applying to physicians, who discovered then, that nothing contributed more to the preservation and re-establishment of health, than exercises proportioned to the different complexions, ages and sexes; and being convinced by experience, of their usefulness, they applied themselves to it. — *Hippocrates* was the first, who treated of the utility of exercise, in his book of *regimen*; but as he, nor the other physicians, did not adopt all the exercises of the gymnastick art into their practice, they left the most violent and laborious, to the masters of the military and athletick exercises.

The exercises for diversion were dancing; all the exercises with *pilæ* or balls; mounting the horse; riding in chaise, litter, or other wheeled vehicle; rocking in beds or cradles; and sometimes swinging; swimming, &c.

The hope of being proclaimed and crowned conquerors in the publick games, which they thought was the highest honour a mortal could

arrive at, had rendered the *Grecian* youths over diligent in those kinds of exercises, and caused such emulation among them, that what was originally only amusement, became at length, a matter of such importance, as to interest famous cities, and entire nations in the practice. — Nay, in process of time, all *Greece* went so far as to imagine, that even *gods* and *demi-gods* were not insensible, of what men were so captivated withal; and in consequence hereof to introduce the greatest part of these exercises into their religious ceremonies, the worship of their gods, and the funeral honours done the *manes* of the dead.

We have no earlier monument now extant, of the *Grecian Gymnasticks*, (which is the name they gave to these exercises) than the description of them in the 23d book of the *Iliad* of *Homer*, where he describes the games celebrated at the funeral of *Patroclus*, which was at the time of the *Trojan war*, and whereby we learn that they had chariot-races, foot-races, boxing, wrestling, gladiators, throwing the *discus*, drawing the bow, hurling the javelin, &c.

We have not the least trace remaining of *Grecian Gymnasia*, which the *Romans* improved and advanced to the utmost pitch of magnificence; but the declension of the empire having involved the arts in its ruin, the *Gymnasia* were deserted, and those sumptuous edifices entirely ruined; so that all that's seen of them at present, are only the places where they were erected.

The BRIDGES, the next piece of *antiquity*, which falls under our consideration, are commonly defined an edifice, either of stone or timber, consisting of one or more arches, erected over a river, canal, or the like, for the conveniency of crossing or passing over from one side to the other.

Abundance of *bridges* were erected by the antients in several places, but particularly in *Italy*, and on the *Tyber*; whereof some are this day entire, and others have some small remains only left, to preserve their memory. — Those, which are, at present, entire on the *Tyber*, are that of the castle of *St. Angelo*, called antiently the *Elia's Bridge*, from the Emperor *Elius Adrianus*, who erected in this place his own monument. — The *Fabrician Bridge*, erected by *Fabricius*, now called the four-headed bridge, or *ponto quattro capi*, from the four heads of *Janus*, or four *Termini*, placed on the left hand of this bridge, whereby the island of *Tyber* is joined to the city. — The *Cestian Bridge*, now called *St. Bartholomew's bridge*, which from the other side of the island passes to *Trans-Tyberim*, or over the *Tyber*. — The bridge called *Senatoris* from the Senators, and *Palatinus*, from the adjacent

hill, made of rustick work, and now called *St. Mary's Bridge*.

But the *Bridges*, whereof the antient remains are only to be seen in the *Tyber*, are the *Sublician Bridge*, called likewise the *Lepidan Bridge*, from *Emilius Lepidus*, who made it of stone, though it was first made of wood, and was built near *Ripa*. — The *Triumphal Bridge*, whose pilasters are still to be seen over against the church of the *Holy Ghost*. — The *Janiculan Bridge*, so named from its being adjacent to Mount *Janiculus*; which because Pope *Sixtus IV.* repaired it, is now called *Ponte Sisto*. — And the *Milvian Bridge*, now called *Ponte Mollo*, in the *Flaminian way*, not two miles distant from *Rome*, and retaining only the foundations of its antient form. It is reported to have been erected in the time of *Sylla*, by *Marcus Scaurus* the *Censor*.

There are likewise the remains of a *Bridge*, to be seen, erected by *Augustus*, of rustick work, upon the *Vera*, a most rapid river near *Narni*; and another of the same work upon the *Metaurus*, at *Calgi*, in *Umbria*, with particular counter-work at each end of it upon the banks; which makes it exceeding strong, and supports the road. — But among all the celebrated *bridges*, that is recorded as a miracle, which *Caligula* built from *Puteoli* to *Baia*, in the midst of the sea, almost three miles in length; and on which it is said, he expended the whole revenue of the Empire.

There was a *bridge* built over the *Danube* in *Transilvania*, which was extraordinary great, and deserving admiration, on which were inscribed these words. PROVIDENTIA AUGUSTI VERE PONTIFICIS, VIRTUS ROMANA QUIS NON DOMET? SUBJUGOR ECCE RAPIDUS DANUBIUS, *i. e.* Can any thing be above the *Roman* strength, assisted with *Augustus*, truly pontiff's, special care; after it has stopt the rapidity of the *Danube*? — This *Bridge* was afterwards broke down and demolished by *Adrian*, to prevent the *Barbarians* from coming over to plunder the *Roman* provinces; and its pilasters are still to be seen in the middle of the river.

But none of the antient *bridges* appear more beautiful, and more worthy of observation, than that erected by *Augustus Caesar*, at *Ariminum*, a city of the *Flaminian* tribe. It is divided into five arches, the three middlemost whereof are equal, consisting of 25 feet in breadth; and the two next the banks are less, consisting only of twenty feet. All these arches consist of a semicircle, and the depth of their *Archivolte* is a tenth part of the light, or void of the greater, and an eighth part of the light of the lesser ones. The pilasters, as to their thickness, are a little more than the half of

the light of the greater arches. The angle of the spurs, which cut the water, is a right angle, (this the ancients followed in building all their *bridges*, as being stronger than the acute angle; and for that reason, the acute angle is less exposed to be thrown down and destroyed by trees, or any other matter, which rolls down with the stream) on the sides of the *bridge*, there are some niches, wherein there must formerly have been some statues directly over the pilasters. Over these niches there is a cornice, the length of the whole *bridge*, which, although it is plain, adds nevertheless a most agreeable decoration to the work.

Over the *Bacchiglione*, and the *Bezone*, two rivers, which run through *Vicenza*, (the *Bezone* losing its name at its entrance into the *Bacchiglione*, without the city) are two antient *bridges* built. The pilasters and one arch of that built over *Bacchiglione*, are still entire, and to be seen near the church of *St. Mary of the Angels*; the rest is all modern work.

The other over the *Bezone*, and which is called by the common people, *Il Ponte belle Beccarie*, or the *Butcher's bridge*, because it is adjacent to the greatest shambles of the city, is still entire, and varies but little from that on the *Bacchiglione*, being divided into three arches, and the middlemost larger than either of the other two. — Both the one and the other of these *bridges* are composed of *Costozza* stone, which is a soft stone, and is sawed like wood.

The *HIGH-WAYS*, or *roads*, of the antient *Romans*, are also pieces of antiquity worthy our notice; and though almost spoilt by time; yet some of them preserve still in some places the memory of their former beauty and convenience; and among them the *Flaminian* and *Appian* ways are the most famous.

The *Flaminian way* was made by the consul *Flaminius* after his conquest over the *Ligurians*, or *Genoese*: it took its beginning from the gate *Florentana*, (now called *Porta del Populo*) and passing through *Tuscany* and *Umbria*, led to *Ariminum*; from whence it was afterwards continued by *Marcus Lepidus*, his colleague, to *Bononia* (now *Bologna*;) and winding round the marshes, near the foot of the *Alps*, ended at *Aquileia*.

The *Appian way* owed its name to *Appius Claudius*, who made it with great labour and expence; whence, on account of its great magnificence and art, it was called the *Queen of roads*. — This way began from the *Coliseo* (or *Pompey's amphitheatre*;) and leading through the *Porta-Capena* (a gate of *Rome* so called) is extended as far as *Brundisium*. — It was carried no farther than *Capua* by *Appius*; and

and who was the author of it beyond, is uncertain, tho' by some it is imagined to be *Cæsar*, because *Plutarch* says, that the care of this way was committed to *Cæsar*, and he laid out a large sum of money upon it.—It was last of all repaired by the emperor *Trajan*, who, by draining of marshes, levelling of mountains, filling up of vallies, and making bridges where it was requisite, made it both expeditious and agreeable to passengers.

The *Aurelian way* is also very famous; so called from *Aurelius*, a citizen of *Rome*, who made it.—It took its beginning from the *Aurelian gate*, now called the gate of *St. Pancrace*, and extending itself along the maritime places of *Tuscany*, ended at *Pisa*.

The *Numentan*, the *Prenestin*, and the *Labican ways*, were all equally celebrated.—The first began from the gate *Viminalis*, now called the gate of *St. Agnes*, and extended to the city of *Numentum*.—The second, at the gate *Esquila*, now called that of *St. Laurence*.—The third, from the gate *Nevia* (which is now the *Porta Maggiore*, the great gate,) and both led to the city of *Prebest*, now called *Pellestrino*, and to the celebrated city of *Labicana*.

There were several other ways, such as the *Via Salaria*, the *Collatina*, the *Latina*, and others, which authors have mentioned, and made famous; every one of which took its name, either from the man who made it, or from the gate where it began, or from the place where it ended. But the *Portuense way*, which reached from *Rome* to *Ostia*, surpassed them all, no doubt, for beauty and conveniency; because, as *Alberti* affirms, it was divided into two ways; between each of which there was a course of stones, a foot higher than the rest of the way, and which served for a division; so that people went one way, and returned the other, whereby they avoided all hindrances, or jostling of each other; and it was indeed a very commodious invention considering the vast concourse of people that flocked then to *Rome* from all parts of the world; and worthy of imitation near *London* at this time.

The ancients made two kinds of those roads, which they called *military roads*; that is, one was paved with stones, and the other covered all over with gravel and sand.—The *ways* of the former kind were divided into three spaces, as far as by some remains of them we are able to conjecture.—On the middlemost, which was higher than the other two, and which rose a little in the middle, that no water might rest upon it, but run off immediately, went the people who travelled on foot.—It was paved with irregular stones; that is, such as had unequal sides and angles.—The other two

spaces on each side of this were made a little lower, and covered with sand and fine gravel, being appropriated for the passage of horses and other cattle.—Each of these spaces were but half as large as that in the middle, from which they were divided by a range of stones, pitched edge-ways; and there were other stones, somewhat higher, at certain distances, on which they got up when they mounted on horseback, the ancients not having had the use of stirrups.—Besides the stones for this purpose there were others, a considerable deal higher, set an equal distance, on which were engraven the miles of the whole journey: these were set up, and the ways measured by *Cneius Gracchus*.

The *military ways* after the second manner; that is, those made of sand and gravel, were raised by the ancients a little in the middle; for which reason no water being able to rest upon them, and consisting of matter, very apt to become dry in a short time, they were always even and smooth, without either dust or dirt.—Of this sort there is one to be seen in *Friuli*, which leads into *Hungary*, which by the inhabitants is called the *posthumous way*. There is another of them in the country of *Padua*, which beginning from the said city, at the place called *Argere*, passes through the midst of *Cicogna*, the *Villa* of the two brothers, the count *Edward*, and *Theodore de Thieni*, and lead to those *Alps*, which divide *Italy* from *Germany*.

The ancients had also magnificent *VILLAS*, or country-houses, of which there is none extant at present, though they pretend to shew some ruins of that magnificent one of *Cicero* at *Tusculano*.—The ancient *Romans* took particular care to have the principal front of their country buildings turned to the south, which front had a gallery, from which there was a passage into the kitchen, which received its light above the places adjacent; the chimney being always in the middle.—The stalls for the oxen were on the left hand, the manger whereof was turned to the east.—The bagnios were likewise on the same side, and at an equal distance from the kitchen, and from the gallery, on account of the room they required.—The oil-presses, and other places for the oil, answered the places of the bagnios, and were turned to the east, south, and west, on the right-hand.—The cellars were backwards, far from all noise, and open to the north, that they might not be exposed to the sun.—The granaries were above, and received the same light the same way as the cellars did.—On the right and left sides of the court were stalls for the oxen, for the horses, conveniences for the sheep, and other animals.—Hay-lofts and barns to put the straw in, and bake-houses were as far from

the fire as conveniently could be.—The master's apartments were backwards, with the principal front opposite to the farmer's house; so that the halls were always in the back part of these country buildings.

I had almost forgot to mention **AQUEDUCTS** among pieces of *antiquity*, which is a construction of stone or timber, built on an uneven ground, to preserve the level of water, and convey it by a canal from one place to another; and in which the *Romans* were very magnificent.—They had some *aqueducts* that extended an hundred miles.—*Frontinus*, a man of consular dignity, and who had the direction of the *aqueducts* under the emperor *Nerva*, tells us of nine that emptied themselves thro' 13594 pipes of an inch diameter.—*Vigener* has observed, that in the space of four and twenty hours, *Rome* received from these *aqueducts*, no less than 500,000 hogsheds of water.—There is still an *aqueduct* of a *Roman* fabrick, which brings the water from *Arcueille* to *Paris*.—The *aqueduct* built by *Lewis XIV.* king of *France*, near *Maintenon*, for carrying the river *Bure* to *Verfailles*, is perhaps the greatest in the world.—It is 7000 fathoms long, and its elevation 2560 fathoms; containing 242 arcades.

The pieces of antiquity we have left to examine, as *busts*, or *bustos*, *medals*, *medallions*, *manuscripts*, &c. are more properly called *antiques*.

**BUSTS** or *bustos* denote the figure or pourtrait of a person in *relievo*, shewing only the head, shoulders, and stomach; the arms being lopped off, ordinarily placed on a pedestal or console.

The *bust* is the same with what the *Latins* called *Herma*, from *Hermes*, *Mercury*; the image of that god being frequently represented in this manner among the *Athenians*.

The *antique busts*, were commonly made with the head of marble, and the shoulders and stomach of porphyry, or bronze.—Of them there are none to be seen, except in *France* among the king's collection of *antiquities*; at *Rome* and *Florence*, among those of the pope, and of the Grand Duke; tho' some of the most curious of our *Antiquaries*, pretend to be possessed of those rare pieces of *antiquities*, as well as of,

**MEDALS**, which are small figures or pieces of metal, in the form of a coin, destined to preserve to posterity the pourtrait of some great man, or the memory of some glorious action.

*Medals* have two parts or sides, the one called the face or head, and the other, the reverse of the *medal*. Each side has three parts, *viz.* the *area*,

or field; the rim or border; and the *exergum* or *exergue*, which is a word, motto, or the like, beneath the ground whereon the figures are represented, though oftner placed in the reverse of the *medal*.—What we find in the *exergum* is sometimes no more than some initial letters, whose meaning we are unacquainted withal; though sometimes too they contain *epochas*, or words, that may be accounted an inscription.—The *type* or *device* of the *medal* is the figure represented; and the *legend* is the writing, especially that around the *medal*; though in the *Greek medals* the inscription is frequently in the *arca*.—The *legend* serves to explain the *figures* or *devices*.

*Legends* on *medals*, are either in *Latin* or *Greek*; and their ordinary subjects, the virtues of Princes, the honours they have received, consecrations, signal events, publick monuments, deities, publick vows, privileges, &c.—The *Greek* characters, consisting of capital letters, appear uniform on all *medals*; no change or alteration being found in confronting the several characters; though it is certain there was in the ordinary use and pronunciation.—All we observe on *medals*, is sometimes a mixture of *Greek* and *Latin* characters.—The character was preserved in all its beauty till the Time of *Gallienus*.

From the time of *Constantine*, and for the space of 500 years, the *Latin* tongue was alone used in the *legend* of *medals*, even in those struck at *Constantinople*.—*Michael* began the first, whose *legend* was in *Greek*; and from his time the language, as well as the characters, began to alter for the worse.

Every *medal* has two *legends*, that on the front, and that on the reverse. That on the front, for the generality, serves only to distinguish the person, by his name, titles, offices, &c. and that on the reverse is intended to express his noble and virtuous sentiments, his good deeds, and the advantages the publick has reaped by him. This however does not hold universally; for sometimes we find the titles shared between both sides, and sometimes also the *legend*.

In the *medals* of cities and provinces, as the *type* or *head* is usually the *genius* of the place, or at least some *deity* adored there; the *legend* is the name of the city, province, or deity, or of both together; and the reverse some symbol of the city, province, &c. frequently without a *legend*; sometimes with that of one of its magistrates.

It seems as if the antients had intended their *medals* should serve both as images, and as emblems; the one for the common people, and the other for persons of taste and parts: the images to represent the faces of Princes; and emblems to represent

represent their virtues and great actions; so that the *legend* is to be considered as the soul of the *medal*, and the figure as the body.

Mr. *Patin* and F. *Joubert* imagine, that the ancient *medals* were used for money, and that they had all (even without excepting the *Medallions*) a fixed regular price in payments. But those of a contrary opinion maintain, that we have no real money of the antients; and that the *medals*, we now have, never had any currency as coins; though we may reasonably keep a medium between both, and very well suppose, that some of those ancient *medals* we have, were real money, and some not; but how to distinguish the one from the other, is a very difficult matter; since we find none number'd by our *Antiquaries* among the *Roman* coins, and all that Mr. *Patin* alledges in defence of his opinion, is but mere supposition.

Ancient *medals*, properly called *antiques*, are divided into those of the higher and lower antiquity; and those again are subdivided into *Greek* and *Roman medals*.

The *Greek medals* are such as have either the heads of *Greek* Emperors, or *Greek Legends*. — These are the most ancient and the most beautiful; since the *Greeks* struck *medals* in all the three metals with such exquisite art, as the *Romans* could never come up to; the *Greek medals* having a design, accuracy, energy, and a delicacy, that expresses even the muscles and veins, and it must be owned goes infinitely beyond any thing of the *Romans*.

*Medals* of the higher antiquity of both nations, consist of such as were struck before the end of the third century; and those of the lower, of such as were struck between the third and ninth century.

The *Roman medals* are distinguished by consular and imperial.

The *Consular medals* are certainly the most ancient medals of the *Romans*, since they were struck before the Emperors had usurped the sovereign authority, and when the republick was governed by Consuls; and yet those of copper and silver do not go beyond the 484th year of *Rome*; nor those of gold beyond the year 546. If any are produced of an older date, they are spurious.

Of the *Consular medals* Father *Joubert* reckons about 50 or 60 of gold; 250 of copper; and near 1000 of silver. — *Ursinus* and Mr. *Patin* have disposed them genealogically, according to the order of the *Roman* families, and computes 1037 *Consular medals*, which relate to one hundred seventy-eight *Roman* families. — The *medals*, whose edges are cut, or notched like teeth, which is a sign of their purity and antiquity, are common among the *Consular*; but we have none later than *Augustus*.

There are several of them, however, among those of the Kings of *Syria*.

Among the *imperial medals* we distinguish between the upper and the lower empire. — The upper empire commenced under *Julius Cæsar*, and ended about the year of *Christ* 260. — The lower empire comprehends near 1200 years, viz. 'till the taking of *Constantinople*, by *Mahomet I.* emperor of the *Turks*. It is the custom however to account all the *imperial medals*, 'till the time of the *Palæologi*, among the *antique*, and yet we have no *imperial medals* of any considerable beauty, later than the time of *Heraclius*, who died in 641.

After the time of *Phocas* and *Heraclius*, *Italy* became a prey to the Barbarians; so that the monuments we have remaining of those two emperors finish the set or series of *imperial medals*. — To these are added the *medals* of the lower empire and the *Greek* emperors; whereof a series may be made as low as our time, taking in the modern ones. — Mr. *Patin* has made an ample collection of the *imperial medals* 'till the time of *Heraclius*.

The *Gothick medals* make part of the *imperial* ones: They are so called, as having been struck in the times of the *Goths*, and in the declension of the empire; and favouring of the ignorance and barbarity of the age.

*Medals* have been struck in three several kinds of metal, which make three several sets or series in the cabinet of the curious, we mean as to the arrangement of the several *medals*. — The gold series, for example, of *imperial*, amounts to about 1000, or 1200; that of silver may amount to 3000; and that of copper, in all of three sizes, great, middle, and small, to 6 or 7000. — Of these the series of middle copper is most complete and easily formed, as it may be brought down to the fall of the empire in the west, and the time of the *palæologi* in the east.

The series of *medals* are usually formed from the side called the head. — In the first class is disposed the series of kings. — In the second, that of the *Greek* and *Latin* cities. — In the third, the *Roman* consular families. — In the fourth, the imperial. — In the fifth, the deities: to which may be added a sixth series, consisting of *medals* of illustrious persons.

It is not either the metal or the size, which makes a *medal* valuable; but the scarcity of the head, or of the reverse, or the *legend*. — Some *medals* are common in gold, which, yet, are very rare in copper; and others very rare in silver, which in copper and gold are very common. — The reverse is sometimes common, where the head is singular; and some heads are common, whose reverse is very scarce.

There are also *medals* very scarce in some sets, and yet very common in others. — For instance, there is no *Antonia* in the sets of large copper, and the middle copper is forced to supply its place. — The *Otho's* are very rare in all the copper sets, and yet common in the silver ones. — *Otho's* of the large copper are held at an immense price. There were but five of them struck, and the dye broke at the fifth; and *Otho* survived that accident but a few days. Four of those are deposited in the cabinets of the king of *France*, the pope, the grand duke, &c. Those on the middle copper are sold at forty or fifty pistoles; and the *Gordian Affrick*, near as high. — Singular *medals* are invaluable.

We commonly understand by singular *medals*, such as are not found in the cabinets of the curious, and are only met with by chance; but in a stricter sense are such whereof there is not above one of a kind extant. — When a *medal* exceeds the value of ten or twelve pistoles, it is worth what the owner pleases. — The *Pescennius Niger* and *Pertinax* are very rare in all metals. — The *Didius Julianus* is hardly found any where, but in large copper. — *Carteron* a *Dutchman*, and some others, have made mills on purpose to strike *medals* that never were, as those of *Cicero*, *Virgil*, *Priam*, &c.

There are no true *Hebrew medals*; those we see of the heads of *Moses* and *Jesus Christ*, are spurious and modern. — We have a few shekels of copper and silver, with *Hebrew* or *Samaritan legends*; but none of gold; though there is mention made of one in the king of *Denmark's* cabinet. — Father *Souciet* has a dissertation on the *Hebrew medals*, commonly called *Samaritan medals*, where he distinguishes accurately between the genuine and the spurious, and shews that they are true *Hebrew* coins struck by the *Jews*, but on the model of the ancients, and that they were current before the *Babylonish* captivity.

These *Samaritan medals* have been infinitely canvassed by the critics, both *Jew* and *Christian*; particularly *Rabbi Alascher*, *Rabbi Bartenora*, *Rabbi Azarias*, *Rabbi Moses*; father *Kircher*, *Vcl-lalpandus*, *Waserus*, *Couzingius*, *Hottinger*, father *Morin*, *Walton*, *Harduin*, *Spanheim*. — It is from the characters, not from being struck by the *Samaritans*, that they are called *Samaritan medals*: and none are genuine *Samaritan*, of which father *Souciet* distinguishes four kinds.

The first bears expressly the name of *Simon*, and the subject for which they were struck, viz. the deliverance of *Jerusalem*. — The second kind have not the name of *Simon*, but only the deliverance of *Sion* or *Jerusalem*. — The third kind have neither *Simon*, nor the deliverance of *Sion*;

but only the *epocha's* first year, second year, &c. — The fourth class have neither any inscriptions, nor any thing whence one may judge of the time when they were struck.

The three first kinds were certainly struck after the return from the *Babylonish* captivity, and in the time of *Simon Maccabeus*, after *Jerusalem* had been freed from the yoke of the *Greeks*. But though struck after the captivity, father *Souciet* observes, their character shews itself to be that of the ancient *Hebrew*, which was used before the captivity, and the use whereof was lost by the people, during their sojourn in *Babylon* and *Chaldea*; but restored after their return on the same footing as before. He adds, that the legends are pure *Hebrew*, such as was spoke before the captivity; that the character therefore is the true ancient *Hebrew* character; that it was the custom to write each language in its proper character; that if they had departed from this rule, they had doubtless used the new character they had brought with them from *Babylon*; that there could be no other reason, but that on settling all things on the same foundation they were on before the destruction of *Jerusalem*, that could have induced them to use this character of their coins. And lastly that these *medals* were not struck by the *Samaritans*, but by the *Jews* and in *Jerusalem*.

Father *Souciet* is very full on all these points, and to the proofs drawn from *medals*, adds two others foreign thereto; the first drawn from the resemblance of the *Greek* letters, introduced by *Cadmus* the *Phœnician*, with the *Hebrew* character; which was the same with that of the *Phœnicians*, as the language of those people was the same with that of the *Hebrews*. — The second drawn from several various readings in the scriptures, which cannot be well accounted for otherwise, than by supposing that the books wrote before the captivity, were in the same character with those of the *medals*, and which shew, that it is the conformity which certain letters have in that character, that has deceived the copyist.

From the whole, he concludes, that this character of the *medal* is the true ancient *Hebrew* character; and that to judge of the various readings of the *Hebrew* text, and the differences of the ancient *Greek* and *Latin* translations, either from themselves, or from the *Hebrew* text, recourse must be had to this character.

The *medals*, which are defaced or not entire, are called *mutilated medals*. — And those wherein we find the letters *rest*, which shew that they have been restored by the emperors, *reintegrated medals*.

*Spurious*

*Spurious medals* are either dipt or plated. — The dipt ones are struck of pure copper, and afterwards silver'd (a contrivance the curious have frequent recourse to, in order to compleat their fets.) — The plated or covered *medals*, are those which have only a thin silver leaf over the copper, but which are struck so artfully, that the cheat does not appear without cutting them: These are the least suspected.

There are also modern *medals*, which are such as have been struck in *Europe*, since the usurpation of the *Goths* has been extinct; and sculpture and engraving have begun to flourish. — The first was of *John Hufs*, in 1415. If any pretend to be more antient, they are *spurious*. — In *France* there were none struck with the king's effigy before the reign of *Charles VII*.

These *medals* have also their series; that of the pope commences only, according to protestant *antiquaries*, from *Martin V*. in 1430; from which time we have, as they pretend, a series of papal *medals*, tolerably compleat, to the number of 5 or 600. One might likewise have a series of emperor's from *Charlemaigne*, provided one took in the current coins; but in practice they commonly commence from *Frederick II*. in 1463. The series of the kings of *France* is the most numerous and most considerable of all the modern kings.

The study of modern MEDALS is so much the more useful, as they afford more light than the antient; and mark the time and consequences of events more precisely; whereas the legends or inscriptions of antient *medals* are very short and simple, and generally without any date. Add to this, that the antient *medals* are extremely liable to be counterfeited, by reason of the excessive price they bear; but in the modern there is not near the danger of being imposed upon.

Mr. *Vaillant* has collected all the *medals* struck by the *Roman* colonies; father *Hardouin* those of the *Greek* and *Latin* cities; father *Noris* those of *Syria*. Mr. *Morel* has undertaken an universal history of medals, and promised cuts of 25000. He ranges them under four classes; the first contains the *medals* of kings, cities, and people, which have neither the name, nor image of the *Roman* emperors: The second contains the consular *medals*: The third the imperial *medals*; and the fourth the *Hebrew*, *Punick*, *Parthian*, *French*, *Spanish*, *Gothick*, and *Arabick*. He begins with the imperial and brings them down as low as *Heraclius*: He places the *Latin* in order before the *Greek*. *Ad. Occo*, a *German* physician, and count *Mezzabarba*, have endeavoured to range the *medals* in a chronological order; but that is impracticable, for in many of the imperial *medals* there is no mark, either of the

consulate, or of the year of the reign; and since *Galicinus*, there are few of the imperial *medals* that bear the least trace of chronology.

The most noted *medalists*, or authors on *medals*, are *Antonius*, *Augustinus*, *Wolf. Lazius*, *Fill. Urfinus* a learned antiquary, *Aneasvicus*, *Hubert*, *Goltrius* a famous engraver, *Oisclius*, *Sequin*, *Oeco*, *Tristan*, *Sermond*, *Vaillant*, *Patin*, *Noris*, *Spanheim*, *Hardouin*, *Morel*, *Joubert*, *Mezzabarba*, *Beger*, &c. We have had also, lately, in *England*, persons of the first rank, who were very good medalists; as the late duke of *Devonshire*, Sir *Andrew Fountaine*, Sir *Hans Sloane*, &c. as also Mr. *Cox* and Mr. *Goffet*.

As for *medallions* they are nothing else but *medals* of an extraordinary size, which princes use to present as a token of honour or esteem, for which reason the *Romans* called them *Missilia*.

*Medallions* are distinguished from *medals* by the volume, that is, by the thickness and compass; as well as by the largeness and *relievo* of the head. — They were never current coins, as *medals* probably were; they were struck purely to serve as publick monuments, or to make presents of. — There cannot be any set made of them, even though the metals and sizes should be joined promiscuously; the best cabinets do not contain above four or five hundred; though Mr. *Morel* promises us figures of above a thousand.

Authors vary about the time when they first began to be struck; some *antiquaries* will have it under the empire of *Theodosius*: But this must be a mistake; for there were some struck even in the time of the upper empire; witness a *Nero*, a *Trajan*, and an *Alexander Severus*, still extant. — *Medallions* of gold are very rare, as also those of a large copper.

*Medals* and *medallions* are almost coined in the same manner with money; with only this difference, that money having but a small *relievo*, receives its impresson at a single stroke of the engine; whereas for *medals* or *medallions*, the height of their *relievo* makes it necessary that the stroke be repeated several times; to this end the piece is taken out from between the dyes, heated, and returned again; which process in *medallions*, and large *medals*, is sometimes repeated fifteen or twenty times, ere the full impresson be given; care being taken every time the planchet is removed to take off the superfluous metal, stretched beyond the circumference, with a file. — Add to this, that *medallions* and *medals* of high *relievo*, by reason of the difficulty of stamping them in the balancier, or prefs, are usually first cast or moulded in sand, like other work of that kind, and are only put in the prefs to perfect them; by reason the sand does not leave them

them clean, smooth, and accurate enough.—*Medals* therefore receive their form and impression by degrees; money at once.

The rule whereby they judge the *medal* to be sufficiently stamped is, when feeling it with the hand, it is found firm, and not to be shaken, as filling the dye equally every where.

Antient MANUSCRIPTS, are also pieces of *antiquity* very much esteemed by *antiquaries*, and other curious persons, the great number of rare and uncommon ones rendering always a library valuable.

There are antient *manuscripts*, which like *medals* of the first class, have no price: such as all originals of any consequence, either history, sacred or profane, divinity, especially the books of the New Testament; those of the old given for such, being nothing else but simple copies, though even some of those copies are very valuable. The antient fathers of the church, as St. *Athanasius*, *Origen*, *Justin the martyr*, St. *Basil*, St. *Jerome*, St. *Augustin*, St. *Cyprian*, St. *Ambrose*, &c. The history of both the *Greek* and *Roman* empires. That of the different monarchies which have risen from the ruins of those two empires, &c. &c. But among those originals and scarce copies, there are many spurious ones, though so well counterfeited, that the best *Antiquary* is often deceived in them. There are even some *manuscripts* written, since the invention of printing, which are imposed upon us, as having preceded that ingenious and useful art.

It is not very easy to distinguish an antient *manuscript* from a counterfeited one, especially those in the oriental language, whose originals being all lost, by the different revolutions happening in those countries where they were first written; and those languages, as they are spoken at present, very different from what they were at first, we cannot compare them with the copies, and therefore are obliged to trust to those copies, often but too imperfect, as if they were originals.

I know very well that all *originals* in those languages have not undergone the same fate; especially as to the books of the New Testament, and the works of some of the antient fathers of the *Grecian* church: of which there are still some few originals extant, which have been saved from the ruin of the eastern empire; and those are but in a

very small number, and to be seen but in the most celebrated libraries, as those of the *Vatican*, of the king of *France*, of the *Grand Duke*, the *Bodlian* and *Cottonian* libraries, the *British Museum*, &c.

The best *manuscript* bibles are those copied by the *Jews* of *Spain*. Those copied by the *Jews* of *Germany* are less exact but more common. — The two kinds are easily distinguished from each other; the former being in beautiful characters like the *Hebrew bibles* of *Bomberg*, *Stephens*, and *Plantin*; the other in characters like those of *Munster* and *Grypbius*. — *F. Simon* observes, that the oldest *manuscript Hebrew bibles* are not above 6 or 700 years old; nor does *Rabbi Menaham*, who quotes a vast number of them, pretend any of them exceed 600 years.

There are several different *manuscripts* of the bible in all the oriental languages, *viz.* *Hebrew*, *Samaritan*, *Chaldee*, *Syriac*, *Arabic*, *Ethiopic*, *Coptic*, (of which there's one in the king of *France's* library) and *Greek*.

The great difference found between the different *manuscript* copies of the antient fathers, and the faults and imperfections they are crowded with, proceed sometimes from the ignorance, sometimes from the unfaithfulness, and sometimes from the partiality of the copyists; which the better to understand, we must know that most of those copies were written by monks, who often for want of very well understanding the true sense of those fathers, whose works they were employed to copy or transcribe, or perhaps divided in their sentiments, as to religious matters, each of them gave to the original what sense they thought most favourable to the sect they were most inclined to.

I do not believe it necessary to take any great notice here of *Mummies*, which are also considered as pieces of *Antiquity*; since we have but very few, perhaps none at all, genuine ones; and as ever since our *Antiquaries* have dealt that way, we have no less than twenty *Ptolomies*, besides as many *Cleopatra's* brought over to us, besides those left under the *Egyptian* pyramids, and reserved, as I suppose, to divert our posterity, as these have diverted us, though at the same time they have very much puzzled our *Antiquaries* in the explanation of the *hieroglyphicks*, those *mummies* are powdered with.

# A R C H I T E C T U R E.

**A**RCHITECTURE is the art of erecting edifices or buildings, whether for habitation or defence.

In this view, it has three objects, or branches, which are called *civil*, *military* and *naval*, of which this we shall discourse separately in their proper places. And, first,

## OF CIVIL ARCHITECTURE.

CIVIL ARCHITECTURE, which is commonly by way of eminence called absolutely ARCHITECTURE, is the art of contriving and executing commodious buildings for the use of society and the convenience of *civil life*.

In this art our chief regard is to be paid to *conveniency*, *strength* and *beauty*.

The *conveniency* is a matter principally to be considered in the *plan* of a building; so to order the parts thereof, that they may answer the intention of the work; and not embarrass one another.

The *strength* depends on the choice and goodness of the *materials*, and upon the solidity of the foundation, the *squaring*, *levelling*, and *plumbing* of the walls, &c. and a due attention to the bearings of every part.

The *beauty* consists in an exact order or symmetry, which should be observed in every part; so that one member of the building does not exceed its proportion in regard to another member; and that, when complete, they should all together yield an agreeable form and pleasing appearance.

Therefore to give a just idea of this subject, we must first consider it in a *general view*, and then descend to *particulars*.

In a *general view*: ARCHITECTURE is to be treated of in regard to its different stages or periods, *v.z.* either as *antique*, or *ancient*, *Gothic*, *modern*, &c. or as it is divided into its several *orders*, *viz.* *Tuscan*, *Doric*, *Ionic*, *Corinthian* and *Composite*.

But before we proceed, it will not be improper to observe, that the study of *Architecture* is profitable to *Gentlemen*, as well as to *Artists*: and to give a short account of the origin and progress of ARCHITECTURE.

Though we borrow the assistance of the ARCHITECT and the MASON, when we have a house to build, or an apartment to be repaired; yet *we*, at the same time, act a wise part in presiding over

the whole; and acquire a right to it, by early taking a proper notice of their works. This we have daily opportunities of doing: and having conversed with, and taken advice of an honest tradesman, who though he builds his house without any ostentation and magnificence; yet does it in taste, and shews as much judgment in the disposal of every part, as in the management of his expences, is as sure a means of improving our minds, as it is of succeeding in what we undertake.

Human abodes have varied from time to time, according to local conveniencies, and with relation to the different genius and character of every nation. The *first* manner of building houses since the *deluge* (for we are perfect strangers to all events before it) was the architecture of the children of *Noah* in *Gorduen* or *Curdistan*, where the Ark stopt.

The appendices of rocks, the caves and hollow places dug under ground, were the first retreats of their families, at this time much increased in number in that mountainous land. There they sheltered themselves from rains and sharp winds, but not from damps and obscurity. The melancholy situation, and the barrenness of those regions, which were hardly habitable on account of the sands, chafms and broken rocks, of which they were full, drove them over the river *Tigris* into the plains of *Mesopotamia*.

The want of *stone*, or any other hard matters fit for making themselves shelters, taught them how to mould bricks, or square pieces of clay, and bake them hard, wherewith to lay strata of MASONRY perfectly even. They bound them together with a viscous bitumen, which the same country still affords, and which they thickened with reeds and straw cut small.

That country, so delightful in itself, became more so by the conveniencies, which the art of building began to procure them, when providence obliged them to desperse themselves in colonies from one end of the earth to the other, leaving them for their guides the instructions of their fathers, their own wants, and a few natural talents.

When insuperable obstacles obliged them to fly from one country into another, the *woods*, which were easily found in almost every place, and equally fit to make pieces of support and to procure them roofs and linings, were the most solid as well as the most pliant matters, that procured to the new colonies

nies a well situated, wholesome, commodious habitation, instead of the lurking holes and obscure dens, which had often sheltered them in their peregrinations; and though they were at first, and for want of skill, obliged to content themselves with green arbours void of proportion and symmetry, or with twisted willows cemented with clay; they nevertheless had there the benefit of the day light, and breathed a very pure air.

*Wood* took whatever form they were pleased to give it. The tools they had invented, turned it by degrees into *hurdles, poles, beams, joists, boards, laths,* and pieces of *all shapes, and sizes.* The pliantness and perpetual reproduction of wood, and the skill of the *hurdler* and *carpenter,* are then the causes to which we are really indebted for the manner of building, which was most universal in the beginning, and which has rendered the earth truly habitable.

It is the use of *wood* that first distinguished the habitations of men from those of wild-beasts, all over the earth.

But then, the decay of wood after a few years time, obliged men to add, or even as much as possible, to substitute to it *clay, loam, stone, slate,* and most commonly baked earth or *brick*; where *stone* was wanting.

This sparing disposition has often introduced and perpetuated among whole nations the fashion of *rotundo's,* or circular buildings of hurdles, covered with thatch and rushes, and ending in a cone like ice-houses.

The *hurdler's* work was sometimes strengthened with a plaistering made of chopped straw and loam. A hole, opened at the point of this rustick dome, gave vent to the smoak. The fire-place, somewhat sunk in the middle of the room, and garnished simply with wood-coals, comforted the whole family dispersed around it. The fabrick of such buildings and the common exigencies of life, required only the cutting down of coppices or under-wood.

It was this simplicity that did for so many ages together preserve the immense forests with which *Germany* and *Gaul* were covered. Such was the ARCHITECTURE of our forefathers; and the remains of their way of building, as well as the form of their habitations, are still to be seen in the villages of *Lorrain, Germany, Poland,* and also in some parts of *Britain.*

Other nations built their houses in a quite different manner.

The EGYPTIANS, after having run over and closely examined the two sides of their river *Nile,* took a resolution to fix their abode in the plains it most fertilized, and to bring thither by the help of

navigation the *stone, marble,* and all other matters fit to build, which they could no where find but at the farther end of *Africa.* The plenty of every thing determined them to fix there, and a national taste occasioned partly by the beauty of these matters, and partly by the situation and disposition of the country, accustomed them to introduce sublimity in their ARCHITECTURE.

Hence, those magnificent habitations in form of terrasses, and all those lofty monuments, which must have been rendered superior to the inundations, and indestructible to all the efforts of water. *Wood* had hardly any share at all in their buildings. The country afforded but very little of it; nor would it have been lasting, being successively and yearly preyed upon by water and air.

The elegance, that shines throughout the writings of the *Greeks,* is again found in their ARCHITECTURE, and in all their inventions. We had from them the finest operations of *Geometry,* the correctness of *Drawing,* the several ORDERS of ARCHITECTURE, the beautiful *proportions* in every thing, the *principles* of all the LIBERAL ARTS.

The ROMANS, less civilized and poorer in the beginning, built their houses at first with *wood, earth, and stubble.* We nevertheless find a character of nobleness, in their primitive simplicity: nay, they arrived perhaps at once at the true grandeur, since they never spared any thing to perfect the edifices they built for common utility.

In the time of *Tarquin* the elder, that is, 600 years before our SAVIOUR, the whole soil of their town was channeled and inwardly traversed by several large canals of MASONRY, which, like so many branches of one trunk, terminated in a *common conduit,* that was arched and accessible to the carts of their scavengers, that the foul water of all their houses might at any time be discharged into the *Tyber.* This love of magnificence and cleanliness, in point of works designed for the public utility, was perpetuated through every age of the republic, and was still regarded by the first Emperors.

The greatest emulation of the most wealthy citizens was to convey from far wholesome water into *Rome,* for the service of the people: to procure them very spacious buildings, where the young *Romans* might strengthen their constitution by bodily exercise: to build and adorn with statues large portico's, where the people might at any time stand under shelter, when they were to make their purchases, or to the end that they might study the monuments and the history of their country there.

The greatest enterprise, that ever was attempted by the *Romans,* was not only that of paving, but also

also of *masonry* upon solid foundations all the high roads that traversed the whole empire. *Agrippa*, the son-in-law of *Augustus*, who took the execution of it upon himself, with so much zeal and success, was a true hero; since he thereby did a piece of service to all mankind in general.

The inconveniences and decay of *wooden-buildings* brought MASONRY more and more in request, both for public and private use. Society was a double gainer by it. Its habitations became more commodious: the matter of wood, so necessary to navigation, for the dressing of victuals, and for many other uses, was considerably spared.

It nevertheless, still came in for a great share in the construction of most edifices. It now and then supplies the whole carcass, or what they call the frame of them; which is afterwards filled up with a slight MASONRY. There is no doing without wood, when the division of *stair-cases* is to be made; and it is indispensably necessary to *tye* in the walls, and to preserve the whole by the shelter of the *roof*.

When we are either unable or unwilling to lay deep foundations, we are contented in that case with the solidity, which we find in a *wooden-building* from the several fastenings and tyes, that out of a great many different pieces form a complete whole; and the ground being less charged with it, yields less to its weight, than it would do to that of a *stone-masonry* not founded on a firm bottom.

When, on the contrary, we would have a solid foundation upon *quicksands*, or in a place where the firmest ground cannot easily be attained; it is wood that comes in to our assistance, and insures an unshaken solidity to the MASONRY. The *piles*, which are driven into these soft soils by repeated blows of the rammer, have their foot perpendicularly resting upon turf, and with their level heads they support the weight of an immense edifice.

Thus did the MASON and the CARPENTER settle their respective provinces: they were then of mutual help one to another, and never parted afterwards.

The SMITH came next to fasten and perfect the work of both by strong ties and by several instruments fit to prevent the insults of the elements, or the violence of usurpers. Workmen and professions were multiplied with the several helps we might desire to have. Many of them owed their birth barely to a taste for new conveniences. How many precautions, machines, and fabrics altogether different in *iron-work* alone? How many other processes in the several uses of *copper* and *lead*? How many more for the conveyance of waters and the preservation of drinks? What a world of other contrivances have they not imagined

for the bare distribution of light? The *hurdler* and *basket-maker* had at first barred the windows of every habitation with thin wrought *lattices*, which admitted the day, but did not stop out the passage of the winds, or inclement air. The *weaver* improved the service of these blinds by that of thin cloths; and the *glass-maker*, at last, substituted to the lattices of cloth, of alabaster, or of any other thin stone, the fine white glass.

These noble inventions, and a great many others had their birth in *ages*, which we are pleased to term the *times of ignorance*. Let us do them justice. Sound philosophy is the product of all ages. True *philosophers* are like true *Christians*, whom we at any time discern by their fruits. These are the men that do real honour to the human mind. Those, who did not scruple to *assume* the titles of *masters* and *sages* to themselves, have generally taught us nothing but words and the art of disputing upon *possibilities*: but *artists* have instructed disciples, who, like their masters, go on from age to age with multiplying conveniences, and producing new beings for our service.

All is rough and in a battered condition in the places where the *architect*, the *carpenter*, the *mason*, the *joiner*, and the *smith* are but just come: and we find at their going from thence, *symmetry*, *harmony*, *proportions*, *cleanliness*, and *ease*, on all sides united with solidity.

*Vitruvius* contends for the origin of *architecture*, being almost as ancient as human society, and that the rigour of the seasons first led men to make little cabins to retire into; at first half under ground, and then half above covered with stubble; at length, growing more expert, they planted trunks of trees an-end, laying others a-cross, to sustain the covering.

But, however, as I don't suppose those first *Architecture* to have been very curious in the symmetry of their edifices, or observed any regular order, I will rather believe, with some of the ancient writers, that *Architecture* first began to be reduced to any tolerable order among the *Tyrians*; that, as *Villalpandus* asserts, *Solomon* was the first, who brought it under those rules, which he had received from God himself (whence he supposes *architecture* of divine invention) and that the *Tyrians*, employed by that prince, had learned that art from him, and carried it afterward into their country. To what a pitch of magnificence and grandeur the *Tyrians* carried it ere it came to the *Greeks*, may be learned from *Isaiab* xxiii. 8. Yet in the common account, *Architecture* should be almost wholly of *Grecian* original: three of the regular orders, or manners of building, are denominated from them, *viz.* *Corinthian*, *Dorick*, and *Ionick*, and scarce a part,

a single member or moulding, but comes to us with a *Greek* name.

Be that as it will; it is certain the *Romans*, from whom we derive it, borrowed what they had entirely from the *Greeks*; nor seem, till then, to have had any other notion of the grandeur and beauty of buildings, besides what arises from their magnitude, strength, &c. Thus far they were unacquainted with any order but the *Tuscan*. Under *Augustus*, *Architecture* arrived at its glory: *Tiberius* neglected it as well as the other polite arts. *Nero*, amongst a heap of horrible vices, still retained an uncommon passion for buildings; but luxury and dissoluteness had a greater share in it than true magnificence. *Apollodorus* excelled in *architecture* under the emperor *Trajan*, by which he merited the favour of that prince: and it was he who raised the famous *Trajan's* column, subsisting to this day. After this, *architecture* began to dwindle, and though the care and magnificence of *Alexander Severus* supported it for some time, yet it fell with the *Western* empire, and sunk into a corruption, from whence it was not recovered for the space of twelve centuries.

The ravages of the *Visigoths* in the fifth century destroyed all the most beautiful monuments of antiquity; and *architecture* thence forwards became so coarse and artless, that their professed Architects understood nothing at all of their design, wherein its whole beauty consists: hence a new manner of building took its rise, called the *Gothick*.

*Charlemagne* did his utmost to restore *architecture*; and the *French* applied themselves to it with success, under the encouragement of *H. Capet*, the first of the line of the *Capetians*, from whom the present king of *France* is lineally descended. His son *Robert* succeeded him in this design, till by degrees the modern *architecture* was run into as great an excess of delicacy, as the *Gothick* had before done into massiveness. To this may be added the *Arabick*, *Morish*, or *Morish architecture*, which were most of a piece with the *Gothick*, only brought in from the south by the *Moors* and *Saracens*; as the former was from the north by the *Goths* and *Vandals*.

The Architects of the thirteenth, fourteenth, and fifteenth century, who had some knowledge of sculpture, seem to make perfection consist altogether in the delicacy and multitude of ornaments, which they bestowed on their buildings, with a world of care and solicitude, though frequently without any conduct or taste.

In the two last centuries, the Architects of *Italy* and *France* were wholly bent upon retrieving the primitive simplicity and beauty of ancient *architecture*, in which they did not fail of success; inso-

much that our churches, palaces, &c. are now wholly built after the *antique*.

The most celebrated Architects are, *Vitruvius*, *Palladio*, *Scamozzi*, *Serlio*, *Vignola*, *Barbaro*, *Cataneo*, *Alberti*, *Viola*, *Inigo Jones*, *Mansard*, *Bullant*, *Sir Christopher Wren*, and *De Lorme*.

We have no *Greek* authors extant on *architecture*. The first who wrote of it was *Agatharus* the *Athenian*, who was seconded by *Democritus* and *Theophrastus*. Among the *Latins*, *Fuffitus*, *Terentius Varræ*, *Publius Septimius Rufus*, and *Ephroditus* wrote *De Re Architectonica*. But of all the ancients, *Vitruvius* is the only entire author; though *Vegetius* relates that there were 700 Architects at *Rome* in his time. He lived under *Augustus*, and composed a complete system of *architecture* in ten books, which he dedicated to that prince. There are two things censured by the moderns in this excellent work, *viz.* want of method, and obscurity. The mixture of *Latin* and *Greek* in *Vitruvius* is such, that *Leon Baptista Alberti* has observed, he wrote *Latin* to the *Greeks*, and *Greek* to the *Latins*: he adds, that the work contains abundance of things superfluous and foreign to the purpose. For this reason *M. Perrault* has extracted all the rules out of *Vitruvius's* prolix work, methodised, and published them in a little abridgment. Several authors have also endeavoured to explain the text of *Vitruvius*, particularly *Philander*, *Barbaro*, and *Salmasius*, in notes added to their several editions; *Rivius* and *Perrault* in the notes to their *German* and *French* versions; and *Baldus* in his *Lexicon Vitruvianum*, enlarged by *De Lact*. The same *M. Perrault*, has also composed an excellent *Treatise of the five Orders*, which may be esteemed a Supplement to *Vitruvius*, who left the doctrine of the five orders defective.

The authors upon *architecture* since *Vitruvius* are, *Leon Baptista Alberti*, who in 1512, published ten books of the art of building, in *Latin*, designed to outvie *Vitruvius*; in which however he has not succeeded; his work has abundance of good things, but is deficient in the doctrine of orders. *Seb. Serlio*, who wrote seven books of *architecture*, five of which, concerning the *five orders*, were made publick in 1602; throughout all which, he religiously keeps to *Vitruvius's* rules: the seventh was since published in 1675; but the sixth, concerning private buildings, has not yet appeared. And *Palladio*, who wrote four books of *architecture*, containing the fundamental rules of the art, with various instances of all the kinds of works, published in *Italian*, in 1575: the two first books are rendered into *High Dutch*, and enlarged with annotations by *Boeckler*; and the four published in *English*, in 1735, embellished with a large variety

of chimney-pieces, collected from the works of *Inigo Jones* and others. *Phil. De Lorme*, who published nine books of *Architecture* in *French*. *J. Barozzi De Vignola*, who in 1631, made publick his rules of the five orders in *Italian*, since translated with large additions by *Daviler*, under the title of *Cours d'Architecture*, &c. and since also into *High Dutch*, with notes.

To these are to be added *Vincent Scamozzi*, his idea of *Universal Architecture*, published in 1615, in *Italian*; *Car. Phil. Dieussart*, in his *Theatre of Civil Architecture*, published in *High Dutch*, in 1697; wherein he not only delivers the rules of *architecture*, but explains and compares the five orders, as laid down by *Palladio*, *Vignola*, *Scamozzi*, &c. which same design was also executed in *French* by *R. Freart De Cambray*, in a *Parallel of the ancient Architecture with the modern*, published in *French*, in 1650, and since translated into *English*, with additions by *Mr. Evelyn*. *Fr. Blondel*, director of the royal academy of painting, &c. in 1698, gave a *Course of Architecture* in *French*, being a collection from all the celebrated writers upon the subject of the orders, &c. *Nic. Goldman*, in a treatise *De Stylometris*, published in *Latin* and *High Dutch*, in the year 1661, has done good service by reducing the rules and orders of *architecture* to a further degree of perfection, and shewing how they may be easily delineated, by means of certain instruments invented by him.

Lastly, the *Elements of Architecture* are very ingeniously laid down by *Sir H. Wotton*. The same are reduced by *Starmius* and *Wolfius*, to certain rules and demonstrations; and thus is *architecture* brought into the form of a *mathematical art*; by the first, in his *Mathesis Juvenil*, and the second in his *Elementa Matheseos*, Tom. 2. An. 1715.

These particulars premised, let us now proceed with the division of ARCHITECTURE.

ANTIQUÉ ARCHITECTURE is the name given to buildings erected from the days of *Alexander the Great* to the reign of the emperor *Phocas*; which happened about the year of CHRIST 600. From this epocha the artists call the buildings or edifices only *ancient*; because they were erected in a more barbarous stile by the *Goths* and *Vadals*.

The difference between *antique* and *ancient* buildings appears particularly in the joining of the stones together; in which the *antique* Architects were so very curious and exact, that it is very difficult to discern the joints in a great many places, and which contributed much to the beauty, strength, and solidity of the building.

This, in my opinion, could not be done, without having those sides of the stones squared and wrought first, which were to be laid one above an-

other, leaving the other side rough, after which they were made use of in the building; so that the angles or edges of the stones not being so sharp, they could move them up and down better, till they joined well, and were in no more danger of breaking, than if all the sides had been squared; for the angles being then too thin, are apter to break.

In this manner they made all their stone buildings rough and rustic, as it were; and when these were completed, they continued to polish those sides of the stones that were exposed to view.—It must be acknowledged, that as the roses between the modillion or other decorations of the cornice, could not be commodiously worked after the stones were fixed, they made them while they lay on the ground.—This is evident by many ancient buildings, in which several stones are found that were left unwrought and unpolished. The arch near the old castle in *Verona*, and all the other arches, and ancient edifices in that place, were made after the same manner: this we easily discover by the marks of the tools, which shew in what manner the stones were wrought.

The columns of *Trajan* and *Antoninus* at *Rome*, were thus wrought; for it would have been impossible, otherwise, to have fixed the stones, so as that the joints should meet so close together, cross the heads, and other parts of the figures.—The same may be said of those triumphal arches that are found there, for when they had any large edifice to erect, as the amphitheatre of *Verona*, that of *Pola*, and the like, to save time and charge, they only wrought the impost of the arches, the capitals and cornices, leaving the rest rustick, regarding only the beauty of the whole fabrick.—But in temples and other magnificent edifices, that require great delicacy, they spared no labour in working them, but glazed and polished them, even to the very flutes of the columns, with the utmost accuracy and application.

GOTHICK ARCHITECTURE, is that which deviates from the proportions, characters, &c. of the *antique*.

The *Gothick architecture* is frequently very heavy, solid, and massive; and sometimes, on the contrary, exceedingly light, delicate and rich.—The abundance of little whimsical, impertinent ornaments, are its most usual character.

Authors distinguish two kinds of *Gothick architecture*; the one *ancient*, the other *modern*.—The ancient is that which the *Goths* brought with them from the north, in the fifth century: the edifices built in this manner were exceedingly massive, heavy and coarse.

Those of the *modern Gothick* run into the other extreme

extreme, being light, delicate, and rich to a fault; witness *Westminster-Abbey*, the cathedral of *Litchfield*, the *cross* of *Coventry*, &c.

The last kind continued long in use, especially in *Italy*, viz. from the thirteenth to the restoration of the *antique* building in the sixteenth century. All the ancient cathedrals are in this stile.

MODERN ARCHITECTURE is that which partakes partly of the *antique*, retaining somewhat of its delicacy and solidity; and partly of the *Gotick*, whence it borrows members and ornaments, without proportion or judgment.

Before I give an exact description of the FIVE different ORDERS of *architecture*, which all public and private edifices must be composed of, it will not be improper to observe here, that the *columns*, in each of the FIVE ORDERS, are to be made so, as the diameter of the upper part of the column, may be less than at the base, and have a little swelling in the middle.

In the diminution of the *columns*, we must take care that the longer they are, the less they must diminish; because the height, by reason of the distance, has the effect of diminution.

*Vitruvius*, l. iii. c. 2. gives us directions to that purpose; for he says, that if the column be fifteen feet high, the diameter at the bottom must be divided into six parts and a half; and five and a half must be the thickness at top; if from fifteen to twenty feet, the diameter at the bottom must be divided into seven parts, and six and a half will be the diameter at top.—The same observation must be made in those that are from twenty to thirty feet high; where the diameter, at the bottom, must be divided into eight parts, seven of which will be the diameter at top; and thus such columns as are of a greater height, will diminish in the manner above mentioned.

As to the swelling, which is to be in the middle of the column, this excellent author has left us in the dark; but *Palladio* has supply'd his defect, and left us a method for the profile of such swelling.—He divides the *flut* of the column into three equal parts, and leaves the lower part exactly perpendicular; to the extremity whereof he applies a thin rule of the exact length, or sometimes a little longer than the column, and bends that part of the rule which comes forwards, till the point thereof touches the point of diminution of the upper part of the column, under the *collarino*; then he marks as that curve directs; thus he has the column swelling a little in the middle, and projecting forward, which strikes the eye very agreeably.

The diameter must always be taken at the lowest part of the column, and the intercolumnations,

which are the distances between the columns, are to be one diameter and a half, or of two diameters, of two and a quarter, of three, and sometimes more of the column, though the ancients never exceeded three, except in the *Tuscan order*, where the architraves being of timber, they made the intercolumnations very large. But then they never made them less than a diameter and a half, which distance they particularly observed when the columns were very lofty.—But they principally approved of those intercolumnations, which were of two diameters and a quarter, and esteemed them as most elegant and beautiful.

The beauty and elegance of the columns are very much heightened by the proportion and harmony between them and the intercolumnations; for if small columns are made with large distances, or intercolumnations, the too great quantity of air in the void spaces will very much lessen their thickness, and consequently diminish their beauty; and if, on the contrary, there are but small intercolumnations between large columns, the too little vacuity will make them appear heavy, thick, and disagreeable. Therefore, if the distance be more than three diameters, the thickness of the column must be a seventh part of its height, as I shall observe hereafter in the *Tuscan order*.—But if the distances are three diameters, then the length of the column must be seven diameters and a half, or eight, as they are in the *Dorick order*.—If two and a quarter, the columns must be nine diameters and half in length; as in the *Corinthian*.—And if a diameter and a half only, the length of the columns must be then ten, as in the *Composite*.

In the front of any edifice, the columns must be of an even number, that there may be an opening in the middle, larger than the other distances and intercolumnations, for the doors and entries; that is to say, for single pillars and columns.—But if galleries are to be made with pilasters, they must be disposed so, that the thickness of pilasters or piers be not less than the third of the void from pier to pier, and to those in the angles two thirds, which will make the angle in the building more solid and substantial.—When these piers are to support a cumbrous load, as in large structures, then they must have half the thickness of the vacancy, or otherwise two thirds in public edifices; but in private ones they must be as thick at least, as the third part of the opening, but no thicker than two thirds, and ought to be square.—But to save charges, and make it more commodious, and the passage more open, they need not be so thick in flank as in front, and, for its embellishment, half columns or pilasters may be placed in the middle, to support the cornices over the arches of the gallery, whose  
thickness

thickness must be in proportion to their height, according to each order, as I shall demonstrate in the course of this treatise.

For the division and mensuration of the above-mentioned orders, we'll make use of the same measure or *module*, which *Vitruvius* used to divide the *Dorick order* with, which *module* is taken from the diameter of the column, and which may be used in all the orders.

This *module* is the diameter of the column at bottom, and is divided into sixty minutes, except in the *Dorick*, in which the *module* is half the diameter of the column, and is divided into thirty minutes, this being more commodious in the divisions of that order.—One may therefore divide the *module* into more or less parts, according to the quality of the edifice, and use the designs of the proportions and profiles suitable to each order.

A COLUMN in *architecture* is a round pillar, made to support or adorn a building.

The entire *column* in each order is composed of three principal parts, the *base*, the *shaft*, and the *capital*. See Plate IV.

(A) The *BASE* of a *column* is that part between the shaft and the pedestal, if there be any pedestal; or if there be none, between the shaft and the plinth, or socle.

The *base* is supposed to be the foot of the *column*, or as some will have it, it is that to a *column*, which a shoe is to a man.

The *base* is different in the different orders, as we shall see when we come to treat of those orders.

(B) The *SHAFT* of a *column* is the body thereof; thus called from its straitness; though most commonly called *shaft*.

(C) The *CAPITAL* is the uppermost part of a *column*, serving as the head or crowning thereof, placed immediately over the *shaft* or *shaft*, and under the *entablature*. The *capital* is a principal and essential part of a *column*, is made different in the different orders, and is that, which chiefly distinguishes the orders themselves.

Each of these parts is again subdivided into a great number of lesser, called *members* or *mouldings*, some whereof are essential, and found in all *columns*; others are only accidental, and found in particular orders.

MEMBERS or MOULDINGS are Jettings or Projections beyond the naked part of a *column*, of a wall, waincot, &c. the assemblage whereof forms cornices, door-cases, and other decorations of *architecture*.

Some *mouldings* are square, others round, some straight, others carved, &c.—Some are plain, others carved, or adorned with Sculpture, either hollowed, or in *relievo*.

Some *mouldings*, again, are crowned with a *fillet*, others are without, as the *ducine*, *talon*, *ovolo*, *torus*, *plinth*, *scotia*, *astragal*, *gula*, *corona*, and *cavetto*.

FILLET, in *architecture*, is a little square member or ornament, used in divers places, and on divers occasions; but generally as a sort of *corona*, over a greater moulding; and on occasion, serves to separate the *flutings* of *columns*.

The *fillet* is the same with what the *Italians* call *lissa*, or *listella*; and the *French*, *bande*, *bandelette*, and *reglet*; though the *reglet*, according to *Daviler*, differs from the *fillet*, in that it projects equally like a ruler.

The *DOUCINE* is a *moulding* on the highest part of the cornice, in form of a wave half convex and half concave.—The *ducine* is the same with a *cymatium* or *gula*.

*Vitruvius* does not confine *cymatium* to the cornice, but uses it indifferently for any similar moulding, wherever he meets with it: in which he differs from the most accurate among the moderns.

*Filibien* makes two kinds of *cymatiums*; the one right, and the other inverted; in the first, that part, which projects the furthest, is concave; and is otherwise called *Gula recta* and *Doucine*.—In the other, that part, that projects farthest, is convex, called *Gula inversa*, or *Talon*, i. e. *Ogee*.

Our *architects* do not use to give the name *cymatium* to these mouldings, except when found on the tops of *cornices*; but the workmen apply the name indifferently, wherever they find them.—*Palladio* distinguishes the *cymatium* of the cornice, by the name *intavolata*.

TALON (a *French* word which literally signifies *heel*) is a *moulding* concave at the bottom, and convex at the top; having an effect just opposite to the *ducine*.—When the concave part is a-top, it is called an *inverted talon*.

The *talon* is usually called by our *English* workmen *ogee*, or *O. G.* and by authors an *upright*, or *inverted cymatium*.—The figure of the *ogee* bears some resemblance to that of an *S*.

The *OVOLO* is a round *moulding*, whose profile or sweep in the *Ionic* and *Composite* capitals, is usually a quadrant of a circle; whence it is also popularly called the *quarter round*.—It is usually enriched with sculptures among the ancients in form of chestnut-shells; whence *Vitruvius*, and other of the ancients call it *Echimus*, chestnut-shells.—Among us it is usually cut with the representation of eggs, and anchors, or arrows-heads, placed alternately; whence its *Italian* name *ovolo*, *Latin*, *ovum*, q. d. *egg*.

(D) PLINTH is a flat square member in form of a brick; sometimes also called the *slipper*.—

The *Plinth* is used at the foot or foundation of *columns*; being that square flat table under the mouldings of the *base* and *pedestal*, at the bottom of the whole *order*; seeming to have been originally intended to keep the bottom of the primitive wooden pillars from rotting.—The *plinth* is also called *orle* or *orlo*.—*Vitruvius* also calls the *Tuscan abacus*, *plinth*, from its resembling a square brick.

The *Torus* or *Tore*, is a large round moulding used in the bases of *columns*.—The *tore* is also called *gros baton*, and *tordin*.—It is the biggest that distinguishes the *tore* from the *astragal*.—The bases of the *Tuscan* and *Dorick order*, have but one *tore*, which is between the *plinth* and the *listel*.—In the *Atiick base* there are two; the upper, which is the smaller; and an under, or bigger.

*Scotia* is a femicircular cavity or channel between the *tores*, in the bases of *columns*.—It is a concave, dark moulding; whence its name, viz. from *σκωτος*, obscurity, darkness.—The *scotia* has an effect just opposite to that of the *quarter-round*.—Our workmen frequently call it the *casement*.—It is also called *trochillus*, partly from its form.—In the *Ionick* and *Corinthian base*, there are two *scotia's*, the upper whereof is the smaller.—According to *Filibien*, the *cavetto* is a fourth part of the *scotia*.

The *Astragal*, in *architecture*, is a little round member, in form of a ring, or bracelet; serving as an ornament at the tops and bottoms of *columns*.—The *astragal* is sometimes also used to separate the *fasciæ* of the *architrave*; in which case it is carved chaplet-wise, with beads and berries.—It is also used both above and below the *listel*, adjoining immediately to the square or dye of the *pedestal*.

The *Gula*, *Gueule*, or *Gola*, in *architecture*, is a wavemember, whose contours resemble the letter S.—This member is of two kinds, *recta* and *inversa*.—The first and principal has its cavity above, and convexity below. This always makes the top of the *corona* of the cornice, jetting over, the drip of the cornice like a wave ready to fall.—It is called *gula recta*, by the *French*, *doucine*.—The second is just the reverse of the former, its cavity being at the bottom; so that it appears inverted, with regard to the former.—This is used in the *architrave*, and sometimes in the cornice, along with the former, only separated by a *reglet*.

Some derive the word from the resemblance these members bear to the *gula*, or throat of a man: others from the herald's terms, *gules*; as supposing the moulding form'd from the ancient manner of wearing their garments, which consisted of slips

of swaths, alternately fur and stuff of various colours; the intervals between which were called *gules*, or *gules*.

The *Corona*, *crown*, or *crowning*, is a large, flat, massive member of the cornice; so called because it crowns not only the cornice, but the entablature, and the whole order.—The workmen call it the *drip*, as serving, by its great projecture, to screen the rest of the building from the rain.—Some *Latin* authors call it *supercilium*; and, as it should seem, by mistake *stilicidium*.—Certain *Latin* authors *mentum*, chin; from its keeping the weather from the parts underneath, as the *chin* does the sweat, &c. out of the neck.

Some call it absolutely the *cornice*, as being the principal member thereof.—*Vitruvius* frequently uses the word *corona* for the whole *cornice*.—The *corona* is itself crowned or finished with a *reglet* or *fillet*.—There are sometimes two *corona's* in a *cornice*, as in the *Corinthian* of the *Rotunda*.

The *Cavetto* is a hollow member or moulding, containing a quadrant of a circle, and having an effect just contrary to that of a *quarter-round*: it is used as an ornament in *cornices*.—Mr. *Filibien* observes, that the workmen confound the *cavetto* with a *scotia*, but to ill purpose; the *cavetto* being, in effect, only half a *scotia*: yet he himself is chargeable with the same oversight.—When in its natural situation, the workmen frequently call it *gula*, or *gucula*; and when inverted *gorge*; which *gorge* is a sort of concave moulding, concave in the upper part, and convex at bottom, more properly called *gula* and *cymatium*.

The *Abacus* is the uppermost member of a *capital* of a *column*, serving as a kind of crowning, both to the capital, and the whole *column*.

*Vitruvius*, and others after him, who give the history of the orders tell us, the *abacus* was originally intended to represent a square tile laid over an *urn*, or over a basket. An *Athenian* woman happening to place a basket thus covered, over the root of an *acanthus*; that plant shooting up the following spring, encompassed the basket all around, till meeting with the tile, it curled back into a kind of scrolls. An ingenious sculptor passing by, took the hint, and immediately executed a capital on this plan; representing the brick by the *abacus*, the leaves by the *volutes*, and the basket by the *vassa*, or body of the *capital*. Such was the rise of the first regular order.

There is some difference in the form of an *abacus* in different orders. In the *Tuscan*, *Dorick*, and ancient *Ionick*, it is a flat square member, well enough representing its original tile, whence the *French* call it *tailloir*, trencher. In the richer orders it loses its native form; its four sides or faces being

being arched, or cut inwards, with some ornament, as a rose, or other flower, or fishes tail, in the middle of each arch. But some *architeëts* take other liberties in the *abacus*, both in respect of its name, place and office. Thus in the *Tuscan order*, where it is the larger and more massive, as taking up one third of the height of the whole *capital*, it is sometimes called the *dye* of the *capital*. In the *Dorick*, it is not always the uppermost member of the *capital*; a *cymatium* being frequently placed over it. In the *Ionick*, some make it a perfect *ogee*, and crown it with a *fillet*.

The proportion of the *abacus*, as prescribed by *Vitruvius* (4. 1.) is short, is diagonal (from corner to corner) being twice its height, a rule which the moderns make no difficulty of dispensing withal.

**VOLUTE** is a kind of spiral scroul, used in the *Ionick* and *Composite capitals*, whereof it makes the principal characteristick and ornament. Some call it the *ram's-horn*, from its figure, which bears a near resemblance thereto. Most *architeëts* suppose that the ancients intended the *volute* to represent the bark, or rind of a tree, laid under the *abacus*, and twisted thus at each extreme where it is at liberty; others will have it a sort of pillow, or bolster, laid between the *abacus* and *echinus*, to prevent the latter being broke by the weight of the former, and the *entablature* over it, and accordingly call it *pulvinus*. Others after *Vitruvius*, will have it to represent the curls or tresses of a woman's hair. The number of *volute*s in the *Ionick order*, is four; in the *Composite*, eight. There are also eight angular *volute*s in the *Corinthian capital*, accompanied with eight other small ones, called *helices*.

**THE ACHANTUS** is only an ornament in the *Corinthian* and *Composite orders*; being the representation of the leaves of an *achantus* plant, in *English*, *bear's-foot*, in the capital thereof.

Over the *capital* is the **ENTABLATURE**; comprehending the *architrave*, *freeze*, and *cornice*. The *entablature* is also called the *trabeation*, and by *Vitruvius* and *Vignola*, *ornament*: It is different in the different orders: Indeed it consists of the three grand parts or divisions above-mentioned in all; but those parts consist of a greater or less number of particular members or sub-divisions, as the orders are more or less rich. *Vignola* makes the *Entablature* a quarter of the height of the whole column, in all the orders. In the *Tuscan* and *Dorick*, the *architrave*, *freeze*, and *cornice*, are all of the same height. In the *Ionick*, *Corinthian*, and *Composite*, the whole *entablature* being fifteen parts; five of them are allowed for the *architrave*, four for the *freeze*, and six for the *cornice*.

(E) **THE ARCHITRAVE** is that part of a *column*, which lies immediately upon the *capital*; the

*Greeks* call it *epistyle*. The *architrave* is the lowest member of the *entablature*. The *architrave* is supposed to represent the principal beam in timber buildings, whence the name which is formed of the *Greek*,  $\alpha\rho\chi\tau\epsilon\upsilon\sigma$ , Chief, and the *Latin*, *Trabs*, Beam.—The *architrave* is different in different orders.—In the *Tuscan* it only consists of a plain face, crowned with a *fillet*; and is half a *module* in height.—In the *Dorick* and *Composite*, it has two faces, or *fascia*; and three in the *Ionick* and *Composite*, in which last order, it is  $\frac{1}{2}$  of a *module* high.—*Architeëts* however take a deal of latitude in this part; some using more members than others; and many of them having two or three forms of *architraves*.—*Architrave* is also called the *raason-piece*, or *master-beam*, in timber buildings, as portico's, cloisters, &c.—In chimnies, it is called the *mantle-piece*; and over the jaumbs of doors or lintels of windows, *hyperthyron*.

(F) **THE FREEZE** or **FRIZE**, is that part of the *entablature* of *columns* between the *architrave* and *cornice*; and is properly a large flat face, or member, separating the *architrave* from the *cornice*.—The ancients called it *Zophoros*,  $\zeta\omega\phi\omicron\rho\omicron\varsigma$ , by reason it was usually enriched with figures of animals; and our denomination *freeze*, has a like origin, being formed of the *Latin*, *phrygio*, an embroiderer, because it is commonly adorned with sculptures in *basso relievo*, imitating embroidery.

The *freeze* is supposed to be intended to represent the heads of the transverse beams that sustain the roof or covering. In the *Tuscan order* it is quite plain. In the *Dorick*, enriched with *triglyphs*. In the *Ionic* it is sometimes made arched or swelling, in which case it is called by *VITRUVIUS*, *pulvinatus*, *q. d.* bolstered. In the *Corinthian* and *Composite*, it is frequently joined to the *architrave* by a little sweep; and sometimes to the *cornice*. And in these richer orders it is usually adorned with sculptures, figures, compartments, histories, foliages, festoons, &c.

As to the height of the *freeze*, it is, in general, much the same with that of the *architrave*. The *Tuscan freeze* *Vitruvius* makes 30 minutes: *Vignola*, 35; *Palladio*, who makes it swelling, gives it but 26; and *Scamozzi* 42. The *Doric*, in *Vitruvius* and *Vignola*, is 30 or 40 minutes; in *Palladio*, &c. 45. The *Ionick* *Vitruvius* makes flat, adorned with *achantus's* leaves, lions, &c. and makes it 30 minutes high: *Vignola* also makes it flat, gives it 45 minutes; and *Palladio*, who makes it convex or swelling, 27 minutes; and *Scamozzi*, 28. The *Corinthian*, *Vitruvius* enriches with *achantus's* leaves, human figures, &c. and makes its height, 37 minutes; *Vignola*, 45; *Palladio*, 28; and *Scamozzi* 35 $\frac{1}{2}$ . Lastly, The *Composite*,

*Composite*, which in *Vitruvius* is set with cartoozes, and carved between them, is  $34\frac{1}{2}$  minutes; *Vignola*, who makes it like *Vitruvius's* only gives it 45 minutes; *Palladio*, who makes it swelling, only 30; and *Scamozzi* 32.

From the variety of the enrichments of the freeze, they become variously denominated, as

*Convex* or *pulvinated* FREEZES are those whose profile is a curve, the best proportion whereof is when drawn on the base of an equilateral triangle.—In some, the swelling is only a top, as in a console: in others a bottom, as in a balluster.

*Flourished freezes*, are those enriched with rinds of imaginary foliages; as the *Corinthian freeze* of the frontispiece of *Nero*; or with natural leaves, either in clusters or garlands; or continued, as in the *Ionick* of the gallery of *Apollo* in the *Louvre*.

Historical freezes are those adorned with *basso relievo's* representing histories, sacrifices, &c. as that of the arch of *Titus* of *Rome*.—*Marine freezes*, are those representing sea-horses, Tritons, and other attributes of the sea; or shells, baths, grotto's, &c.—*Rustick freezes*, are those whose courses are rusticated or imbossed; as the *Tuscan freeze* of *Palladio*.—*Symbolical freezes* are those adorned with the attributes of religion; as the *Corinthian* of the temple, behind the capitol at *Rome*, whereon are represented the instruments and apparatus of sacrifice.

The uppermost member of the entablature of a column, or that which crowns and finishes the order, is called CORNICHE (g) or CORNICE, from the *Latin coronis*, a crowning. The cornice is the third grand division of the trabeation, commencing from the freeze, and ending with the cymatium.

The cornice is different in the different orders: In the *Tuscan order* it is most plain. *Vignola* makes it consist of an ovum, or quarter-round; an astragal, a fillet, a larmier, and a talon. In the *Dorick*, he uses capitals to the triglyphs of the freeze, with their bandelettes, a talon, mutules or dentils, a larmier, with its guttæ underneath, a talon, fillet, cavetto and reglet. In the *Ionick* the members are in most respects the same as in the *Dorick*, except that they are frequently enriched with carving, and there are always dentils. In the *Composite*, there are dentils; its mouldings are carved, and there are channels under the soffit. The *Corinthian cornice* is the richest; and is distinguished by having both modillions and dentils; contrary to the opinion of *Vitruvius*, who looks on those two ornaments as incompatible; and of Mr. *Le Clerc*, who regards the dentils as peculiar to the *Ionick*.

For the heights and projectures of the cornices in the several orders, *Goldman* makes the height of the *Tuscan*  $1\frac{1}{2}$ , its projecture  $2\frac{2}{3}$  modules: the height of the *Dorick*  $1\frac{1}{2}$ , its projecture  $2\frac{2}{3}$ ; height of the *Ionick*  $1\frac{1}{2}$ , its projecture  $2\frac{2}{3}$ ; height of the *compo-*

site  $1\frac{1}{2}$ , projecture  $2\frac{2}{3}$ ; height of the *Corinthian*  $1\frac{1}{2}$ , projecture  $2\frac{2}{3}$ .

There are different sorts of cornices; viz. *architrave cornice*, which is that immediately contiguous to the *architrave*, the freeze being retrenched. *Mutilated cornices*, whose projecture is omitted, or else interrupted, right to the larmier, or reduced into a plat-band with a cymatium. *Cantiliver cornice*, a term used by the workmen for a cornice that has cantilivers underneath it. *Modillon cornice*, a cornice with modillions under it. *Coving cornice*, a cornice which has a great casement or hollow in it; ordinarily lathed, and plaistered upon compasses, sprokets, or brackets.—*Cornice* is also used in general, for any little projecture, either of Masonry or Joinery, even where there are no columns. Thus we say, the cornice of a chimney, a beaufet, &c.

*Cornice* is also applied to the crowning of pedestals. This cornice is different in the different orders: in the *Tuscan*, according to Mr. *Perrault*, it has a platband which serves as a corona, and a cavetto, with its fillet. In the *Dorick* it has a cavetto, with a fillet, which bears a drip, crowned with a square. In the *Ionick*, a cavetto, with its fillet above, and a drip or pendant square, crowned with an ogee and its fillet. In the *Corinthian*, an ogee with its fillet, a cymatium under the corona, which it hollows to make a drip, a corona, and an ogee with its fillet. Lastly, in the *Composite*, a fillet with a sweep over the dye, and astragal, cyma with its fillet, corona, and ogee, with its fillet.

We have so often mentioned FASCIA'S or FASCIAE, that it is not improper to observe here, that *Fascia*, in *architecture*, is a broad list, fillet, or band; particularly used in *architraves* and *pedestals*.

The *architrave* consists of three fascia's or bands; thus called by *Vitruvius*, as resembling fwaths, called in *Latin*, *fascia*.—That author admits no fascia in the *Tuscan order*, and *Dorick architrave*, i. e. he makes all plain, without any division, or cantoning into parts or fascia; but the modern architects take liberty to differ from him herein. In brick buildings, the juttings out of the bricks, beyond the windows in the several stories, except the highest, are called fascia's or fasciae.—These are sometimes plain and sometimes moulded; but the moulding is only a cyma reversa, or an O. G. at the bottom, with two plain courses of bricks over it, then an astragal, and lastly a boutine; which boutine, or boltel, is the workmen's term for a convex moulding, whose periphery is just  $\frac{1}{2}$  of a circle; placed next below the plinth, in the *Tuscan* and *Dorick CAPITAL*.

Thus we have carried the column, to its uppermost extremity, and crowned the whole order; but we have left it without a pedestal, which is the lowest

lowest part of an order of columns; being that which sustains the column, and serves it as a foot, or stand.

(H) The PEDESTAL (from the *Latin*, *pes*, a foot, and *συλῶς*, column) consists of three principal parts; viz. a square trunk or dye, which makes the body; a cornice the head; and a base the foot of the pedestal. The pedestal is properly an appendage to a column, not an essential part thereof; though Mr. *Le Clerc* thinks it is essential to a complete order.

The proportions and ornaments of the pedestal are different in the different orders: *Vignola*, indeed, and most of the moderns, makes the pedestal, and its ornaments in all the orders, one third of the height of the column, including the base and capital: but some deviate from this rule. Mr. *Perrault* makes the proportions of the three constituent parts of pedestals, the same in all the orders, viz. the base one fourth of the pedestal; the cornice, an eighth part; and the socle or plinth of the base two thirds of the base itself. The height of the dye is what remains of the whole heights of the pedestal.

(h 1) *Tuscan* PEDESTAL, is the simplest, and the lowest. *Palladio* and *Scamozzi*, make it three modules high; *Vignola* 5. Its member, in *Vignola*, is only a plinth for a base, the dye and a talon crowned, for a cornice. It has rarely any base. *Dorick* pedestal, (h 2) *Palladio* makes four modules, five minutes high; *Vignola* five modules four minutes. In the antique, we not only do not meet with any pedestals; but even not with any base in the *Dorick* order. The members in *Vignola's* *Dorick* pedestal, are the same with those in the *Tuscan*, with the addition of a mouchette in its cornice. (h 3) *Ionick* PEDESTAL in *Vignola* and *Serlio*, is six modules high; in *Scamozzi*, five; in the temple of *Fortuna virilis*, it is seven modules, twelve minutes. Its members and ornaments are mostly the same with those of the *Dorick*, only a little richer. The pedestal now usually followed, is that of *Vitruvius*; though we do not find it in any work of the antique. Some in lieu hereof use the *Attick* base, in imitation of the antient.

The *Corinthian* PEDESTAL (h 4) is the richest and most delicate. In *Vignola*, it is seven modules high; in *Palladio*, five modules one minute; in *Serlio*, six modules, fifteen minutes; in the *Coliseum*, four modules, two minutes. Its members, in *Vignola*, are as follows: in the base, are a plinth for a socle, over that a tore carved; then a reglet, gula inverted and enriched, and an astragal. In the dye are a reglet, with a *conge* over it, and near the cornice a reglet with a *conge* underneath. In the cornice is an astragal, a freeze, fillet, astragal, gorge, talon, and a fillet.

In *Vignola* the Composite PEDESTAL is of the same height with the *Corinthian*, viz. seven modules; in *Scamozzi*, six modules, two minutes; in *Palladio*, six modules, seven minutes; in the goldsmiths arch, seven modules, eight minutes. Its members in *Vignola*, are the same with those of the *Corinthian*; with this difference, that whereas these are most of them enriched with crownings in the *Corinthian*, they are all plain in the *Composite*. Nor must it be omitted, that there is a difference in the profiles of the base and cornice in the two orders. *Daviler* observes, that the generality of Architects use tables or pannels, either in *relievo*, or creux, in the dyes of pedestals; without any regard to the character of the order. He observes farther, that those in *relievo*, only fit the *Tuscan* and *Dorick*; the three others must be indented; which, he adds, is a thing the antients never practised, as being contrary to the rules of solidity and strength.

There are besides, square, double, and continued pedestals. *Square* pedestal, is that whose height and width are equal. As that of the arch of the *Lions* at *Verona*, of the *Corinthian* order; and such, some followers of *Vitruvius*, as *Serlio*, *Philander*, &c. have given to the *Tuscan* order. *Double* pedestal, is that which supports two columns, and is more in width than height. *Continued* pedestal, is that which supports a row of columns, without any break or interruption; such is that which sustains the fluted *Ionick* columns of the *Tuilleries*, on the side of the garden.

The DYE, is the trunk of the pedestal, or that part between the base and the cornice; being so called, because it is frequently made in the form of a cube.

There are two ways of determining the measures or proportions of buildings.

The first by a fixed standard measure, which is usually the diameter of the lower part of the column, called a *module*, subdivided into 60 parts called *minutes*.

A *minute* denoting a 60th, and sometimes only a 30th part of a division of a *module*.

*Vignola* divides his *module*, which is a semi diameter, into twelve parts, in the *Tuscan* and *Dorick*; and into eighteen for the other orders. The *module* of *Palladio*, *Scamozzi*, *M. Cambray*, *Des Godetz*, *Le Clerc*, &c. which is also the semi-diameter, is divided into thirty parts or minutes, in all the orders.

In the second there are no minutes, nor any certain and stated division of the *module*; but it is divided occasionally into as many parts as are judged necessary. — Thus the height of the *Attick* base which is half the *module*, is divided, either into three,

three, to have the height of the *plinth*; or into four, for that of the greater *torus*; or into six for that of the lesser. —

Both these manners have been practised by the ancient as well as the *modern Architects*; but the *second*, which was that chiefly used among the *antients*, is, in Mr. *Perault's* opinion, preferable to all others.

As *Vitruvius*, in the *Dorick* order, has lessened his *module*, which in the other orders, is the diameter of the lower part of the column; and has reduced that *module* to a mean one, which is a *Semi-diameter*: Mr. *Perault* reduces the *module* to a third part for the same reason, *viz.* to determine the several measures without a fraction. — For in the *Dorick* order, besides that the height of the base, as in the other orders, is determined by one of these mean *modules*; the same *modules* give, likewise, the heights of the capital, architrave, triglyps, and metopes. — But our little *module* taken from the third of the diameter of the lower part of the column, has uses much more extensive; for by this the heights of *pedestals*, of columns, and entablatures, in all the orders, are determined without a fraction. — As then the great *module* or diameter of the column has 60 minutes; and the mean *module*, or half the diameter 30 minutes; our little *module* has 20.

There are a few ornaments, which we had almost forgot mentioning, as the *triglyphs*, and *metopes*, both repeated, only in the *Dorick* freeze; the *triglyphs* at equal intervals. — Each *triglyph* consists of two entire gutters or channels, cut to a right angle, called *glyphes*, and separated by three interstices, called by *Vitruvius*, *femora*, from each other, as well as from two other half channels, which are at the sides.

The ordinary proportion of *triglyphs*, is to be a *module* broad, and one and a half high. — But this proportion Mr. *Le Clerc* observes, sometimes occasions ill-proportioned intercolumnations in portico's; for which reason he chuses to accommodate the proportion of his *triglyphs*, to that of the intercolumns.

The intervals between the *triglyphs* are called *metopes*, which the antients used to adorn with carved works or paintings, representing the heads of oxen, vessels, basons, and other utensils of the heathen sacrifices.

As there is found some difficulty in disposing the *triglyphs* and *metopes* in that just symmetry which the *Dorick* order requires; some Architects make it a rule never to use this order but in temples. *Semi-metope*, is a space somewhat less than half a *metope*, in the corner of a *Dorick* freeze.

The *triglyphs* make the most distinguishing cha-

rafter of the *Dorick* order. Some imagine them originally intended for the conveyance of the *gutta* that are underneath them: Others fancy they bear some resemblance to a lyre, and thence conjecture the ornament to have been originally invented for some temple dedicated to *Apollo*.

We'll now proceed to the FIVE different ORDERS of Architecture, *viz.* *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, and *Composite*.

The *TUSCAN* order is the first, simplest, and most massive of the *five orders*. It is called by *Vitruvius*, the *rustick* order, to be used, properly, in country houses and palaces; in *Vignola's* manner of composition, it is a beauty, even in its simplicity, and as such should find place, not only in private edifices; but likewise in publick ones, as in the *piazza's* of squares and markets; in the magazines and granaries of cities, and even in the offices and lower apartments in palaces.

Of all the orders the *Tuscan* is the most easily executed, as having neither *triglyphs*, nor *dentils*, nor *modillions* to cramp its inter-columns. On this account, the columns of this order may be ranged in any of the five manners of *Vitruvius*, *viz.* the *Pycnostyle*, *Systyle*, *Eustyle*, *Diastyle*, or *Aræostyle*.

The *Tuscan* order takes its name from an antient people of *Lydia*, who coming out of *Asia* to people *Tuscany*, first executed it in some temples which they built in their new plantations.

*Palladio* gives us these instructions for the *Tuscan* order; that the column (See *Plate* iv. 1) together with its base, (a 1) and capital (c 1) must be seven *modules* in length, and its diminution a fourth part of its bigness. That if a work is to be composed of this plain order, the intercolumnations should be very wide, because the architraves are made of timber, which, therefore, will be very commodious for country buildings, on account for the easy passage for carts and other country conveniences.

The same author observes that the *pedestals*, (h 1) which are under this order, must be very plain and simple, and the height of a *module*; and that of the base of the column, half its diameter. That this height must be divided into two proportional parts, one whereof is to go to the *plinth*, which is round; and the other subdivided into four parts, one whereof is appropriated to the *listella* or fillet, which is sometimes made a little less. That in this order only the *listella* makes a part of the *base*; and a part of the column in all the others; the other three parts being appropriated to the *torus*. That this base ought always to project a sixth part of the diameter of the column. That the height of the capital is half the diameter of the lower part of the column,

column, and is divided into three proportional parts; the first applied to the *abacus*, which, from its form, is generally called *dado*, or a *dye*; the second to the *ovolo*; and the third subdivided into seven parts, the *listella* under the *ovolo*, being one of them, and the other remaining six are applied to the *collorino*, or neck of the column. The *astragal* (says he) is twice the height of that of the *listella*, under the *ovolo*; and its centre is made on the line, which falls perpendicular from the *listella*, the projecture of the *cincture*, which is as thick as the *listella*, falls directly upon it. The projecture of this *capital* corresponds with the shaft of the column below: Its *architrave* (e 1) is composed of timber, the height whereof must be equal to its breadth, and its breadth must never be greater than the shaft of the column at top. The joists, which are instead of the *guttæ* or *drip*, project a fourth part of the length of the column. The profiles on the side of the plan of the base and capital are the impost of the arches.

But, continues he, if the architraves are composed of stones, you must observe what I have already mentioned, with respect to the intercolumnations; and which is the same mentioned at the beginning of this treatise.

*Mauclerc* will have the height of the *Tuscan column*, divided into nine parts; two whereof are for the *stilobate*, or *pedestal*; and those two subdivided into six parts; one to be applied to the inferior *cymatium*, one to the superior, and the four remaining to describe a square, intersected by two diameters or diagonal lines. In that square he would have a circle made, and another square in that circle, which inward square will be the swelling of the lower part of the column, and the outward one the breadth of the plinth of the base. He will have the swelling at top to be the middle square, which is to be divided into eight parts, two whereof will be the diminution of the column. The projecture of the *cymatium* of the plinth he divides into six parts; one to project out, in which he places the square. He also divides the *base* of the column into two parts, one whereof to be the *plinth*, and the other to be subdivided into four, one for the *tailloir* over the *listel*, and one of the remaining three to be divided into two, one whereof for the *reglet*, or *fillet*, under the *cornice*, which is to project out square-like. Thereby, says he, the whole projecture will be the seventh part of the breadth of the *pedestal*.

In his opinion, the upper *cymatium*, otherwise called the *cornice* of the *pedestal*, is to be divided into four parts; one to be applied to the *listel*, or *talcar*, two to the *plinth*, and the fourth to the *astragal*, or *fillet*; so that the *astragal* might be

twice larger than the *fillet*. The *base* of the column is to be divided into two parts; one for the *plinth*, (D 1) and the other subdivided into three; two whereof to be applied to the *torus*, and the third to the *fillet*; so that its whole projecture is the interval from the exterior square to the interior. The projecture of the *fillet* must be a square from the column, and the rest is given to the *torus*. The height of the *rust* of the column must be six parts of its breadth, with its *cymatium* and capital. The height of the capital must be half the breadth of the lower part of the *shaft* or *fust* of the column, and is to be divided into three parts, one whereof to be given to the *abacus*, the second to the *torc*, and the third to the *freeze*. The *torc* being divided into four parts; one is given to the *fillet*, and the rest makes up the *torus*. The *freeze* (f 1) is divided into two, one for the breadth of the *astragal*, and this to be subdivided into three, one for the *fillet*, and the two others for the *astragal*. The eighth part of the breadth of the *fust* of the column below will be the projecture of the *capital*. He gives the following directions for the diminution of the column.

The length of the column between its two *cymatiums*, is to be divided into six parts, two thereof for the lower part of the column, and make a third of its height. Having made the division from the bottom to the top, transversal lines are to be drawn on each side, and the compass applied from one end to the other of the line of the third part; the compass placed on the side, the circle is to be divided from one of the sides of its semicircle to that part, where the line falls perpendicularly for the higher scope of the column, to the six parts of the *ichnography* on the *pedestal*, where they cut the *semicircle* on the left, into four parts. Likewise, from each part must be drawn a line upwards, beginning outwards, and proceeding to the sixth part of the *fust*; from the second and third of these lines thus conducted, must be drawn those for the diminution of the column. But to render the diminution more just, and agreeable to the eye, he advises, that instead of dividing the circle into four parts, it is better to divide that same space, together with the column, into 5, 6, 7, or 8, since the great number of divisions renders always the diminution more agreeable and perfect.

*Vitruvius*, lib. 3. c. 12. gives other instructions for the diminution of these columns, and will have the lower diameter of a *Tuscan* one, in which is 16 feet in height from the *base* to the *capital*, divided into six parts, allowing five for the top. Those from 15 to 20 feet, their lower diameter is to be divided into six parts and a half, five and a

half for the top. From 20 to 30, the diameter is divided into seven parts and a half, six and a half whereof are to be given to the top. But from 40 to 50, the diameter must be divided into eight parts, allowing seven to the top, from whence will issue a handsome *diminution*.

The same author divides the *architrave*, which he makes half the breadth of the lower part of the column, into six parts, one he gives to what he calls the superior cornice, and subdivides that also into three, one for the fillet, and the two others for the left *talon*; but the other five remaining parts of the *architrave*, he subdivides into nine, five whereof he gives to the superior *fascia*, and the four remaining to the inferior, the whole with its projecture. He also makes the height of the freeze half the breadth of the lower part of the column. Over the freeze he places the cornice, of an equal altitude with the freeze, whose projecture on the left side, is equal to its height; and is to be divided into four parts, one for the *talon*, subdivided into three, one thereof for the *fascia*, and the two others for the *talon*; but of the three parts remaining of the cornice, one he gives to the *echine*, and to the fillet, and this he subdivides into four, one for the fillet, and three for the *echine*, and the two parts remaining of the first three, are for the projecture, which is equal to the height.

Others divide the height given for this whole order, into ten several parts, take two for that of the *pedestal*, and divide the remaining eight parts into five, one whereof for the altitude of the *entablature*, and the other four for the length of the column, the *base*, and the *capital* included; so that the entablature is by that means, made one fourth of the length of the column.

Having divided the entablature into seven parts, they apply two to the *architrave*, two to the *freeze*, and two to the *cornice*: making of four of these parts, the diameter of the column.

They divide the altitude of the *pedestal* (h 1) into six parts; two for the *base* and *plinth*; three for the altitude of the *dye*; and one for that of the *cap*.

In order to find out the breadth of the *dye*, the diameter of the column is divided into five parts, and seven such parts is the breadth, and is likewise, the projecture of the base of the column.

The *base* of the *pedestal* is found by the division of the two parts allotted for the *base* and *plinth*, into three, allowing one to the *base* and two to the *plinth*. The projecture of the *cap* and *base* of the *pedestal* is equal to the altitude of the said base.

In order to diminish the shafts of the column, they will have its diameter taken with compasses,

and find it six times contained between the *base* and the *capital*; at two of which from the *base*, they make a semi-circle; then let fall a perpendicular from the diameter at top, and cut the semi-circle at four; after that divide the part of the semi-circle, so cut off into four parts (because four parts of the *shaft* remain above) and raise perpendiculars from the said points, to the correspondent division, which will form a regular curve for the swelling.

The altitude of the *base* of the column, is half a diameter, and is divided into two, allowing one to the *plinth*, the other part is divided into four, giving one to the *fillet*, and three to the *torus*. The whole projection is one fifth of the diameter of the column, and the fillet projects equal to its altitude.

For the several and respective members of the *pedestal*, *base*, *plinth*, and *cap*, they divide the base into three, allowing one to the *fillet* and three to the *hollow*.

They divide the altitude of the *cap* into four, allowing one to the *ogee*, two to the *corona*, and one to the *band* at top. For the projections, they make them both equal to the altitude of the *base*, and both being divided into three parts, they conceive, by inspection, the projecture of the several members.

Having shewn the whole altitude of the *entablature* to be one diameter, and three fourths, and set off the principal height of the *architrave*, *freeze*, and *cornice*; as for the particular members, they divide the *architrave* into six parts, allowing two to the first *fascia*, three to the second, and one to the band at top. They make the projection equal to the altitude of the first band, and give one third to the second *fascia*.

They divide the altitude of the *cornice* into nine parts (*i. e.* each principal third into three) allowing one and a half to the *hollow*, half to the *fillet*, one and a half to the *ovolo*, two to the *corona*, half to a *fillet*, two to the *scima recta*, and one to the upper *fillet*. They make again the projection equal to its altitude, and to contain the same divisions, pretending the several divisions to be obvious by the inspection of the scales only.

They make the *capital* half a diameter in height, and divide it into three parts, allowing one to the freeze of the *capital*, another to the *ovolo* and *fillet*, which is one fourth, and the other part to the *atacus*. Thereby the projection is one eighth of the diameter, which gives likewise the diameter of the column at top. The fillet is equal to the height.

The *astragal*, or *collovino*, is one third of the said freeze of the capital in height, and the fillet the

the height thereof, and is equal to the height in its projection.

In the *Tuscan cornice*, (g 1) as well as in all others, they preserve the principal divisions, both with respect to the height and projection, and introduce them again, with no other intent but to corroborate the rules, and to shew the method of forming the several and respective mouldings, and which they suppose discernable by inspection.

THE DORICK is the second of the FIVE ORDERS, being that between the *Tuscan* and *Ionick*.

As for the invention of the *Dorick order*, the tradition is, that *Dorus*, king of *Achaia*, having first built a temple of this order at *Argos*, which he dedicated to *Juno*, occasioned it to be called *Dorick*; though others derive its name, we know not how, from its being invented or used by the *Dorians*.

'Tis the most natural and the best proportioned of all the orders; all its parts being founded on the natural position of solid bodies.—At its first invention it was more simple than at present; and when in process of time they came to adorn and enrich it more, the appellation *Dorick* was restrained to its richer manner, and the primitive simple manner, they called by a new name, *Tuscan Order*.

Some time after its invention they reduced it to the proportion, strength and beauty of the body of a man. Hence, as the foot of a man was judged the sixth part of its height, they made the *Dorick* column, including the *capital*, six diameters high, *i. e.* six times as high as thick.—Afterwards they added another diameter to the height, and made it seven diameters; with which augmentation, it might be said to be near the proportion of a man: the human foot, at least in our days, not being a sixth, but nearly a seventh part of the body.

The characters of the *Dorick order*, as now managed, are the height of its column, which is eight diameters; its freeze, which is enriched with *triglyphs*, *drops*, and *metopes*; its *capital*, which is without *volutes*, and its admitting of *cymatiums*.

*Vitruvius* complains of the *Dorick*, as very troublesome and perplexing, on account of the *triglyphs* and *metopes*, so as scarce to be capable of being used, except in the *pycnostyle*, by putting a *triglyph* between two columns; or in the *araostyle*, by putting three *triglyphs* between each two columns.

The moderns, on account of its solidity, use it in large, strong buildings; as in the gates of cities and citadels, the outsidcs of churches, and other massy work, where delicacy of ornament would be unsuitable.

*Vignola* adjusts the proportions of the *Dorick ORDER*, thus: the whole height of the order, with-

out *pedestal*, he divides into twenty parts or modules; one of which he allows the *base*, fourteen to the *shaft* or fust, one to the *capital*, and four to the *entablature*.

*Palladio* will have the *module* of this *order* to be but half the diameter of the column, divided into thirty minutes, whercof in the other orders, he makes it the whole diameter, divided into sixty.

The same author will have the *Dorick column*, if insular without piers, to be eight diameters in length, or seven and a half at least; and seventeen *modules*, and a third (including the *base* and *capital*) when joined to piers.

He observes, that when a *pedestal* (h 2) is to be joined to this *order* (which he says was not the custom of the ancients) the *dado* or *dyc*, must be square, from whence the measure of its decorations must be taken; therefore he divides it first, into three proportional parts, allowing two for the *base* and its *plinth*, and the third for the *cymatium*, whereto the *plinth* of the *base* of the column must be joined.

He supposes no peculiar *base* (a 2) to this order, which is the reason he gives for these columns being found without bases in several buildings, as the theatre of *Marcellus* at *Rome*; the temple *de la Pieta*, adjacent to it, the theatre of *Vicenza*, &c. but pretends the *Attick base* to be a great ornament to it.—He then proceeds to give us the exact measures thereof.—He will have its height half the diameter of the column, and divided into three proportional parts; one for the *plinth*, and the other two subdivided into four proportional parts; one for the upper *torus*, the other three subdivided again, into two proportional parts; one whereof is the lower *torus*, and the other the *cavetto*, with its *listella's*.—He also gives these their particular measure, and divides them into six parts; the first for the upper *listella*, the second for the lower, and the four others for the *cavetto*.—He makes the whole projecture, the sixth part of the diameter of the column, and the *cincture* half the upper *torus*.—In case he divides it from the *base*, he makes its projecture a third of that of the *base*; but in case the *base* and part of the column make one perfect piece, he will then have its *cincture* small.

The *capital*, (b 2) says he, must be half the diameter of the column, and divided into three parts, the first whereof subdivided into five parts, of which three are for the *abacus*, and the other two for the *cymatium*; which being subdivided into three parts, the first goes to the *listella*, and the two last to the *cymatium*.—The second principal part he subdivides into three proportional parts; one for the annulets or squares, which are all proportional; the other two for the *ovolo*, the projecture whereof he

makes two thirds of its height; allowing the third principal part for the *collorino*, so that the entire projecture must be the fifth part of the diameter of the column.

He makes the height of the *astragal* proportional to the three *listella's*, and to project to the lower part of the shaft of the column; and the *cincture* half the height of the *astragal*, and its projecture direct with its center.—The architrave (e 2) raised upon the capital, and whose height must be half the diameter of the column, (b 2) he divides into seven parts, one for the *tenia* or *fillet*, whose projecture is proportional to its height, and afterwards subdivides the whole into six parts, one for the *guttæ*, of which there must be six, and the *listel* under the *tenia*, which he makes a third part of the *guttæ*.—The remainder from the *tenia* downwards, he subdivides into seven parts; three of them for the first *fascia*, and the other four for the second.—He makes the freeze (f 2) a *module* and a half high, the breadth of the *triglyph* a *module*, and its *capital* the sixth part. The *triglyph* he divides into six parts; two whereof are for the two channels in the middle, one for the two half channels at the ends, and three for the spaces between the said channels. He'll have the *metope*, which is the space between the *triglyphs*, a perfect square.—He'll have also the *cornice* (g 2) a *module*, and a sixth in height, and divided into five parts and a half, two for the *cavetts* and *ovolo*, (the *cavetto* to be less than the *ovolo*, and exactly as much as its *listella*) the other three and a half for the *corona*, and both the *imbas*, the *recta*, and the *reversa*.

He makes the projecture of the *corona*, two thirds of a *module*, and in the face thereof, which looks downwards, and projects along the *triglyphs*, places six *guttæ* in length, and three in breadth, with their *listella's*, and some *roses* over the *metope*. The *guttæ* are round in the form of bells, and answer to those under the *tenia*. The body of the *cymatium* is one eighth larger than the *corona*, and is divided into eight parts, two for the *plinth*, and six for the *cymatium*, the projecture whereof is seven and a half: so that the altitude of the *architrave*, the *freeze* and *cornice*, are a fourth part of the height of the column.

Most of the *Architects* divide the altitude given for this whole order, first into ten parts, allowing two to the *pedestal*, and dividing the remaining eight parts into five; then give four to the length of the column, including the *base* and *capital*, and reserve the other one for the entablature, which they divide into four parts, two whereof they make the diameter of the column: thus the column will be eight diameters high, and the *entablature* one fourth of the length of the column. Having di-

vided the architrave into four, they give one to the architrave, one and a half to the *freeze*, and one and a half to the *cornice*. They make the *architrave* to project one sixth of its height, and the *cornice* a diameter of the column; that is to say, four such parts as it is three in height. The height of the *pedestal* they divide into seven parts, allowing two to the *base* and *plinth*, four to the *dado*, or *dye*, and one to the *cap*.

They diminish the column one sixth of the diameter, from one third of the length of the *shaft* or *fust*; and say, that if the diameter at bottom be divided into five, the *base* of the column will project, on each side, one of these parts, which will give the breadth of the *dado* of the *pedestal*, and by that means make it a square. They make the *base* of the *pedestal* one third of the two parts for the *base* and *plinth*, and its projection equal to the height, and the *cap* to project four fifths of the height.

They make the height of the *base* of the column half the diameter, and the projection to give the breadth of the *pedestal*, which is a diameter, and two fifths.

For the particular members of the *pedestal* they divide the height of the *base* into six, giving three to the *torus*, one to the *fillet*, and two to the *hollow*, pretending that the projection being the same parts, each member is easy to set off by inspection. They divide the *cap* into five parts, giving one to the *hollow*, half a part to the *fillet*, one and a half to the *ovolo*, one and a half to the *corona*, and half a part to the *fillet* at top; therefore the projection must have four of these parts.

The height of the *base* of the column they divide into three parts, one for the *plinth*, the half of another for the upper *torus*, and the half of the remainder for the lower *torus*; then the remaining three fourths are divided into six, one for each *fillet*, and four for the *scotia*. They make the whole projection one fifth of the diameter, and dividing it into three, they give one to the upper *fillet*, which is part of the column, and is double the height of the others, and another to the upper *torus*.

They make a *Dorick fluted column* (b 2) with twenty in number, fluted to an edge, some making their form or depth by the center, being in the middle of a square; others by the joint of an equilateral triangle.

Having made the whole height of the *entablature* two diameters, they divide it into four, one for the *architrave*, one and a half for the *freeze*, and one and a half for the *cornice*. As for the particular members they divide the *architrave* into six; two for the first face, three for the second, and one for the band at top. They allow one of these parts to the *guttæ* or bells, and a third thereof to their *fillet*;

as well as to the projection. They adorn the *freeze* with *triglyphs*, which are half a diameter in breadth, one whereof they place in the middle of the column, and make the *metope*, or place between, equal to the height of the said *freeze*. They, afterwards, divide the *triglyphs* into twelve parts, allowing one to each half channel, two to each whole channel, and two to each of the space between the channels. They make the projection of the *triglyph* one and a half of these parts.

They divide the height of the *cornice* into three, and divide again the lower part into three; one gives the *cap* of the *triglyph*, one the *hollow* and *fillet*, (which is one fourth) and the other the *ovolo*. The other two parts they divide into seven, allowing two to the *mutule* and *cap*, two to the *corona*, one to the *scima reversa* and *fillet*, and two to the *scima recta* and *fillet*, and discover the smaller divisions by inspection.

As to the *projections*, the whole being four such parts as the three in height, they divide again the first of them into three, allowing one to the cap of the *triglyph*, another to the *cavetto*, and the other to the *ovolo*. The outer part they subdivide likewise into seven, which regulate the *scima* and *corona*.

The height of the *capital* they divide into three, one gives the *freeze* of the *capital*, another the *fillets* and *ovolo*, and the third the *abacus*, *scima reversa* and *fillet*; but to be more particular, the middle part is divided into three, allowing one to the *fillets*, which are three, and equal, or (as on the other side) one to a *fillet*, and two to an *astragal*; the upper third part they divide into five, allowing three to the *abacus*, and two to the *scima reversa* and *fillet*, which is one third. They make the projection equal to the height of the *freeze*, and *fillets* together, and from its being divided into four, expect the rest to be seen at once.

To regulate the *intercolumnations* in the *Dorick* order, it must be done according to the number of *triglyphs* intended between, allowing for one *triglyph* between, one diameter and a half; for two *triglyphs* two and three fourths, and for three *triglyphs* four diameters.

The IONIC COLUMN (b 3) is the third in order, and is distinguished from the *Composite*, in that it has none of the leaves of the *acanthus* in its *capital*; from the *Tuscan*, *Dorick* and *Corinthian*, by the *volutes* or rams-horns, which adorn its *capital*; and from the *Tuscan* too by the channels, or flutings in its *shaft*.

The IONIC ORDER owes its origin to *Ionia*, a province of *Asia*, and it is said the temple of *Diana* at *Ephesus*, the most celebrated edifice of all antiquity was of this order. The *Ionic* has an advan-

tage above any of the rest; and it consists in this, that the fore and hind parts of its *capital* are different from its sides. But this is attended with an inconvenience, when the ordonnance is to turn from the front of the building to the sides; to obviate which, the *capital* may be made angular, as is done in the temple of *Fortuna Virilis*.

This *column* is a medium between the massive and delicate orders, the simple and the rich. Its height is eighteen *modules*, or nine diameters of the column taken at the bottom. When it was first invented its height was but sixteen *modules*; but the ancients, to render it still more beautiful than the *Dorick*, augmented its height by adding a *base* to it, which was unknown in the *Dorick*.

M. Le Clerk makes its *entablature* four *modules* and ten minutes, and its *pedestal* (h 3) six entire *modules*; so that the whole order makes twenty-eight *modules* and minutes.

*Palladio* will have this column with its *capital* (c 3) and *base* (a 3) nine *modules* high, (making the *module* a diameter of the column below.) Its *architrave*, (e 3) *freeze*, (f 3) and *cornice*, (g 3) are a fifth part of the height of the column, and the *intercolumnations* two diameters and a quarter, which he believes the most commodious, and the most fit to strike the eye agreeably.

In the *arches* where the *Ionic columns* are to have *pedestals*, he makes their height equal to half the breadth of the opening of the arch, and divides it into seven parts and a half, two for the *base*, one for the *cymatium*, and the other four and a half for the *dado*. He makes the *base* of the *Ionic order* half a *module* thick, and divides it into three parts, one for the *plinth*, the projection whereof is the fourth, and an eighth part of the *module*, dividing the other two into seven parts, three whereof he gives to the *torus*, subdividing the other four into two parts, one for the upper *cavetto*, and the other for the lower *cavetto*, which ought to have the greatest projection. He has the *astragals*, the eighth of the *cavetto*, the *cincture* of the column the third part of the *torus* of the *base*, provided the *cincture* be not joined to the *base* of the column; for in that case he makes it smaller, making its projection half of that above mentioned.

To make the *capital*, he divides the diameter at the *base* of the column into eighteen parts, and nineteen of such parts make the length and breadth of the *abacus*, one half whereof is the height of the *capital*, with its *volutes*, whence its height must be nine parts and a half; one and a half whereof is for the *abacus* with its *cymatium*, and the other eight for the *volutes*, which he makes after this manner.

He takes one of the nineteen parts from the end

of the *cymatium*, inward, and from the point made, he lets down a plum-line to divide the *volute* in the middle. Where the point falls upon this line, which separates the four parts and a half above, from the three and a half below, the centre of the *volute* is made, whose diameter is one of the eight parts; and from the aforesaid point he draws a line, which as it cuts the *catbeto* at right angles, divides the *volute* into four parts. Then he makes a square in the eye of the *volute*, about the same bigness as the semi-diameter of the same eye; and drawing diagonal lines, he marks the points upon them, where the fixed foot of the compass must stand to make the *volute*; which points or centers are thirteen in number, the eye inclusive. He places the *astragal* of the column in a direct line with the eye of the *volute*. He makes the thickness of the *volute*, in the middle, in proportion to the projecture of the *ovolo*, which must project beyond the *abacus*, just as much as the eye of the *volute*. The channel of the *volute* is even with the *shaft* of the column. The *astragal* of the column goes under the *volute*, and is always seen.

*Palladio* usually makes *capitals* in the angles of colonades or portico's of the *Ionic order*, with *volute*s, not only in the front, but also in that part which would have been the flank, in case the *capital* was to be made as generally it is; by which means they have the front on two sides, and are called by him *Angular Capitals*.

The same author makes the *architrave*, *freeze*, and *cornice*, a fifth part of the altitude of the *column*, and divides it into twelve parts; some whereof are for the *architrave*, three for the *freeze*, and five for the *cornice*. The *architrave* he subdivides into five parts, one for the *cymatium*, and the remainder is again subdivided into twelve parts; three whereof are for the first *fascia* and its *astragal*, four for the second, and five for the third. He divides the *cornice* into seven parts and three-fourths, two for the *cavetto* and the *ovolo*, two for the *modillon*, and three and three-fourths for the *corona* and the *cymatium*. The projecture or jetting out of the whole *cornice*, he renders proportional to its altitude.

Others divide whatever height he given for the whole order, into ten parts, and allowing two to the *pedestal*, divide the remaining eight into six, giving one to the *entablature*, and five to the length of the column, inclusive of the *capital* and *base*. The said length being divided into nine parts, they find it to be the diameter of the column, which, like most of the other *Architects*, they make use of to regulate some of the smallest members.

The height of the *entablature* they divide into six, allowing two to the *architrave*, one and a

half to the *freeze*, and two and a half to the *cornice*, making the projecture of the *architrave* one fourth of its height, and that of the *cornice* equal to its height. They divide the height of the *pedestal* into seven parts, allowing two to the *base* and *plinth*, four to the *dado*, and one to the *cap*.

They diminish the column one sixth of the diameter, from one third of the length of the *shaft*, in the same manner as the last order, and the *base* of the column projects the same, which gives them likewise the breadth of the *dado* of the *pedestal*. They make the *base* of the *pedestal*, one third of the two parts given for the *base* and *plinth*, and the projection thereof equal to the height, and the *cap* to project three fourths of its height.

They make the height of the *base* of the column half the diameter, and the projection one fifth part of the whole diameter, which gives the breadth of the *pedestal*; for the principal members thereof they divide the height of the *base* into four parts, allowing half a part to the *fillet*, two to the *cymate*, one half part to the *fillet*, and one to the hollow. The projection being equal to the height, and divided into the same number of parts, the members, say they, appear by inspection. They likewise divide the *cap* into four parts, allowing one to the *hollow* and *fillet*, which is one fourth, another to the *ovolo*, another to the *corona*, and one to the *ogee* and *fillet*, which is one third. They make the whole projection three of the four parts of the height, and dividing each third into three, they set off as to appear by inspection.

The *base* of the column they divide into three parts, one for the *plinth*, and the other two as they are divided in the *Dorick order*. They make the *bead* above the upper *torus*, part of the column, and double the height of the *fillets*; and the *fillet* above the said *bead* equal to the others, and the projection the same as in the *Dorick*.

They make twenty-four flutes in the fluted columns of the *Ionic*, each of a semicircle in depth, and the *list* or *fillet*, between each one third of the said flutes.

The whole height of the *Ionic capital*, (c 3) which they conceive to be more difficult than the former, is made half a diameter, which being first divided into three parts, the upper part is for the *abacus*, which is divided again into three, one for the upper part, half a part for the *fillet*, and one and a half for the lower part. From the middle of the said *abacus* downwards, it is divided into eight parts, allowing two and an half from the bottom of the *volute* to the *fillet*, half a part to the *fillet*, one to the *astragal*, and two to the *ovolo*.

The whole height of the *entablature*, they divide into six parts (as before mentioned) allowing

two to the *architrave*, one and an half to the *freeze*, and two and an half to the *cornice*; as for the particular members, the *architrave* (e 3) being divided into two parts, each is subdivided into eight, in all sixteen, allowing three to the first face, four to the second, five to the third, one to the *bead*, two to the *ogee*, and one to the *fillet*. They make the projection one fourth of the height, and the upper face one third thereof. They form the *freeze* (f 3) by making a triangle on the middle part of three in its height, whose opposite angle is the center for the curve or swelling.

They divide the height of the *cornice* (g 3) into eight parts, allowing one to the *hollow* and *fillet*, (which is one fourth) another to the *ovolo*, and two more to the *modillon* and *cap* (which is half a part) the upper four parts they subdivide into five, giving two to the *corona*, one to the *scima reversa* and *fillet* (which is one fourth,) one and an half to the *scima recta*, and half a part to the *fillet*. They make the whole projection equal to the height, and divide it into nine parts (each being one twelfth of the diameter) and as to the several members, they refer to a due inspection.

*Scamozzi*, and some other modern *Architects*, have introduced the upper part of the *Composite capital* in lieu of the *Ionic*, imitating that of the temple of *Concord*, whose four sides are alike; to render it more beautiful, the *volute* may be made a little oval and inclining.

At present the *Ionic order* is properly used in churches and religious houses, in courts of justice and other places of supposed tranquility, and devotion.

THE CORINTHIAN ORDER, the fourth, or as *Scamozzi* and *M. Le Clerc* make it, the fifth, and last of the ORDERS of ARCHITECTURE is the noblest, richest, and most delicate of them all. This is said by the ancients to be invented as remarked on page 142. But *Callimachus*, a *Corinthian* Sculptor, is thought by most of the modern writers to have been the inventor of this order of *Architecture*, and that passing by the tomb of a young lady, over which her nurse had placed a basket with some of her play things, and covered it up from the weather with a tile; the whole having been placed on a root of *achantus*; as it sprung up, the branches encompassed the basket, and bending down a-top under the corner of the tile, formed a kind of *volute*s; hence *Callimachus* took his hint: the basket he imitated in the *vase* of his column; the leaves in the *volute*s, and the tile in the *abacus* of his order. *Villalpandus* treats this story of *Callimachus*, as a fable; and will have the *Corinthian capital* to have taken its origin from an order in *Solomon's temple*, the leaves whereof were those of the palm tree.

The *Corinthian* has several characters, whereby it is distinguished from the rest. Its *capital* (c 4) is adorned with two rows of leaves, between which rise little stalks or caulicoles, whereof the *volute*s are formed, which support the *abacus*, and are sixteen in number. It has no *ovolo*, nor even *abacus*, properly speaking; for the member that goes by that name is quite different from the *abacus* in the other orders; being cut with a sweep, in the middle, on which is carved a rose, or other ornament.

*Vitruvius* observes, that the *Corinthian order* has no particular ordonnance for its *cornice*, or any of the other ornaments of its entablature; nor does he give it any other proportions than those of the *Ionic order*; so that if it appears higher than the *Ionic*, it is purely owing to the excess of the height of its *capital*. He also makes the rest of the entablature the same; and the *Attick base* he uses indifferently for the one and the other.

But we have several examples now remaining of antiquity, which contradict *Vitruvius's* opinion; the most beautiful whereof have a particular *base* (a 4) and the whole order twenty *modules* in height; whereas the *Ionic* has but eighteen. Again, its *capital* is higher than that of *Vitruvius* by one third of a *module*; and its entablature, which has *modillions*, and sometimes *dentils*, together with *modillions*, is very different from the *Ionic entablature*.

Most of the modern *Architects* set aside *Vitruvius's* *Corinthian* ordonnance, and follow that of the ancient buildings, selecting from them according to their several tastes: so that modern *Corinthian* is a kind of *Composite*; differing from any of the ancient buildings, and much more from *Vitruvius's* rules.

*Vignola* and *Mr. le Clerc* make the *Corinthian order* twenty *modules* high: yet *Serlio* makes it only eighteen; and *Mr. Perrault* eighteen and two-thirds, retrenching something from the nineteen of *Vitruvius*. The height of the shaft, *Mr. Perrault* makes less than that of the *Ionic*, by reason of the excess of its *capital*.

*Palladio* makes the *Corinthian columns* nine *modules* and an half in height, including both their *base* and *capital* (and in case they are to be fluted) with twenty-four *flutes* or hollows, whose depth is in proportion to half their breadth. The plan, or interval between two *flutes*, he makes one third part of the breadth of those *flutes*. The *architrave*, (e 4) *freeze*, (f 4) and *cornice*, (g 4) are a fifth part of the height of the column. He will have the altitude of the *pedestal* one fourth part of the height of the column, and divides it into eight parts; one for the *cymatium*, two for the *base*, (a 4) and the other five for the *dye*.—when he has divided the *base* into three parts; two of them go to the *plinth*.

(D 4) and one to the *mouldings*. Like *Vitruvius* he sets the *Attic base* under this order, but different from that which is placed under the *Dorick*, the projecture thereof being one fifth part of the diameter of the column.

He makes the height of the *Corinthian capital*, the diameter of the column below, and a sixth which he allows to the *abacus*, the residue he divides into three proportional parts; the first is for the first row of leaves, the second for the middle row, and the third he subdivides into two parts; the caulicoles, or stalks, together with their leaves, which are, as it were, supported by them, and out of which they grow, he makes of the part which is nearest the *abacus*: the stalk thereof, or *fuft*, from whence they spring, he will have thick, and to decrease gradually in their foldings, like plants which are thicker at the bottom, than at the end of their branches. He makes the *campana*, or bell, which is the stalk of the column under the leaves, perpendicular to the bottom of the *flutes* of the column.

In order to give the *abacus* a proper projecture, he forms a perfect square, the side whereof is a *module* and a half; in which square he draws diagonal lines, the point of the intersection thereof, is in the center, on which he places the foot of the compass, and makes a *module* towards each angle; drawing lines, which cut the said diagonals at right angles, where these points meet, so as to touch the sides of the square; and these are his limits of the projecture, whose length gives the breadth of the horns of the *abacus*. To make its curvature, or diminution, he draws a circular line from one horn to the other, and makes the point; whereby an equilateral triangle is made, the base whereof is the diminution.

Afterwards he draws a right line from the ends of the before-mentioned horns to the end of the *astragal* of the column; which he makes so as to be touched by the tips or ends of the leaves; and this he gives for their projecture. He makes the *rose* a fourth part, as broad as the diameter of the column at the foot. Having made the *architrave*, *freeze*, and *cornice*, a fifth part of the altitude of the column; he divides the whole into twelve parts, as in the *Ionic*, but varies in this, that he divides the cornice of the *Corinthian* into eight parts and a half, giving the first to the *scima reversa*, the second to the *dentils*, the third to the *ovolo*, and the fourth and fifth to the *modillions*, and the other three and a half to the *corona* and the *cymatium*. The projecture of the cornice is in proportion to its height. He has the pannels of the *roses* between the *modillions* square, and the *modillions* half as broad as the plan of the said *roses*.

The height given for the *Corinthian order*, is also often divided into ten parts, giving two to the *pedestal*, (h 4) and dividing the other eight parts into six, five for the length of the column, with the *base* and capital, and the other for the height of the *entablature*. They afterwards divide the length of the column into nineteen parts, and make two of them the diameter of the said column; from whence they form several of the minuter parts.

They divide the height of the *entablature* into six parts, giving two to the *architrave*, one and a half to the *freeze*, and two and a half to the *cornice*; making the projection of the *architrave* one fourth of its height, and that of the *cornice* equal to its height.

The height of the *pedestal* is divided into seven parts; two for the *base* and *plinth*, four for the *dado*, and one for the *cap*.

They diminish the column in the same manner as in the last order, and by taking the height of the *pedestal*, they give the projection of the base of the column, and the breadth of the *dye* of the *pedestal*. They make the *base* of the *pedestal* of one third of the two parts allotted for the *base* and *plinth*, and the projection thereof equal to the height, and the *cap* three-fourths of the height.

They make the height of the base of the column, half a diameter, and find its projection by taking half the height of the *pedestal*, which, also, is the breadth of the *dye*.

For the particular members of the *pedestal*, they divide the height of the *base* into three parts, giving one to the *torus* and *fillet*, which is one fourth, another to the *cymase*, and the third to the *ogee* and *fillet*, which is one fourth also. The whole projection they make equal to the height, and dividing it into five parts, give two to the *ogee*, two to the *cymase*, and the other to the *torus*. The *cap* is divided into four parts; half a part for the *hollow*, one fourth to the *fillet*, one to the *cymase*, one fourth to the *fillet*, one entire part to the *corona*, and one to the *ogee* and *fillet*, which is one third part thereof. They make the whole projection three parts of those four in height, which dividing into four, they set off by inspection.

They divide the height of the *base* of the column into three, one for the *plinth*, subdividing the upper two into five, giving one and a half to the lower *torus*, one to the upper *torus*, one to the *scotia*, and the other one and a half to the *fillets* and *beads*, viz. half a part to each *bead*, and one fourth to each *fillet*, the *bead* above the upper *torus* (being part of the column) is as large as the *fillet* and *bead* together, and its *fillet* the half thereof.

To find the height of the *Corinthian capital*, they divide

divide the diameter of the column into six parts, and make one whole diameter, and one of these parts the height. Those six parts they allow for the *abacus*, which dividing into two, they give one to the hollow, and the other to the *ovolo* and *fillet*. To each height of leaves they give two of the six parts, the remaining diameter is divided into, and make the heads of those leaves to turn down half a part. They divide again the under one, of the upper two parts into two, the heads of the leaves turning down one part, and the upper one into three, giving one to the *fillet*, and two to the small *volutes*; the large *volutes* having the entire part. The *rosette* they make as high as the *abacus* and the *fillet* together.

They make no other difference between the projections of this order, and those of the foregoing one, but by observing in the circumference of the column, that there are eight leaves in each height, and that each leaf has four plants carved with olive, parsley, &c. according to fancy; limiting the projection of their heads, by a right line drawn from the projecture of the *abacus* to the *collarino*, or *astragal* of the column.

Having divided the whole height of the *entablature* into six, they give two to the *architrave*, one and a half to the *freeze*, and one and a half to the *cornice*; and to make up the particular members, they halve each of the two principal parts the *architrave* is divided into, and then divide the lower part into three, giving two to the lower face, and half a part to the *bead*; dividing also a second part of the four into three, allowing one to the *ogee*; also dividing the upper fourth part into three, giving half a part to the *bead*, one and a half to the *ogee*, and one to the upper *fillet*, making the projection one of those fourths in height, of which they give half to the middle face.

For the *cornice*; they divide its height into eight parts, one for the *ogee* and *fillet*, another for the *dentils*, another for the *ovolo* and *fillet*, and the other is divided into six, one fourth whereof they give to the *fillet* under the *modillions*, one and one fourth to the *modillon*, half a part to the *ogee* and *fillet*, one and a half to the *corona*, half a part to the *ogee*, one fourth to the *fillet*, one and one fourth to the *scima recta*, and half a part to the *fillet*, making the whole projecture equal to the height, and dividing it into the same number of parts.

The COMPOSITE (so called from its *capital* (c 5) being composed out of those of the other orders) is the last of the five orders of *architecture*. It borrows a quarter round from the *Tuscan*, and *Doric*; a double row of leaves from the *Corinthian*, and *volutes* from the *Ionick*.—Its *cornice* has simple *modillions* or *dentils*.

*Scamozzi*, and *M. Le Clerc*, place this order between the *Ionick* and *Corinthian*, in regard to its delicacy and richness, which they esteem inferior to the *Corinthian*, and therefore make no scruple to use it under the *Corinthian*, tho' most authors rank it after the *Corinthian*.

The proportions of this order are not fixed by *Vitruvius*; he only marks its general character, by observing that its *capital* is composed of several parts taken from the *Doric*, *Ionick*, and *Corinthian*: He does not seem to regard it as a particular order; nor does he vary it at all from the *Corinthian*, except in its *capital*.—In effect it was *Serlio* who first added the *Composite* order to the four of *Vitruvius*, forming it from the remains of the temple of *Bacchus*, the arches of *Titus*, *Septimus*, and the *Goldsmiths*: Till then this order was esteemed a species of the *Corinthian*, only differing in its *capital*.

This order being thus left undetermined by the antients, the moderns have a sort of right to differ about its proportions, &c. *Scamozzi*, and after him *Mr. Le Clerc*, make its column (b 5) 19 *modules* and a half, which is less by half a *module*, than that of the *Corinthian*; as in effect the order is less delicate than the *Corinthian*.—*Vignola* makes it 20, which is the same with that of its *Corinthian*; but *Serlio*, who first formed it into an order, by giving it a proper *entablature* and *base* (a 5) and after him *M. Perrault*, raise it still higher than the *Corinthian*.—This last does not think different ornaments and characters sufficient to constitute a different order, unless it have a different height too; agreeably to his rule of augmenting the height of the several columns by a series of two *modules* in each; he makes the *composite* twenty *modules*, and the *Corinthian* eighteen; which it seems is a medium between the porch of *Titus*, and the temple of *Bacchus*.

*Palladio* makes the columns of the *composite* ten *modules* long; and the intercolumnation in the designs of colonades, one diameter and a half.—He makes this order slenderer than the *Corinthian*, and its *pedestal* (c 5) one third of the altitude of the column, and which he divides into eight parts and a half, the first for the *cymatium*, and five and a half remaining for the *dado*. He subdivides the *base* of the *pedestal*, into three parts, two he allows for the *plinth*, and one for the *torus*, with its *cymatium*. He makes indifferently the *base* of this column, *attick*, or a compound of the *Attick* and *Ionick*.

He gives to the *Composite* *capital* (c. 5.) the same measures with the *Corinthian*, but varies from it in the *volutes*, the *ovolo* and *astragal*, which he cuts into beads; which members he borrows from the

*Ionick*, and which he makes thus.—He divides the capital from the *abacus* downwards into three parts; the first he allows to the first row of leaves, the second to the middle row, and the third to the *volute*, which takes up so much of the *abacus*, that it seems to go out of the *ovolo*, near the flower which is placed in the middle of the curvature of the *abacus*, and is as thick in front as the breadth of its *horn*, or little more.—The thickness of the *ovolo* he makes three fifths of the *abacus*, and its lower part to begin parallel to the eye of the *volute*; giving to its projection, three fourths of its altitude.—He makes the *astragal* one third part of the altitude of the *ovolo*, and its projection a little more than half its thickness, and to wind about the capital under the *volute*, so as to be always visible.—To the *listella*, which is under the *astragal* and forms the *plinth* of the bell of the capital, he gives half the *astragal*, making the body of the bell perpendicular to the bottom of the flutes of the column.

A great number of modern *ArchiteEs* divide the height given for this order into ten parts, two thereof for the *pedestal*, and dividing the eight remaining parts into six, one for the height of the *entablature*, and five for the length of the column, with *base* and *capital*.—That length they divide into ten parts, which is no more than halving each of the five parts, and that is the diameter of the column below. So will the *pedestal* (h 5) be three diameters, the column ten, and the *entablature* two in height. Having divided the *entablature* into six, they give two the *architrave* (E 5), one and a half to the *freeze* (F 5), and two and a half to the *cornice*, (g 5), making the projection of the *architrave* two sevenths of its height, and that of the *cornice* equal to its height. The height of the *pedestal* being divided into seven parts, they give two to the *base* and *plinth*, four to the *dye*, and one to the *cap*.

They diminish the column as in the last order, and dividing the diameter at bottom, into five, they make the *base* of the column project on each side, one of these parts, which gives the breadth of the dye of the *pedestal*. To the *base* of the *pedestal* they give one third of the two parts for the *base* and *plinth*, and make the projection thereof equal to the height, and that of the *cap* four fifths of the height.

They make the height of the *base* of the column, half a diameter, and its projection one fifth of the whole diameter. For the particular members of the *pedestal*, they divide the height of the *base* into four parts, one for the *torus*, one third of a part for the *fillet*, one and two thirds for the *cymatium*, and the other part, which is one third, to the

*astragal* and *fillet*; the whole projection being equal to the height. The height of the *cap* they divide into five parts, one for the *astragal* and *fillet*; which is one third, two more to the *cymatium* and *fillet*, which is half a part; one to the *corona*, and one to the *ogee* and *fillet*, which is one third; making the whole projection four of the said parts.

The height of the *base* of the column being divided into six, they give one and three-fourths to the *plinth*, one to the lower *torus*, one fourth to the *fillet*, half a part to the *scotia*, one to the *astragal* and *fillet*, (which are subdivided into six, each *fillet* having one, and each *astragal* two) then give half a part to the other *scotia*, one fourth to the *fillet*, and the remaining three fourths to the upper *torus*; as to the *fillet* above, which is part of the column, it is half a part, or double the bigness of the under one.

They make the height of the *Composite capital* a diameter and one sixth, which they divide into seven, giving two to each height of *leaves*, the *head* thereof turning down half a part; two thirds of a part to the space between the *leaves* and *fillet*, one third to the *astragal* and *fillet*, (which is one third of that) two thirds more to the *ovolo*, one third to the space between the *ovolo* and *abacus*, half a part to the *hollow*, and half a part to the *ovolo* and *fillet*, which is one third thereof. They make no other difference between the projection of this, and that of the *Corinthian*, but in the *volute*, which they make after the same manner of the *Ionick*; making besides, this *capital* equal in height to the *architrave* and *freeze* taken together.

For to form the *entablature*, they divide its height into six parts, two for the *architrave*, one and a half for the *freeze*, and two and a half for the *cornice*.—For the particular members, the *architrave* is divided into seven parts, giving two to the first *fascia*, half a part to the *ogee*, two and a half to the second *fascia*, dividing again the upper two parts into five, half a part for the *bead*, one and a half for the *ovolo*, two for the *hollow*, and one for the *fillet*; making the projection two of those seven parts in height.

They observe no other order in the *freeze*, than that followed in the *Ionick*; but they divide the height of the *cornice*, into two and a half principal parts, subdividing each of them into four, and the half into two, which makes ten in the whole; giving one fourth to the *fillet*, one fourth to the *bead*, and one to the *ogee*; one more to the first *fascia* of the *modillions*, half a part to the *ogee*, one and one fourth to the second *fascia*, one fourth to the *fillet*, half a part to the *ovolo*, two to the *corona*, one to the *scima reverfa* and *fillet*, which is

one

one fourth, and one and a half to the *scima recta*, and half a part to the *fillet*; making its whole projection equal to its height.

The COMPOSITE is also called the ROMAN and ITALICK ORDER; as having been invented by the Romans, conformably to the rest, which are denominated from the people among whom they had their rise. Mr. Perrault, in his *Vitruvius*, distinguishes between *Composite* and *composed* order. The latter, he says, denotes any composition whose parts and ornaments are extraordinary and unusual; but have withal somewhat of beauty; both on account of their novelty, and in respect of the manner or *genius* of the *Architect*; so that a *composed order* is an arbitrary humorous composition, whether regular or irregular.

The same author adds, that the *Corinthian order* is the first *Composite order*, as being composed of the *Dorick* and *Ionick*, which is the observation of *Vitruvius* himself, *lib. 4. c. 1.*

GENERAL RULES given by PALLADIO, for avoiding several errors, which were first introduced by the *Barbarians*, and which are still in practice among us in *Architecture*.

1. He would have us admit of nothing in the several ORDERS repugnant to that symmetry, which nature observes in all her works: thus, as trees are bigger at the trunks and near the roots than at the top; he would have it laid down, that columns should be thicker at bottom than at top.

2. He rejects all columns without *bases*; since *bases* with their *torus's* and *cavetto's* represent so naturally the swellings occasioned by the weight they sustain; therefore condemns those, who, deviating from whatever is good, just and beautiful in *Architecture*, instead of pilasters or columns, which are to sustain any weight, place *cartouches*, which he calls *scrolls*, and supposes should strike the eyes of judges very disagreeably; and are so far, says he, from being satisfactory and pleasant to those, who are not, that they give them only an imperfect idea of *Architecture*, and only put builders to an unnecessary expence; for which reason he would have none of those *cartouches* come out of the cornice.

3. He condemns all *frontispieces* of gates, windows, and galleries, divided, and open in the middle, since those *frontispieces* were first made to defend these parts of the edifice from rain, &c. Necessity having instructed the antient *Architects* to cover them, and to give them the shape of a roof. Therefore he thinks that nothing can be more ridiculous than to open that part, which was invented for no other purpose than to shelter the inhabitants, and such as go into it from rain, snow, hail, and other injuries of the weather. And, says he,

though variety and novelty pleases all mankind, yet they are not to be introduced in direct opposition to the rules of art, and the dictates of reason; and it must be acknowledged, that the antients never departed from any general and necessary precepts of art in their various inventions.

4. He forbids the making the projecture of the *cornice*, and other decorations very large, because when they exceed reasonable and due proportion, especially in a close place, they make it still closer, and more disagreeable to the eye, and frighten those who stand under them, who imagine they are every moment to fall on their heads.

5. He will have the *cornice* made in a due proportion to the columns, for if great cornices are put over little columns, or little cornices upon great columns, the whole must needs be disagreeable to the eye.

5. He advises us to avoid the supposing the columns to be composed of various pieces, and jointed together by certain *annulets*, and garlands round them, which appear to keep them close together; because the more solid and whole the columns seem to the eye, the better they answer the end, for which they were raised, which is to make the whole building more strong and secure.

6. And he forewarns us against making some *members* in the *cornice* unequal to the rest: besides several other abuses, which he supposes an able *Architect* can caution himself again.

There are other sorts of ARCHITECTURE; as

ARCHITECTURE in PERSPECTIVE, which is a sort of building, wherein the members are of different measures and modules, and diminish in proportion to their distance, to make the work appear larger, and longer, to the view, than really it is. Such is the celebrated pontifical stair-case of the *Vatican*, built under Pope *Alexander VII.* by *Cavalier Bonino.*

COUNTERFEIT ARCHITECTURE, which is that which has its projectures painted, either in black or white, or coloured after the manner of marble, as is seen practised in frontispieces and palaces in *Italy*, and in the pavilions of *Marli.* This painting is done in *fresco* upon plaster'd walls, and in oil on walls of stone. Under the name of *counterfeit Architecture*, which we, otherwise, call *scene-work*, is likewise comprehended, that painted on flight boards, or planks of wood, whercon the columns, pilasters, and other parts of building seem to stand out, with a *relievo*; the whole being coloured in imitation of various marbles, metals, &c. and serving in the decorations of theatres, triumphal arches, publick entries, funeral pomps, &c. Such is the *catasaleo*, used for a decoration of *Architecture*, Sculpture, and Painting; raised on a timber scaffold

scaffold to shew a coffin or tomb in a funeral solemnity.

The MODERNS have also certain other orders, in their *Architecture*, which may be properly called *national*; and are known by the names of the *Rustick*, *Attick*, *Persian*, *Caryatick*, *Gottick*, *French*, and *Spanish* orders.

The RUSTICK ORDER, is that adorned with *Rustick* quoins, bossages, &c.

ATTICK ORDER, is a little order of low pilasters, with an *architrave cornice* for its *entablature*, as that of the castle of *Versailles*, over the *Ionick*, on the side of the garden. M. *Blondel* calls the little pilasters of *Atticks* and *Mezzanines*, *false orders*.

PERSIAN ORDER, is that which has figures of *Persian* slaves instead of columns to support the *entablature*. This order was first practised among the *Athenians*, on occasion of a victory their general *Pausanias* obtained over the *Persians*; as a trophy of this victory, the figures of men dressed in the *Persian* mode, with their hands bound before them, and other characters of slavery, were charged with the weight of *Dorick* *entablatures*; and made to do the office of *Dorick* columns. Though M. *Le Clerc* observes that *Persian* columns are not always made with the marks of slavery; but are frequently used as symbols of virtues, vices; of joy, strength, valour, &c. as when made in the figures of *Hercules*, to represent strength, of *Mars*, *Mercury*, *Favrus*, *Satyrs*, &c.

The CARYATICK ORDER, is that, whose *entablature* is supported with figures of women, instead of columns. *Vitruvius* observes, that the *Greeks* having taken the city *Carya*, led away their women captives; and to perpetuate their servitude, represented them in their buildings, as charged with burdens, such as those supported by columns. The *Caryatides*, says M. *Le Clerc*, are not now represented as among the *antients*, *viz.* as symbols of slavery, with hands tied before and behind; those characters being supposed injurious to the fair sex. Among us they are represented as images of justice, prudence, temperance, &c. Their legs are always to be close to each other, and even a-cross; their arms laid flat to the body or to the head, or at least as little spread as possible; that, as they do the office of columns, they may have, as near as possible, the figure thereof. Sometimes their arms are cut off for greater delicacy; as in the hall of the *Swiss* guards in the *Louvre*; but M. *Le Clerc* does not approve of such mutilations.

When insulated they should never have any great weight to support; and their *entablature* and *pedestal* are ordinarily to be *Ionick*. When they join to a wall, &c. it is advisable to put a *console* over

them, which may appear to support the weight of their *entablature*; otherwise as they represent women, they do not seem so proper to sustain great loads. When they are made in form of angels, the same author would have them support the *entablature*, which in that case, is to be *Corinthian*, with their hands. The *Antients* made the *Caryatides* frequently to support baskets, or *corbels* of flowers; and these they call *Canephoræ*, or *Cistiferae*; which *Canephoræ*, are in allusion to the *Canephoræ* of the *Antients*, who were two virgins of *Athens*, kept in *Minerva's* temple in the *Acropolis*, who at the feast of the *Panathenæa*, carried baskets on their heads, with something secret or mysterious therein, delivered to them by the priests. The baskets were usually crowned with flowers, myrtles, &c. The *Canephoræ*, in these ceremonies, always marched first, the philosopher or priest next, and the choir of music followed.

FRENCH ORDER, is a new contrived order, wherein the capital consists of attributes agreeing to that warlike nation; as *Cocks heads*, *Flower-de-Luces*, &c. Its proportions are *Corinthian*; such is that of M. *Le Brun*, in the grand gallery of *Versailles*; and that of M. *Le Clerc*. This last gives us a second *Tuscan* order, and a *Spanish* order, besides his *French* order. The *Tuscan* he ranks between the first *Tuscan* and *Dorick*. Its height he makes 23 semi-diameters, 22 minutes. The column to have 15, the *pedestal* 5, and the *entablature* 3, and 22 minutes; and he proposes its *freeze* to be adorned with turtles, which are the arms of *Tuscany*.

The SPANISH ORDER he places between the *Corinthian* and *Composite*. The whole order he makes 30 semi-diameters, 28 minutes, whereof the column has 9, and 25 minutes, the *pedestal* 16, and 18 minutes, and the *entablature* 4, and 15 minutes. The horns of the *Abacus* he sustains with little *volute*s; the middle, in lieu of a rose, has a lion's snout: that animal being the symbol of *Spain*, and expressing the strength, gravity and prudence of that nation.

Having been informed of the *origin*, *progress*, and *use* of the several ORDERS in CIVIL ARCHITECTURE; we shall shew how to compute the charge of a building, to chuse proper materials, lay foundations, and to raise superstructures.

Upon a due examination of the premisses in a model or draught, it may be ascertained how much the whole building shall amount unto: and the builder is directed to make provision of the materials requisite for the work intended.

The computation depends chiefly on a knowledge of the quantity or quality of the materials; and the quality or beauty of the work.

The MATERIALS are chiefly, *stones* and *wood*; *lead*, *tiles*, and *slates*; *lime*, *sand*, *plaster*, *nails*, and *glafs*.

STONES include *marble*, *free-stone*, and *bricks* for walls, &c.

WOOD includes all sorts of *oak*, *fir*, &c. timber, planks and boards.

In the choice of these materials depend, in a great measure, both the decoration and strength of the building: therefore observe,

MARBLE is a precious kind of stone, found in great masses, dug out of pits and quarries, being of a constitution so hard and compact, and again so fine, as readily to take a beautiful polish; much used in ornaments of buildings, as columns, chimney-pieces, tables, &c.

The goodness of *marble*, and its beauty, proceeds chiefly from the different quarries it is dug out of.

The best *marble* we have, at present, is imported from *Italy*; for the quarries of *Parian marble*, of which the greatest part of the *Grecian* statues were made, are lost.

Those from the state of *Genoa* deserve the preference; and of them, there are several sorts, viz. *Marble of Carrara*, which is very white. *White veined marble*, which has large veins, with grey and blue stains on a white ground. *Blue Tarquin marble*, mixed with a dirty kind of white. *Modern green marble*, improperly called *Egyptian*, of a deep green, spotted with grey. These three sorts come from *Carrara*, on the coast of *Genoa*, and are very good.

The other *marbles* from *Italy* are, the *marble of Porta Santa*, called, at *Rome*, *Serna*; which is mingled with large clouds, and veins of red, yellow, and grey. *Marble of Bressi*, yellow with white spots. *Pertor marble*, which has a black ground, with clouds, and veins of yellow. *Marble fior di Persica*, which consists of white and red stains, somewhat yellowish. *Marble ochio di pavone*, or *peacock's-eye*, mingled with red, white, and bluish clouds, somewhat resembling the eyes at the end of the peacock's tail. *Marble of Sicily*, which is a brownish red, stained with oblong squares of white, and *Isabella* like striped taffaty. *Marble of Savoy*, which is a deep red, mixed with other colours; each piece whereof seems cemented on the rest. *Cypollino*, or *Cipollin marble*, of a sea-green colour, mixed with large waves, or clouds of white or pale green.

*Spain* produces likewise some very good *marbles*, viz. the *Brocatella marble*, which is mingled with little shades of *Isabella*, yellow, pale, and grey; and comes from *Tortosa*, where it is dug out of an

ancient quarry. *Marble of Signam*, in the *Pyreneans*, of a greenish brown, with red stains; though this is somewhat various in its colours. *White marble*, that dug out of the *Pyreneans* on the side of *Bayonne*.

The *French* have also quarries of *marble* in several of their provinces, as in *Auvergne*, which produces a pale red marble, mingled with violet, green, and yellow. *Languedoc*, which produces *marble* of a vivid red, with large white veins, or stains; there is some borders pretty much on the blue, but this is of less value. The *marble* of *Barbançon*, in *Hainault*, is black, veined with white. That of *Dinant*, near *Liege*, is of a pure black, very beautiful, and very common. That of *Namur* is black, likewise, but less beautiful, as inclining a little to the blue, and traversed with little streaks of grey; this is very common, and frequently used in paving. The *marble* of *Guachenet*, near *Dinant*, is of a reddish brown, with white spots and veins. That of *Rance*, in *Hainault*, is of a dirty red, mixed with blue and white clouds and veins; this is pretty common, but is different in degree of beauty.

We have, in *England*, *English white marble*, veined with red. *Derbyshire marble*, variously clouded, and diversified, with brown, red, yellow, &c.

MARBLES are divided into *rigid*, *fibrous*, *brittle*, and *terracy marbles*.

The *rigid marble* is that, which being too hard, works with difficulty, and is liable to splinter, as the black of *Namur*. The *fibrous* is that full of threads or filaments. The *brittle*, that which crumbles under the instrument; and the *terracy marble*, that with soft places in it, which must be filled up with cement. These two last kinds are not to be chosen where others can be had, no more than those *marbles* which have the grain too coarse, nor those full of nails, which answers to the knots in wood; or with *emeril*, which is a mixture of copper, or other metals, forming black stains in the *marble*, and rendering it disagreeable to the eye, especially *white marble*, to which the *emeril* is peculiar. The nails augment the difficulty in cutting and polishing the *marble*.

For STONE: here, in *England*, that dug in the *Peninsula of Portland*, and thence called *Portland-stone*, is much used, being softer, and whiter than *Purbeck-stone*, and is commonly raised out of the quarries in bigger blocks than that. The *Ryegate-stone*, called also *fire-stone*, is good, and much used for chimneys, hearths, ovens, and stoves. The *stone* used in the edifices from the conquest to the reign

reign of Henry VI. was chiefly brought from Caen in Normandy.

*Bricks*, among us, acquire various names, according to their form, dimensions, uses, method of making, &c. The principal are *compass bricks*, of a circular form, used in steening of walls. *Concave*, or *hollow bricks*, on one side flat, like a common brick, on the other hollowed; used for conveying water under-ground. *Cogging-bricks*, used for making the indented works under the coping of walls, built with great bricks. *Coping bricks*, formed on purpose, for coping of walls. *Dutch* or *Flemish bricks*, used to pave yards and stables, and for soap-boilers vats and cisterns. *Clinkers*, such bricks as are glazed by the heat of the fire in making. *Feather-edg'd bricks*, like the common statute bricks, only thinner on one edge than on the other, and used to pen up the brick-pannels in timber-buildings. *Great bricks*, are those which are twelve inches long, six broad, and three thick: The weight of one being about 15 pounds, so that 100 weigh 1500, and 1000 of them 15000 pounds: their use is to build fence-walls, together with *pilasters*, or *buttress-bricks*, which are of the same dimensions with the great bricks, only they have a notch at one end, half the breadth of the brick; their use is to bind the work at the *pilasters* of fence-walls, which are built of great bricks. *Paving-bricks* or *Tiles*, are of several sizes in several countries and places. *Place-bricks*, such as are made in a place on purpose for them, near the building they are to be used in. *Statute* or *small common bricks*, when burnt, ought to be nine inches long, four and a quarter broad, and two and a half thick. 100 of these usually weigh about 550 pounds, and 1000, 5500 pounds; about 407 make a ton weight. These are commonly used in paving cellars, hearths, sinks, &c. 30, or 32, if true measure, will pave a yard square, and 330 will pave a square of 100 foot laid flat; but if laid edge-ways, there must be near double the number. *Stock-bricks* are to be of the same dimensions, only  $\frac{1}{8}$  of an inch thicker.

The MATERIAL, which comes next under the consideration of our Architect, is *lime*, which is a white, soft, friable substance, prepared of *stone*, *marble*, *free-stone*, *chalk*, or other stony substance, by burning in a kiln. That which is such as it comes from the kiln or furnace, is called *quick-lime*; and that diluted, or drenched in water, *slack'd lime*.

*Palladio* says, that the best *lime* is made of the hardest, soundest, and whitest stone, and which remains a third part lighter after it is burnt than the

stones it was made of. He observes also, that stones collected up and down, and which have been exposed a long time to the injuries of the weather, are not so proper to make lime with, as those which are newly dug out of the quarry; nor those taken from a dry pit, so good as those from a moist and shady one. That such pebbles as are found in rivers and rapid streams are excellent for lime, and make very white, neat, and smooth work; on which account it is principally used in the rough-casting of walls. That all stones, whether those taken from the hills, or from the rivers, burn faster or slower, in proportion to the fire, which is given them; but that for the generality, they are burnt in threescore hours.

*Dieussant* recommends *lime* made of sea-shells as the best; but *Goldman* finds fault with it, as being impatient of moisture, and therefore easily peeling off from the outside of walls.

Good *lime* may also be made of mill-stone, not coarse, and sandy, but fine, and greasy; and Sir *H. Wotton* finds fault with the *English* for making *lime* as they do, of refuse and stuff without any choice; whereas the *Italians*, at this day, and much more the Antients, burnt the firmest stones, and even fragments of marble, where it was plentiful; which in time became marble again for its hardness; as appears in their standing theatres, &c.

We have two kinds of *lime* in common use in *England*, the one made of hard stone; the other (of most use near *London*) of a soft, calcareous, or chalky stone; whereof the former is much the strongest.

That made of soft stones, or chalk, is fittest for plastering of cielings and walls within doors; and that made of hard stones, for buildings, and for plastering without doors.

Before the *stones* be thrown into the kiln, they are to be broke in pieces, otherwise the air contained in their cavities, too much expanded by the heat, makes them fly with so much violence, as to damage the kiln. According to *Alberti*, and *Palladio*, *lime* will not be sufficiently burnt in less than sixty hours intense heat.

The marks of a well burnt *lime*, is, that its weight be to that of the stone, in a sesquialterate proportion; that it be white, light, and sonorous; that when slacken it sticks to the sides of the vessel; and sends forth a copious thick smoak; and needs a great deal of water to slack it. It must not be wetted all at once; but only by slow degrees, to prevent its burning before it be duly temper'd.

When slack'd, it may be kept several years, by letting it pass through a hole open at the bottom of the vessel, into a pit dug under ground, and as soon as it is full, covering it with sand, to prevent its drying.

drying. *Boekler* gives another method. He will have a *stratum of lime* covered, two or three feet high, with another of sand of the like height, and then water enough poured on to slack the *lime*, but not to reduce it to dust after slacking. If the sand cleave into chinks, as the *sinoak* ascends, they must be covered up, so as no vent may be given thereto. This *lime*, he adds, kept ten or twelve years, will be like glue, and will, further, be of particular use in painting walls, as being no ways prejudicial to the colours.

SAND, is a fine, hard, gravelly sort of earth, or rather stones divided into small grains; of great use in *building*.

There are three sorts of *sand* proper to be employed in *building*, viz. pit-sand, river-sand, and sea-sand.

The first is the best, and is either of a black, white, red, or ash-colour; which last is a sort of earth burnt by fire inclosed in the cavities of mountains. Among the various kinds of pit-sand, the white is found by experience to be the worst; and of river-sand, the best is that which is found in rapid streams, and under water-falls; because it is most purged. Sea-sand is the worst; but if used, it must be that which is of a blackish colour, and shines like glass; but that, whose particles are biggest, and lies nearest the shore, is better than any other sort.

*Pit-sand*, as it is of a fatter substance than the rest, makes a more tenacious cement; and though it is apt to crack, is frequently made use of in *building* long vaults, or raising walls. *River-sand* is proper enough for rough-casting of walls. *Sea-sand* being soon wet, and soon dry, and of a saline quality, which soon melts away, is very improper to sustain any considerable weight.

That *sand* is good in its kind, which, when squeezed and handled, crackles; and if being put on a white cloth, neither stains, nor makes it foul. That *sand* is naught, which, mixed with water, makes it dirty and muddy, and which has been long in the air; for such will retain much earth, and rotten humour. Hence some MASONs wash their *sand* before they use it.

Our TIMBER, which is one of the principal, and of the most expensive articles, must consist, 1. Of *oak*, for posts, rails, boards, &c. 2. *Elm*, for dressers, &c. 3. *Beech*, which can supply the want of *oak*. 4. *Ash*, which is of a general use in *building*, especially where it may lie dry. 5. *Fir*, commonly known by the name of *deal*; for floors, flairs, wainscot, and most works of ornament. 6. *Walnut-tree*, is used within doors, being of a

more curious brown colour than *beech*, and less subject to the worms. 7. *Service-tree*, as yielding beams of a considerable bigness. 8. *Chestnut tree*, which is the most lasting, next to *oak*. And, 9. *Alder*, much used for sewers, and pipes to convey water: when always wet, it grows hard like a stone; but where sometimes wet, and sometimes dry, it rots presently.

The chief care in the choice of this kind of building materials, is to see that it is clear of sap; that it is clean or free from knots, flaws and cracks; and that it be of a proper size for the purposes intended; so that there be as little waste as may be in cutting it out for particular uses.

When *Timber* is cut down, *Palladio* will have it stored up in some place where it may not be exposed to the heat of the sun, or to the injuries of the weather; particularly such trees as rise out of the ground without being planted; and bedaub'd over with cow-dung, to prevent its splitting. It is not to stand upright, but to lie all along, one piece over another, only kept apart by short blocks interpos'd, to prevent a certain mouldiness, which they are apt to contract in sweating on one another; from which frequently arises a sort of fungus, especially if there be any sappy parts remaining. Others advise boards, planks, &c. to be laid in some pool, or running stream, for a few days, to extract the sap from them, and afterwards to dry them in the sun or air. By this means it is said, they will be prevented from either chapping, casting, or cleaving; but against shrinking there is no remedy. Mr. *Evelyn* particularly recommends this method for *Fir*. Others, again, are for burying them in the earth; others in wet; and others for scorching and seasoning them in fire; especially piles, posts, &c. that are to stand either in water, or earth. Sir *Hugh Plat* informs us, that the *Venetians* burn and scorch their *timber* in the flaming fire, continually turning it round with an engine, till it has got a hard, black, crusty coal upon it.

*Timber* must not be work'd, if it is very wet, or very dry; for in one case it will be liable to rot, and in the other will make but very awkward work: neither will it be dry enough to be worked into planks, doors, and windows, in less than three years. But as all Architects do not, or cannot take this last precaution, and consequently *timber* is but too often liable to chops or clefts, by its having been work'd too green, which is a very great eye-sore in many fine buildings; those chops or clefts are clos'd by anointing, suppling, and soaking it with the fat of powder'd beef broth, twice or thrice repeated. Some carpenters use grease and saw-dust mingled, for the same purpose; but the former method

method is excellent, only it is not to be us'd while the *timber* is green.

We must also provide IRON, for cramps, nails, hinges, bolts, gates, bars, and such like work.

One distinguishing mark of the goodness of *iron* is, when its veins are found to run strait, and unbroken, after it is work'd into bars, and when the two extremes of the bar are clean, and without foulness; for these veins are indication that the *iron* is free from knots and flaws; and by the extremes we may judge of the goodness of the middle. If its sides are found to be strait after it is wrought into plates, or into any other form whatever, we may pronounce it equally good in all its parts, as it has endured the hammer in equal proportion.

We may cover buildings either with LEAD, (which is also us'd for pipes and gutters to convey water, and in fastening all sorts of iron-work in stone) or with *copper, slate, or tiles.*

The white and ash-colour'd *leads* are more perfect and valuable than the black, though not really black, but only has a few black spots in it. *Lead* for this use, is either cast into *sheets* in a mould, or *milled.*

COPPER is at present but seldom employed in covering any kind of edifices, not even publick ones; as being too expensive, and too heavy, except in *Sweden*, where it is very common.

This metal was used in making *letters for inscriptions*, that were placed in the frizes of buildings: historians assure us, that the hundred gates of *Babylon*, so much taken notice of, were all of *copper*; as also the two pillars of *Hercules*, which were eight cubits high, in the island of *Gades.*

The best *copper* is that, which, when drawn out of the mine, and purify'd by fire, is of a reddish colour, but somewhat inclining to a yellow, and full of pores. It may be heated like iron, and liquify'd, and therefore capable of being cast; and though hard, may be render'd so soft and pliant, as to be wrought into very thin leaves. When mixed with tin, lead, or latten, which last is another sort of *copper*, but colour'd with *lapis calaminaris*, it makes a metal called *brass*, which is often made use of by *Architects* in making of bases, columns, capitals, statues, and such like decorations.

SLATE is a blue fissel stone, very soft when dug out of the quarry, and on that account easily cut, or sawed into thin long squares, or escallops, to serve in lieu of tiles for the covering of houses.

The *blue slate* is a very light, lasting and beautiful covering, but chargeable withal, in regard

the roof must be leafed over with thin laths, of about two inches broad, and two foot and a half long, plac'd close to one another, and each *slate* requiring a peg, and a nail, at least.

In *England*, besides blue, we have likewise grey slates, called *Horsham stones*, from a town in *Suffex*, of that name, where the greatest quantities of it are found; and which is chiefly used in the covering of churches, chapels, chancels, &c.

The timber of the *roof* need be very strong for the grey *slates*, it being almost double the weight of tiles.

Mr. *Coleprets* informs us, in the *Philosophical Transactions*, that to judge of the goodness of *slate*, it must be knocked against any hard body, to make it yield a sound; for if the sound be good and clear, the *slate* is firm and good, otherwise it is crazy. *Slates* which are scaly like fishes, are not good. These two methods are the surest to discover the goodness of *slate*, and all others proposed by our Naturalists are too tedious, and very uncertain.

Our most common covering in *England* is made of TILES, which are a sort of thin, fictitious, laminated stones; or, more properly, a fat clayey earth, knodden and moulded of a just thickness, dried, and burnt in a kiln; like a brick.

All sorts of *tiles* are not employed in covering, nor proper for it, but only those called *plain*, or *thack tiles*, squeezed flat, while yet soft, in a mould, of an *oblong* figure, and which, by Stat. 17 Ed. IV. c. 4. are to be 10½ inches long, 6¼ broad, and half an inch and half a quarter thick.

Among these may be rank'd, 1. *ridge, roof, or crease-tiles*, made circular, breadth-wise, like a half cylinder, and used to cover the ridges of *houses*; by the *Statute* they are to be 13 inches long, and of the same thickness with the *plain tiles.* 2. *Hip, or corner tiles*, which lie on the hips or corners of *roofs*. They are flat, like *plain tiles*, but of a quadrangular figure, whose two sides are right lines, and two ends arches of circles; one end being a little concave, and the other convex; the convex end to be about seven times as broad as the concave; so that they would be triangular, but that one corner is taken off: then, before they are burnt, they are bent on a mould breadth-wise, like *ridge-tiles*. They have a hole at their narrow end, to nail them on by; and are laid with their narrow end upward. By the *Statute* they are to be 10 inches long, and of a convenient breadth and thickness. 3. *Gutter tiles*, which lie in gutters, or valleys, in cross buildings. They are made like *corner-tiles*, only the corner of the broad end are turned back again with two wings. They have no holes in them, but are laid with  
the

the broad end upwards, without any nailing. They are made in the same mould as *corner-tiles*, and have the same dimensions of the convex side. Their wings are each four inches broad, and eight inches long. 4. *Pan, crooked, or Flemish-tiles*, used in covering of sheds, lean-to's, and all kinds of *flat-roofed* buildings; they are, like *plain tiles*, in the form of an *oblong parallelogram*, but are bent breadth-wise, forwards and backwards, in form of an S, only one of the arches is, at least, three times as big as the other; which biggest arch is always laid uppermost, and the lesser arch of another *tile* lies over the edge of the great arch of the former. They have no *holes* for pins, but hang on the laths by a knot of their own earth; they are usually  $14\frac{1}{2}$  inches long, and  $10\frac{1}{2}$  broad. By 12 *Geo. I. c. 25.* they are to be, when burnt, no less than  $13\frac{1}{2}$  inches long,  $9\frac{1}{2}$  wide, and half an inch thick. 5. *Dormar, or Dormar-tiles*, which consist of a *plain tile*, and a triangular piece of a *plain tile*, and swept with an arch of a circle from the other end, which end terminates in a point. Of these *tiles* there are two kinds, the triangular piece, in some, standing on the right, in others on the left side of the *plain tile*; and of each of these, again, there are two kinds, some having a whole *plain tile*, others but half a *plain tile*: but in them all the *plain tile* has two holes for the pin, at the end where the broad end of the triangular piece stands. Their use is to be laid in the gutters, betwixt the *roof* and cheeks, or sides of the *dormars*, the plain part lying on the *roof*, and the triangular part standing perpendicularly by the cheek of the *dormar*. They are excellent to keep out the wet in those places, and yet are not known, perhaps, any where, but in *Suffex*. The dimensions of the *plain tile's* parts, are the same as those of a *plain tile*; and the triangular part is of the same length, and its breadth at one end 7 inches, and at the other nothing. 6. *Scallop, or Astragal-tiles*, which are in all respects like *plain tiles*, only their lower ends are in form of an *astragal*, viz. a semicircle, with a square on each side. They are used in some places for *weather-tiling*. And, 7. *Traverse-tiles*, a kind of irregular *plain tiles*, having the *pin-holes* broke out, or one of the *lower corners* broke off. These are laid with the *broken end* upwards, upon rafters, where pinn'd *tiles* cannot hang.

All these kind of *tiles* are laid either dry, as they come from the kiln, without *mortar*, or any thing else; or in a kind of *mortar* made of *leam* and *berse-dung*. In some parts of *Kent* they lay them in *moss*.

According to *Stat. 17 Ed. IV.* the earth for *tiles* should be cast up before the first of *November*, shired, and turned before the first of *February*; and not

made into *tiles* before the first of *March*; and should likewise be try'd, and sever'd from stones, marle, and chalk.

We must also provide ourselves with *Flemish, or Dutch tiles*, for jambs of chimneys, instead of chimney corner-stones; for they divert agreeably the sight by the variety of figures painted on them.

When the carcass of the building is finished, GLASS must be provided for the *windows*, of which there are *various sorts*. 1. *Crown glass*; of which, says *Neve*, there are two kinds, distinguished by the places where they are *work'd*, viz. *Ratcliff*, or *Cock-Hill crown-glass*, which is the best, and clearest. Of this there are twenty-four tables to the case, the tables being of a circular *form*, about three foot six inches in diameter. But this varies according to the goodness; it being divided or packed up in three different sorts or degrees; for though the metal shall be all of one goodness, the accidents the *glass* meets with in the pot, or in blowing, or in knealing, occasions an alteration in its price and-package.

2. *Newcastle glass*, which is that most used in *England*, is of an ash colour, and subject to specks, streaks, and other blemishes; and, besides, is frequently warped. *Leybourn* says, there are forty-five tables to the case, each containing five superficial feet; some say there are but thirty-five tables, and six foot in each table.

Having made the necessary provision of *materials* and *workmen*, we begin our *work* with making of MORTAR: which is a *composition* of *lime* and *sand*, mixed up with water; serving as a cement to bind the stones, &c. of a *building*.

*De Lorme* observes, that the best *mortar* is that made of *pazzalana*, for sand; adding, that it penetrates black flints, and turns them white. If we make our *mortar* with pit sand, we must take three parts of it, and mix it with one of lime; but if we make use of river, or sea sand, our proportion must be two parts of sand only, and one of lime. About *London*, the proportion of sand to quick lime is as 36 to 25; in some sort of work they use an equal quantity of each.

It is a maxim among old *Masons* to their labourers, that they should dilute *mortar* with the sweat of their brow, i. e. labour it a long time, instead of drowning it with water, to have done the *sooner*.

There are two other sorts of *mortar* employ'd in *building*, viz. *white mortar*, made of ox-hairs, mix'd with lime and water, without any sand, used in plastering the walls and ciclings; and a hard *mortar* made of lime and hogs grease, sometimes mixed with the juice of figs, and sometimes with liquid pitch,

pitch, employed in making water-courses, cisterns, &c. This, after application, is washed over with linseed-oil.

The FOUNDATION is that part of a building which is *under ground*, and sustains the whole edifice; or upon which the walls of the superstructure are raised. So that of all the *errors in building*, those are the most fatal, that are committed in the *foundation*; because they at once endanger the whole structure: nor can it be rectify'd, but with the utmost difficulty. That therefore the *Architeſt* must take great care to make choice of a *good foundation*.

Let him first examine the bed of earth upon which he is to build.

If the earth be *solid*, the *Architeſt* must adjust the depth of the *foundation* by the height, weight, &c. of the *building*; a sixth part of the whole height, where there are to be no cellars, nor other offices, *under ground*, is looked on as a medium; and as to thickness, double that of the width of the wall, is a good rate.

But if it be a *gravelly*, or *sandy spot*, not to be trusted, particular care is to be taken, whether it be on land, or in the water; for if it be on land, the *observation* of what has been already mentioned, concerning *firm ground*, will be sufficient; if we build in the water, we must therefore dig till we find a *solid bottom*; or, if this can't be effected with ease, we must then dig a little into the sand and gravel, and driving in piles of oak, till the ends reach the *good ground*, and on these we may build. This operation is called *pallification*. But if we are obliged to build upon *massy* and *loose earth*, we must then dig till we find *solid ground*, and that in *proportion* to the thickness of the walls, and the bulk of the structure.

An *old foundation* must never be built upon before we know its depth, and are well assured that it is able to sustain the fabrick.

If the earth we *build* upon be *marshy*, we must strengthen it with piles, whose length must be the eighth part of the height of the walls, and their diameter the twelfth part of their length. These piles must be drove in *so contiguous* to one another, that no others can be set between them; and particular care must be taken to ram them in, with gentle blows often repeated, rather than with violence; for the earth will *consolidate* better the one way, than the other. Piles must be drove, not only under the walls, but also under the inner, or partition-walls; and distributed according to the *proportion* of the walls; those within are placed somewhat thinner than those on the outside of the *building*.

In some places they *found* the piers of bridges, and other *buildings* near the water, on sacks of *wool*, laid like *matresses*; which, being well pressed, and greasy, will never give way, nor rot in water.

The *foundation* is properly so much of the *masonry* as reaches as high as the surface of the *ground*. Sometimes it is massive, and continued under the whole *building*; as in the antique arches, and aqueducts, and some amphitheatres: more usually it is only in spaces, or intervals, either to avoid expence, or because the vacuities are at too great a distance; in which latter case they make use of insulated pillars, bound together by arches.

Having fix'd on the *ground-plot* for our *building*, we will make *draughts* of the *ichnography*, or *ground-plot* of each *floor*, or *story*; which *ichnography* is a transverse section of a *building*, exhibiting the circumference of the whole edifice, and of the several rooms and apartments in the given story, together with the thickness of the walls and partitions, the dimensions of the doors, windows, and chimneys; the projectures of the columns, and piers, with every thing visible in such section. On this draught of the *ichnography* depends the *form* or *disposition* of our *building*, which must be either *simple* or *mix'd*.

The *simple forms* are either *circular*, or *angular*; and the *circular* ones either *complete*, or *just spheres*; or *deficient*, as *ovals*.

The *circular form* is very commodious, of the greatest capacity of any; strong, durable beyond the rest, and very beautiful: but then it is found of all others the most chargeable; much *room* is lost in the bending of the walls, when it comes to be divided; besides an ill distribution of light, except from the center of the roof. It was on this consideration that the ancients only used the *circular form* in temples and amphitheatres, which needed no compartition. *Oval forms* have the same inconveniencies, without the same conveniencies, being of less capacity.

For *angular figures*, Sir Henry Wotton observes, that *buildings* neither love many, nor few *angles*: the *triangle*, v. gr. is condemned above all others, as wanting capacity and firmness; as also because irresolvable into any other regular figure, in the inward partitions, besides its own. For figures of five, six, seven, or more *angles*, they are fitter for *fortifications* than *civil buildings*. There is, indeed, a celebrated *building* of Vignola, at *Caprarola*, in form of a pentagon; but the *architeſt* had prodigious difficulties to grapple with, in disposing the lights, and saving the vacuities. Such *building*, then, seems rather for curiosity than conveniency, and for this reason rectangles are pitched on, as being a medium between the two extremes. But,  
again,

again, whether the rectangle is to be just a square, or an oblong, is disputed. Sir *Henry Wotton* prefers the latter, provided the length do not exceed the breadth by above one third. Mixed figures, partly circular, and partly angular, may be judged of from the rules of the simple ones; only they have this particular defect, that they offend against uniformity. Indeed, uniformity, and variety, may seem to be opposite to each other; but Sir *Henry Wotton* observes, they may be reconciled; and for an instance mentions the structure of the human body where both meet.

Suppose the *building* to be erected is of a *circular form*, according to the *ichnography*: the *foundation* must be as thick again as the wall intended to be raised upon it. The plan of the trench must be exactly level, that the weight may press equally in all parts, and not lean more to one side, than the other, which occasions the cracking and dividing of the walls. The *foundations* must always slope, or diminish, in proportion as they rise; yet so as that there may be as much left on one side as on the other, and so as the middle wall above may be directly perpendicular over the middle of that below; which must be also particularly regarded in the diminishing of walls above ground; for this will make the *fabrick* much stronger than if the diminutions or set offs were made any other way.

*Palladio* is of opinion, that in large *buildings* it is very proper to make vents, or holes, through the body of the walls, from the very *foundations* to the *roof*, in order to let out the winds and vapours, which are very prejudicial to the *fabrick*, diminish the expence, and will likewise be found extremely convenient in case winding stairs are to be made from the bottom to the top.

The *foundations* being laid, we are to erect the walls. The antients made six kinds of walls. The first were called *reticolata*, or *net-work*; the second were composed of *quadrals*, or *bricks*; the third of *cement*, consisting of *cement* or *pebbles*; the fourth of irregular and various stones, and called *Rustick*; the fifth of *free-stone*; and the sixth of *Ricimputa*, or *coffer-work*. They generally made the angles, or corners, of the building of bricks, and laid between every two foot and a half, three courses of bricks, which serve as a kind of band to the whole work.

The moderns distinguish *walls* into *plaster'd* or *mud-walls*, *brick-walls*, *stone-walls*, *flints*, or *boulder-walls*, and *boarder-walls*.

*Mud* and *plastered-walls* are chiefly in ordinary *timber buildings*. These *walls*, being quartered and lathed between the timber, or sometimes lathed

over all, are *plastered* with lome, which being almost dry, is *plastered* over-again with white mortar.

*Brick-walls* are the most important and useful among us. In these, particular care is to be taken about the laying of the bricks, *viz.* That in summer they be laid as wet, and in winter as dry as possible, to make them bind the better with mortar: that in summer, as fast as they are laid they be covered up, to prevent the mortar, &c. from drying too fast: that in winter they be covered well, to protect them from rain, snow, and frost, which are all enemies to the mortar: that they be laid joint on joint, in the middle of the walls, as seldom as may be, but good bond made there, as well as on the out-sides. Care is also to be taken that the angles be firmly bound: in order to which, in working up the angles of a building, it is not advisable to raise any *wall* above three feet high, ere the next adjoining *wall* be wrought up to it. That good binding may be made in the progress of the work.

*Palladio's* sentiment is, that *brick-walls*, intended for any great building, ought to be faced on both sides with brick, and the middle filled with cement, rammed close together with brickbats; and that to every three feet in height, there ought to be three courses of *bricks* of a larger size than the others to bind the whole breadth of the wall. That the first course should be laid, so that the lesser side of the *brick* may be outward; the second length-ways, that is to say, with its larger side on the outside, and the third as the first.

*Flint*, or *boulder walls* are usually raised by a right and left-handed man, who has had a hod of mortar poured down on the work, which they part betwixt them; each spreading it towards himself, and so they lay in the flints. The mortar for this work is to be very stiff. These *walls* are used for fence-walls, a-round courts, gardens and out-houses.

The *cement walls* of the antients were made so, as there should be three courses of bricks, and disposed as above, to every two foot at the least. In erecting their *Rustick-walls*, made of irregular stones, they used a leaden rule, which being bent, according to the place, where the stone was to be set, demonstrated how it was to be squared; so that when it was once cut, they immediately fixed it in its place.

Their *walls*, called *coffer-work*, were made by taking planks laid edge-way, according to the thickness of the *walls*, filling the void with cement, and all sorts of stones mingled together, and continued, after this manner, from course to course of stones laid level, or of the same height, through-

out the whole length of the *building*, and not interrupted by any aperture.

*Walls* as they advance, must diminish proportionably in their thickness; and such as appear above ground must be half as thick as those in the foundations. Those of the second story must be half a brick thinner than those of the first, and in like manner to the top of the *fabrick*: due care, however, must be taken, not to make the upper part too weak. The middle of the *wall* above must be exactly perpendicular over the middle of those below; which will give the whole *wall* a pyramidal form. Moreover, if we be forced to make the superficies of the upper *wall*, exactly over that beneath, it must be done inwardly; for the floors, the beams, the vaults, and other supports of the edifice, will keep the *walls* from falling inward.

The set off, or discharged parts, on the outside, must be covered with a *fascia* and a cornice, which surrounding the whole *fabrick*, will bind as well as beautify it. As the angles of an edifice are common, to two sides or faces to keep them upright and fast together, we must take care to make them very strong and substantial, and to hold them with long and hard stones, as it were with arms. The windows, therefore, and other openings, ought to be as far distant from the angles as possible; or at least, so much space ought to be left, as is the breadth of the said opening.

In *London*, by a statute made for rebuilding the city after the fire; it is enacted, that in all houses of two stories, besides cellars and garrets, and fronting bye-streets, and lanes, the *walls* in front and rear, as high as the first story, shall be full the thickness of the length of two bricks; and thence upwards to the garret of the thickness of one brick and an half; and that the thickness of the *garret walls*, on the back part, be left to the discretion of the builder; so that the same be not less than one brick in length; and that the thickness of the *party-wall*, in the garret, be of the thickness of the length of one brick, at least. That in houses of three stories high, besides cellars and garrets, the *walls* in the front and rear, as high as the first story, be two bricks and a half thick; and from thence upward, to the garret floor, of one brick and an half thick; and the thickness of the *garret walls*, on the back part, be left to the discretion of the builder, so that the same may not be less than one brick thick; and also that the thickness of the *party-walls*, between every house of this second and larger sort of *building*, be two bricks thick, as high as the first story, and hence upwards to the garret of the thickness of one brick and a half. That houses of four stories high, besides cellars

and garrets, the *walls* in front and rear as high as the first story, be two bricks and an half in thickness, and from thence upwards to the garret floor, of the thickness of one brick and an half; and that the thickness of the *garret walls*, on the back part, be not less than one brick: And also that the *party-walls* between every house of this third, and larger sort of *building*, be two bricks thick, as high as the first floor, and thence upwards to the garret floor one brick and an half.

We have observed in this treatise of *Architecture*, that there are five ORDERS of columns, viz. *Tuscan*, *Doric*, *Ionic*, *Corinthian*, and *Composite*. Now says *Palladio*, the strongest and most substantial of those orders, which is the *Tuscan*, must lie undermost; though this order, because of its plainness and simplicity, be seldom used above ground, except in *fabricks* where one order only is employed, never, therefore, in regular, and sumptuous edifices, especially houses, in which the *Dorick* supplies its place, as next to it for simplicity.

From this we'll pass to apertures, which are either *gates*, *doors*, *windows*, *stair-cases*, *chimneys*, or *sewers* for the sullage, &c.

*Palladio* pretends, that no settled and determinate directions can be given for the altitude, and breadth of the *gates* of spacious edifices; nor for the doors and windows of rooms; and gives this for reason, that when an Architect makes any gates, he is forced to adapt them to the largeness of the *fabrick*; to the dignity of a person who employs him, and the conveniency of whatever goes backwards and forwards, either to and from the same; though the method he likes best is to divide the space from the ground to the superficies of the joists into three parts and a half; two whereof must be allowed to the altitude of the void, or opening, and one and a half to the breadth.

Some will have *gates*, through which coaches, &c. are to pass, not less than seven feet broad, nor more than twelve; the height to be one and a half the breadth.

The *gates* and principal doors must be ordered in such a position that an easy access from all parts of the house may be had to them. The doors of rooms must not exceed three foot wide, and six and a half high; nor be less than two foot wide, and five foot high. They ought to be as few in number, and as moderate in dimensions as possible, since all openings are weakenings; though by turning arches over them, they are discharged, in some measure of the super-incumbent weight. They are not to approach too near the angles of the walls; it being a glaring solecism to weaken that part which must weaken all the rest. They should be, if possible, right over one another; that void may be over void;

void; and full over full; and also opposite to each other, so as that one may see from one end of the house to another; which will not only be graceful, but also convenient; as it affords a means of cooling the house in summer, by letting in air; and of keeping out the wind in winter, which way soever it fits.

In small *Buildings*, the breadth of the *Door* of the entry should be four foot, or four and a half; and the breadth of the *Doors* of the chambers  $3\frac{1}{2}$ ,  $3\frac{3}{4}$ , or 4. In middling *Buildings* the Breadth of the entry *Door* ought to be 5 or 6 foot; and that of the chamber *doors* 4, or  $4\frac{1}{2}$ .

There are *gates* (A, see Plate V.) and *doors* of the five *Orders*, viz. *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, and *Composite Doors*.

GATES and DOORS have their heads generally square, and sometimes circular, which last must not be used, if the impost be not above the height of a man.

*Note*, That *imposts*, in architecture, are the capitals of pillars or pilasters, which support arches. An *impost*, sometimes also called *Chapitel*, is a sort of *plinth*, or little cornice, which crowns a pier, and supports the first stone, whence an arch or vault commences. *Imposts* conform to their proper order. The *Tuscan* is a *plinth* only; the *Dorick* has two faces crowned; the *Ionick* a larmier over the two faces, and its moulding may be carved; the *Corinthian* and *Composite* have a larmier, freeze, and other mouldings. The Projecture of the *impost* must not exceed the naked of the pilaster. Sometimes the entablature of the order serves for the *impost* of the arch; and this looks very grand and stately. The *impost* is a thing essential to an ordonnance; in as much as without it, in the place where the curve line of the arch meets with the perpendicular line of the pillar, there always seems a kind of elbow.

*Palladio* gives the following rules for the decorations of *doors*, which decorations consist of the *Architrave*, *Freeze* and *Cornice*. 1. That the *Architrave* should turn about the *door*, and be as thick as the jambs or pilasters, which must not be less than a sixth part of the breadth of the opening, nor more than a fifth. 2. The thickness of the *Freeze* and *Cornice* is to be taken from the same opening. 3. The *Architrave* must be divided into four parts, three of which are to be for the altitude of the *Freeze*, and five for that of the *Cornice*. 4. The *Architrave* must be again divided into four parts; three whereof go to the first *fascia*, four to the second, and the other three are subdivided into five parts; two whereof are for the

*Regolo*, or *Orlo*, and the other three are for the *scima reversa*, otherwise call'd *cymatium*. Its projecture is equal to its altitude, and the fillet projects less than half its thickness. 5. To design the *Cymatium*, we must draw a right line from below the fillet to the upper part of the second *fascia*, which line is to be divided into two equal parts, each whereof is made the base of an isosceles triangle, or which has two sides equal; then the place of the fix'd foot of our compass must be plac'd in the angle over against the base, by which we'll draw the curve lines which give the *Cymatium*.

The *Freeze* ought to be three fourths of the *architrave*, and form'd by the segment of a circle, less than a semicircle, and its convexity, or swelling is to be perpendicular to the *cymatium* of the *architrave*.

The five parts to be given to the *cornice*, must be thus distributed to its members; one to be for the *cavetto*, with its *listella*, which is the fifth part of the *cavetto*, the projecture whereof is two thirds of its altitude; and an isosceles triangle must be drawn to design it, so that the *cavetto* will be the base of the triangle. Another of the said five parts must be allow'd to the *ovolo*, the projecture whereof shall be two thirds of its altitude, and is form'd by drawing an isosceles triangle. The other three to be subdivided into seventeen parts, eight whereof we'll allow to the *corona* with its *listella's*, of which that above takes one of the said eight parts, and that below, which makes the hollow of the *Corona*, must have but a sixth part of the *ovolo*. The other nine will be given to the *scima recta* and its *fillet*, which will be one third of the said *scima*.

*Note*, that DECORATION in Architecture, is any thing that adorns and enriches a *building*. The orders of Architecture contribute greatly to the *decoration*, but then the several parts of those orders must have their just proportions, characters, and ornaments; otherwise the finest order will bring confusion, rather than richness.

As for our other apertures, which are WINDOWS, (B) we must observe the following rules: 1. That they be as few in number, and as moderate in dimensions, as may consist with other respects; 2. That they be plac'd at a convenient distance from the angles, or corners of the *building*; 3. Care must be taken that the *windows* be also equal one with another, in their rank and order; so that those on the right hand may answer to those on the left; and those above be right above those below; As to their *Dimensions*, regard is to be had to the bigness of the rooms which are to receive the light.

The apertures of *windows*, in middle-siz'd houses

houses, may be four and a half, or five feet between the jambs; and in the greater *buildings* six and a half, or seven feet; and their height may be double of the length, at least; but in high rooms, or larger *buildings*, their height may be a third, a fourth, or half their breadth, more than double their length.

Such are the proportions for *windows* of the first story; and according to these must those in the upper stories be for breadth; but as to height, they must diminish; the second story may be one third part lower than the first, and the third story one fourth part lower than the second.

There are different sorts of *windows*, viz. *Architrave windows*, *Dormer windows*, or *Luthern*, and *Transom windows*.

*Architrave windows* of timber, are commonly an *ogee* rais'd out of the solid timber with a list over it; though sometimes the mouldings are struck, and laid on, and sometimes are cut in brick. *Dormer windows*, or *Luthern*, are a kind of *window* over the *cornice*, in the roof of a *building*, standing perpendicularly over the naked part of the walls, and serving to illuminate the upper story. *Transom window* is a double-light *window*, so call'd from the piece that is fram'd a-cross it.

*Windows*, like doors, vary likewise with respect to the different orders of *Architecture*, and have their various decorations in common with doors.

*Windows* and *Doors* are also often adorn'd with *BALCONIES*; which are a jutting, or projecture, in the front of a house, supported by pillars, or consoles, and encompass'd with a ballustrade; which is an assemblage of one or more rows of ballusters, high enough to rest the elbow on, i. e. about four feet.

The next apertures which fall under our consideration, are the *Chimneys*.

*CHIMNEY*, from the *French Chiminee*, is that part of the house where the fire is made. The *Chimney* is compos'd of jambs, or sides, of the back or wood; the mantle-tree resting on the jambs; the tube, or funnel, which conveys away the smoak; the chimney-piece, or moulding, on the fore-side of the jambs over the mantle-tree, and the hearth, or fire-place. But as we are yet on the out-side of the house, we'll consider first the funnel, or tube, which, according to *Palladio*, must never be made too wide, or too narrow; for in the former case the wind having too much room, will drive the smoak downward, and not let it ascend, or go freely out; and in the latter case the smoak, for want of a free vent, will fly back

again. Therefore in the *Chimneys* of rooms the funnels must not be narrower than half a foot, nor wider than nine inches, nor above two foot and a half in length. The mouth of the pyramid, where it joins to the funnel, must be made somewhat narrower, that the smoak driving downward, it may keep it from going into the room. Some make the funnels crooked, that by their winding and the strength of the fire, which forces it upward, they may prevent the smoak from flying back into the room. The funnels, or openings a-top, says the same learned author, through which the smoak should be convey'd, ought to be wide, and set at a distance from any substance that is apt to take fire.

According to *Wolfius*, the breadth of the aperture at bottom ought to be to the height, as three to two; to the depth, as four to two. In small apartments the breadth is three foot, in larger five. In bed-chambers four. In small banquetting-rooms five and a half, in large six; but the height never to exceed two and a half, lest there be too much room for the air and wind to drive the smoak into the room. Nor must the height be too little, lest the smoak mis its way, and be check'd at first setting out. The same author advises, to have an aperture thro' which the external air may, on occasion, be let into the flame, to drive up the smoak, which the internal air would otherwise be unable to do.

*Felicien* orders the mouth of the tube, or that part join'd to the *chimney*-back, to be a little narrower than the rest, that the smoak coming to be repell'd downwards, meeting with this obstacle, may be prevented from getting into the room.

To prevent *smoaking chimneys*, Mr. *Lucar* advises two holes, or two pipes, one over the other, to be left on each side of the *chimney*, one sloping upwards, the other downwards: through one of these, says he, the smoak will pass in any position. *De Lorme* will have a brass ball full of water, with a small aperture, to be hung up in the *chimney*, at a height a little above the greatest flame: here, as the water grows hot, it will rarefy, and drive through the aperture in a vapoury stream, which will drive up the smoak that would otherwise linger in the funnel. Others place a kind of moveable vane, or weather-cock, a-top of the *chimney*; so that what way soever the wind comes, the aperture of the *chimney* will be skreen'd, and the smoak have free egress. Indeed the best prevention of a *smoaking Chimney* seems to lie in the proper situation of the doors of the room, and the apt falling back of the back, and convenient gathering of the wings and breast of the *chimney*.

*Chimneys* are made in the thickness of the wall, and

and care must be taken that no timber be laid within twelve inches of the fore-side of the chimney jambs, that all joists, on the back of the chimney, be laid with a trimmer, at six inches distance from the back; and that no timber be laid within the funnel.

The ancients, in order to heat their apartments, built their chimneys in the middle, with columns or consoles, to uphold the architraves, over which they fixed the pyramidal funnel, through which the smoke was conveyed; though the obscurity of the rules given by *Vitruvius*, on that head, would make one conclude, that the ancients had no chimneys, but only stoves, whereof they had entire apartments.

*Palladio* pretends, that the stoves of the ancients, us'd instead of chimneys, consisted of certain tubes, or pipes, in the thickness of the wall, though which the heat of the fires, which were made under those chambers ascended, and issued out through certain vents, or mouths, at the top of the said tubes, or funnels.

In the year 1713, was publish'd a French book, intituled, *La Mécanique du feu*, or the art of augmenting the effects, and diminishing the expence of fire, by *M. Gauger*; since translated into English, by the celebrated *Dr. Desaguliers*. Wherein the author examines what disposition of chimneys is most proper to augment the heat, and proves geometrically, that the disposition of parallel jambs, with the back inclined, as in the common chimneys, is less fitted for reflecting heat into the room, than parabolical jambs, with the bottom of the tablette horizontal. He gives several new constructions of his new chimneys, and the manner of executing them.

*Note*, That CHIMNEY JAMBS are the sides of a chimney usually standing out perpendicularly, sometimes circularly from the back; on the extremities whereof the mantle-tree rests.

We'll pass now to the STAIR-CASE, (*C ib.*) defin'd an ascent inclosed between walls, or a balustrade, consisting of stairs or steps, with landing places, and rails; serving to make a communication between the several stories of a house.

We must be very curious in placing our stair-case, since it is difficult to find a convenient place for it, which, at the same time, will no ways damage the rest of the fabric. A proper situation, therefore, must be assigned to it, that it may not interfere with any other parts of the house, nor receive any inconvenience from them.

The common rules to be observed in stair-cases, are as follow: 1. They must have three openings; the first of which is the door by which we go

up to them, which the less it is concealed from such as enter the house, the more ornamental it will appear; and, in *Palladio's* opinion, it should be plac'd in such a manner, that before we come at it, we may have a sight of the best part of the house: for, then, the edifice, though little in reality, will appear large. The second opening is the windows requisite to light the stair-case, and which must be situated in the middle, and made high, by which means they will diffuse the light in equal proportion. The third opening is the landing-place, through which we enter into the rooms of the first story, and must lead into the most handsome, spacious, and best furnished rooms of the house.

2. Stair-cases must be made spacious in proportion to the bigness and quality of the building, and never narrower than three or four foot, that when two persons meet, they may have room enough to pass.

3. The steps must be no more than six or seven inches steep, and if they should be less, especially if the stair-cases are long, and have no landing-places, it will make them still more convenient, and less tiresome, by not obliging people to lift their feet so high; but then they must be four inches steep at least. The breadth of the steps must not be more than one foot and a half, nor less than a foot.

The kinds of stair-cases are various; for in some the stairs are strait, in others winding; in others both ways, or mixt: again, of strait stair-cases, called also, *flyers*, some fly directly forwards; others are square; others triangular; and others are called *French flights*.

For the making of strait stair-cases, the whole space must be divided into four parts; two whereof must be allowed to the steps, and the other two to the void in the middle; whence the stair-case, in case it were left open, will receive the light. They may be made with the wall inward, and then the wall itself is inclosed in the two parts, which are allowed to the steps; tho' there be no absolute occasion for this.

*Direct-flyers* or *plain-flyers*, are those which proceed directly from one floor to another, without turning either to the right or left; seldom used, except for garret, or cellar stairs. Square *flyers*, are those which fly round the sides of a square newel, either solid or open; having at every corner of the newel, a square half step, taking up one fourth of a circle, so that they fly from one half step to another; and the length of the stairs is perpendicular to the side of the newel. *French flyers*, fly, first directly forwards, till they come within the length of a stair of the wall; and then have a square

half pace, from which you immediately ascend to another half-pace; from which the stairs fly directly back again, parallel to their first flight.

Of *winding-stairs*, called also *spiral-stairs*; some are square, some circular, and some elliptical: and the scagains, are various, some winding round a solid, and others an open newel.

There are four kinds of circular *winding-stairs* viz. such as wind about a solid newel; the fore-edge of each being in a right line, pointing to the centre of a newel; commonly used in church-steeple, and great old houses. Such as wind round an open newel, the fore side of each being in a right line, pointing to the centre of the newel; as those in the monument of *London*. Such as wind round a solid newel, only the fore side of each, an arch of a circle; either concave or convex, pointing near to the circumference of the newel. And as such resemble the last, in all other respects, save that they have an open newel. Any of these *winding-stairs*, take up less room than other kinds.

When a *stair-case* winds round a solid newel, or a column, *Palladio* will have it made in the manner following: the diameter being divided into three parts, two must be for the steps, and one for the newel; or the diameter shall be divided into seven parts, three of which are to be allowed to the newel, and the four others to the steps; and in case the *stair-cases* be made circular, they will appear very ornamental, and be longer, than if they had been made strait. But in open *stair-cases*, the same celebrated *architect*, divides the diameter into four parts, two of which he gives to the steps, and two to the void in the middle.

He divides *elliptical*, and circular *stair-cases*, in one and the same manner, and judges them very handsome and agreeable, all the windows and doors being at the head, and in the middle of the *cliffs*.

*Palladio* mentions another kind of *stair-cases*, in the portico of *Pompey* at *Rome*, in the way that leads to the quarter of the *Ferros*, which consists of three winding stairs, of a very pretty and artful invention; for being placed in the middle of the building, whence they could receive no light but from above; they were set upon columns, to the end that the light might be equally diffused; in imitation whereof *Bramante*, a celebrated *architect*, in his time, made one in the *Belvidera*, but without steps; and composed it of the four orders following: viz. the *Dorick*, *Ionick*, *Corinthian* and *Composite*. This kind of *stair-case*, is made, by dividing the square into four parts; two of which are given to the void in the middle, and one to each side of the steps, or columns.

*Mixt-stairs*, are such as partly fly, and partly wind; whence some call them *flyers* and *winders*: Of these are several kinds; as *doglegged-stairs*, which, first fly directly forwards, then wind a semicircle; and then fly directly backwards, parallel to that. *Square flyers* and *winders*, which have a square newel, either solid or open, and fly by the sides of the newel, winding a quadrant of a circle, at each corner. *Solid* and *open newelled-flyers*, and *winders*, which are of two kinds; the one winds a quadrant of a circle of about a solid newel, then flies by the side of a square open newel; then winds again, by the side of a solid newel; then flies again, and so alternately. The other flies first, then winds, and then flies again alternately.

Several modern *Architects*, especially the *French*, have introduced *twisted-rails*, in many of their *stair-cases*; which are formed in the following manner:

When we have made our plan, and thereby found the breadth, or tread of the steps, and have also fixed on the bigness of the intended *rail*, with the form and projection of the mouldings; then the front of the second step must be continued out farther, and thereon a circle described, touching the inside of the *rail*, and whose diameter must be equal to the breadth of two steps, which we'll divide into eight equal parts; then we'll describe on the center of the said circle, another circle, equal to the bigness of the *rail*, and also another circle to the extremities of the mouldings.

If we draw a diagonal line, and describe the part of a circle, and dividing it into eight equal parts, continue it from the center to the line, we have the diminishing scale for the formation of the *scroll*. Then transferring the respective distances within the great circle, on each eighth part thereof, and finding the center of the eye, or block, for the first eighth part of the *scroll*, and proceeding from thence to all the distances, we have the whole *scroll* compleated, and finishing in the block, at one *revolution* of a circle. But here it is to be observed, that the inside *scroll*, though drawn from the same centers, must not meet on the aforesaid eight parts of the great circle, but a line drawn from the outer *scroll* to each center respectively.

For forming the *scroll* of the first *step*, the same method is to be used as above; observing, only, that as it begins to be circular from the second eighth part, the distance to the *rail* must be divided into seven parts, and gathering in, one at a time, it will be compleated.

Should it be required to make the *scroll* of a larger *revolution*, we must describe a circle whose diameter is equal to three *steps*, and divide the diminishing scale into twelve parts; and by proceeding, as be-

ore, to strike one eighth of the great circle at a time, we have the *scroll* at one *revolution* and a half of a circle. But wanting it still larger, we'll make a circle, whose diameter is equal to the breadth of four *steps*, and the diminishing scale divided into sixteen parts, the *scroll* will be formed at two *revolutions* of the circle.

Having carried the walls as high as we are determined they shall go, having made the vaults, laid the joists of the floors, (which *joists* are those pieces of timber framed into the girders and summers, on which the boards of the floor are laid,) brought up the *stair-cases*, &c. in the next place we must raise the *roof* (*D. ib.*) which as it embraces all the parts of the fabric, and presses the walls thereof equally with its weight, is, by that means, a kind of bandage to the whole, and serves for shelter, to carry off the rain from the walls.

*Note*, That the *Joists* are from six to eight inches square, and ought seldom to lie at a greater distance from each other than ten inches, never twelve: nor ought they ever to bear at a greater length than ten foot, or to lie less into the wall than eight inches. Sometimes carpenters *furr* their *joists*, as they call it; that is, lay two rows of *joists* one over the other. *Summer* is a large stone, the first that is laid over columns and pilasters, in beginning to make a cross vault; or it is the *stone*, which being laid over a *piedroit*, or column, is hollow'd to receive the first haunce of a plat-band. *Girders* are the largest pieces of timber in a *floor*; their ends are usually fastened into the *summers*, or *breast summers*; and the *joists* are framed in at one end to the *girders*. By the *statute*, for rebuilding *London*, no *girder* is to lie less than ten inches into the walls; and their ends to be always laid in loam, &c.

*Palladio* will have *roofs* made more or less shelving, according as the climate is either hot or cold; for which reason, in *Germany*, says he, where the snow falls in great quantity, the *roofs* are made very sharp, and are covered with shingles, or little thin pieces of wood, or else with very thin tiles; for otherwise the weight of the snow would crush them. But those who live in gentle and moderate climates should raise their roofs with grace and politeness, and to such an altitude, as that the rain may easily roll off. Therefore the breadth of the plate to be *roof'd*, continues he, must be divided into nine parts; two whereof shall be the pitch; for if it were made of one fourth of the breadth, the *roof* would be too sharp, so that the tiles would scarce cleave; and if they were made but of a fifth

part, the *roof* would be too flat, whereby the superincumbent weight of the tiles, shingles, and snows would press too much upon it. He concludes, by observing, that gutters are usually made all round the house, into which the water which falls from the tiles is conveyed away, by spouts, at a considerable distance from the walls. That the gutters must have a foot and a half of wall over them, which will not only keep them in much stronger, but likewise preserve the timber in the *roof* from any damage which the rains might otherwise occasion.

When the *roof* is *pointed*, its most beautiful proportion is, to have its profile an equilateral triangle; when *square*, that is, when the pitch, or angle of the ridge, is a right angle, it must be considered as a mean proportion between the pointed and the flat-form. A *flat roof* is that in the form and proportions of a triangular pediment. Sometimes the *roof* is in the pinnacle form; sometimes it has a double ridge; sometimes it is cut or mutilated; that is, consists of a true and a false *roof* laid over the former; sometimes it is truncated, that is, instead of terminating in a ridge, or angle, it is cut square off, at a certain height, and covered with a terrace, and sometimes, also, encompassed with a ballustrade. Sometimes it is in manner of a dome, that is, its plan is square, and the contour circular; sometimes it is round, that is, the plan is round, or oval, and the profile spherical. Sometimes the base being very large, it is cut off to diminish its height, and covered with a terrace of lead, raised a little in the middle with sky-lights, from space to space, to give light to some corridors, or other intermediate piece, which without such an expedient would be too dark.

There is also the *hip-roof*, which is a *roof* that has neither gable-head, shread-head, nor jirkin-head; which last are both gable and hip at the same end. A *hip-roof* has rafters as long, and with the angles at the foot, &c. at the end of *buildings*, as it has at the sides; and the feet of the rafters on the end of such *buildings*, as have *hip-roofs*, stand on the same plan, *viz.* parallel with the horizon, and at the same height from the foundation with rafters on the sides of the *roof*.

All kinds of *roofs* are composed of *beams*, *rafters*, *hips*, &c. A *beam* is the largest piece of wood in a *building*, being laid across the walls, and serving to support the principal *rafters* of the *roof*. No house has less than two of these *beams*, *viz.* one at each head: into these the *girders* of the garret-floor are also framed; and if the *building* be timber, the teazle tenons of the posts.

The proportions of *beams* near *London*, are fixed by statute as follows: A *beam* 15 feet long must be

seven inches on one side its square, and five on the other; if it be 16 feet long, one side must be eight inches, the other six; if 17 feet long, one side must be ten inches, the other six. In the country they usually make them stronger. Sir H. Wotton advises these to be of the strongest, and most durable timber.

Hence Mr. Parent remarks, that the common practice of cutting the beams out of trees, as square as possible, is ill husbandry; and hence takes occasion to determine geometrically what dimensions the base of a beam, to be cut out of any tree propos'd shall have, in order to its being of the greatest possible strength; or, which is the same thing, a circular base being given, he determines the rectangle of the greatest resistance that can be inscribed, and finds, that the sides must be nearly as 7 to 5, which agrees with observation. Hitherto the length of the beam has been suppos'd equal; if it be unequal, the bases will resist so much the less, as the beams are longer.

Mr. Parent has calculated tables of the weights that will be sustain'd in the middle, in beams of various bases and lengths, fitted at each end into walls, on a supposition that a piece of oak of an inch square, and a foot long, retained horizontally by the two extremes, will sustain 315 pounds in its middle before it breaks, which it is found, by experience, it will.

Rafters are pieces of timber, which standing by pairs upon the rafter, meet in an angle at the top, and form the roof. No rafters should stand farther than 12 inches from one another. For the sizes, or scantlings of rafters, it is provided, by act of parliament, that principal rafters, from 12 feet 6 inches, to 14 feet 6 inches long, be 5 inches broad a-top, and 8 at the bottom, and 6 inches thick; those from 14 feet 6 inches, to 18 feet 6 inches long, to be 9 inches broad at the foot, 7 at the top, and 7 thick; and those from 18 feet 6 inches, to 21 feet 6 inches, to be 10 inches broad at the foot, 8 at the top, and 8 thick. Single rafters 6 feet 6 inches long, to be 4 feet, and 3 inches in their square; those 8 feet long, must be  $4\frac{1}{2}$ , and  $3\frac{1}{4}$  inches square.

The hips are those pieces of timber, plac'd at the corners of the roof. The hips are much longer than the rafters, by reason of their oblique position, and are plac'd not with a right or square angle, but a very oblique one; and, by consequence, are not, at least ought not to be square at any angle, (as rafters are at all) but bevel at every one of them; and, which is yet inore, as rafters have but four plains, these commonly have five. Hips are called by country workmen corners; some call them princi-

pal rafters, and others sleepers. Indeed hips and sleepers are much the same, only the sleepers lie in the vallies, and join a-top with the hips; but those surfaces, or plains, which make the back of the hips, are the under sides of the sleeper. The backs of a heap are those two superficieses, or plains, on the out-side of the hips, which lie parallel, both in respect of their length and breadth, with the superficieses of the adjoining sides, and end of the roof.

The highest part of the roof, or rather the piece of wood wherein the rafters meet, is called the ridge of the roof.

Having finished the outward case of the edifice, the next thing is, to distribute the ground-plot into apartments; in which distribution regard must be had to gracefulness, and usefulness, for rooms of office, and entertainment, as far as the capacity thereof, and the nature of the country, will allow.

The gracefulness consists in a double analogy, or correspondency, first, between the parts of the whole, whereby a large fabrick should have large partitions, entrances, doors, columns, and, in brief, all the members large; the second between the parts themselves, with regard to length, breadth, and height.

Palladio will have a building disposed and ordered in such a manner, as that the most noble and beautiful parts of it be the most exposed to all spectators, and the less agreeable thrown into by places, and removed, as much as possible, from publick view; because the refuse of the house, or whatever may produce any ill effect, or incumbrance, ought to be carried thither; and for this reason the cellars, wood-houses, coal-holes, pantries, kitchen, servants-hall, laundries, ovens, and other offices, which are for ever in use, should, in his opinion, be placed in the lower and most obscure part of the edifice, and some of them a little under ground.

The usefulness consists in having a considerable number of rooms of all kinds, with entries, halls, and light stair-cases, which must be made spacious, and easy, to go up and down; and the meanest, and less graceful of them, situated advantageously, to serve the other more spacious apartments. The rooms must be large, moderate, or middle-siz'd, and small, and all contiguous to one another. Convenient partitions must be likewise contrived for closets, libraries, horse-furniture, and other things which are in daily use, and which would appear very indecent in a bed-chamber, dining-room, or other place set a-part for the reception of strangers.

Palladio orders the summer rooms to be spacious, and open to the North; and the winter ones small, and expos'd to the South and West. But the rooms intended

intended for *spring* and *autumn*, ought to be towards the *East*, and have their *prospect* towards *greens* and *gardens*. *Studies* and *closets* should likewise have the same *prospect*. But, where the *Architect* is confined within certain limits, beyond which he has no *power* to go, *necessity* obliges him to suit himself according to the situation of the place.

In the partition, an *Architect* has often occasion for several shifts; through which his own sagacity, more than any rules, must conduct him. Thus he is frequently put to struggle with scarcity of ground; sometimes to damn one room, for the benefit of the rest; as to hide a buttery under a *stair-case*, &c. at other times, to make those the most beautiful, which are most in sight; and to leave the rest, like a painter in the shadow, &c.

Since the *hall*, or *sallo*, is properly the first, and finest partition of an apartment, and is placed at the entrance of a fine house, palace, or the like; it therefore deserves, first, our attention.

*Vitruvius* mentions three sorts of *halls*: the *tetrapstyle*, which has four columns supporting the platform, or ceiling: the *Corinthian*, which has columns all around, let into the wall, and is vaulted over; and the *Egyptian*, which had a peristyle of insulated *Corinthian* columns, bearing a second order with a ceiling. These were called *Occi*.

To make a *Tetrapstyle* hall, according to *Palladio's* design, its length should be divided into five equal parts, three thereof must be allowed to the breadth. The wings (that is, the space between the wall and the pillars, or columns, which is not included in the breadth of the hall) have in breadth a fifth part of the altitude of the columns. The columns, of what order, please most the Architect, and which he thinks most proper for the ornament and magnificence of the *hall*; which, commonly is the *Corinthian*. The diameter of those columns, ought to be equal to the breadth of one half of the wings: the opening above, one third part of the breadth of the *hall*.

The length of a *Corinthian-hall*, should be the diagonal of its square; and the wings have in breadth, two sevenths of the length of the *hall*, that is, one for every wing; the diameter, and height of the columns, in proportion; as well as the opening in the middle.

The *Egyptian-halls*, are very much like *Basilicas*, or the courts of justice of the antients; because they have a portico, in which the columns are distant from the wall, like in the *Basilicas*; and upon these columns, are placed the architrave, freeze, and cornice. The space, or distance between the columns and the wall, is covered with a platform,

surrounded by a corridore with rails, and ballusters. Above the said pillars there is a continued wall, with half columns, on the inside of it, one fourth part less than the lower ones. The windows which give light to the *hall*, and through which, when laid open, such as are on the platform can look into it, are placed between the said half columns.

The antients had another sort of *hall*, called *testitudinated*; that is, made in a form of a *tortoise*. The length of a *testitudinated-hall*, is equal to the diagonal of its square, and has its full breadth in height; which reaches as far as the summer, or architrave of the roof. The rooms on the side are six feet less in height; and above the walls, which separate them from the *hall*, there are columns, which bear the roofs of the said *hall*. Between these columns, there are some apertures, or windows, which give light to the *hall*. A little farther are the *peristyles*, about which are piazzas, that are the height of the columns. The chambers are of the same breadth, and their height to the imposts of the arches, is equal to their breadth; as the arches have in height the third part of their diameter.

The length of *halls* should never exceed twice their breadth; but the nearer they are to a square, the more uniform and commodious they will be.

We must not confound *halls*, with *entries*, though we often give to *entries*, the name of *halls*; though *entries* be in the lower parts of the house, and *halls* in the upper. *Entries* are but a sort of landing-place, with which all the other principal parts of the house have a communication, and where persons wait till the master of the house appears; and after the *galleries*, are the first places that present themselves to such as enter the house.

The *galleries* are covered places in palaces, much longer than broad; which serve to walk in. If there be but one, 'tis usually made in the fore, or back front of an edifice; if two, in the wings. They are either large, or small, as conveniency, and the quality of the *building*, may require; but they should never be above twenty feet broad; or less than ten. The *galleries* of the *Louvre* are magnificent.

The *rooms* must be distributed equally on each side of the *entry*, and the *hall*; and care must be taken that those on the right hand, answer to, and be of an equal largeness, with those on the left, whereby there will be a just harmony, and proportion in the several parts of the edifice; and the wall will be in equal proportion pressed by the roof: for if the apartments are bigger on one side the edifice than on the other, in the former case they will resist the weight with ease, because of the solidity, and thickness of the walls; but in the latter

they will be too weak, which will create great inconveniencies, and at last, destroy the whole structure.

*Palladio* says, that in the designing of *rooms*, there are seven beautiful proportions; for either they are made round or square; but that the former is now entirely neglected, and laid aside; or their length is the diagonal of their square; or of one square, and a third; or a square, and a half; or a square, and two thirds; or lastly, of two squares.

For the altitude of *rooms*, it must be taken from the different form of the ceiling; which is either arched or flat. If flat, the altitude from the *floor* to the *joists*, must be in equal proportion to their breadth; and the *rooms* over them, must be a sixth part lower than those beneath. If arched, as they usually are in the first story (for this gives them a grace and beauty, and renders them less liable to fire) their altitude, in square *rooms*, is a third part more than the breadth of the *rooms*. But in those, where the length exceeds the breadth, an altitude must be sought equal to their length and breadth; and dividing the whole into two equal parts, one of which will be the exact altitude of the arch. Or if the chambers, to be arched, be twelve foot in length, and six in breadth, we must add the two numbers together, and the sum is eighteen, which divided by two, gives nine, and this is the altitude of the arch required.

Another method of finding the altitude of a *room* by numbers, is, by finding (after the length and breadth of the room has been given) a number that bears the same proportion to the breadth, as the length does to it; which is performed by multiplying the lesser extreme by the greater, and the square root of the product, will be the height. For example, suppose the place to be arched be nine feet long, and five feet broad, the altitude of the arch will be six feet; and the same proportion that nine has to six, six has to four. But however we must observe, that this altitude cannot always be found by numbers.

To find in numbers, another altitude, which though it be less, will still be in proportion to the *room*; we must first have found by the length and breadth of the chamber, its altitude according to the first rule; which in the foregoing instance was nine, and having added the length, breadth, and altitude together, we'll multiply the nine by twelve, and afterwards by six: setting the product, made by twelve, under twelve, and the product made by six under six; when this is performed, we'll multiply six by twelve, and set the product thereof, which is 72, under 9; lastly, having found a number, that, multiplied by 9, produces 72, which

in this instance will be eight; eight foot must be the altitude of the arch. These several altitudes have this relation between themselves, *viz.* that the first exceed the second, in the same *ratio*, or proportion, as the second exceeds the third. Each of these altitudes may then be used, according to the conveniency which they give for contrivance; that various *rooms* of several dimensions may be so made, as to have all their arches of an equal altitude; and be at the same time exactly proportionate: by this means the chamber will look agreeable, and be very convenient for the *floor* above, which will be upon a level. There are other proportions for the altitude of arches, which do not come under any particular rules; and are therefore left to the *Architect*, to use them as necessity requires.

For our private *buildings*, here in *London*, the parliament, after the conflagration, thought proper to determine the several proportions of the apartments, according to the bigness of the house, *viz.* in houses fronting by streets or lanes, of two stories high, besides cellars and garrets; the cellars ought to be six feet and a half high, if the spring of water hinder not; and the first story nine feet from the *floor* to the *ceiling*, and the second story as much. That in houses fronting streets or lanes of note, and the river of *Thames*, which ought to be three stories high, besides cellars and garrets; the cellars should be six feet and half high, if the springs hinder not; the first story full ten feet from the *floor* to the *ceiling*; the second ten feet; the third nine feet. That in houses fronting the high and principal streets, which shall be of four stories high, besides cellars and garrets, the first story be full ten feet and a half in height, from the *floor* to the *ceiling*; the second ten feet, and the third nine feet; the fourth eight feet and an half.

In large *buildings*, and sumptuous edifices, the *rooms* are arched. *Palladio* reckons six kinds of arches adapted to that purpose, *viz.* crossed, fasciated, flat, circular, grinded, and shell-like; all which are in altitude one third of the breadth of the *room*. The four first were used by the antients, and the two last are of the invention of the moderns, who divide arches, into *circular*, *elliptical*, or *strait*; and subdivide the *circular*, into *semicircular*, *scheme*, and *arches of the third and fourth point*.

*Semicircular-arches*, are those which make an exact *semicircle*, and have their center in the middle of the chord of the arch; called also by the *French* builders, *perfect arches*, and *arches en pleine cinture*. *Scheme-arches* are those which are less than a *semicircle*, and consequently are flatter arches; containing some 90 degrees, others 70, and others 60: called also *imperfect-arches*. *Arches of the third*

third and fourth point, consist of two arches of a circle, meeting in an angle at the top, and are drawn from the division of the chords, into three or four parts at pleasure. Of this kind, there are many in old *Gothick buildings*; but on account of their weakness and unsightliness, they ought, according to Sir *Henry Wotton*, to be for ever excluded out of all *buildings*.

*Elliptical arches* consist of a *semi-ellipsis*; and were formerly much used, instead of *mantle-trces*, in *chimneys*. These have commonly a key-stone, and chaptrels or impostes. *Strait-arches* are those whose upper and under edges are *strait*; as in the others they are curved; and those two edges also parallel, and the ends and joints, all pointing towards a centre. These are principally used over windows, doors, &c.

*Circular-arches*, are made in square chambers, and, according to *Palladio*, raised in this manner: in the angles of the *room*, are left certain *mutules*, or *modillions*, which sustain the *semi-circle* of the arch; which is flat in the middle, but more *circular* the nearer it approaches the angles.

As for the *cielings* of our *rooms*, there are different methods of making them; for some people are very curious to have them of beautiful and well wrought *joists*; in which case particular care must be taken, that the distance between the *joists*, be once the thickness and a half of the said *joists*; for that distribution will make the *cieling* very agreeable, and so much of the wall will be left between the ends of the *joists*, as will suffice to support the weight over it; but in case they are made at a greater distance, they will look very unhandsome; and if at a lesser, they will divide as it were the upper wall from the lower; and if the *joists* should prove rotten, or by any casualty be set on fire; the upper wall must fall of course. Others are fond of compartments made of *stucco-work*, or of timber; these they fill with pictures, so that they may be variously decorated, and therefore no fixed and positive precepts, can be prescribed upon this topic. Though those which are to have a picture in the middle, are commonly divided into square panels in the corners, and a large circle in the middle proper for painting; the borders or margin, being ornamented with *frets* and *guilochis*.

*Note*, That *FRET* in *Architecture*, is a kind of knot, or ornament; consisting of two lists, or fillets, variously interlaced, or woven; and running at parallel distances, equal to their breadth. A necessary condition of these *frets*, is, that every return, and intersection, be at right angles. This is so indispensable, that they have no beauty without it; but become perfectly *Gothick*. Sometimes the *fret* consists but of a single *fillet*; which if well

managed, may be made to fill its space exceedingly well. The antients made great use of these *frets*; the places they were chiefly applied on, were even, flat members, or parts of *buildings*, as the faces of the corona, and eaves of cornices; under the roofs, soffits, &c. on the plinths of bases, &c. The appellation was occasioned hence, that the *French* word *frette*, literally signified the timber work of a roof, which consists chiefly of beams, rafters, &c. laid a-cross each other and as it were *fretted*. *Frets* and *guilochis* are synonymous. These ornaments, though small, if they be well adjusted, are very pleasing. They are frequently used in picture-frames, soffits, of arches, and on architraves, and sometimes on *fascia's*, and the plinths of bases, if the other members be carved.

As we have left our *chimneys* without ornaments, we'll return to them, and have them decorated, each with its *chimney-piece*; which is a composition of certain mouldings, of wood or stone, standing on the *fore-side* of the jambs, and coming over the *mantle-tree*.

*Chimney-pieces* must be made larger, or smaller, in proportion to the *size* of the *rooms* where they are intended. As for the various ornaments of *chimney-pieces*, they are at the discretion of the *Architect*, provided they prove answerable to the other ornaments of the *rooms*.

Our *FLOORS* are to be of earth, bricks, stones, or timber. *Palladio* observes, that brick pavements are very ornamental, and strike the eye agreeably, as well on account of the variety of colours which they borrow from the various sorts of earth of which they are compos'd, as from the various forms which may be given them. He observes, further, that the *floors* of chambers are but seldom made of *natural stones*, since they are too cold in *Winter*; but that they are agreeable enough in *galleries*, and apartments for publick entertainments.

*Carpenters* never *floor* their rooms with boards till the carcase is set up, and also inclos'd with walls, lest the *weather* should wrong the *flooring*; yet they generally rough plane their boards for the *flooring*, before they begin any thing else about the *building*, that they may set them by to dry, and season; which is done in the most careful manner.

It must be observed, that such chambers as are upon the same *story*, must have their pavements level, and so as that the *thresholds* of the *doors* may be no higher than the rest of the plan of the *rooms*; and if any little *room*, or *closet*, should not rise to that height, the remainder must be supply'd with a *Mezzanin*, or *false cieling*.

He that intends to build a *COUNTRY SEAT* has some other matters to consider peculiar to a country life. The situation should be near the center of the

the estate, well covered, if possible, from the wind, and near a river, or some head of water.

It is not adviseable to *build* in *valleys* inclosed by *mountains*; because *houses* will lie concealed in such places, besides the disadvantage of their having no distant *prospects*, and not being conspicuous to the eyes of others; by which means, all their *beauty* is lost, besides their being, in all respects, prejudicial to *health*. Being then determin'd to *build* upon an *eminence*, we will chuse such a *situation* as is expos'd to the most *temperate region* of the air, and is neither always *overshadowed* by higher hills, nor *scorch'd*, as it were, with two suns, by the reflection of the real one from some adjacent rock; for in either of these cases it becomes an *inconmodious habitation*. But if we cannot avoid *building* on *low ground*, we must set the first *floor* above the *ground* the higher, to supply what we want to sink in our *cellar* in the ground; for in such *low*, and *moist grounds*, it conduces much to the *dryness* and *healthiness* of the air, to have *cellars* under the *house*, so that the *floors* be good, and ciled underneath. *Houses* built *too high*, in places expos'd to the winds, and not well *defended* by *hills*, or *trees*, require more materials to build them, and also more reparations to maintain them; and are not so *commodious* to the inhabitants as those which have those *advantages*.

As for the distribution of the apartments, in *country houses*, it is made in the same manner as in *city houses*, i. e. according to the quality of the *master*, the numerous companies he is to *entertain*, and the number of his *servants*. On both sides of the *court* (the *house* being in the *front*) may be built, the *stables*, *cellars*, *granaries*, and such other *commodious places*, for the *service* of the *house*.

THE ARCHITECT is to be learned also in other parts of ARCHITECTURE: such as the building of temples, or churches, bridges, and other public edifices.

A CHURCH is defin'd, by *Daviler*, a large, *oblong edifice*, in form of a *ship*, with *nave*, *choir*, *isles*, *chapels*, *belfries*, &c.

*Palladio* is of opinion, that the most agreeable, and most regular forms a *church* can be made in, are the round, and the triangular; and, again, of these two he chuses the round form as the most perfect, for the following reasons: 1. Because, says he, the round form alone, among all figures, is simple, uniform, equal, strong, and most capacious; and therefore can contain a greater multitude of people. 2. That its being included in a circle, wherein neither end nor beginning can be found; having all its parts alike, and each of them partaking of the figure of the *whole*, and the extrem in every part being equally distant from the *center*; it is therefore the most proper figure to de-

note the unity, Essence, uniformity and justice of GOD.

*Churches*, according to the same *author*, should have large *portico's*, with greater *columns* than are requisite in common *buildings*. The orders of the *columns* should be as beautiful as possible, and each order ought to have its own proper and convenient decoration. *Churches* should also be made of the choicest, and most valuable materials. White, of all colours, continues *Palladio*, is the most suitable to *temples*; because the purity of it, express'd in the purity of life, is *highly acceptable* to the *Almighty*. But in case they must be painted, there ought to be no statues nor pictures in them that may, in the least, tend to the alienation of man's mind from the contemplation of the Divinity.

These are *Palladio's* general observations on the structure of *temples*, from which he enters into particulars, with regard to the compartments of *churches*, considering that it is absolutely necessary that all their parts should correspond together, and have such a proportion, that there be none of them by which the whole may not be measured, as well as every individual part. But, however, as he supposes the round and quadrangular forms the two most regular, he confines himself to give us the necessary directions and rules followed by the antients in the *building* of those two kinds of *temples*.

The diameter of the whole space which the *temple* was to take up, is divided into three equal parts; one whereof is given to the steps, that is, the ascent of the *floor*; and two remained for the *temple* itself, and the columns, which are placed upon pedestals, and with their bases and capitals, are as *high* as the diameter of the least course of the steps, and a tenth part as *thick* as they are *high*. The architraves, freezes, and other decorations, are made according to the rules given in our treatise of *Architecture*.

But such *churches* or *temples* as are made with a *nave*, are either wing'd round, or made with a *portico* only in the front. The compartments of such as are wing'd round, are as follows:

Two courses of steps are made quite round, and the pedestals are set upon them, and upon these the columns. The wings are a fifth part of the diameter of the *temple*, taking the diameter from the inner part of the pedestals. The columns are as long as the cell is large, being a tenth part as thick as they are long. The *cupola* is to be raised above the architrave, freeze, and cornice of the wings, proportionable to the half of the whole work. The columns, which begin from the floor, and consequently are without pedestals, render the *temple* more pompous and majestic; pedestals, besides, obstructing the going into the *temple*. If a *portico* be erected in the front only of a round *temple*, it must be made as long as the *nave* is large, or an

*eighth part* less; and tho' it may be made shorter, yet it must, however, never be shorter than *three quarters* of the *breadth* of the *church*; nor must it ever be made broader than a *third part* of its *length*.

In quadrangular *temples*, the *portico's* in the front are to be made as long as the *temple* is broad, and if the manner be *Eustylos*, (i. e. whose columns have proper and convenient intervals) which is the most elegant and beautiful, the compartments must be made in this manner: if the prospect be of four columns, the whole front of the *temple* (omitting the projecture of the bases of the columns in the corners) must be divided into eleven parts and a half; one whereof might be called a *module*, or the standard whereby the other parts are to be measured; four whereof are to be given to the columns, if they be one *module* thick; three to the middle intercolumniation; and four and a half to the other two; that is, two and a quarter to each. But in case the front has six columns, it must be then divided into eighteen parts; if eight, into twenty-four and a half; and if ten, into thirty-one; giving always one of these parts to the thickness of the columns, three to the middle void, and two and a half to each of the other. The height of the columns must be managed according as they are either *Ionic* or *Corinthian*.

The *ante-temple* was beyond the *portico*, and the *nave* after the former. The breadth was divided into four parts, and the length of the *temple* consisted of eight such; five whereof were given to the length of the *nave*, including the wall wherein the door is; and the other three remained to the *ante-temple*, which has two wings of walls on its side, continued to the wall of the cell. At the end of these are made two *ante's*, that is, two pilasters as *thick* as the columns of the *portico's*; and since between these wings there may be a greater or less space, if the larger be twenty foot, there ought to be two columns put between the said pilasters, nay, more, if there should be occasion, directly opposite to the columns of the *portico*. The use of them is to separate the *ante-temple* from the *portico*; and the three, or more voids, that will be between the pilasters, must be closed with pannels of wood, or marble; the necessary opening however, must be left for entering into the *ante-temple*. But if the *breadth* exceeds forty foot, there must be other columns placed within, over-against those between the pilasters; and they must be made as *high* as those without, tho' not quite so *thick*; for the open air will take away from the *thickness* of those without, and the inclosure will not let the

smallness of those within be seen, so that they will appear equal.

Thus the antients (according to *Vitruvius*) ordered the compartments of their *temples*, which had always *portico's* to them, to shelter the people, who waited for the hour of the sacrifice, against the injuries of the *weather*. But we *Christians*, not regarding whether the *portico* surrounds the *temple* or not, build our *churches* much like the antient *basilica's*, or court of justice, with *portico's* within; the reason whereof is, that the first who embraced the *Christian* religion used to meet for fear of the *Gentiles*, in the *basilica's* of private persons; and observing, afterwards, that this form was very convenient, because the altar could be placed in the room of the tribunal to great advantage, and that the choir could stand round the altar in good order, while the remaining part might hold the people, they have not thought proper to alter it since.

Some *authors* pretend, that the *choir*, in the *Christian churches*, was not separated from the *nave* till the time of *Constantine*; that from that time the *choir* was railed in with a ballustrade, with curtains drawn over, not to be opened till after the consecration. That in the 12th century they began to inclose the *choir* with walls, but the antient ballustrades have been since restored, out of a view to the beauty of *architecture*. In nunneries, the *choir* is a large hall, adjoining to the body of the *church*, separated by a grate, where the religious sing the office.

Most of the *Christian churches* were made, for a considerable number of centuries, in the form of a cross. In that part which makes the foot of the cross, is the entrance over-against the great altar, and the choir; and in the two isles extending like arms on each side, are two other entrances, or two altars.

There are churches in a *Greek cross*; and others in a *Latin cross*. Churches in a *Greek cross*, are those where the length of the transverse part is equal to that of the *nave*; so called, because most of the great churches are built in this form. Churches in a *Latin cross*, are those whose *nave* are longer than the *cross* part, as most of our antient *churches*.

There are also churches in *rotundo*, which are those, whose plan is a perfect circle; and which in *Palladio's* opinion, are the most beautiful, commodious, and regular. In all these different sorts of churches, the dimensions, with respect to their breadth, length, the height, and bigness of the pillars; their different orders, &c. should be observed as above prescribed; avoiding as much as possible, their having too great a number of mon-  
strous

strous columns in the *nave*; which is a choaking imperfection, in our church of *St. Paul's* in *London*.

*Palladio* gives us the description of a church, called the *Baptism of Constantine*, and which is at *St. John de Lateran*, at *Rome*; this he supposes to have been built of the spoils and ruins of antient fabrics: as learned authors believe the design beautiful, and the decorations very well carved, I will insert it here, for the benefit of *Architects*, who have not *Palladio's* works. The columns are of *porphyry*, and of the *Composite* order. the base is a compound of the *Attic* and *Ionic*, but instead of two *astragals*, which are made between the *scotias* in the *Ionic*, this has one only, which takes up the room of two: all these members are beautifully carved, and have fine *intaglias*. The bases of the columns in the portico, are embellished with leaves, running up along the shaft of the column; and though the shafts of the columns, are not so long as they should be, yet by this management the work is not robbed in the least, of its beauty and majesty. The capitals are compounded of *Ionic* and *Corinthian*, with *acanthus* leaves. The architrave is very well carved, its cimase having a *fusarole*, and above half an *ovolo*; instead of a *gula inversa*, the freeze is plain. The cornice has two *gulae rectæ*, one above the other, which is a thing that very seldom happens: since two members of the very same sort, should not be put over each other, without some other intermediate member besides the listel. Over these *gula-rectas* or *cymatiums*, is a *dentil*, and then the *corona* with its *ogee*, and last of all a *gula recta*, or another *cimase*; so that the *Architect* in this cornice, has, by making *dentils*, avoided *modillions*.

*Vitruvius* had distinguished *temples*, with regard to their construction, into various kinds; as, *temple in antæ*, *ædes in antis*, which were the most simple of all *temples*; having only angular pilasters, called *antæ*, or *parastatæ*, at the corners; and two *Tuscan* columns on each side the doors. *Tetrastyle*, which was a *temple* that had four columns in front, and as many behind. *Prostyle*, which had only columns on its front, or fore-side. *Amphiprostyle*, which had columns both before and behind; and which was also *tetrastyle*. *Pireptere*, which had four rows of insulated columns around, and was *hexastyle*; that is, had six columns in front. *Dioptere*, which had two wings, and two rows of columns around, and was also *octastyle*, or had eight columns in front.

There were also *pseudodioptere temples*, which had eight columns in front, and a little row of columns all around; by which it was distinguished from the *dioptere*, which had two rows of columns

all around. *Hypæthros*, which had no roof, or covering. *Monoptere*, which was round and without walls, having its dome supported by columns.

From the building of churches, we will pass to the erection of BRIDGES, which are edifices either of stone or timber, consisting of one or more arches; erected over a river, canal, or the like, for the conveniency of crossing, or passing over from one side to the other.

*Bridges* should be always well designed, commodious, durable, and well decorated. The piers of stone are to be equal in number, that there may be one arch in the middle, where commonly the current is strongest. Their thickness not to be less than a sixth part of the span of the arch, nor more than a fourth. They are commonly guarded in front with an angular starling, or spur, to break the force of the current; though this defence is sometimes also turned *semicircularly*; in the antient bridges, it is always a right angle; which has the advantage of being stronger, and more durable than acute ones. The strongest arches are those whose sweep is a whole *semicircle*.

The breadth of a bridge, according to *Baptista Alberti*, ought to be the same as that of the highway which abuts on it: the breadth of the piers is to be one third of the apertures of the arches; the starling to be one half the breadth of the piers, and to rise above the greatest height, to which the water ever mounts.

*Palladio* says, that four things are to be considered in the erection of stone bridges, viz. the heads which are made at the banks; the piles, or pilasters, which are fixed in the river; the arches which these pilasters support; and the pavement which is made over the arches.

He observes, that the heads of these bridges, should be made as firm and substantial as possibly can be; because they not only serve to support the weight of the arches as the other pilasters do, but they likewise keep the whole bridge together, and the arches from cracking or opening. That they are made, therefore, where the banks are of stone, or at least of solid earth; and that no bank of earth being naturally solid enough for this occasion, art must be used to make them firm and strong, and other arches and buttresses must be added; that if the water should happen to destroy the bank, yet the way to the bridge might still be preserved. That the pilasters, which are to be made in proportion to the largeness of the river, should always be even in regard to their number; not only the better to support the weight, but that they should likewise strike the eye agreeably, and render the work more substantial, since the current of the

river in the middle (where it is naturally more rapid, as being more distant from the banks) is thus free, and does not prejudice the pilasters by perpetually shaking them. For this reason the pilasters ought to be so comparted, as to fall in that part of the river where the course is least rapid. That the foundation of *bridges* ought to be made at that time of the year when the waters are lowest, which is in *autumn*; and in case the bottom of the river be of stone or gravel stone, or any soft stone whatsoever, which is a kind of earth that is partly stone, the foundations are already made without any trouble of digging, because these are naturally the best foundations; but in case the bottom of the river be sand or gravel, it must be digged therein till the workmen come to the solid ground; or if that should prove too laborious or impracticable, he must dig moderately deep in the sand or gravel, and then drive in oaken piles, which will reach the solid and firm ground, with the iron by which their points are to be armed. That to lay the foundation of the pilasters, only one part of the bed of the river must be enclosed from the water, and then build there, that the other part being left open, the water may have its free current; and so to go on from part to part. That the pilasters must not be less in dimension, than the sixth part of the breadth of the arch; nor generally speaking larger than a fourth. That they should be made of great stones joined together with cramps, and bars of iron, fastened with lead, that they may be, as it were, all of one piece by such ligaments. That the fronts of the pilasters, or that side which faces the stream, should be made angular; that is, ending in a right angle; and sometimes, they are made circular (as we have already observed) in order to divide or break the water; and that those things which are impetuously brought down the river, when they strike against them, may be shoved from the pilasters, and pass through the middle of the arch. That the arches too, should be made very strong and substantial, and with great stones, well united together, the better to resist the constant passing of carriages, or any other weight that shall happen to come over them; which arches are the strongest, when they consist of a semicircle, because they entirely rest upon the pilasters, and never press upon each other; but, that if by the nature of the situation and disposition of the pilasters, a perfect semicircle should not be commodious, as rendering the ascent and descent difficult, a lesser section must be then made use of, and such arches should be made as rise only the third part of the diameter; and in this case, the foundations must be made extremely strong upon the banks. Lastly, that the pavement of these *bridges*, ought to be made

exactly like those of ways and streets. These are *Palladio's* instructions and rules for the erection of *bridges*.

Notwithstanding all these rules given by *Palladio*, and other eminent *Architects*, as *Alberti*, *Scamozzi*, *Goldman*, *Harekfinor*, and *Gautier*, who has a piece express on *bridges*, ancient and modern, viz *Traité des Ponts*, Paris, 1716, 12mo, complaints are still made, that no demonstrative reasons are given, of the several proportions of the most essential parts of *bridges*; much of which is still left to the discretion of the *Builder*, to be regulated according to the circumstances, design, place, magnitude, &c. of the designed edifice.

The current of a river is sometimes diminished, to secure the piers of the *bridge* which are *building* over it; which is done either by lengthening its course, by making it more winding, or by stopping its bottom with rows of banks, flakes, or piles, which break the current. The piers always diminish the current of a river: suppose this diminution one fifth part, it will follow, that in case of inundations, the bed must be sunk, or hollowed one fifth part more than before, since the waters gain in *depth* what they have lost in *breadth*. And, as the quantity of the water remains still the same, it will pass with greater velocity, by one fifth part, in the place where such contraction is; all which conduces to wash away the foundation. The stream thus augmented in velocity, will carry away flints and stones, which, before, it could not stir.

*Palladio* gives us the draught of a *bridge* of his own invention, which was to be *built* over a very rapid river, one hundred and eighty feet broad. The whole *breadth* of the *bridge* is divided into three *arches*, that of the middle to be sixty feet broad, and the other two forty-eight each. The pillars for the support of the *arches* were twelve feet *thick*, being, thereby, a fifth part of the middle *arch*, and a fourth part of the lesser ones; which tho' deviating from the common measures of *pilasters*, were made so *thick* on purpose that they might project very far from the body of the *bridge*, in order to resist the rapidity of the current, and oppose the stones and trees which fall down with the stream. The *arches* were to have been a portion of a circle less than a semicircle, that the *ascent* and *descent* of the *bridge* might be plain and easy. The *archivolte* of the *arches* to have been made a 17th part of the void of the middle *arch*, and a 14th part of the other two. Over the *pilasters* were to have been *niches*, and *statues*, and a *cornice*, on both sides, the *whole length* of the *bridge*.

*Bridges* are also often made of wood, and consist of beams and joists sustained by punchions, well cramp'd, and bound together.

*Palladio* pretends, that the particulars for the erection of *wooden bridges* being innumerable, no certain or determinate rules can be given about them; but, however, he presents us with some *draughts* of several *bridges* of that kind, and by particularizing their several proportions, believes, that an *Architect* who has the least genius, can hence take its measures for the erection of *wooden bridges*. Among his several *draughts*, he proposes that of the *wooden bridge* built over the *Cismona*, a river which falls from the mountains that divide *Italy* from *Germany*, and enters into the *Buenta* a little above *Bassano*, as the most substantial, beautiful, and commodious. The river over which this *bridge* stands, is a hundred foot broad, which *breadth* is divided into six equal parts, and at the end of each part (except at the banks, which are strengthen'd with two solid butments of stone) are placed the beams which constitute the bed, and *breadth* of the *bridge*. Over these, directly with the first, are placed the *Coloneli*, or little pillars, on each side; these pillars are fasten'd to the beams, (which make the *breadth* of the *bridge*) with iron cramps, contriv'd to pass through a hole, made for that purpose, in the heads of the said beams, in that part which advances beyond those pieces which constitute the sides. These cramps being in the upper part, along the said strait and plain pillars, perforated in divers places, and in the under part, near to those thick beams before-mentioned, and with a moderately big hole, went into the pillars, and fasten'd again below with little bars, or pins of iron, made for that purpose. Hence the whole work becomes, as it were, united; so that the beams, which make the *breadth* of the *bridge*, and those of the sides, are, in a manner, one piece with the pillars; which thus come to support the beams that make the *breadth*, as these are again supported by the arms which extend from one pillar to the other. Thus all the parts mutually support each other, and their disposition is such, that the greater *weight* there is on the *bridge*, so much the faster do they close together, and corroborate the work. All those arms, and other pieces of timber, which make up the body of the *bridge*, are but a *foot* in *breadth*, and *three fourths* in *thickness*; but those pieces which make the bed of the *bridge*, that is to say, those laid *length-wise*, are considerably smaller.

The same learned *author* assures us, that *wooden bridges* may be made without any posts in the water, in the following manner: the banks having been strengthen'd with butments, as far as it is convenient, one of the beams which make the *breadth* of the *bridge*, must be laid at a small distance from them, and then the beams, which make the sides,

dispos'd upon it, which, with one of their heads, are to lay upon the bank, and to be fasten'd to it; then upon these, direct with the beam laid for the *breadth*, the *coloneli*, or pillars, must be plac'd, which are to be fasten'd into the said beams with iron cramps, and supported by the braces well fix'd in the head of the *bridge*; that is to say, in the beams which make the sides upon the bank. Afterwards, leaving as much space as shall be left by the said beam for the *breadth* to the bank, the other beam must be laid for the *breadth*, which shall be in like manner fastened to the beams which are to be laid over it *length-wise*, and to the pillars likewise, as they will be supported by their braces. And thus must it be done from one end to the other, or as far as it will be requisite, always observing, in such *bridges*, that in the middle of the *breadth* there be a pillar, the braces whereof shall meet over-against one another, and in the upper parts other beams must be put, which extending from one pillar to another, will keep them united, and (together with the braces plac'd in the head of the *bridge*) they will make a portion of a circle less than a semicircle. Thus making every brace support its pillar, and every pillar the cross beam, and those that make the sides, every part supports its own *weight*. Such *bridges* are large at their heads, and grow narrow near the middle of their *length*. They are called *pendant*, or *hanging*, or *philosophical bridges*.

Dr. *Wallis* gives the design of a *timber bridge*, seventy foot long, without any pillars; and Dr. *Plot* assures us, that there was formerly a large *bridge* over the castle ditch of *Tutbury* in *Staffordshire*, made of pieces of timber, not much above a yard long, and yet not supported underneath, either with pillars, or *arch-work*, or any other sort of prop whatever.

*Note*, That *BUTMENTS*, in this place, are those supporters, or props, on, or against which, the feet of *arches* rest. *Cramps*, are pieces of iron bent at each extreme, serving to bind together pieces of wood, stones, or other things. *Brace*, a piece of timber fram'd with bevel-joints; serving to keep the *building* from swerving either way.

As for the other sorts of *bridges*, as *draw-bridges*, *flying-bridges*, *bridges of boats*, &c. which properly belong to *fortification*, we'll defer treating of them till we come to our treatise of *fortification*.

As there is also an art in judging of *buildings*, as well as in erecting of them, Sir *Henry Wotton* has been so kind to lay down, for that purpose, the following rules: that before fixing any judgment a person ought to be inform'd of its age, since if apparent decay be found to exceed the proportion of

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time,

time, it may be concluded, without further inquiry, either that the situation is naught, or the materials, or workmanship, too slight. If it be found to bear its years well, we must run back from the ornaments, and things which strike the eye first, to the more essential members; till we be able to form a conclusion that the work is commodious, firm, and delightful; the three conditions, in a good *building*, laid down at first, and agreed on by all *authors*.

*Vassari* proposes another, *viz.* by passing a running examination over the whole *edifice*, compar'd to the structure of a well-made man; as whether the walls stand upright on a clean footing and foundation; whether the *building* be of a beautiful stature; whether for the breadth it appears well burnish'd; whether the principal entrance be on the middle line of the front, or face, like our mouths; the windows as our eyes, set in equal number and distance on both sides; the offices, like the veins, usefully distributed, &c.

*Vitruvius* gives a third method of judging; summing up the whole art under these six heads: *ordination*, or settling the model, and scale of the work; *disposition*, the just expression of the first design thereof; (which two, Sir *H. Wotton* thinks he might have spar'd, as belonging rather to the *artificer*, than the *cenfurer*;) *Eurythmy*, the agreeable harmony between the *length*, *breadth*, and

*height* of the several *rooms*, &c. *symmetry*, or the agreement between the parts and the whole; *Decor*, the due relation between the *building* and the inhabitant; whence *Palladio* concludes, the principal entrance ought never to be limited by any rule, but the dignity and generosity of the master; and, lastly, *distribution*, the useful casting of the several rooms for offices, entertainment, or pleasure. These last four are ever to be run over, before a man passés any determinate censure; and these alone, Sir *Henry* observes, are sufficient to condemn or acquit any *building* whatever.

*Dr. Fuller* gives us two or three good *aphorisms* in *building*; as, 1. Let not the common rooms be several, nor the several rooms common; *i. e.* the common rooms not to be private, or retired, as the *hall*, *galleries*, &c. which are to be open; and the *chambers*, &c. to be retir'd. 2. A house had better be too little for a day, than too big for a year; houses, therefore, ought to be proportion'd to ordinary occasions, no extraordinary. 3. Country houses must be substantives, able to stand of themselves; not like city *buildings*, supported and shelter'd, on each side, by their neighbours. 4. Let not the front look askint on a stranger, but accost him right at his entrance. 5. Let the offices keep their due distance from the mansion house; those are too familiar which are of the same pile with it.

A R I T H M E T I C K.

WE have very little intelligence about the origin and invention of *arithmetick*; history neither fixes the author, nor the time. In all probability however, it must have taken its rise from the introduction of commerce, and consequently be of *Tyrian* invention.

From *Asia* it passèd into *Egypt*, (*Josephus* says by means of *Abraham*) here it was greatly cultivated and improv'd; insomuch that a large part of their philosophy and theology, seems to have turned altogether upon numbers, hence those wonders related by them about unity, trinity; the numbers seven, ten, four, &c. In effect, *Kircher* in his *Ædip. Ægypt. Tom. II. p. 2.* shews that the *Egyptians* explained every thing by numbers; *Pythagoras* himself affirming that the nature of numbers goes through the whole universe; and that the knowledge of numbers is the knowledge of the deity.

From *Egypt*, *arithmetick* was transmitted to the *Greeks*, who handed it forward, with great improvements, which it had received by the compu-

tation of their *astronomers*, to the *Romans*; from whom it came to us.

The *antient* ARITHMETICK however, fell far short of that of the *moderns*; most of what they did was to consider the various divisions of numbers; as appears from the treatises of *Nicomachus*, wrote in the third century of *Rome*, and that of *Boethius* still extant. A compendium of the *antient arithmetick*, wrote in *Greek*, by *Ptellus*, in the ninth century from our Saviour, was given us in *Latin* by *Xylander*, in 1558. A more ample work of the same kind was wrote by *Jordanus*, in the year 1200; published with a comment by father *Stapulensis*, in 1480.

*Arithmetick*, under its present state, is divided into different kinds; *viz.* *Theoretical*, *practical*, *instrumental*, *logarithmetical*, *numerous*, *specious*, *decimal*, *dignamical*, *tetraedical*, *duodecimal*, *sexagesimal*, &c.

*Euclid* furnishes a *theoretical arithmetick*, in the seventh, eighth, and ninth books of his elements (which *theoretical arithmetick* is the science of the properties, relations, &c. of numbers considered

abstractedly with the reasons and demonstrations of the several rules.) *Barlaamus Monachus* has also given a theory for demonstrating the common operations, both in *integers* and broken numbers, in his *Logistica*, published in *Latin* by *J. Chambers* an *Englishman*, in 1600. To which may be added *Lucas de Burgo*, who in an *Italian* treatise, published in 1523, gives the several divisions of numbers from *Nicomachus*, and their properties from *Euclid*; with the algorithm, both in *integers*, *fractions*, *extractions of roots*, &c.

The first entire body of *practical arithmetick* (which is the art of numbering or computing from certain numbers given, or finding certain others, whose relation to the former is known, as if a number be required equal to two given numbers 6 and 8) was given by *Nich. Tartaglia Venetian*, in 1556, consisting of two books; the former, the application of *arithmetick* to civil uses; the latter, the grounds of *algebra*. Something had been done before by *Stifelius*, in 1544; where we have several particulars concerning the application of *irrationals*, &c. no where else to be met withal.

There is almost an infinite number of *practical* authors, who have appeared since; as *Gemma Frisius*, *Metius*, *Clavius*, *Ramus*, *Euckley*, *Diggs*, *Record*, *Wingate*, *Cocker*, *Leyburn*, *Ward*, *Malctom*, &c.

The theory of *arithmetick* is joined with the practice, and even improved in several parts by *Maurolicus*, in his *Opuscula Mathematica*, 1575; *Heneschius* in his *Arithmetica Perfecta*, 1609, where the demonstrations are all reduced into the form of *sylogisms*; and *Tacquet* in his *Theoria & Praxis Arithmetices*, 1704.

*Instrumental Arithmetick* is that where the common rules, are performed by means of instruments contrived for ease and dispatch; such are several scales and sliding rules; more particularly those called *Neper's Bones*, an instrument whereby multiplication and division of large numbers are facilitated and expedited; and so called from its inventor *John Neper*, baron of *Marchiston* in *Scotland*.

This instrument is made of five rods, plates, or lamellæ, of wood, metal, horn, past-board, or other matter of an oblong form, and divided each into nine little squares; each of which is resolved into two triangles by diagonals. In these little squares are wrote the number of the multiplication table, in such manner as that the units, or right-hand figures, are found in the right-hand triangle; and the tens, or the left-hand figures in the left-hand triangle. See *Multiplication* and *Division*.

To *Neper's* bones may be added *Sir Sam. Moreland's* instrument, the description whereof was pub-

lish'd by himself in 1666; that of *Mr. Leibnitz*, described in the *Miscellan. Berolin*; that of the *Polenus*, published in the *Venetian Miscellany*, 1709; the *Arithmetica Logarithmica* of *Hen. Briggs*, published 1624: and the universal *arithmetical tables of Prosthaphæreses*, published 1610, by *Herwart ab Hoberburg*; whereby *Multiplication* is easily and accurately performed by *Addition*, and *Division* by *Subtraction*.

The *Chinese* have little regard to our rules in their calculations; instead of which, they use an instrument made of a little plate, a foot and half long, a cross which are fitted ten or twelve iron wires, on which are strong little round bales. By drawing these together, and dispersing them again one after another, they count somewhat after the manner in which we do by counters: but with so much ease and readiness, that they will keep pace with a man reading a book of accounts, let him make what expedition he can: and at the end the operation is found done; and they have their way of proving it.

The *decimal Arithmetick* is not of a very antient date; since it was first introduced into *Europe*, by *Gerbert*, afterwards pope, under the name of *Silvester II.* who borrowed it from the *Moors of Spain*. No doubt it took its origin from the ten fingers of the hands, which were made use of in computation before *arithmetick* was brought into an art. The eastern missionaries assure us, that to this day the *Indians* are very expert at computing on their fingers, without any use of pen and ink. Add; that the natives of *Peru*, who do all by the different arrangement of grains of maize, out-do any *European*, both for sureness and dispatch, with all his rules.

ARITHMETICK is the art or science of numbering: and is that branch of pure mathematics, which treats of the powers and properties of numbers.

NUMBER in *arithmetick*, according to *Euclid* is a collation or assemblage of several *units*, or things of the same kind. But *Sir Isaac Newton* makes it to consist in the abstract *ratio* of a quantity of any kind, to another quantity of the same kind, which is the *unity*.

*Number*, thus defined, is by him also divided into *integers*, *fractions*, and *hundreds*, of which respectively we shall treat in their proper place.

UNIT is the number *one*, or one single individual part of *discrete quantity*.

The manner of expressing these *units* in *arithmetick* is by certain *characters*, or *figures*.

Nine of these CHARACTERS or FIGURES are called *significant* figures, and are thus written,

- 1 One
- 2 Two
- 3 Three
- 4 Four
- 5 Five
- 6 Six
- 7 Seven
- 8 Eight
- 9 Nine

There is a tenth called a *cypher* 0

Of NUMERATION.

All NUMBERS are either a *simple* or *compound*.

Every *single* figure is a *simple number*; as 2, 4, 6, 8 or 1, 3, 5, 7, 9.

A *compound number* is composed of two or more figures in one line; as 15, 223, 1759, &c.

Every *significant* figure has a *certain* and *uncertain* value.

Every *single* figure is of a certain value, as 2 can signify no more than *two*; 3, no more than *three*, &c. but when any figure is to be compounded with some other, it takes its value occasionally from its place or position in the sum to be numbered; thus 4 prefixed to 2, as in 42 is valued at *forty*, but if the 4 should be placed on the right side of the 2, as in 24, the 4 is valued at no more than *four*. Thus 5 may be placed to signify no more than *five*, and it may be placed so as to signify *fifty-five* 55, *five hundred and fifty-five* 555, *five thousand five hundred and fifty-five* 5555, &c.

Where you may observe that the *order* of placing figures to encrease their value, is from the right

hand to the left: the first figure or cypher on the right hand, being the place of the *units*; the second the place of the *tens*; the third the place of the *hundreds*; and in this order, it must be remembered that a cypher 0 or cyphers, give the value to the figure according to its place; thus 10 signifies *ten*, 100, one *hundred*, 1000, one *thousand*; because the *significant* figure, in such sums, stands in the place of *tens*, *hundreds*, *thousands*, &c. the value of every figure increasing in a decuple proportion, as they fall back from the right hand to the left; every place being *ten times* the value of that immediately before it; as will more fully appear in the following schemes.

NUMERATION TABLE.

Hundreds of Millions	Tens of Millions	Millions	Hundreds of Thousands	Tens of Thousands	Thousands	Hundreds	Tens	Units
9	8	7	6	5	4	3	2	1
1	2	3	4	5	6	7	8	9
	2	3	4	5	6	7	8	9
		3	4	5	6	7	8	9
			4	5	6	7	8	9
				5	6	7	8	9
					6	7	8	9
						7	8	9
							8	9
								9

The numbers in the TABLE are thus to be read, viz.

987 Mil.	654 Th.	321
123 Mil.	456 Th.	789
23 Mil.	456 Th.	789
—3 Mil.	456 Th.	789
—————	456 Th.	789
—————	56 Th.	789
—————	6 Th.	789
—————		789
—————		89
—————		9

A *cypher* is of itself *insignificant*, but by its place alters the value of the subsequent figure: and, since the value of each place is *ten times* the value of the next before it, it is certain

that  $\left\{ \begin{array}{l} 1 \\ 2 \\ 3 \\ \text{\&c.} \end{array} \right\}$  in the first place is  $\left\{ \begin{array}{l} 10 \\ 20 \\ 30 \\ \text{\&c.} \end{array} \right\}$  in the second,  $\left\{ \begin{array}{l} 100 \\ 200 \\ 300 \\ \text{\&c.} \end{array} \right\}$  in the third,  $\left\{ \begin{array}{l} 1000 \\ 2000 \\ 3000 \\ \text{\&c.} \end{array} \right\}$  in the fourth, &c.

The value of each figure in any rank of numbers, how large soever, is readily found by the following rule.

Begin at *units*, set a point under the *seventh* place; then reckoning that as *one*, count forwards, and set another under the next *seventh* place, so continue to the end.

Then the  $\left\{ \begin{array}{l} \text{first} \\ \text{second} \\ \text{third} \\ \text{fourth, \&c.} \end{array} \right\}$  point from units stands under  $\left\{ \begin{array}{l} \text{millions,} \\ \text{billions,} \\ \text{trillions,} \\ \text{quadrillions, \&c.} \end{array} \right\}$

As is evident in the following example,

Periods	Quadril.	Trillions	Billions	Millions	Units
Half-periods	th. units				
Degrees	cxucxu	cxucxu	cxucxu	cxucxu	cxucxu
Figures	123456	789098	765432	101234	567891

*N. B.* A PERIOD is a million times the value of the place before it. A HALF PERIOD is a thousand times the value of the place before it. By this means you may have as clear a notion of, and may as easily read a number of *seventy* places, as of *seven*.

The next enquiry is to find how these figures are to be rendered useful; which will be shewn under distinct RULES, or operations to find the sums or numbers unknown, and to facilitate the art of *computation*.

### R U L E I.

#### A D D I T I O N.

A D D I T I O N is the first of the four principal rules in *Arithmetic*, whereby we are taught to find a *sum* equal to several small ones.

#### A D D I T I O N of Simple Numbers.

If you were to add 136 and 42 together, they must be placed one under the other as followeth, *viz.*

$$\begin{array}{r} 136 \\ 42 \\ \hline \end{array} \quad \text{Or,} \quad \begin{array}{r} 42 \\ 136 \\ \hline \end{array}$$

Having placed the given numbers as before is directed, then draw a straight line under them, and (beginning at the place of *units*) add all the figures together that stand over one another in that *rank*; putting their sum under the said straight line; as in this example, I say, 2 and 6 is 8, wherefore I put 8 under the line, and in its proper place, under 2 and 6, and proceed to the next rank, which is the place of *tens*; saying, 4 and 3 is 7, wherefore I put 7 in its own proper place under the line; and proceed to the next and last rank, where I find only 1, wherefore I put one in its proper place under the line, and so the work is finished; and I find thereby that the total sum of 136 and 42 to be 178. See the operation as followeth.

$$\begin{array}{r} 136 \\ 42 \\ \hline 178 \end{array} \quad \begin{array}{r} 42 \\ 136 \\ \hline 178 \end{array}$$

If, in adding together any of the ranks the sum amounts to, or exceedeth 10, or any number of tens, then in such a case you are either to set down a *cypher* under the line in its proper place, or else

the *excess* above the *ten to tens*; and for every *ten* carry an *unit* to be added to the next rank of figures. As, if it amount to 30, then set down (0) a cypher, and carry 3 (for the three tens) to be added to the next rank; if it amount to 34, then set down 4 under the rank that you add, and carry three to the next, &c. And when you have cast up the last rank or series towards the left-hand, set down the total that it amounteth to, as in the following examples.

( 1 )	( 2 )	( 3 )	( 4 )
748	4558	1648	20864
364	6673	3472	78987
296	2891	1865	6217
242	1862	3479	4320
Sum 1650	15984	10464	110388

In the first of these examples I begin, saying, 2 and 6 is 8, and 4 is 12, and 8 makes 20, which is just two tens; wherefore I put down 0 under the line, and carry 2 to the next rank for the two tens, and proceed, saying, 2 that I carry, and 4 is 6, and 9 is 15, and 6 is 21, and 4 is 25, which is 5 above 20, wherefore I put down 5 under the line, and carry 2 for the two tens to the next rank, and then proceed, saying, 2 that I carry, and 2 is 4, and 2 is 6, and 3 is 9, and 7 makes 16, wherefore (because it is the last rank) I put down 16 under the line, and so the work is finished; the total sum of the *Addition* being 1650. The same is to be observed in the rest of the examples.

To prove your *Addition* after you have added up your whole sum, draw a line with your pen under the uppermost number, and when you have so done, add all the other numbers, except the uppermost; and when you have so done, add the amount or sum thereof to the uppermost sum above the line; and if the sum be the same with the sum first found, your work is true, otherwise not.

In ADDITION of *diverse denominations*, place the given numbers in such order under each other, that each rank from top to bottom may consist of one and the same value.

ADDITION of MONEY.

In ADDITION of ENGLISH money, it is necessary first of all to understand the meaning and signification of all the characters supercribed over every sum, as *lib. s. d.*

Note, That *lib.* signifies *libra*, a *pound*, not here in respect to common weight, but *money*, and for distinction is called a *pound sterling*. So *s.* stands for a shilling. *d.* stands for *denarius*, a *penny*; the 12th part of a shilling. For until the reign of Henry VI. a *penny* was the 20th part of an ounce of silver, and in his reign made the 30th. By Edward IV. 40 *pence* make an ounce. By Henry VIII. there was allowed 45 *d.* to the ounce. And by Queen Elizabeth an ounce of silver was divided into 60 parts, called *pence*, as it is at this day.

PENCE TABLE.

<i>d.</i>	<i>s.</i>	<i>d.</i>	<i>d.</i>	<i>s.</i>
20	1	8	12	1
30	2	6	24	2
40	3	4	36	3
50	4	2	48	4
60	5	0	60	5
70	5	10	72	6
80	6	8	84	7
90	7	6	96	8
100	8	4	108	9
110	9	2	120	10
120	10	0	132	11
130	10	10	144	12

AND

ENGLISH MONEY.

4 Farthings	} make	One penny.	<i>d.</i>
12 Pence		One shilling.	<i>s.</i>
20 Shillings		One pound.	<i>l.</i>

NOTE, These are the general names of *English* money observed in trade and accounts; but there are other names in common use, whose value is according to the following table.

A Half-penny	} valued at	<i>l.</i>	<i>s.</i>	<i>d.</i>
A Two-pence				2
A Three-pence				3
A Groat				4
A Six-pence				6
A Half crown			2	6
A Crown			5	0
A Quarter-guinea			5	3
A Half-guinea			10	6
A Guinea			1	1

Having first drawn a line under the ranks, add them together, considering how many of each smaller denomination make an unit of the next that is superior to it (always observing to begin at the least denomination) and for every such unit, carry one to the next superior denomination, viz. for every 4 in the farthings you must carry 1 to the pence; for every 12 in the pence carry 1 to the shillings; and for every 20 contained in the shillings, carry 1 to the pounds, according to the table; and the odd farthings, pence, and shillings, set down in their proper ranks under the line, as in the following example.

When you would write down three *farthings*, or a *half-penny*, or a *farthing*, write it thus.

$\frac{3}{4}$	—	Three Farthings.
$\frac{1}{2}$	—	A Hal-penny.
$\frac{1}{4}$	—	A Farthing.

Let it be required to add together 134 *l.* 16 *s.* 8 *d.*  $\frac{1}{4}$ . and 286 *l.* 10 *s.* 4 *d.*  $\frac{1}{2}$ . and 489 *l.* 13 *s.* 5 *d.*  $\frac{1}{2}$ . and 794 *l.* 18 *s.* 09 *d.*  $\frac{1}{4}$ . Then in order to the work I set them down, and draw a line under them, as followeth.

<i>l.</i>	<i>s.</i>	<i>d.</i>
134	16	8 $\frac{1}{4}$
286	10	4 $\frac{1}{2}$
498	13	6 $\frac{1}{2}$
794	18	9 $\frac{1}{4}$

First, begin with the least denomination, which is that of farthings, and add them together, saying,  $\frac{1}{4}$  and  $\frac{1}{2}$  is  $\frac{3}{4}$  and  $\frac{3}{4}$  is 6, and  $\frac{1}{4}$  is 7 farthings, which is 1 penny and 3 farthings, wherefore put 3 farthings under the line, and under the denomination of farthings, and carry 1 (for the penny) to the next denomination of pence, saying, 1 that I carry and 9 is 10, and 6 is 16, and 4 is 20, and 8 is 28, now 28 pence is 2 shillings and 4 pence, wherefore put 4 under the line, and carry 2 shillings to the denomination of shillings, saying 2 that I carry and 18 is 20, and 13 is 33, and 10 is 43. and 16 is 59 shillings, which is 2 pounds 19 shillings; whereof put the 19 shillings under the line, and under the denomination of shillings, and carry 2 (for the 2 pence) to the denomination of pounds, and proceed, saying, 2 that I carry and 4 is 6, and 8 is 14, and 6 is 20, and 4 makes 24, wherefore put down 4 under the line, and carry 2 for the two tens to the next rank, saying, 2 that I carry and 9 is 11, and 9 is 20, and 8 is 28, and 3 is 31, which is 1 above 30, wherefore I put 1 under the line and carry 3 (for the three tens) to the next rank, and proceed, saying, 3 that I carry and 7 is 10, and 4 is 14, and 2 is 16, and 1 is 17, wherefore put 17 under

under the line, because it is the sum of the last rank, and so the whole work is finished, and we find the sum of the given numbers to be 1714 *l.* 19 *s.* 4 *d.* 3 *qr.* as by the following work appeareth.

<i>l.</i>	<i>s.</i>	<i>d.</i>
134	16	8 $\frac{1}{4}$
286	10	4 $\frac{3}{4}$
498	13	6 $\frac{1}{2}$
794	18	9 $\frac{1}{4}$
Sum	1714	19
	19	4 $\frac{3}{4}$

To prove your *Addition*, after you have added up your whole sum, draw a line with your pen under the uppermost number or sum, and then add together all the other numbers, except the uppermost. And when you have so done, add the amount, or sum thereof to the uppermost sum above the line; and if that sum be equal to the sum first found, the work is true, otherwise not

The same method is used to prove *Addition* of diverse denominations, as above in sums of one denomination.

Here, *Note, once for all*, That whatsoever sums you are to add together, whether of *Money, Weight, Measure, Time, &c.* that when you come to the greatest denominations, as you cast up the several ranks thereof, you are to carry the tens of every preceding rank to that which follows it, as is directed in the *fifth Section* of this chapter, and as the ranks in the denomination of pounds in the last *Example* are cast up.

In adding up of money, *first*, cast up your pence, or make a small comma at every 60 *d.* which is 5 *s.* (and it will be a great ease to the memory where sums are long) and by the Table you may readily know, how many shillings and pence your pence amount to; then set down your odd pence under the place of pence, and carry your shillings to the unit of shillings, and then add them up as in *Addition of single numbers*, by setting down the odd above the tens, and carry the tens to the tens of *shillings*.

ADDITION of WEIGHTS.

The WEIGHT used in *England* for large and coarser commodities, as *cheese, wool, lead, &c.* is called *Avoirdupois*: the pound whereof is made up of sixteen ounces, and bears the proportion of 17 to 14 to a pound *Troy*.

The Table for AVOIRDUPOIS WEIGHT.

16 Drams	}	make	One Ounce	<i>oz.</i>
16 Ounces			One Pound	<i>lb.</i>
28 Pounds			One Quarter	<i>qr.</i>
4 Quarters			One Hundred	<i>C.</i>
20 Hundred			One Ton	<i>Tn.</i>

*Note*, This weight differeth in diverse goods and places by custom and statute law; for,

A barrel of anchovies weighs	30
— Figs from	26 $\frac{1}{2}$
———— to	98
— Raisins	112
— Gun powder	112
— Candles	120
— Potash	200
— Butter	224
— Soap	256
A puncheon of prunes 10 or 12 C.	
A stone of glass	5
———— Butchers meat	8
———— Iron, wool, &c.	14
———— Butter and cheese	16
A quintal of dry fish	100
A faggot of steel	120
A seam of glass	120
A burden of gad steel	180
A clove of cheese and butter	8
A wey in <i>Suffolk</i>	256
———— in <i>Essex</i>	336
A fodder of lead	19 C and 56

*Note*, That in Reduction of *Avoirdupois weight* there are certain allowances to the buyer, which must be deducted out of the gross or whole weight and package, before you can reduce the neat weight.

These allowances are called *tare, tret* and *cloff*.

*Tare* is an allowance for the weight of the box, bag, &c. according as shall be agreed between buyer and seller.

*Tret* is 4 *lb.* in 104 *lb.* for waste, &c. in some kind of goods.

*Cloff*, is 12 *lb.* on every draught above 300 *lb.* weight, allowed only to the citizens of *London* on *Sumac, Argol, &c.*

Sometimes there happens to be *tare* and *tret* in the same parcel of goods; then you must deduct the *tare* first, and the remainder is termed the subtle weight. See REDUCTION.

Observe *once for all*, That the neat weight of any goods is their real weight after all allowances are deducted.

ADDITION of AVOIRDUPOIS weight.

Here *note* also that *T.* stands for *tons*, *C.* for *hundred weight*, *qr.* for *quarters of hundred*; *lb.* for *pound weight*; *oz.* for *ounces*; *dr.* for *drams*.

EXAMPLE.

EXAMPLE:

Ton	C.	qr.	lb.	G.	qr.	lb.	oz.
25	14	2	24.	154	1	19	10
57	16	3	25.	275	3	19	11
42	10	1	17.	476	2	10	07
96	14	2	27.	57	3	14	08
54	17	2	18.	45	1	10	10
59	16	3	22.	17	2	22	11
35	14	2	19.	45	3	17	09
64	17	3	26.	76	2	19	14
<hr/>				<hr/>			
438	04	0	18	1150	1	23	00

Let it be required to add up the sum above, expressing *Tons*, *C.* *qr.* and *Pounds*. First, add up the pounds by making a speck or tittle at every 28 you find in the place of pounds, as you may see in the abovementioned *Example*, where is found to be six specks, and 18 *lb.* over, which 18 place under the denomination of pounds, and carry 6 to the quarters, and add them up they make 24, which is 6 *C.* for which put a (0) under the place of *qr.* and carry 6 *C.* to the place of *C.* Then proceed to add up your *C.* after the same manner as you carry from shillings to pounds, because 20 *C.* make a *Ton*. Lastly, add up the *tons*, and the total will appear to be 438 *tuns*, 4 *C.* 0 *qr.* 18 *lb.*

The pound *Avoirdupois*, containing 16 ounces, is equal to 14 *oz.* 12 *dwt.* *Troy-weight*. And the pound *Troy-weight*, consisting of 12 ounces, is about 13 ounces, 2 drams and a half of *Avoirdupois-weight*.

Wool is weighed with *Avoirdupois weight*, but the divisions are somewhat different. For in wool,

7 Pounds is a clove, 2 clove is a stone, 2 stone is a todd, 6 todods 1 stone, or 13 stone is a wey, 2 weys is a sack, 12 sacks is a last of wool.

*Note*, That according to the foregoing division 182 *lb.* is a wey, but in some counties the wey is 256 *lb.* *Avoirdupois*, as in *Suffolk*; &c. And in *Essex* there is 336 *lb.* in a wey.

ADDITION of *TROY Weight* has its particular marks and denominations, as in the following Table.

THE TABLE OF TROY WEIGHT.

24 Grains	}	make	{	One penny wt.	<i>dwt.</i>
20 Penny wt.				One ounce	<i>oz.</i>
12 Ounces				One pound	<i>lb.</i>

*NOTE*, This weight only gives five score to the hundred.

EXAMPLE.

Let it be required to add the following particulars together, *viz.* 24 *lb.* 9 *oz.* 6 *dwt.* 11 *gr.* and 164 *lb.* 10 *oz.* 14 *p. wt.* 18 *gr.* and 82 *lb.* 7 *oz.* 17 *dwt.* 20 *gr.* and 8 *lb.* 11 *oz.* 18 *dwt.* 22 *gr.*

To find out the sum of these given quantities, place them one under another orderly, as you see here, and draw a line under them.

lb.	oz.	dwt.	gr.
24	09	06	11
164	10	14	18
82	07	17	20
8	11	18	22
<hr/>			
281	03	17	23

Then begin with the denomination of *grains*, making a dot with a pen at every 24, (for ease) and bear the overplus to the next above, saying, 22 and 20 is 42, which is 18 above 24, wherefore make a dot at 20, and carry the 18 up higher, saying 18 and 18 is 36, which is 12 above 24, wherefore make a mark at 18, and carry the 12 to the next above, saying, 12 and 11 makes 23, which put under the line in its proper place, and observe how many dots are made in the casting up this denomination, which you'll find to be 2, wherefore carry 2 to the next, and proceed (as in the *shillings* in *Addition of Money*, because you carry one for every 20) saying, 2 and 8 is 10, and 7 is 17, and 4 is 21, and 6 is 27, and (then down again with the tens) 10 is 37, and 10 is 47, and 10 is 57 *penny-weights*, which is 2 *oz.* 17 *dwt.* wherefore put 17 *dwt.* in its place under the line, and carry the 2 *oz.* saying, 2 that I carry and 1 is 3, and 7 is 10, and 9 is 19, and 10 is 29, and 10 is 39 *ounces*, which is 3 *lb.* 3 *oz.* wherefore put the 3 *ounces* in its proper place under the line, and carry 3 *lb.* to the *pounds*, and proceed to finish the work as is before directed; which being done, you will find the total sum to be 281 *lb.* 3 *oz.* 17 *pw.* 23 *gr.* as above.

ADDITION of *APOTHECARIES Weight*, is performed nearly the same way as *Troy weight*; only the subdivisions of the pound are different, as followeth, *viz.*

*Note*, That 20 grains is a scruple, 3 scruples is a dram, 8 drams is an ounce, and 12 ounces is a pound weight.

The marks or characters, by which *Apothecaries weights* are known, are these, *viz.* For pounds (*℔*), ounces (*ʒ*), drams (*ʒ*), scruples (*ʒ*), grains (*gr.*)

lb.	3	5	9	gr.
76	00	2	0	15
54	10	5	2	17
68	11	7	1	12
28	04	4	1	14
16	10	0	2	18
35	06	1	0	14
280	7	6	1	10

## ADDITION of LIQUID MEASURE.

The least denomination in LIQUID Measure is a pint, which was heretofore deduced from a pound Troy-weight, a pound of wheat Troy-weight making a pint liquid measure, but in regard of the disagreement thereof with the rules of solid Geometry in the gauging of brewers vessels, some taking 288 solid inches for a gallon, some 286 &c. it occasioned a difference between the brewers and the managers of his Majesty's excise, till the parliament, taking the matter into consideration, ordained, That 282 solid inches should make the gallon of beer measure, and the gallons being subdivided into 2 pottles, each pottle into 2 quarts, and each quart into 2 pints, so that the pint being the eighth part of a gallon, must contain 28 solid inches and 7 eighth parts of an inch for Wine Measure, and 35 solid inches, and a quarter for Beer Measure.

Wherefore note, That  $35\frac{1}{2}$  solid inches make a pint of Beer Measure, 2 pints a quart, two quarts a pottle, 2 pottles, or 282 solid inches, a gallon, 8 gallons a firkin of ale, 9 gallons a firkin of beer, 2 firkins a kilderkin, 2 kilderkins a barrel,  $1\frac{1}{2}$  a barrel, or 54 gallons a hoghead of beer.

## In WINE MEASURES.

2 Pints make a quart, 2 quarts a pottle, 2 pottles a gallon, 42 gallons a tierce, or third part of a pipe or butt, 63 gallons a hoghead, 2 hogheads a pipe or butt, and 2 pipes or butts a tun of wine.

Note, Honey and oil are bought and sold by this measure.

## EXAMPLE of WINE MEASURE.

T.	hbds.	gal.	pts.
37	3	18	5
48	2	24	0
67	1	20	6
38	2	17	7
79	0	47	3
64	1	52	4
335	3	55	1

## ADDITION of DRY MEASURE.

The least denominative part of Dry Measure a pint, which is taken from Troy Weight.

With these are measured all dry substances, as corn, salt, coal, sand, &c. The table followeth.

In Dry Measure, Note, That 2 pints make a quart, 2 quarts a pottle, 2 pottles a gallon, 2 gallons a peck, 4 pecks a bushel Land Measure; 5 pecks a bushel Water Measure; 8 bushels a quarter; 4 quarters a chaldron, and 5 quarters a wey.

Note, 36 Bushel is a chaldron of sea-coal in London.

## EXAMPLE of DRY MEASURE.

Chalds.	qrs.	Bush.	pec.
148	3	6	3
375	1	7	2
296	2	4	3
128	1	5	0
94	0	5	2
38	2	4	3
1082	1	2	1

## ADDITION of LONG MEASURE.

Long Measure is originally deduced from a barley-corn taken out of the middle of the ear and well dried, from whence is deduced the following table.

3 Barley-corns make an inch; 12 inches a foot; 3 feet a yard; 3 feet 9 inches, or a yard and a quarter, is an ell English; 6 feet a fathom, 5 yards and a half, or 16 feet and an half, make one statute pole, or perch; 40 poles or perches make a furlong, and 8 furlongs make an English mile.

## EXAMPLE of LONG MEASURE.

Miles	Fur.	Perch.
48	7	24
37	3	18
65	3	28
36	5	00
107	1	07
205	6	17
501	3	14

## ADDITION of CLOTH MEASURE.

4 Nails or 9 inches make a quarter of a yard; 3 quarters of a yard make an ell Flemish; 4 quarters a yard English; 5 quarters of a yard, or 45 inches, is an ell English.

### EXAMPLES of CLOTH MEASURE.

Yds. gr. na.	Ells gr. na.	Ells Fl. gr. na.
137 3 3	376 2 0	184 1 2
295 1 2	378 3 3	357 2 1
112 2 3	742 3 1	475 2 2
215 0 1	97 2 2	251 1 0
174 1 2	84 1 2	164 0 2
764 3 0	68 0 3	87 1 3
1700 0 3	1747 3 3	1521 0 2

### ADDITION of LAND MEASURE.

From the foregoing table of *Long Measure*, is also *Superficial Measure* deduced; that of *Land Measure* being as follows, viz.

In *Land Measure*, 40 square *poles* or *perches* make a *rood*, and 4 *roods* make an *acre*.

### EXAMPLE of LAND MEASURE.

Acr.	Rood	Per.
120	2	34
275	3	14
162	1	35
98	2	20
47	3	30
64	1	15
769	3	28

### ADDITION of TIME.

The denominative parts of *time* are originally deduced from the *sun's* motion in the heavens, which is carried round the same from *east* to *west*, by the rapid motion of the *primum mobile*, in one *day natural*, which day is divided into 24 supposed equal parts, called *hours*, and each *hour* is subdivided into 60 *minutes*, &c. whence ariseth the following table.

60 Minutes make an hour, 24 hours make a natural day, 7 days make a week, 4 weeks make a month consisting of 28 days, 13 months, one day and six hours make a year.

Note, That the minute is usually subdivided into 60 seconds, and each second into 60 thirds, &c.

The *tropical year*, or the time the sun leaves the *tropick*, til the time it returns to it again, by the observations of the most accurate *Astronomers*, is found to consist of, 365 *days*, 5 *hours*, 49 *minutes*, 4 *seconds*, and 21 *thirds*.

### E X A M P L E.

10 Ys.	13 Mo.	4 W.	7 D.	24 H.	60 Min.
319	3	2	6	12	14
298	7	1	5	12	20
487	9	3	4	12	30
402	1	2	3	10	0
320	2	1	0	6	7
376	7	2	4	8	3
278	1	0	0	0	0
172	8	3	5	0	0
100	0	0	0	0	0
2755	3	2	1	31	14

### Of SUBTRACTION.

SUBTRACTION teacheth to take a *lesser number* from a *greater*, or an *equal* from an *equal*; whereby we discover the *remainder*, *excess*, or *difference*.

If the numbers given be *integers*, that is, consisting of *one denomination*, then place the *biggest number uppermost*, and the *lesser* in order *under it*, viz. *units under units, tens under tens, hundreds under hundreds, &c.* And draw a line under them, as in *Addition*.

Then begin at the place of *units*, taking the lowermost figure *out of* the uppermost, and place the *remainder* under the line; then proceed to the place of *tens*, and do in the same manner; and then to the place of *hundreds*, &c. till the whole work be finished. The *number* under the said line shall be the *remainder* or *difference*.

### E X A M P L E.

Let it be required to find the difference between 48 and 16? Place them thus.

From	48
Take	16
	32
Remains	32

First, put down the *biggest* number 48, and place 16 the *lesser* number under it, and under both draw a line; then begin at the place of *units*, saying, 6 out of 8 and there remains 2, which place under the line and proceed to the next place, saying, 1 from 4 and there remains 3, which likewise place under the line, and the work is finished. So that the *remainder* or *difference* between 48 and 16 is 32, as you may see by the work above.

But if the particular figure, which you are to *subtract*, be *greater* than the figure, *out of* which it is to be *subtracted*, then you are to borrow 10, and add it to the uppermost figure, and then *subtract* the said lowermost figure from their sum, and place the *remainder* underneath the line, and for that

which you borrow, add 1 to the next figure in the lowermost line, and proceed. Let this be repeated as often as there is occasion.

## E X A M P L E.

Let it be required to subtract 3872 from 43758.

$$\begin{array}{r} 43758 \\ \underline{3872} \\ 39886 \end{array}$$

The given numbers being placed, and a line drawn under them, as is before directed, begin at the right hand, saying, 2 from 8, and there remains 6, which set under the line, and proceed, saying 7 from 5 I cannot, but 7 from 15, and there remains 8, which put under the line, and proceed to the next, saying, 1 that I borrowed and 8 is 9, 9 from 7 I cannot, but 9 from 17 and there remains 8, which put under the line, and proceed to the next figure, saying, 1 that I borrowed and 3 is 4, 4 from 3 I cannot, but 4 from 13 and there remains 9, which put under the line; now, because there is no figure standing under the 4, I therefore suppose a (0) to be placed there, and because I borrowed 1 at the last figure, therefore I pay it here by subtracting it out of the 4, saying, 1 that I borrowed out of 4 and there remains 3, which put under the line, and the work is finished. and you will find (after the work of *Subtraction* is ended) the remainder to be 39886.

For *proof of Subtraction*, add the rest, or remainder, to the number subtracted, and if the sum be equal to the uppermost number, (*being the number from whence Subtraction is made*) your work is true, otherwise false.

## SUBTRACTION of MONEY.

If the given number consist of divers denominations, such as *money, weight, measure, time, &c.* then you are to place the lesser number under the greater in such sort, that each denomination may stand under his correspondent name, as has been directed in *Addition*; and draw a line under them.

Then proceed to *subtract* the undermost from the uppermost, beginning at the *last denomination*, and proceeding gradually towards the left hand, setting the remainder of each denomination under the line, until the whole be finished.

## E X A M P L E.

Let it be required to subtract 129*l.* 7*s.* 4*d.*  $\frac{1}{4}$  from 250*l.* 13*s.* 10*d.*  $\frac{3}{4}$ . First place them down, the lesser under the greater, and draw a line under them,

$$\begin{array}{r} \textit{l. s. d. f.} \\ 250 \quad 13 \quad 10 \frac{3}{4} \\ \underline{129 \quad 7 \quad 4 \frac{1}{4}} \\ 121 \quad 6 \quad 6 \frac{1}{2} \end{array}$$

Then begin at the right hand, saying, 1 farthing from 3 farthings, and there remains 2, which put under the line in the place of farthings, and proceed to the denomination of pence, saying, 4 from 10 and there remain 6, which put under the line in the place of pence, and then go to the denomination of shillings, saying, 7 from 13, and there rest 6, which put under the line in the place of shillings, and then proceed to finish the work, as directed above; which being ended, we find the remainder to be 121 *l.* 6 *s.* 6 *d.*  $\frac{1}{2}$ , as in the example.

But if the lowermost number in any of the denominations chance to be greater than the uppermost, you must in such case borrow an unit from the next greater denomination, subtracting the lowermost number therefrom, and adding the remainder to the said uppermost number, and place that sum under the line, and then proceed, adding one to the next lowermost number to the left hand for that you borrowed, &c.

## E X A M P L E.

Let it be required to subtract 178*l.* 15*s.* 9*d.*  $\frac{1}{4}$  from 348*l.* 12*s.* 7*d.*  $\frac{3}{4}$

$$\begin{array}{r} \textit{l. s. d.} \\ 348 \quad 12 \quad 07 \frac{3}{4} \\ \underline{178 \quad 15 \quad 09 \frac{1}{4}} \\ 169 \quad 16 \quad 10 \frac{1}{2} \end{array}$$

First, place them down in order, and draw a line under them. Then begin at the right hand with the denominations of farthings, saying, 1 from 3, and there remains 2, which put under the line, and proceed to the denomination of pence, saying, 9 pence out of 7 I cannot, but borrowing 1 from the next denomination, which is shillings, and makes 12 pence, say, 9 from 12, and there remain 3, which add to 7 pence, and that makes 10 pence, wherefore put 10 pence under the line, and proceed to the next denomination which is shillings, and say, 1 that I borrowed, and 15 is 16, from 12 I cannot, but (borrowing 1 pound from the next denomination, which is 20 shillings) 16 from 20, and there remains 4, which added to the said 12, makes 16 shillings, which set down under the line, and proceed to the pounds, saying, 1 that I borrowed and 8 is 9, 9 from 8 I cannot, but 9 from 18, &c. And the work being finished, we find the remainder to be 169*l.* 16*s.* 10*d.*  $\frac{1}{2}$ , as appears by the work above.

# A R I T H M E T I C K.

*The PROOF.*

	l.	s.	d. f.
From	348	12	7 $\frac{1}{4}$
Subtr.	178	15	9 $\frac{1}{4}$
<hr/>			
Remain	169	16	10 $\frac{1}{2}$
<hr/>			
Proof	348	12	7 $\frac{1}{4}$

In this *example* the remainder is found to be 169*l.* 16*s.* 10*d.*  $\frac{1}{2}$ , which I add to 178*l.* 15*s.* 9*d.*  $\frac{1}{4}$  (this number being subtracted,) and the sum is 348*l.* 12*s.* 7*d.*  $\frac{1}{4}$ , which is equal to the uppermost of the given numbers, wherefore the subtraction is truly wrought.

*EXAMPLES for Practice.*

	l.	s.	d. f.	l.	s.	d. f.
Received	295	11	3 $\frac{1}{4}$	425	00	05 $\frac{1}{2}$
Paid	107	14	9 $\frac{1}{2}$	107	11	08 $\frac{1}{4}$
<hr/>						
Reft	187	16	5 $\frac{3}{4}$	317	08	09 $\frac{1}{4}$
<hr/>						
Proof	295	11	3 $\frac{1}{4}$	425	00	05 $\frac{1}{2}$
<hr/>						
Debtor	100	00	00	1072	01	05
Creditor	75	00	9	107	16	10 $\frac{1}{2}$
<hr/>						
Balance	24	19	3	964	04	06 $\frac{1}{2}$
<hr/>						
Proof	100	00	00	1072	01	05
<hr/>						
Received	1010	10	10	100	00	09 $\frac{1}{2}$
Disburst	942	13	11 $\frac{1}{2}$	47	00	10
<hr/>						
Reft	67	16	10 $\frac{1}{2}$	52	19	11 $\frac{1}{2}$
<hr/>						
Proof	1010	10	10	100	00	09 $\frac{1}{2}$

If a sum be lent, and payment thereof made at *several times* in part, and you would know how much remains due, in this case you must add the several payments into one sum, and subtract that sum from the sum lent, and the remainder will shew how much is due.

E X A M P L E S.

	l.	s.	d. f.	l.	s.	d.
Borrowed	3475	10	05	572	11	5
<hr/>						
Paid at several times	358	14	07 $\frac{1}{2}$	154	9	7 $\frac{1}{4}$
	524	07	11 $\frac{3}{4}$	95	10	7
	294	16	09	6	14	5 $\frac{1}{2}$
	344	10	08 $\frac{1}{2}$	72	11	4
	365	15	10 $\frac{1}{4}$	16	17	2
	795	15	07 $\frac{3}{4}$	9	14	11 $\frac{1}{2}$
<hr/>						
Paid in all	3146	16	02 $\frac{1}{4}$	502	15	10 $\frac{1}{4}$
<hr/>						
Refts due	328	14	02 $\frac{3}{4}$	69	15	6 $\frac{3}{4}$
<hr/>						
Proof	3475	10	05	572	11	5

Lent

4768	17	10 $\frac{3}{4}$
------	----	------------------

Received at  
several  
times,

347	14	7 $\frac{1}{2}$
785	11	11 $\frac{3}{4}$
128	15	9 $\frac{1}{4}$
420	16	5
124	00	2 $\frac{3}{4}$

Received in all

1806	18	11 $\frac{3}{4}$
------	----	------------------

Remains due

2961	18	11
------	----	----

	l.	s.	d. f.	l.	s.	d. f.
Borrowed	3475	10	5	4620	00	00
<hr/>						
Paid at several times,	358	14	7 $\frac{1}{2}$	409	9	10
	514	7	11 $\frac{3}{4}$	276	15	7 $\frac{1}{4}$
	294	16	9	195	13	11 $\frac{1}{4}$
	344	10	8 $\frac{3}{2}$	167	19	10 $\frac{1}{2}$
	365	15	10 $\frac{1}{4}$	984	19	5 $\frac{1}{4}$
	792	5	6 $\frac{1}{2}$	215	7	6
<hr/>						
Paid in all	2670	12	3 $\frac{1}{2}$	2250	6	2 $\frac{3}{4}$
<hr/>						
Refts due	804	18	1 $\frac{1}{2}$	2369	13	9 $\frac{1}{4}$
<hr/>						
Proof	3475	10	5	4620	00	00

SUBTRACTION of AVERDUPOIS Weight.

A Salter buys 45 ton, 6 C. 1 qr. 12 lb. of logwood, of which he fold 19 ton, 14 C. 1 qr. 18 lb.

I difpoſe the given numbers according to the directions already given, drawing a line under them, as you ſee in the

EXAMPLE.

Ton	C.	qr.	lb.
45	7	1	12
19	14	1	18
25	12	3	22

Then begin at the right hand, which is *pound weight*, ſaying, 18 out of 12 I cannot, but 18 out of 28 (borrowing a *qr.* of a *C.* (which is 28 lb.) and and there remains 10, to which add the 12 lb, it makes 22lb, which place under the lb, and carry 1 to the *qrs.* and ſay, 1 that I borrowed and 1 is 2, now 2 *qrs.* out of 1 I cannot, but 2 out of 4 *qrs.* (which is *C. weight*) there remain 2, to which add the 1 *qr.* it makes 3, which place under the *qrs.* and proceed to the *C.* and ſay, 1 that I borrowed and 14 *C.* is 15 *C.* now 15 *C.* out of 7 *C.* I cannot, but 15 *C.* out of 20 *C.* (which is 1 ton) there remains 5, to which add the 7 *C.* it makes 12 *C.* which place under the *C.* and proceed to the *tons*, and ſay, 1 that I carried and 9 is 10, 10 out of 5 I cannot, but out of 15, reſt 5, and carry 1, and ſay, 1 that I carry and 1 is 2, 2 out of 4, and there remains 2, and the work is finiſhed, and we find the remainder or difference to be 25 ton 12 *C.* 3 *qrs.* 22 lb.

More examples for the learners to praſtiſe.

	Ton	C.	qr.	lb.	C.	qr.	lb.
Bought	107	10	2	5	74	0	15
Sold	94	17	3	10	19	1	11
Reſt	12	12	2	23	54	3	04
Proof	107	10	2	05	74	0	15

If ſeveral quantities of *grofs weight* be given, out of which you would ſubtract the *tare*, in ſuch a caſe add the *grofs weight* into one total: and add the *tare* likewiſe into one total. Then ſubtract the total of the *tare* from the total of the *grofs*, the remainder is *neat weight*.

EXAMPLE.

A Merchant ſells 6 hogſheads of SUGAR, viz.

No.	1	Gr.	14	2	10	C.	qr.	lb.	Tare	1	3	5
2	7	1	19						2	0	5	
3	16	2	14						2	1	10	
4	17	1	10						2	1	16	
5	18	2	17						2	1	12	
6	14	1	22						1	3	22	
Groſs	89	0	08						Tare	12	3	14
Tare	12	3	14									
Reſt neat	76	0	22									

SUBTRACTION of TROY Weight.

	oz.	dwt.	gr.	oz.	dwt.	gr.		
Bought	115	7	5	966	11	6		
Sold	94	3	10	149	14	11		
Reſt	21	3	19	816	16	19		
Proof	115	7	5	976	11	6		
	lb.	oz.	dwt.	gr.	lb.	oz.	dwt.	gr.
Bought	375	5	13	194	5	9	16	
Sold	196	10	17	95	7	14	18	
Reſt	178	6	16	98	7	14	22	
Proof	375	5	13	194	5	9	16	

I might proceed to give examples in *Subtraction of Liquid Meaſure, Dry Meaſure, Long Meaſure, Apothecaries Weight, Time, Motion, &c.* but there being no more difference between the working of theſe and thoſe examples, than only obſerving the tables of each, therefore I forbear; this being ſufficient for the meaneſt capacity.

OF MULTIPLICATION.

In *Multiplication* there are always two numbers given to find out a *third*, which ſhall contain either of the given numbers, as many times, as the other containeth a *unit*.

Of the two numbers given, the one is called the *Multiplicand*, and the other is called the *Multiplier*, and the number found out by the operation is called the *Product*.

The *MULTIPLICAND* is the number given to be multiplied, and is uſually, for order's ſake, the *biggeſt* of the two given numbers.

The MULTIPLIER is that, by which the *Multiplicand* is multiplied, and is usually the *least* number.

The PRODUCT is the number produced by the *Multiplication*, and it containeth the *Multiplier* as many times, as the *Multiplicand* containeth *units*: or it containeth the *Multiplicand*, as often as the *Multiplier* containeth *units*.

*Multiplication* is either *simple* or *compound*.

*Simple Multiplication* is when the *Multiplicand*, and the *Multiplier*, do each of them consist of *one single figure* only; as if it were required to multiply 4 by 3, 5 by 2, 9 by 7; here 3 times 4 is 12, and 2 times 5 is 10, and 7 times 9 is 63; now 12, 10, and 63, are the *Products* of each *Multiplication*.

All the variety of *Simple Multiplication* is contained in the following table, which must be learned by heart, before the learner can make any further progress.

Multiplication TABLE.

2 times	}	2 is 4	5 times	}	5 is 25				
		3 6			6 30				
		4 8			7 35				
		5 10			8 40				
		6 12			9 45				
		7 14			10 50				
		8 16			11 55				
		9 18			12 60				
		10 20							
		11 22							
		12 24							
		3 times			}	3 is 9	6 times	}	6 is 36
4 12	7 42								
5 15	8 48								
6 18	9 54								
7 21	10 60								
8 24	11 66								
9 27	12 72								
10 30									
11 33									
12 36									
4 times	}		4 is 16	7 times		}			7 is 49
			5 20						8 56
		6 24	9 63						
		7 28	10 70						
		8 32	11 77						
		9 36	12 84						
		10 40							
		11 44							
		12 48							
		5 times	}		5 is 25		8 times	}	8 is 64
					6 30				9 72
					7 35				10 80
8 40	11 88								
9 45	12 96								
10 50									
11 55									
12 60									
6 times	}			6 is 36	9 times	}			9 is 81
				7 42					10 90
				8 48					11 99
				9 54					12 118
		10 60							
		11 66							
		12 72							
		7 times	}	7 is 49					
				8 56					
				9 63					
				10 70					
				11 77					
12 84									
8 times	}			8 is 64					
				9 72					
				10 80					
				11 88					
				12 96					
				9 times	}	9 is 81			
		10 90							
		11 99							
		12 118							

*Compound Multiplication* is when the *Multiplicand*, or *Multiplier*, or both of them, do consist of *compound numbers*; that is, of more figures or places than one.

As if it were required to multiply 324 by 2, here the *Multiplicand* is 324, which consisteth of 3 places, and the *Multiplier* is 2.

When it is required to multiply one number by another, first set down the biggest number for the *Multiplicand*, and under that the *Multiplier* in such order as has been taught in *Addition* and *Subtraction*, viz. *units* under *units*, *tens* under *tens*, &c. and draw a *line* under them.

EXAMPLE.

To multiply 324 by 2, set them down thus,

$$\begin{array}{r} \text{The Multiplicand} \quad 324 \\ \text{The Multiplier} \quad \quad 2 \\ \hline \end{array}$$

Then I begin with the place of units, saying, 2 times 4 is 8, which I put under the line; then 2 times 2 is 4, which I also put under the line, and 2 times 3 is 6, which I also put under the line, and the work is finished; so that I find 324 being multiplied by 2, produceth 648, as by the following work.

$$\begin{array}{r} \text{The Multiplicand} \quad 324 \\ \text{The Multiplier} \quad \quad 2 \\ \hline \text{The Product} \quad \quad 648 \end{array}$$

When the *Product* of any single figure amount<sup>s</sup> to 10, or a certain number of *tens*, then you are to set down a *cypher*, and carry a *unit* for every *ten* to the *Product* of the next figure; or if it comes to above 10, or any number of *tens*, then set down the *excess*, and carry an *unit* for every *ten*, &c. as in

EXAMPLE.

Let it be required to multiply 785641 by 5, set it down thus:

$$\begin{array}{r} 785641 \\ \quad \quad 5 \\ \hline 3928205 \end{array}$$

The number being set down, begin, saying 5 times 1 is 5, which put under the line, and proceed, saying, 5 times 4 is 20, whereof put down 0, and carry 2 for the two tens to the next, saying, 5 times 6 is 30, and 2 that I carried is 32, whereof put down 2, and carry 3 for the three tens to the next figure, saying, 5 times 5 is 25, and 3 that I carried is 28, wherefore put down 8, and carry 2 to the next, saying, 5 times 8 is 40, and 2 that I carry is 42, so put down 2, and carry 4 to the next figure, saying, 5 times 7 is 35, and 4 that I carry

is

is 39, which being the last figure, put down 39 under the line, and so the work is finished, and we find that 785641 being multiplied by 5, the *Product* is 3928205, as appears by the whole work above.

Here, note, that *Multiplication is a compendious performance of Addition*; for in the last example, if instead of multiplying 785641 by 5, we had put down the *Multiplicand* 5 times in order one under the other, and added them altogether, then the *sum* of them would amount, to the *Product* that was found by the foregoing work of *Multiplication*, as appears by the work.

$$\begin{array}{r}
 785641 \\
 785641 \\
 785641 \\
 785641 \\
 785641 \\
 \hline
 3928205
 \end{array}$$

When the *Multiplier* consists of *divers places*, then must there be as many *particular Products* as there are *places* therein; and for the true placing of each *Product*, observe to put the first figure or place of units under its proper *Multiplier*, and when you have done, draw a line under the whole work, and add the *several Products* together, and their sum will be the total *Product* required.

EXAMPLE.

Let it be required to multiply 46753 by 46:

$$\begin{array}{r}
 46753 \\
 46 \\
 \hline
 280518 \\
 187012 \\
 \hline
 2150638
 \end{array}$$

Having placed the given numbers thus in order, and drawn a line under them, begin to multiply with the 6, saying, 6 times 3 is 18, wherefore put down 8 under the line, and carry 1 to the next, saying 6 times 5 is 30, and 1 that I carry is 31, &c. so that the *Product* by 6 is 280518. Then begin with the 4, saying 4 times 3 is 12, wherefore put down 2 (under the line, and under the figure 4, by which multiply) and carry 1 for the ten to the next, saying 4 times 5 is 20, and 1 that I carry is 21; whereof set down 1, and carry 2 to the next, &c. and we find the single *Product* by 4 to be 187012, and so the *Multiplication* is ended: then draw a line under these *two particular Products*, and add them together, in the order as

they stand, and the *sum* is 2150638, which is the true *Product* of 46753 being multiplied by 46, that is, 46 times 46753, is 2150638, and is equal to the *sum* of 46753, being set 46 times one under another, and added together. See the whole work of *Multiplication* above.

A general rule in *Multiplication* is chiefly to observe, that in whatsoever place the *figure* of the *Multiplier* (whether a *cypher* or *cyphers*) stand from the place of *units*, in the same place must the first *figure* of that *Multiplication* be set from the *unit* of the *Multiplicand*.

And since the greatest difficulty in *Multiplication* arises from having a *cypher* or *cyphers* in the *Multiplier*, I shall endeavour to make it plain and easy by the following examples.

EXAMPLE I.

Where there is one or more *cyphers* in the *Multiplier* betwixt *significant figures*.

$$\begin{array}{r}
 8465008 \\
 4006 \\
 \hline
 5079004 \\
 33860032008 \\
 \hline
 33910822048
 \end{array}
 \qquad
 \begin{array}{r}
 45793 \\
 507 \\
 \hline
 320551 \\
 2289650 \\
 \hline
 23217051
 \end{array}$$

In the first example, you see that the *cyphers* are put at the same distance from the *unit* of the *Multiplicand* that they stand in from the *unit* of the *Multiplier*; as 4, the fourth figure of the *Multiplier* (the first figure in that *Multiplicand*, which is 2) is set in the fourth place from the *unit* of the *Multiplicand*.

EXAMPLE II.

Where the *Multiplier* hath one or more *cyphers* to the right hand thereof.

$$\begin{array}{r}
 546735 \\
 4620 \\
 \hline
 10934700 \\
 3280410 \\
 2186940 \\
 \hline
 2525915700
 \end{array}
 \qquad
 \begin{array}{r}
 7645932 \\
 48000 \\
 \hline
 61167456 \\
 30583728 \\
 \hline
 367008436000
 \end{array}$$

Or, You may multiply by the *significant figures*, neglecting the *cyphers* (as in the *second sum*.) as if there were none, only to the product *annex*, as many *cyphers* as there were *cyphers* in the *Multiplier*.

EXAMPLE

### EXAMPLE III.

Where the *Multiplcand* and *Multiplier* have each of them cyphers at the right hand.

58400	438700
760	67000
3504000	30709
408800	26322
44384000	29392900000

Or, you may neglect the cyphers, (as in the second sum) only to the Product annex as many cyphers as there were cyphers to the right hand of the *Multiplcand* and *Multiplier*.

When the *Multiplier* consists of an *unit* in the highest place towards the left hand, and all the rest cyphers towards the right hand, as 10, 100, 1000, &c. then is the whole work performed by annexing the cyphers of the *Multiplier* to the figures of the *Multiplcand*; as

### EXAMPLES.

6507	6507	6507
1000	100	10
6507000	650700	65070

It is necessary for all such as would be dextrous and ready at Arithmetick to learn to *multiply*, by these *compound numbers* following, very readily at one operation, *viz.*

<i>Exa.</i>	<i>Mult.</i>	57497	<i>Mult.</i>	842958
	by	11	by	12
	makes	6324637	makes	10115496
		345876		859427
		110		120
<i>Product</i>		38046360	makes	103131240
		7504675		3217295
		12		12
		90056100		39607540

Here 574967 is multiplied by 11; thus 11 times 7 is 77, put down 7, and carry 7, and then 11 times 6 is 66, and 7 I carry is 73, put down 3, and carry 7, then 11 times 9 is 99, and 7 I carry is 106, put down 6, and carry 10; then 11 times 4 is 44, and 10 I carry is 54, put down 4 and carry 5; then 11 times 7 is 77, and 5 is 82, put down 2, and carry 8; then 11 times 5 is 55, and 8 I carry is 63; which put down, the Product of 574967 multiplied by 11 is found to be 6324637.

In like manner to multiply 842958 by 12, say, 12 times 8 is 96, put down 6, and carry 9, then

12 times 5 is 60, and 9 I carry is 69, put down 9, and carry 6, and so proceed till you have gone through your sum.

To multiply any number, by 110, or 120, put down a cypher, and multiply as before.

<i>Multiply</i>	<i>Multiply</i>
425760	543760
by 12000	by 1200
<i>Product</i> 5109120000	<i>Product</i> 652512000

There are also some *abbreviations* in this ART.

— Thus, to *multiply* a number by 5, you need only add a *cypher* to it, and then halve it. —

To multiply by 15 do the same, then add both together, the sum is the product.

*Use of Neper's bones in Multiplication.* To multiply any given number by another; dispose the *lamellæ* in such manner, as that the top figures may exhibit the multiplicand; and to these on the left-hand, join the *lamellæ* of units; in which seek the right hand figure of the multiplier; and the numbers corresponding thereto, in the squares of the other *lamellæ*, write out, by adding the several numbers occurring in the same rhomb together, and their sums. After the same manner write out the numbers corresponding to the other figures of the multiplier, let them be disposed under one another, as in the common Multiplication: And lastly add the several numbers into one sum. For example:

Suppose the multiplicand 5978, and the multiplier 937, from the outermost triangle on the right-hand, which correspond to the right-hand figure of the multiplier 7, write out the figure 6, placing it under. In the next rhomb towards the left, add 9 and 5; their sum being 14, write the right-hand figure, *viz.* 4 against 6; carrying the left-hand figure 1, to 4 and 3, which are found in the next rhomb. The sum 8 join to 46 already put down; after the same manner in the last rhomb, add 6 and 5, the latter figure of the sum 11, put down as before, and carry 1 to the 3 found in the left hand triangle; the sum 4 join as before on the left of 1846: Thus will you have the factum of 7 into 5978; and after the same manner will you have the factum of the multiplicand, into the other figures of the multiplier. The whole added together, gives the whole product.

5978
937
41846
17934
53802
5601386

The proof of *Multiplication* can only be made exactly by *Addition*; and therefore shall defer shewing the manner of doing it till we come to that *Rule*.

## OF DIVISION.

*Division* teacheth to divide any number into as many equal parts as you please: Or,

It is that by which we discover how often one number is contained in another.

In *Division* there are always three numbers *certain*, and a fourth *accidental*.

Of the three numbers *certain*, two are always given to find out a third, *viz.* The one of the numbers given is to be *divided*, the other number given, is that by which the first is *divided*, and the number found out is the *quotient*, and discovers how often the one number is contained in the other.

Therefore in this rule are three remarkable numbers, *viz.* The *dividend*, the *divisor*, and the *quotient*.

The *DIVIDEND* is the number given to be divided into equal parts.

The *DIVISOR* is the number given by which the *dividend* is to be divided, which declareth into how many equal parts the *dividend* is to be divided.

The *QUOTIENT* is the number obtained by the operation, and shews how often the *divisor* is contained in the *dividend*.

And the *remainder* is the number which remains after the *division* is ended, which is *uncertain*, or the fourth *accidental* number mentioned before.

As, suppose 15 were given to be divided by 3, or 15 shillings to be divided amongst 3 men, here 15 is the *dividend*, 3 is the *divisor*, and 5 is the *quotient*; for 3 is contained in 15 just 5 times, without any *remainder*; but if you were to divide 20 by 3, the *quotient* would be 6, and the *remainder* 2, for 3 is contained in 20, 6 times, and 2 remains over.

In *DIVISION* (by one figure) you are first to write down the *dividend*, and then draw a crooked line, and place the *divisor* on the left hand thereof, then draw a line at the end of the *dividend*, after which place your *quotient*.

If 40 were given to be divided by 8, the number produced would be 5.

$$\begin{array}{r} \text{Dividend} \\ \text{Divisor } 8 \text{ ) } 40 \text{ ( } 5 \text{ Quotient} \\ \hline 40 \\ \hline 0 \end{array}$$

This method must be observed in every *division*; first, ask how many. Secondly, multiply. Thirdly, subtract.

## EXAMPLE.

Let it be required to divide 88 by 4, first write down the *dividend*, and then draw a parenthesis,

and place the *divisor* on the left hand thereof, then begin your work.

$$\begin{array}{r} \text{Dividend} \\ \text{Divisor } 4 \text{ ) } 88 \end{array}$$

Thus having placed a *parenthesis* at each end of the *dividend*, that on the left hand for the *divisor*, and that on the right for the *quotient*; then if the *divisor* be a single figure, subscribe a point under the first figure of the *dividend* towards the left hand, and ask how often the *divisor* 4 is contained in the *dividend* 8; the answer is 2, wherefore write 2 in the *quotient*; then multiplying the *divisor* 4 by 2, (the number placed in the *quotient*) the product is 8, which place orderly under the *dividend* 8; and after a line is drawn underneath the product, subtract it from the *dividend* 8, and place the remainder underneath the line. Then proceed and place another point under the next place of the *dividend*, towards the right hand, and bring down the figure or cypher standing in that place to the remainder; that is, set it next after it, so the whole will be a new *dividual*: Thus a point being placed under the other 8, write down 8 next after 0, to wit, on the right hand of the remainder 0; so is 8 a new *dividual* or number, whereof the second question must be asked, and the number will stand thus:

$$\begin{array}{r} 4 \text{ ) } 88 \text{ ( } 22 \\ \quad 8 \text{ .} \\ \hline \quad 08 \\ \quad \quad 8 \\ \hline \quad \quad 0 \end{array}$$

A new *dividual* being brought down, which is 8, renew the question, and ask how often 4 is contained in 8; the answer is 2, wherefore write 2 in the *quotient*; then multiplying the *divisor* 4 by 2, the product is 8, which place under the *dividual* 8, and after a line is drawn, subtract the product 8, from the *dividual* 8, and there being no *remainder*, place 0 under the line: so the whole work is finished, the *quotient* is found 22. Wherefore if 88 pounds were to be divided among four persons, the share of each will be 22 pounds.

The operation is a great deal more difficult, when the *divisor* consists of two, three, or several figures; though it depends on the same rules; for *Example*. — Let it be required to divide 896487 by 648, or, which is all one, to divide 896487 into 648 equal parts.

First a table must be made, to shew at first sight, any product of the *divisor*, it being taken twice, thrice, or any number of times under ten, so having written

written down the *divisor* itself 648, and drawn a line on the right-hand thereof, place 1 on the right-hand of the line directly against the *divisor*; then underneath the *divisor* 648, place the *double* thereof, which is 1296, and place the figure 2 directly against the said double on the other side of the line; again by multiplying the *divisor* 648 by 3, the sum is 1944, this *triple* place under the *double*, and place 3 on the other side of the line right against the *triple*; and so proceeding, in like manner, with the *quadruple*, *quintuple*, *sextuple*, &c. to the *nonuple* of the *divisor*:

Divisor 648		1	
Multiples of the Divisor	{	1296	2
		1944	3
		2592	4
		3240	5
		3888	6
		4536	7
		5184	8
		5832	9

Now for a proof of the said Table, adding the last number thereof, to wit 5832, which 648 was found to be nine times the *divisor*, to 10 the *divisor* 648, we find the sum to be 6480, which is ten times the *divisor*, as you may see in the margin; wherefore the table is true, because the last number thereof is derived from all the superior numbers.

The principal method of *Division* (which to those who have the *multiplication table* by heart, is easy enough) is when the *divisor* consists of more places than one, to set out so many figures on the left-hand of the *dividend* for a *dividual*, and then put a point under the figure of the *dividual*, which stands next to the right-hand. Then seek how often the first figure towards the left-hand of the *divisor*, is contained in the first figure towards the left-hand of the said *dividual*, and place the answer in the *quotient*. Then multiply the whole *divisor* by the said figure so placed in the *quotient*, and place the *product* in order under the *dividend*. Which being done, subtract the said *product* from the *dividual*, placing the *remainder* under the line. Then put a point under the next figure of the *dividend*, and annex it to the *remainder*, so you have a new *dividual*, in which you are to proceed, as shall be directed.

EXAMPLE.

Let it be required to divide 8904 by 42, here the given number being disposed of, as before directed, will stand thus;

$$42) 8904$$

Then because there are two figures in the *divisor*, therefore you must take the two first figures on the left-hand of the *dividend* for a *dividual*, which is 89, putting a point under the 9. Then ask how

often the first figure 4 is contained in the first figure 8, the answer is two times; wherefore multiply 2 in the *quotient* by 42 the *divisor*, and the *product* is 84, which place directly under 89, and subtract it, and there will remain 5. Then put a point under the next figure, which is 0, and annex it to the *remainder* 5, and it makes 50 for a new *dividual*, and the operation will stand as follows:

$$\begin{array}{r} 42) 8904 \quad (21 \\ \underline{84} \phantom{00} \\ 50 \phantom{0} \end{array}$$

Asking afterwards how often can have 4 in 5, the answer will be 1, which place in the *quotient*, and multiply the *divisor* 42 by 1 which makes 42, which place under 50, and subtract it from 50, and there will remain 8, which place in order under the line, and thereto annex the next figure of the *dividend* which is 4, and then it makes 84 for a new *dividual*, and then the operation will stand as follows;

$$\begin{array}{r} 42) 8904 \quad (212 \\ \underline{84} \phantom{00} \\ 50 \phantom{0} \\ \underline{42} \phantom{0} \\ 84 \\ \underline{84} \\ 0 \end{array}$$

For a conclusion, ask how often 4 is contained in 8, and the answer will be 2 times; wherefore put 2 in the *quotient*, and thereby multiply the *divisor* 42 by 2, which makes 84, and by subtracting 84 from 84 the remainder is nothing, and the operation is ended; so that if I divide 8904 pounds amongst 42 persons, each person must have 212 pounds.

Whenever the *product* of the *Multiplication* by the *divisor* is greater than the *dividual* from which it ought to be subtracted, such *product* must be struck out; and a lesser figure is to be placed in the *quotient*, for you cannot subtract a greater figure from a lesser. For Example, if it be required to divide 4763585 by 587, because the *divisor* 587, is bigger than the *dividual* 476, therefore put the point to 3, then the *dividual* becomes 4763, from which taking the *divisor* 587 out of the *dividual*, we find it 8 times (for 9 times is too much) so placing 8 in the *quotient*, and having multiplied the *divisor* thereby, which is 4696, and subtracting it out of 4763, the remainder is 67, to which, by putting a point to 5, then we have 675 for a new *dividual*,

dividual, and so proceeding according, as before taught, the *quotient* will be 8115, and 80 for the *remainder*.

$$\begin{array}{r}
 \text{Thus, } 587 \overline{)4763585} \text{ (8115} \\
 \underline{4696 \dots} \\
 675 \\
 \cdot 587 \\
 \hline
 883 \\
 \underline{587} \\
 3015 \\
 \underline{2935} \\
 80 \text{ the Remainder.} \\
 \hline
 \end{array}$$

There is another method of *Division*, preferable to any common way of dividing, by dashing out of figures, where the steps of the *division* are so confounded, by a promiscuous *multiplication* and *division*, that if any error happens, it can scarce be corrected without beginning the work a-new; but in this, explained underneath, the particular *multiplications*, *subtractions* and *remainders*, which belong to every figure of the *quotient*, are so distinctly and clearly set down, that if an error happen it may easily be reformed.

EXAMPLE.

Let it be required to divide 7910010295 by 59746; the operation will stand thus:

$$\begin{array}{r}
 59746 \overline{)7910010295} \text{ (132393} \\
 \underline{59746 \dots\dots} \\
 193541 \quad \text{132393 Quotient mult.} \\
 \underline{179238} \quad \text{by 59746 Divisor} \\
 143030 \quad \underline{794358} \\
 119492 \quad \underline{529572} \\
 \underline{119492} \quad \underline{926751} \\
 235382 \quad \underline{1191537} \\
 \underline{179238} \quad \underline{661965} \\
 709952178 \\
 \underline{561449} \quad \underline{58117} \text{ Remanider ad.} \\
 537714 \\
 \underline{537714} \\
 237355 \\
 \underline{179238} \\
 58117 \text{ Remainder.} \\
 \hline
 \end{array}$$

We must observe, that there are to be as many points in the *dividend*, as there are figures in the

*quotient*, as in this Example. you have six points in the *dividend* and six figures in the *quotient*.

*Division* is proved by multiplying the *quotient* by the *divisor*, or the *divisor* by the *quotient*, and adding what remains of the *division*, if there be any thing. If the sum be found equal to the *dividend*, the operation is just, otherwise there is a mistake.

And the most certain proof of *Multiplication* is by *Division*. They interchangeably prove each other. For, if the *product* be divided by the *multiplicand*, the *quotient* will be equal to the *multiplier*: and if the *product* be divided by the *multiplier*, the *quotient* will be equal to the *multiplicand*.

When the *divisor* consisteth of any other number, with a *cypher* or *cyphers* annexed thereto, then cut off the *cyphers* of the *divisor* with a dash of the pen, and as many *cyphers* as you cut off from the *divisor*, so many *places* must you cut off from the *dividend*; then proceed to divide by the remaining figures in the *divisor*, as if there were no such *cyphers* or *figures* of the *divisor*, or *dividend* as you cut off, and if nothing remain after *Division* is ended, then shall the figures you cut off from the given *dividend* be the true remainder; but if any thing do remain after *Division* is ended, you are then to annex the figures of the *dividend* that were before cut off, so shall the said *remainder*, with the figures annexed thereto, be the true *remainder*.

EXAMPLE.

Divide 486763 by 15000. *First*, cut off the three *cyphers* of the *divisor*, and also *three places* of the right hand of the *dividend*, so we have 15 for the *divisor*, and 486 for the *dividend*, viz.

$$\begin{array}{r}
 15 \overline{)486} \text{ (32} \\
 \underline{45} \\
 36 \\
 \underline{30} \\
 6
 \end{array}$$

By the short way of *Division*.

$$\begin{array}{r}
 15 \overline{)486} \text{ (32} \\
 \underline{45} \quad 36 \\
 32 \quad \underline{6}
 \end{array}$$

Here I find the *quotient* to be 32, and the *remainder* is 6, to which annexing the figures cut off from the *dividend*, viz. 793, it makes 6793 for the true *remainder*.

*Use of Neper's bones in Division.* Dispose the *lamellæ* so as that the uppermost figures may exhibit the *divisor*; to these on the left-hand join the *lamellæ* of units. Descend under the *divisor*, till  
 || you

you meet those figures of the *dividend*, wherein it is first required, how oft the *divisor* is found, or at least the next number, which is to be subtracted from the *dividend*; the number corresponding to this, in the place of units, write down for a *quotient*. By determining the other parts of the *quotient* after the same manner, the *division* will be completed. For Example:

Suppose the *dividend* 5601386, and the *divisor* 5978; since it is first asked how often 5978 is found in 56013, descend under the *divisor*, till in the lowest series you find the number 53802 approaching nearest to 56013; the former whereof is to be subtracted out of the latter, and the figure 9 corresponding thereto in the *lamellæ* of units, write down for the *quotient*. To the remainder 2211, join the following figure of the *divisor* 8; and the number 17934 being found, as before, to be the next less number thereto, the corresponding number in the *lamellæ* of units, 3, is to be wrote down for the *quotient*; and the subtraction to be continued as before. After the same manner the third and last figure of the *quotient* will be found to be 7; and the whole 937.

$$\begin{array}{r}
 5978) 5601386 \quad (937 \\
 \underline{53802} \\
 22118 \\
 \underline{17934} \\
 41846 \\
 \underline{41846} \\
 \hline
 00000
 \end{array}$$

Of REDUCTION.

Having given the *operations* of the FOUR chief RULES in *Arithmetick*, we proceed with those *operations*, which are built upon them and invented for expedition and exactness in different transactions and calculations.

REDUCTION teacheth to *reduce* numbers, whether *money*, *weight*, *measure*, *time*, *motion*, &c. from one denomination to another, discovering the same value, but in different terms.

*Reduction* is performed by *multiplication* and *division*.

All *great* denominations are brought into *lesser* of the same value by *multiplication*, and this is by some called *Reduction descending*.

All *small* denominations are brought into *greater* of the same value by *division*, and this is by some called *Reduction ascending*.

To reduce *greater* denominations into *lesser* of the same value. Consider how many of the lesser

are equal to one of the greater, and multiply the given number thereby, so shall the product be the answer to the question.

E X A M P L E.

Reduce 3468 shillings into pence.

$$\begin{array}{r}
 3468 \\
 \underline{12} \\
 41616
 \end{array}$$

Here consider, 12 pence is a shilling, and the pence ought to be twelve times the number of shillings, wherefore multiply by 12 at one operation, and the product is 41616 pence.

To reduce *smaller* denominations into *greater* Consider *how many* of the *smaller* are equal to *one* of the *greater*, and *divide* thereby; the *quotient* is the answer to the question.

E X A M P L E.

Reduce 41616 pence into shillings.

$$\begin{array}{r}
 12) 41616 \\
 \hline
 3468 \text{ shillings.}
 \end{array}$$

First, consider that 12 pence is a shilling, and that the shillings ought to be a twelfth part of the pence; wherefore divide the given number by 12 at one operation, and say, 12 in 41, three times, rest 5, which to the 6 makes 56, then 12 in 56, 4 times, rest 8, which makes the 1, 81; then 12 in 81, 6 times, rest 9, which makes the 6, 96, then 12 in 96 is 8 times, and the *quotient* gives 3468 shillings, which is the answer to the question, and may serve for a proof of the foregoing example.

In *Reduction of money*, multiply the shillings by 12 at one operation; and likewise divide by 12 at one operation.

E X A M P L E I.

In 685 l. I demand how many *shillings*, *pence*, and *farthings*.

$$\begin{array}{r}
 685 \text{ pounds,} \\
 \underline{20} \\
 13700 \text{ shillings,} \\
 \underline{12} \\
 164400 \text{ pence,} \\
 \underline{4} \\
 657600 \text{ farthings.}
 \end{array}$$

First, multiply by 20 (because 20 *shillings* is a pound,) and the product is 13700 *shillings*, then multiply the *shillings* by 12, (because twelve pence is a shilling) and the product is 164400 *pence*; then multiply

multiply the *pence* by 4, (because four farthings is a penny) and the product is 657600 *farthings*.

This or any other number of pounds, might be reduced into pence or farthings at one operation, without reducing it into the intermediate denominations.

For if you multiply pounds by 240 (because 50 many pence make a pound) the product will be pence, and if you multiply pounds by 960 (because 960 farthings is a pound) the product will be farthings: so, in the foregoing example, 685 *l.* being multiplied by 240, the product you will find to be 164400 pence, and if you multiply 685 *l.* by 960, the product will be 657600 farthings, for the reasons before said.

But you may say, you cannot well remember how many pence or farthings make a pound, I will therefore teach you how to find it out at any time when you have occasion. You may easily remember 20 shillings is a pound, and that multiplied by 12 produceth 240 pence, which being multiplied by 4, produceth 960 farthings, as follows.

$$\begin{array}{r}
 20 \text{ shillings,} \\
 12 \\
 \hline
 240 \text{ pence,} \\
 4 \\
 \hline
 960 \text{ farthings,} \\
 \text{or one pound.}
 \end{array}$$

#### EXAMPLE II.

In 657930 *farthings*, I demand how many *pence*, *shillings*, and *pounds*?

This question is the reverse of the former, and may serve for a proof thereof: first, I divide the farthings by 4, and the quotient is 164400 pence, then I divide the pence by 12, and the quotient is 13700 shillings, and the shillings I divide by 20, and the quotient is 685 pounds: which is equal to the given number in the first example. See the whole operation as followeth:

$$\begin{array}{r}
 4) 657600 \text{ farthings.} \\
 \hline
 12) 164400 \text{ pence.} \\
 \hline
 20) 13700 \text{ shillings.} \\
 \hline
 \text{makes } 685 \text{ pounds.}
 \end{array}$$

When in *Reduction descending*, the number propounded to be reduced consisteth of diverse denominations, as of *pounds*, *shillings*, *pence*, and *farthings*; or of *pounds*, *ounces*, *penny-weights*, and *grains*, &c. then you may readily reduce it into the lowest

denomination. Thus when you reduce an higher denomination into the next inferior, add to the product the expressed parts into which you reduce it, as if you were to reduce pounds into shillings, add to the product (as you multiply) the shillings that are expressed in the number propounded; proceed in the same method till you have reduced the given number into the denomination required, as in the following example.

#### EXAMPLE III.

Reduce 567 *l.* 15 *s.* 6 *d.*  $\frac{1}{4}$  into *farthings*.

First, multiply by 20 to bring into *shillings*, saying, 0 times 7 is 0, but 5 is 5, (taking in the 5 that is in the place of units in the rank of shillings, and setting it in the place of units in the product) then 2 times 7 is 14, and 1 is 15, (taking in the 1 that is in the place of tens in the rank of shillings) so set down 5 in the place of tens in the product, &c. the product is 11355 shillings. then multiply the shillings by 12 to bring them into pence, saying, 12 times 5 is 60, and 6 is 66, (taking in the 6 that stands in the rank of pence) &c. and the pence make 136266; then multiply the pence by 4, to bring them into *farthings*, saying, 4 times 6 is 24, and 3 is 27, taking in the 3 which stands in the rank of farthings, &c. so the farthings amount to 545067, as by the whole operation appeareth, *viz.*

$$\begin{array}{r}
 567 \text{ l. } 15 \text{ s. } 6 \text{ d. } \frac{1}{4} \\
 20 \\
 \hline
 11355 \text{ shillings,} \\
 12 \\
 \hline
 136266 \text{ pence,} \\
 4 \\
 \hline
 545067 \text{ farthings.}
 \end{array}$$

Observe the like in any other example.

When in *Reduction Ascending* any thing remains after *division* is ended, it is always of the same denomination with the *dividend*, as in the following example.

#### EXAMPLE IV.

In 545067 *farthings*, I demand how many *pounds*?

First, divide the given number of *farthings* by 4, and the *quotient* is 136266 pence, and there remains 3, which is 3 farthings; because the *Dividend* was farthings.

Then divide the *pence* by 12, and the *Quotient* is 11355 *shillings*, and there remains 6, which is 6 *pence*; because the *Dividend* was *pence*.

Then

Then divide the *shillings* by 20, and the *Quotient* is 567 *l.* and there remains 15, which is *shillings*; because the *Dividend* was *shillings*: so that we find by the work, 545067 farthings to be 576 *l.* 15 *s.* 6 *d.*  $\frac{3}{4}$  as by the following work.

4) 545067  
 12) 136266  $\frac{3}{4}$   
 2|0) 113515 : 6 *d.*

makes £. 567 : 15 *s.* 6 *d.*  $\frac{3}{4}$

This question is the inverse of the third example, and may very well serve for a proof thereof.

Here by the way take notice, that when you are (to divide any number by 20, that is) to bring *shillings* into pounds, the best way is to cut off a figure to the right-hand for *shillings*; and then to take half the figures to the left-hand for pounds, and if 1 remain, it is 10 *shillings* to be added to the figure first cut off. For example.

Where 11355 *shillings* are to be reduced into pounds, cut off the last figure 5 for *shillings*, and say, Half of 11 is 5, half of 13 is 6, half of 15 is 7, and there remains 1, which makes the 5 *shillings* to be 15 *shillings*.

1134 *l.* 5 *s.* 0 *d.*

makes 567 15 0

Note, Once for all, that *Reduction Ascending*, proves *Reduction Descending*, the one being a reverse to the other, as shall be demonstrated in the questions that follow, in all the varieties of *Reduction*.

Quest. I. In 7642 *l.* 17 *s.* 11 *d.*  $\frac{2}{3}$ , I demand how Money]

20 (many half farthings?)  
 152857 *shillings.*  
 12  
 1834295  
 8

14674364 half farthings.

Ton, C. qr. lb.

Quest. II. In 95 11 3 15 how many pounds Avoirdupois } 20 (weight? weight. } —

1911 hundreds.  
 4  
 7647 quarters.  
 28  
 61181  
 15295

makes 214131 pounds weight.

C. qr. lb. oz.  
 Quest. III. In 50 2 15 9 how many (ounces!

4  
 202  
 28  
 1621  
 405  
 5671  
 16  
 34035  
 5671

makes 90745 ounces.

By this you see, that if 50 C. 2 qr. 15 lb. 9 oz. be multiplied, the product will be 90745 ounces, which is the reverse or proof of the second Question.

Quest. IV. In 214131 pounds weight, how many 28) 181 (tons?

133  
 4) 7647 211  
 2|0) 1911  $\frac{1}{2}$  15 pounds.

95 : 11 :

Proof 95 : 11 : 3 : 15. By this you see, that if 214131 pound weight be divided by 28, by 4, and by 20, it produces 95 ton, 11 C. 3 qrs. 15 lb. which is the reverse of the second Question.

Quest. V. In 90745 ounces, how many hundred 16) 107 (weight?

114  
 28) 5671 25  
 71 —  
 4) 202 — 9  
 15 ounces.  
 C. 50 : 2 : 15 : 9 proof.

oz. dw. gr.  
 Quest. VI. In 50 10 11 how many grains Troy } 20 (weight? Weight. } — of Silver?

1010  
 24  
 4041  
 2021

makes 24251 grains of Silver.

Quest.

Quest. VII. In 507 <sup>oz. dw. gr.</sup> 10 11 how many grains  
 Troy } (of Silver?)  
 Weight. }  
 20  
 -----  
 10150 penny weight.  
 24  
 -----  
 40601  
 20301  
 -----  
 makes 243611 grains.

Quest. VIII. In 243611 grains, how many ounces  
 24) 36 (of Silver?)  
 -----  
 121  
 2|0)1015|0  
 -----  
 11  
 Proof 507 10 dw. 11 grains.

Quest. IX. In 54 2 25 Tun. hhd. gall.  
 Liquid } how many quarts  
 Measure. } (of Wine?)  
 4  
 -----  
 218 bheads.  
 63  
 -----  
 659  
 1310  
 -----  
 13759 gallons.  
 4  
 -----  
 Proof 55036 quarts.

Quest. X. In 55036 quarts, how many tuns of  
 4) 13759 (Wine?)  
 -----  
 63) 13759  
 -----  
 115  
 4) 218 529  
 -----  
 54 25 gallons.  
 tons. 54: 2bb. 25 gallons.

Quest. XI. In 75 5 3 2 Last. qr. bush. gall.  
 Dry } how many gallons  
 Measure. } (of Wheat?)  
 10  
 -----  
 755 quarters.  
 8  
 -----  
 6043 bushels.  
 8  
 -----  
 makes 48346 gallons.

Q. XII. In 48346 gallons, how many Lasts of  
 8) 6043 2 (Wheat?)  
 -----  
 6043 2  
 -----  
 1|0) 7 15 3  
 -----  
 Proof 75 5 3 2

CLOTH MEASURE.

Quest. XIII. In 207 ells 2 quarters, 2 nails,  
 5 (how many nails?)  
 -----  
 1037 quarters.  
 4  
 -----  
 makes 4150 nails.

Quest. XIV. In 107 yards, 3 quarters, 1 nail,  
 4 (how many nails?)  
 -----  
 431 quarters.  
 4  
 -----  
 makes 1725 nails.

Quest. XV. In 312 ells Flemish, 2 quarters, how  
 3 (many quarters?)  
 -----  
 makes 938 quarters.

Quest. XVI. In 112 aulns, 1 quarter, 2 nails,  
 6 (how many nails?)  
 -----  
 673 quarters.  
 4  
 -----  
 makes 2694 nails.

Note, An auln here is reckoned 1 1/2 yard.

LONG MEASURE.

Quest. XVII. The circumference of the earth  
 being 360 degrees, and every degree 60 English  
 miles, demand how many miles, furlongs, perches,  
 inches, and barley-corns will reach round the world?

360 Degrees.  
60 Miles a Degree.

21600 Miles about the Earth.  
8

172800 Furlongs about the Earth.  
40 Perches in a Furlong.

6912000 Perches about the Earth.  
33 Half Feet in a Pearch.

20736  
20736

228096000 Half Feet about the Earth.  
6 Inches in a half Foot.

1368576000 Inches.  
3 Barley-Corns is an Inch.

4105728000 Barley-Corns about the Earth.

To expedite the practice, several compendious ways of *Reduction* have been invented. Thus yards are turned into ells, by subtracting a fifth, and into ells *Flemish* by adding a fifth. Ells *Flemish* are reduced into yards by subtracting a quarter. Ells *Flemish* reduced to ells *English* by multiplying by 6, and cutting off the right-hand figure. Great pounds of silk of 24 ounces, are reduced to pounds of 16 ounces, by adding one half. Pounds of 16 ounces into pounds of 24, by subtracting one third.

TARE and TRET is also another kind of REDUCTION.

*Tare* is an abatement or deduction on the price of a commodity, on account of the weight of chests, casks, bags, frails, &c. The casks, chests, or whatever else contains the commodity, is also called *Gross*.

*Tret* is an allowance made, in commerce, for the waste, or the dust, that may be mixed with any commodity; which is always 4 pounds in every 104 pounds.

The *Tare* is very different in different merchandizes: in some there is none at all allowed. It is a thing much more regarded in *Holland* than in *England*, or elsewhere. M. *Ricard* treating of the commerce of *Amsterdam*, observes that the *Tares* are one of the most considerable articles a mer-

chant is to be acquainted withal, if he would trade with security.

Sometimes the *Tare* is, as it were, regulated by custom; but generally, to avoid all dispute, the buyer and seller make a particular agreement about it. We shall here add from the forementioned author, some instances of *Tare* allowed at *Amsterdam*.

*Spanish* wool is subject to a kind of double *Tare*; for first they deduct the *Tare* marked on the bales, and after that 24 pounds *Tare* for every 175 pounds weight, besides the *rebate* for prompt payment. Indeed for the common wools, the seller will seldom allow above 14 *per Cent*, for the whole *Tare*; for which reason the bargain is to be agreed on before.

Tare of	{	Roman Allum is 4 lb. per sack.
		Irish, &c. Butter, 20 lb per Cent.
		Crude Borax, 15 lb. per Cent.
		Cinnamon, 17 lb. the Burthen.
		Capers 33 lb. per Cent.
		White Pepper, 40 lb. per Barrel.
		Black Pepper, 5 lb. &c.

But to reduce *Tare* and *Tret* into practice with regard to arithmetick; if I be asked, for example, in 48 C. 3 qrs. 14 lb. *Tare*. 3 C. 3 qrs. 00 lb. how many pounds neat? I proceed thus:

C.	qrs.	lb.	
48	3	14	<i>Gross</i>
3	3	00	<i>Tare deducted</i>

45 0 14  
4

180 Quarters  
28

1444  
361

5054 Pounds neat

C.	qrs.	lb.	
112)	5054	(45 0 14	neat
	448		

574  
560

14

Which pounds neat being divided by 112, gives me 45 C. 0 qrs. 14 lb. neat weight.

Or this other question: in 145 C. 2 qrs. 16 lb. Tare 14 per C. Tret 4 per 104, how many pounds neat? to answer which I proceed in the following manner:

C. qrs. lb.	C. qrs. lb.
145 2 16	145 2
4	14
582 Quarters	580
28	145
4662	2030
1165	9 allowed for 2 qrs.
16312 lb. Subtle	16
2039 lb. Tare	2039
14273 Remainder	26)16312(627 lb. Tret
627 lb. Tret	156
13646 lb neat	71
I divide the pounds	52
subtle, by 26, because	192
4 pounds is the 26th	182
of 104, the allowance	10
always given for Tret.	C. qrs. lb.
	112)13646(121 3 10
	112
Or the pounds neat being	244
divided by 112, makes	224
121 C. 3 qrs. 10 lb.	206
neat weight.	112
	94

And thus of all other commodities or merchandizes, in proportion.

Of the RULE of THREE.

The RULE of THREE, otherwise called the GOLDEN RULE and the RULE of PROPORTION, is one of the most useful operations in *Arithmetick*. It is either *single* or *compound*.

The *single Rule of Three* is generally taught to contain two branches, called by the writers of *Arithmetick*, *direct* and *inverse*: but this is multiplying *rules* without reason, as will appear hereafter.

The RULE OF THREE DIRECT teaches how to find a fourth proportional number, to three others given.

In this rule we must always observe, in stating the question, to make our first and third number be of one denomination, and the second figure being

the supposition, must, after the operation, be found in the same degree, with the fourth number sought. We must also make our first and third numbers both of one kind. Then go unto the second or middle number, and reduce that into the lowest value there named: then multiply our second number under our third, making that number our *Dividend*; and divide by our first number; and the *Quotient* of our *Division* answers the question demanded, and is always of the same denomination with our second number; whether pounds, shillings, pence, or farthings, or any other name or kind whatever: which if it shall happen to be of any greater number, whether *weight*, *measure*, or *time*, we may reduce them into its lowest value, by the rule of *Reduction* before taught.

*Quest.* If three degrees of the equator contain 70 leagues, how many do 360 degrees, the circumference of the earth, contain?

The rule is this: multiply the second term 70, by the third 360, divide the *Product* 25200 by the first term 3, the *Quotient* 8400 is the fourth term required.

The use of this rule is of vast extent both in *common life*, and the *sciences*; yet it has no place, but where the proportion of the given numbers is known. -- Suppose, for instance, a large vessel full of water to empty itself by a little aperture; and suppose three gallons to flow out in a minute; and it were required to know in what time 100 gallons would be thus evacuated: here indeed are three terms given and a fourth required, but as it is evident from experience, that water flows faster at first than afterwards, the quantity of flowing water is not proportional to the time; and therefore the question does not come under the *Rule of Three*.

The things which come under *commerce* are *proportionable* to their *prices*; twice as much of any commodity costing twice as much money, &c. The price therefore, of any quantity of a commodity being given, the price of any other quantity of the same, or quantity of the commodity answering to any other given him, is found by the *Rule of Three*.

EXAMPLE.

If 3 lb. cost 17 s. what will 30 lb. cost? Since as 3 lb. are to 30 lb. so is the value of the former 17 s. to the value of the latter. The question stands thus:

lb.	s.	lb.
3	17	30
		17
		210
		30

$$8 l. 10 s. \quad 3)510(170 s.$$

Again,







$\frac{1}{2}$ 264 yds. at 18 d. 132 <hr/> 39 6 <hr/> 19 - 16 - 0 Facit.	$\frac{1}{2}$ 295 Gall. at 19 d. 147 - 6 24 - 11 <hr/> 4617 s. - 5 d. <hr/> 23 - 7 - 5 Facit.
---	--

Ells. 375 at 8 s. 6 d. 8 <hr/> 3000 187 - 6 <hr/> 318 7 - 6 <hr/> 159 - 7 - 6 Facit.
--

Ells. 493 at 15 s. 10 d. 15 <hr/> 2465 493 <hr/> 246 - 6 d. 164 - 4 d. <hr/> 780 5 - 10 <hr/> 390 - 5 - 10 Facit.
---

$\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ $\frac{1}{8}$ 672 lb. at 20 d. $\frac{3}{4}$ 336 224 42 <hr/> 1274 <hr/> 63 - 14 - Facit.	$\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ $\frac{1}{4}$ 456 Ells at 21 d $\frac{1}{4}$ 228 152 38 9 - 6 <hr/> 88 3 <hr/> 44 l. 3 - 6 Facit.
--	---

C. s. d. 295 at 12. - 9 12 <hr/> 3540 147 - 6 73 - 9 <hr/> 376 1 - 3 <hr/> 188 - 1 - 3 facit.
--

C. s. d. 214 at 7. - 11. 7 <hr/> 1498 107 <hr/> 53 - 6 35 - 8 <hr/> 169 4 - 2 <hr/> 84 - 14 - 2 Facit.
--

In 672 lb. at 22 d.  $\frac{3}{4}$  a lb. I take  $\frac{1}{2}$  for 6 d. the  $\frac{1}{3}$  for 4d. and the  $\frac{1}{8}$  for the  $\frac{1}{4}$ . because  $\frac{3}{4}$  is the  $\frac{1}{8}$  of 6 d. by which you will find that in 672 sixpences there is 336 shillings, and in 672 groats there is 224 shillings, and in 672 three farthings there is 42 shillings.

If the given price be such shillings as are an even part of a pound Sterling, take such a part of the given quantity, and the *quotient* is pounds.

If your given price be any number of pounds, shillings and pence; reduce first your pounds and shillings into shillings, and proceed according to the last rule.

$\frac{1}{2}$ Ells. s. d. 433 at 1 - 8 <hr/> l. 36 - 1 - 8 Facit.	$\frac{1}{10}$ Yards. 271 at 2 s. <hr/> 27 - 2 - 0 Facit.
$\frac{1}{8}$ 674 at 2 s. 6 d. <hr/> 84 - 5 - 0 Facit.	$\frac{1}{6}$ 495 at 3 s. 4 d. <hr/> 82 10 - 0 Facit.

Pieces l. s. d. 754 at 4 - 3 - 7 83 20 <hr/> 2262 83 6032 377 62 - 10 <hr/> 6302 1 - 10 <hr/> 3151 - 1 - 10 Facit.
--

Tun. l. s. d. 176 at 3 - 7 - 10 67 20 <hr/> 1232 67 1056 <hr/> 11792 88 58 - 8 <hr/> 1193 8 - 8 <hr/> 596 - 18 - 8 Facit.
--

Crowns. 457 at 5 s. <hr/> $\frac{1}{4}$ 114 - 5 - 0 Facit.	Dollars. 612 at 4 s. <hr/> $\frac{1}{5}$ 122 - 8 - 0 Facit.
$\frac{1}{3}$ 295 at 6 s. 8 d. <hr/> 98 - 6 - 8 Facit.	$\frac{1}{2}$ 372 at 10 s. <hr/> 186 - 0 - 0 Facit.

If your given price be any number of pounds, and exceeding five pounds, then multiply your given quantity by the number of the pounds, and take your *aliquot* parts in shillings and pence, viz.

In this first Example of 433 Ells, at 1 s 8 d. I take the  $\frac{1}{12}$ , because 1 s. 8 d. is the  $\frac{1}{12}$  of 2 l. and say, 12 in 43 is 3 times, rest 7, which makes the 3 to be 73, then 12 in 73, is 6 times, rest one, which is 1 s. 8 d. which I put down as above.

If the given price be such shillings and pence as are no even parts of a pound, multiply the given quantity by the number of shillings, and take the *aliquot* parts of pence, and proceed according to the second rule.

C. l. s. d. 74 at 11 - 12 - 6 11 <hr/> 814 37 d. 9 - 5 - 0 <hr/> 860 - 5 - 0 Facit.
---

bbeads. l. s. d. 394 at 16 - 16 - 3 16 <hr/> 2364 ? at 16 l. 39 } 197 at 10 s. 98 - 10 at 5 19 - 14 at 1 4 - 18 - 6 at 3 d. <hr/> 6624 - 2 - 6 Facit.
--

If the given quantity be any number of *C. qrs.* or *pounds*, or *tuns C. qrs.* and *pounds*, &c. work as before, where no part is, and take your *aliquot* parts in *quarters* and *pounds*, or in *C. qrs.* and *pounds*, and add them to your first work. An Example or two will make this plain

<table border="0"> <tr><td>C.</td><td>s.</td><td>d.</td></tr> <tr><td>75 <math>\frac{1}{2}</math></td><td>at 22</td><td>- 6</td></tr> <tr><td>22</td><td></td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td></td><td>11</td><td>- 3</td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>150</td><td></td><td></td></tr> <tr><td>150</td><td></td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>37</td><td>- 6</td><td></td></tr> <tr><td>11</td><td>- 3</td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>169</td><td>18 - 9</td><td></td></tr> <tr><td>84</td><td>- 18 - 9</td><td>Facit.</td></tr> </table>	C.	s.	d.	75 $\frac{1}{2}$	at 22	- 6	22			-----				11	- 3	-----			150			150			-----			37	- 6		11	- 3		-----			169	18 - 9		84	- 18 - 9	Facit.	<table border="0"> <tr><td>C.</td><td>s.</td><td>d.</td></tr> <tr><td>63 <math>\frac{3}{4}</math></td><td>at 12</td><td>- 11</td></tr> <tr><td>12</td><td>Mult.</td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>756</td><td>s.</td><td></td></tr> <tr><td>31</td><td>- 6 d.</td><td></td></tr> <tr><td>21</td><td></td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>9</td><td>- 7 <math>\frac{1}{2}</math> C.</td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>818</td><td>- 1 <math>\frac{1}{2}</math> Sum.</td><td></td></tr> <tr><td colspan="3" style="text-align: center;">-----</td></tr> <tr><td>40</td><td>- 18 - 1 <math>\frac{1}{2}</math></td><td>Facit.</td></tr> </table>	C.	s.	d.	63 $\frac{3}{4}$	at 12	- 11	12	Mult.		-----			756	s.		31	- 6 d.		21			-----			9	- 7 $\frac{1}{2}$ C.		-----			818	- 1 $\frac{1}{2}$ Sum.		-----			40	- 18 - 1 $\frac{1}{2}$	Facit.
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In the Example of 63  $C. \frac{3}{4}$  at 12 s. 11 d. the *C.* weight, I multiply the *C.* by 12 s. and take the parts in pence for the odd pence, then for the  $\frac{3}{4}$  of *C.* I first take the  $\frac{1}{2}$  of the price of a *C.* and that makes 6 s. 5 d. the price of  $\frac{1}{2}$  a *C.* and then I take the  $\frac{1}{4}$  of that which gives 3 s. 2 d.  $\frac{1}{2}$ . the price of a *qr.* of a *C.* Add them together, it gives the price of  $\frac{3}{4}$  of a *C.* which is 9 s. 7 d.  $\frac{1}{2}$ . and must be added to your first work.

Of FELLOWSHIP or COMPANY.

FELLOWSHIP is a rule of great use in balancing accounts amongst partners, or where two or more have a joint stock and trade together, in order to ascertain the proportion of profit and loss to each party.

FELLOWSHIP is either *with* or *without* time.

Questions *without* time, or in the *single rule of Fellowship*, as it is frequently called, are wrought by the following proportion.

As the whole stock to the whole gain or loss, so is each man's particular stock to his particular share of gain or loss.

EXAMPLE.

A, B, and C make a joint stock: A puts in 460 l. B 510 l. and C 480 l. they gain 340 l. what part of it belongs to each?

In order to the solution of this question, find the total of their joint stock, *viz.*

A's stock 460 l. + B's stock 510 l. + C's stock 480 l. = 1450 l. the total stock. Then 1. To find A's share of the gain, state as follows: If 1450 l. : 340 l. :: 460 l. which being worked by the Rule of Three, the answer will be 107 l. 17 s. 2  $\frac{1}{2}$  d. for A's share of the profit.

2. B's share of the gain, by stating thus, if 1450 l. : 340 l. :: 510 l. and working by the Rule of Three, will be found to be 119 l. 11 s. 8  $\frac{1}{2}$  d.

3. C's share will appear 112 l. 11 s. 0  $\frac{1}{4}$  d. when worked as before, after having stated thus. If 1450 l. : 340 l. :: 480 l.

Again, suppose three partners, A, B, and C make a joint stock in this manner: A puts in 24 l. B. 32 l. and C 40 l. in all 96 l. with which they trade, and gain 12 l. required each man's true share of that gain? The first operation for A's part of the gain will stand thus,

$$96 \text{ l.} : 12 \text{ l.} :: 24 \text{ l.} : 3 = \text{A's gain.}$$

$$96 \text{ l.} : 12 \text{ l.} :: 32 \text{ l.} : 4 = \text{B's gain.}$$

$$96 \text{ l.} : 12 \text{ l.} :: 40 \text{ l.} : 5 = \text{C's gain.}$$

Proof 3 l. + 4 l. + 5 l. = 12 l. the whole gain. That is, if the total of all their particular gains amounts to the whole gain, the work is true; if not, some mistake has been committed.

FELLOWSHIP *with* Time, (usually called the *Double Rule of Fellowship*, because every man's money is to be considered with relation to the time of its continuance in the joint stock) is worked thus, Multiply each man's stock by the respective time he puts it in for, and add all the products; the total of which must be your first number through all the statings: the gain or loss the second, as before; and each man's particular stock multiplied by its time, the third.

Note, All the particular times (if not so given) must be reduced into one denomination, *i. e.* all years, all months, all weeks, or all days, &c. See REDUCTION.

EXAMPLE I.

A put into company 560 l. for eight months, B 279 l. for ten months, and C 735 l. for six month; they gained 1000 l. What share of it must each have? For the solution of this question proceed as follows.

A's stock 560 l.  $\times$  8 its time = 4480, B's stock 279 l.  $\times$  10 its time = 2790, C's stock 735 l.  $\times$  6 its time = 4410. Then 4480 + 2790 + 4410 = 11680.

Now, 1. To find A's share of the profit, state thus. If 11680 l. : 1000 l. :: 4480 l. which being worked by the *Rule of Three*, the answer will be 383 l. 11 s. 2  $\frac{1}{2}$  d. for A's share of the gain.

2. For finding B's share, state thus, if 11680 l. : 1000 l. :: 2790 l. and working as before directed, the answer will be 238 l. 17 s. 4  $\frac{1}{4}$  d.

3. To find C's proportion of the gain, say, if 11680 l. : 1000 l. :: 4410 l. then working it by the *Rule of Three*, the true amount of his share will appear to be 377 l. 11 s. 4  $\frac{1}{4}$  d.

Ex-

EXAMPLE II.

Three merchants, A, B, and C, enter into partnership thus ; A puts into the stock 65 l. for eight months ; B puts in 78 l. for twelve months ;

and C puts in 84 for six months. With this joint stock they traffic, and gain 166 l. 12 s. It is required to find each man's share of the gain proportionable to his stock and time of employing it.

- 1. A's stock 65 l. × 8 months, the time it was employed = 520
  - 2. B's stock 78 l. × 12 months, the time it was employed = 936
  - 3. C's stock 84 l. × 6 months, the time it was employed = 504
- The sum of all those products is 1960

Then, as before, the several proportions will stand thus :

1960 : 166,6 :: 520 : 44, 2 = 44 l. 4 s. for A's share.  
 1960 : 166,6 :: 936 : 79,56 = 79 l. 11 s. 2½ d. for B's share.  
 1960 : 166,6 :: 504 : 42,84 = 42 l. 16 s. 9½ d. for C's share.  
 The whole gain = 166 l. 12 s.

OF BARTER.

BARTER is the exchanging of wares for wares, or one commodity for another.

Two merchants barter. A. has 3 C 2 qrs. of pepper at 13 d. ½ per lb. B has ginger at 15 d. ¼ per lb. I would know how much ginger must be delivered for the pepper. The process is thus :

1. If 1 lb. of pepper costs 13 d. ½. What will 3 C. 2 qrs. ?

13 d. ½	3 C. 2 Qrs.
4	4
54	14
—	28

112  
28  
—

12	392
4)21168(5292(44 1	54
48 .. —	1568
— 22 1	1960
49	21168
48	1 s.
—	12 Answer 22 l.
12	Pepper.
12	
—	
0	

2. If 15 d. ¼ buys 1 lb. of ginger, what will 22 l. 3 s.

4	20
61	443
61)21264(348 + ⅔ lb. Ginger.	12
183..	5316
296	4
244	21264
524	
488	
36	

Answer 348 = ⅔ Pounds of Ginger must be delivered for the Pepper.

Another EXAMPLE.

A has 100 pieces of silk, which are worth but 3 l. a-piece in ready money, yet he barterers them with B at 4 l. per piece, and at that rate takes their value of B in wools at 7 l. 10 s. per C. which are worth but 6 l. per C. in ready money : the question will be to know what quantity of wool pays for the silks, and which of the two, A or B is the gainer, and how much ?

To which I answer 53 C ⅓ of wool pay for the silk, and A gains 20 l. in money by the barter. Demonstrated thus :

I. If



Here the blank will be under the third place, multiply the three last for a dividend, and the two first for a *divisor*, the *quotient* of these gives the sixth; that is,  $6 \times 50 \times 3 = 900$ , and  $100 \times 12 = 1200$ , row 1200)90000(75 = 15s. required.

If the demand had been, in how many months would 50l. have gained 15s. or if 100l. in twelve months gains 6l. what shall the principal be that in three months would gain 15s. In these cases the blank would have been under the first or second term; then by another rule, multiply the first, second, and last for a dividend, and the third and fourth for a *divisor*; the *quotient* is the answer.

l. Months l.  
100 12 6

3 75 = 15s.

Then by the rule  $100 \times 12 \times .75 = 90000$  and  $6 \times 3 = 18$ )900.(50 l. required.

This Rule shews *Simple Interest*, and all that belongs to it, with ease, and was thus found: put P for the Principal, T for the Time, and G for the Gain in the Conditions, and *p t g* answering, it will be

$P : G :: t : p$  and  $T : G p :: t \frac{G p t}{T P} = g$ , which

is the first rule; that is, multiply the three last for a dividend, and the two first for a divisor, and because  $\frac{G p t}{T P} = g$ , therefore  $G t p = T p g$ , and consequently

$t = \frac{T P g}{G p}$  and  $p = \frac{T P g}{G t}$ , which is the

second rule.

COMPOUND INTEREST, is that which is counted both from the principal, and the *simple Interest* forborn, called also *Interest* upon *Interest*.

This sort of *Interest* is commonly worked by *decimal Arithmetick*; but for the better understanding of it I shall state a few questions, to be performed by *vulgar Arithmetick*. For example:

If 300l. be put out at 6l. per Cent. per Ann. reckoning interest upon interest, what money must I receive then?

l. l.  
300 at 6 per Cent.  
6

l. s. d.  
18|00 300 00 0 Principal  
18 00 0 Interest

318 00 0 Increase the first Year.

l. s. d. l.  
318 00 0 at 6  
6

19|08 00 6  
20

1|60  
12

7|20  
4

c|80

l. s. d.  
318 00 0  
19 01 7

337 01 7 Increase the 2d Year.

l. s. d. l.  
337 1 7 at 6 per Cent.  
6

20|22 9 6  
20

4|49  
12

5|94  
4

3|6

l. s. d.  
337 1 7  
20 4 6  $\frac{3}{4}$

357 6 0  $\frac{3}{4}$  Increase Third.

l. s. d. l.  
357 6 0  $\frac{3}{4}$  at 6 per Cent.  
6

21|43 16 4  $\frac{1}{2}$   
20

8|6  
12

9|6  
4

o|56

l. s. d.  
357 06 0  $\frac{1}{2}$   
21 08 9

378 14 9  $\frac{1}{2}$  Fourth Year.

So that at the fourth year's end he must receive for principal and interest 378 l. 14 s 9 d.  $\frac{1}{2}$ .

This way of operation is more compendious than by the *Rule of Three*.

First state your question as before. If 100*l.* gain 6*l.* what will 300*l.* your principal? Multiply first your principal by your interest; that done, cut off the two first figures towards your right hand of the pounds with a line. Then multiply them by 20, 12, and 4, and all above two figures towards your right hand, carry over the line to the left, as you see in the above-mentioned example.

Thus much for *Simple and Compound Interest* till we come to *Decimal Arithmetick*.

OF EXCHANGE.

EXCHANGE implies the trade of money carried on between one nation and another, by means of *Bills of Exchange*.

EXAMPLE.

A merchant delivered 530*l. sterling* in London, at 20*s per l.* to receive the same, by a *Bill of Exchange*, at Amsterdam, the exchange at thirty-three shillings and four pence *Flemish*, for a pound *sterling*, I demand the same in *Flemish* money.

*Note*, That in the stating of your question, your first and third numbers must be both of one kind; if the first be *sterling* money, the third must be *sterling*; if the first be *Flemish*, the third must be *Flemish*. Therefore I ask

If 20*s sterl.* give 33*s. 4d.* what will 530*l. sterl.*?

s.	s.	d.	l.
If 20	33	4	530
	12		20
	400		10600
			400
			4240000

20)	4240000	(212000	(1766 6
	40	12	883 6 8
	24	92	
	20	84	
	40	80	
	40	72	
	0	80	
		72	
		80	
		72	
		8	

Answer *Flem.* 883*l.* 6*s.* 8*d.*

Or thus shorter:

l.	s.	d.
3)	530	at 33 4
	33	
	1590	
	1590	
	17490	
	176	8
	1766 6	8
	883 6	8

I ask farther at what rate when the *Exchange* from London to Rotterdam, when I delivered 700 pounds *Sterling* in London; and received in Rotterdam 1010*l. Flemish*?

If 700*l. Sterling* make 1010*l. Flemish*, what will 20*s. Sterling*?

l.	s.	d.	
Facit per Rule of Three	1	8 10 1/4	
l.	l.	s.	d.
Proof 700	at	1	8 10 1/4
		1	
2/3)	700	0	0 0
8)	140	0	0 0
8)	140	0	0 0
2)	17	0	0 0
	8	15	0 0
	4	7	6 0
	0	14	7 0
	1011	7	1

8*s.* 2/3 of a *l. Sterling*.  
 6*d.* 1/8 of 4*s.*  
 3*d.* 1/2 of 6*d.*  
 1*d.* 1/2 of 3*d.*  
 1/5 of 1*d.* 1/2.

1011 7 1 1 Small difference.

OF ALLIGATION.

ALLIGATION is the *Rule of Mixture*, teaching to compound several species of ingredients or commodities together, according to any intent or design proposed; and is either *medial* or *alternate*.

MEDIAL *Alligation* shows the rule or price of mixtures, when the several quantities of the mixture and their several values are known.

To work this rule, multiply the ingredients severally by their own prices, and divide the sum of those *Products* by the sum of the ingredients, the *Quotient* answers the question.

Therefore repeating again the above-faid example, I demand how much that miffing is worth? Thus according to *rule*.

s. d.	s.	s. d.
2 8	2	13 4
5	9	18 0 add
13 4	18	31 4
		12
		376 Dividend.

5 Bushels of Wheat  
 9 Bushels of Rye  
 — add  
 14 Divisor

Then 376 divide by 14. *Answer*, 2 s. 2 d.  $\frac{3}{4}$ .

12 s. d.
14)376(26   2 2 + $\frac{3}{4}$ or $\frac{6}{7}$
98 · 24
96 2
84 —
12

So that I conclude that a bushel of that miffing may be afforded for 2 s. 2 d.  $\frac{6}{7}$ , or  $\frac{3}{4}$  farth. Which is the resolution of the question proposed.

In *Alligation medial*, the *proof* of the work is by comparing the total value of the several simples, with the value of the whole mixture; and when those sums agree, the operation is perfect; so as in this example.

s. d.	
5 Bushels of Wheat at 2 s. 8 d. is	13 4 } add
9 Bushels of Rye at 2 s.	18 0 }
all which amounts unto	31 4

which is likewise the value of 14 bushels of wheat at 2 s. 2 d. +  $\frac{3}{4}$ . For by the *Rule of Three*, if 1 bushel cost 2 s. 2 d. +  $\frac{3}{4}$  what will 14 bushels? *Answer*, 31 s. 4 d. with the fraction  $\frac{6}{7}$ , or  $\frac{3}{4}$  farth.

The nature, quality, &c. of the several ingredients of a mixture being given, to find the temperament, or degree of fineness resulting from the whole. Place the several quantities of the mixture in rows; against which, place the several qualities or fineness; then as the sum of the quantities is to their product, so is the unity to the quality or fineness of the mixture. For example.

A Goldsmith has 8 lb. weight of silver bullion of 7 oz. fine, 15 lb. of 8 oz.  $\frac{1}{2}$  fine, and 13 of 10 oz.

fine, and he would melt altogether, and know what fineness a pound weight of that mass would come to?

lb. oz.	lb. oz.	lb. oz.
8 of 7	2)15 of 8 $\frac{1}{2}$	13 of 10
7	8	10
56	120	130
	7 $\frac{1}{2}$	
	127 $\frac{1}{2}$	

add 56	8
127 $\frac{1}{2}$	15
130	13
313 $\frac{1}{2}$	36
2	2

Dividend 627 Divisor 72

oz.	pwt. gr.
72)627(8 + $\frac{5}{7}$ or $\frac{1}{2}$ makes 14 4	
576	
51	

*Answer*, the mass must be 8 oz. 14 pwt. 4 gr.

Given the total of a mixture with the whole value; and the value of the several ingredients, to find the several quantities mixed though unequally, Multiply the total of the mixture by the least value. Subtract the product from the total value; and the remainder is the first dividend. Then take the said least value from the greatest valued ingredient, and the remainder is the first divisor. The quotient of this division shews the quantity of the highest priced ingredient, and the other is the compliment of the whole. And when more ingredients than two are in the composition, the divisors are the several remains of the least value, taken from the other: The dividends are the remains left upon the divisions, till none remain there; which will be one short of the number of ingredients; and this defective ingredient is to be supplied as a complement; and in division no more must be taken in every quotient, than that there may remain enough for the other divisors; and the last to leave nothing remaining.

*ALLIGATION Alternate*, is when the rates or qualities of several simples are given; and the quantity of each is required necessary to make a mixture of the given rate or quality. *Alligation Alternate*, shews the due proportion of several ingredients; and counter-changes the places of such excesses or differences as arise between the mean price and the extremes;

extremes; ascribing that to the greater extreme, which proceeds from the lesser; and contrarily.

The Rules which obtain in *Alligation Alternate* are these.

*First*, You must set down the numbers of which you will make the *Alligation*, orderly one under the other: and the common number whereinto you must reduce them, set on the left hand. Then note which of the said numbrs are lesser than that common number, and which of them be greater, and with a draught of your pen link two numbers together; so that the least number may be still linked with the greatest, and the greatest with the smallest. Then add up all these differences into one total, which shall be the first number in the *Rule of Three*, and the second number the common number, then the third must be each difference done by itself. For example:

A Vintner has four sorts of low wine of four several prizes; the first at 8 *d.* per gallon, the second at 10 *d.* per gallon, the third at 15 *d.* per gallon, and the fourth at 18 *d.* per gallon: now he would mix all these sorts together, that a gallon of these (lower, decay'd) wines may be worth 12 *d.* the puncheon holding 84 gallons, Then:

12	8	—6	If 15—84—6
	10	—3	Makes 33 + $\frac{2}{3}$ of the first fort,
	15	—2	
	18	—4	Gall.
		—	If 15—84—3
		15	Makes 16 + $\frac{2}{3}$ of the second fort.

If 15 give—84—what will 2?  
Makes 11 +  $\frac{1}{3}$  of the third fort.

If 15 give—84—what will 4?  
Makes 22 +  $\frac{2}{3}$  of the fourth fort.

which quantities added up make 84, viz.

	<i>Fractions</i>	
add	33    3	5)10(2 for <i>Fractions</i> .
	16    4	
	11    1	
	22    2	
	2    —	
	—    10	
for the Proof	84	

*Further*, A Goldsmith has divers sorts of gold, viz. some of 24 caracts, others of 22 caracts others of 18 caracts, and others of 16 caracts fine; is desirous to melt as much of all these four

sorts together, as may make a mass of gold to contain 16 ounces of 21 caracts fine. Then he proceeds thus:

21	24	—5	Oz.	
		22	—3	If 12—60—5
		18	—1	Makes 25 ounces of the first.
		16	—3	
		12	Oz.	
			If 12—60—3	
			Makes 15 ounces of the second.	

Oz.  
If 12—60—1  
Makes 5 ounces of the third.

Oz.  
If 12—60—3  
Makes 15 ounces of the fourth.

which quantities so taken and mixed, make up the mass of 60 ounces of 21 caracts fine.

Oz.  
viz. 25 of the first fort  
15 of the second fort  
5 of the third fort  
15 of the fourth fort  
—  
60 of 21 caracts fine

OF POSITION.

When we calculate on several false numbers, taken at random, as if they were true ones; and from the differences found therein, determine the number sought; such rule is called in *Arithmetick* the rule of *False Position*.

*POSITION* is either *single* or *double*. *Single Position* is when there happens in the propositions some partition of numbers into parts proportional, in which case the question may be resolved at one operation by this rule. Imagine a number at pleasure, and work therewith, according to the tenor of the question, as if it was the true number; and what proportion there is between the false conclusion and the *false Position*, such proportion the given number has to the number sought, the number sought by argumentation, shall be the first term of the *Rule of Three*; the number supposed the second term, and the given number the third. For example:

Three men build a ship (which cost them 2700*l.*) viz. *A*, *B*, and *C*, and they so agree that *B* is to pay double what *A* must pay, and *C* triple of what *B* pays; I would know how much every man ought to pay? To resolve this question, I suppose *A* paid 6*l.* therefore *B* paid 12*l.* and *C* must pay 36*l.* But by this *Position* of 6*l.* + 12*l.* + 36*l.* added, makes but

but 54 *l.* which by the intent of the question ought to have been 2700 *l.* nevertheless by those suppositi-  
 onal numbers I shall discover the true sums which  
 the several parties ought to pay; for I say, by the  
*Rule of Three:*

1<sup>st</sup>. As 54 is to — 6 — what will 2700  
 6

16200

54)16200(300 *A* must pay  
 16200

000

2<sup>d</sup>. As 54 is to — 12 — what will 2700  
 12

32400

54)32400(600 *B* must pay  
 32400

00

3<sup>d</sup>. As 54 is to — 36 — what will 2700  
 36

16200  
 8100

97200

54)97200(1800 *C* must pay  
 54000

432

432

00

Proof *A* pays 300  
*B* pays 600  
*C* pays 1800

Total is 2700 the sum propounded.

Further, A gentleman having about him a cer-  
 tain number of crowns, said, if a fourth, a third,  
 and a sixth of them were added to what he had  
 about him, they would make 45 crowns, what  
 were the number of crowns he had about him?  
*Answer* 60 crowns. I suppose then he had 24  
 crowns.

Crowns.

$\frac{1}{4}$  of 24 is 6

$\frac{1}{3}$  of 24 is 8

$\frac{1}{6}$  of 24 is 4

all which make 18

But if 18 come of 24 what will 45 Crowns ?

24

180

90

18) 1080 (60 Crowns.

Crowns

108

Proof  $\frac{1}{4}$  of 60 is 15

$\frac{1}{3}$  of 60 is 20

$\frac{1}{6}$  of 60 is 10

makes 45 Crowns.

The *Double Position* is, when there can be no  
 partition in the numbers, to make a proportion.  
 In this case therefore, you must make a supposition  
 twice; proceeding therein according to the tenor of  
 the question. If neither of the supposed numbers  
 solve the proposition, observe the errors, and whe-  
 ther they be greater or lesser than the resolution re-  
 quires; and mark the errors accordingly with the  
 signs + and —

Multiply contrarywise, the one position by the  
 other error; and if the errors be both too great, or  
 both too little, *subtract* the one product from the  
 other, and divide the difference of the products by  
 the difference of the errors. But if the errors be  
 unlike, *viz.* one great and the other little, add the  
 products, and divide the sum thereof by the sums  
 of the errors added to the greater; for the propor-  
 tion of the errors is the same with the proportion of  
 the excesses or defects of the numbers supposed, to  
 the numbers sought. A few Examples will dem-  
 onstrate this rule to be plain and easy.

Note, That this character — signifies that the  
 lesser of the two numbers, betwixt which it is  
 found, ought to be subtracted from the greater;  
 and that this + intimates that the numbers betwixt  
 which it is found, ought to be added together.

We must observe farther, that for the operation of this rule, we must draw two lines a-cross, and place the terms of the *false position*, (*viz.* those that have the same denomination) at the uppermost end of the cross, and each error under its respective position, at the lower end of the same cross.

EXAMPLE.

A certain man being demanded what was the age of his four sons? answered that his eldest was four years older than the second; the second four years older than the third; the third four years older than the fourth; and the fourth was half the age of the eldest; We demand then what was the age of each son?

To answer which, suppose first the age of the eldest 16, then by the question, the second must be 12, the third 8, and the fourth or youngest 4: but it ought to have been 8; so that it wants 4 of what it ought to be. Therefore make a second supposition, and take 20 for the age of the eldest son, then the age of the second will be 16, the age of the third 12, and the age of the fourth or youngest 8, which should have been half 20, so that it wants 2 of what it ought to have been; so that in both these suppositions there are defects, and by consequence alike the scheme follows:

16	20		
<del>48</del>			
4	2		
<del>2</del>			
	16		
	<del>2</del>		
		20	
		<del>4</del>	
		80	
		<del>32</del>	
		48	
4			
<del>2</del>			

(24 both defects work accordingly as per rule.)

1 Divisor.      2)48(24 Years of age the eldest.  
 Therefore the age of the eldest is  
 24 eldest son.  
 20 second son  
 16 third Son  
 12 youngest son.

Which answers the question; for 12, the youngest son, is half the age of the eldest, *viz.* 24.

Farther, let it be required to divide 100*l.* among three persons, *viz.* A. B. C. in such a manner that

the share of B. may be the triple of the share of A. and 4*l.* over and above; also that the share of C. may be equal to the sum of the shares of A. and B. and 6*l.* over and above. Thus:

Let the first position for the share of A.      12  
 be 12, then B. must have 40*l.* and C. 58*l.*      40  
 but 12*l.* 40*l.* and 58*l.* is 110*l.* which is 10*l.*      58  
 too much.      110

Then for a second Position I suppose for A. 8  
 the share of A. 8*l.* then B. must have 28*l.*      28  
 and C. 42*l.*; but 8 + 28 + 42 = 78*l.*; but      42  
 this 78*l.* is too little by 22; for if I subtract      —  
 78 from 100, there will remain 22, which is      78  
 too little; therefore this question, by the sup-  
 positions, proves one too little by 22, and  
 the other supposition 10*l.* too much.

264 +	80	
<del>12</del>	<del>8</del>	
	344	
		10 <i>l.</i> + $\frac{3}{4}$ <i>lb.</i> or 10 <i>l.</i> 15 <i>s.</i>
10	+ 22	
	<del>32</del>	

Proof A.      *l.*      *s.*  
 A.      10      15  
 B.      36      5  
 C.      53      0

100      0 Total.

Farther, A man gives away his estate in this manner, to A.  $\frac{1}{2}$ . and he gave back 10*l.* to B.  $\frac{1}{3}$ , and he gave back 6*l.* and to C.  $\frac{1}{4}$ , and he gave back 4*l.* Last of all he had 16*l.* remaining, what was his estate?

For supposition, suppose	Second supposition; again,
60, then	suppose 10 <i>l.</i> then,
60 $\frac{1}{2}$ 30 — 10 = 20	120 $\frac{1}{2}$ 60 — 10 = 50
60 $\frac{1}{3}$ 20 — 6 = 14	120 $\frac{1}{3}$ 40 — 2 = 34
60 $\frac{1}{4}$ 15 — 4 = 11	120 $\frac{1}{4}$ 30 — 4 = 26
<u>45</u>	<u>110</u>

45 + 16 = 61, therefore is 1 too much.      110 + 16 = 126, which is 6 too much.

His Estate 848*l.*  
 Proof.

5)240(48	360	
<del>20</del>	90	120
	240	
40		4
<del>40</del>		
0		
	1	6
	5	

48  $\frac{1}{2}$  24 — 10 = 14 A.  
 48  $\frac{1}{3}$  16 — 6 = 10 B.  
 48  $\frac{1}{4}$  12 — 4 = 8 C.  
30 + 16 = 48*l.*

FRACTIONS.

FRACTION in *Arithmetick* is a part or division of an *unit* or *integer*; or a member; which stands to an *unit*, in the relation of a part to its whole.

*Fractions* are usually divided into *vulgar* and *decimal*.

VULGAR FRACTIONS, called also simply *Fractions*, are always expressed by two numbers, the one wrote over the other with a line between them.

The lower, called the *denominator* of the *Fraction*, denotes the *unit* or whole that is divided into parts; and the upper, called the *numerator* of the *Fraction*, expresses the parts given in the present cases. Thus two third parts of a line, or other things are wrote  $\frac{2}{3}$ ; where the *denominator* 3 shews that the whole line is supposed to be divided into three equal parts; and the *numerator* 2 indicates or assigns two of such parts.

Again, twenty-nine sixtieths is wrote  $\frac{29}{60}$ , where the *numerator* 29 expresses 29 parts of an *integer* divided into 60; and the *denominator* 60 gives the denomination to these parts, which are called *sixtieths*.

The real design of adding the *denominator*, is to shew what *aliquot* part the broken number has in common with unity. In all *Fractions*, as the *numerator* is to the *denominator*, so is the *fraction* itself to the whole, whereof it is a *Fraction*. Thus supposing  $\frac{3}{4}$  of a pound equal to 15 s. it is evident that 3 : 4 :: 15 : 20, whence it follows, That there may be *infinite Fractions* of the same value one with another; in as much as there may be infinite numbers found, which shall have the ratio of 3 : 4.

*Fractions* are either *propor* or *improper*. PROPER FRACTION, is that where the *numerator* is less than the whole or *integer*, as  $\frac{2}{5}$ . IMPROPER FRACTION, is where the *numerator* is either equal to or bigger than the *denominator*; and of course the *Fraction* equal to or greater than the whole, or *integer*, as  $\frac{5}{5}$ , or  $\frac{7}{5}$ , or  $\frac{9}{2}$ .

*Fractions*, again, are either *simple* or *compound*. SIMPLE FRACTIONS, are such as consist of only one *numerator*, and one *denominator*, as  $\frac{2}{7}$ , or  $\frac{1}{3}$ , &c. COMPOUND FRACTIONS, called also *Fractions of Fractions*, are such as consist of several *numerators* and *denominators*, as  $\frac{1}{2}$  of  $\frac{1}{2}$  of  $\frac{1}{2}$  of  $\frac{1}{2}$ , &c.

Of *Fractions* those are equal to each other, whose *numerators* have the same ratio to their *denominators*. Those are greater, whose *numerators* have a greater ratio; and those less, which have less: Thus  $\frac{3}{5} = \frac{6}{10} = \frac{9}{15} = \frac{12}{20} = \frac{1}{2}$ . But  $\frac{3}{4}$  is greater than  $\frac{2}{5}$ ; and  $\frac{1}{6}$  less than  $\frac{1}{8}$ . Hence if both the *numerator* and *denominator* of a *Fraction*, as  $\frac{4}{6}$ , be multiplied or divided by the same number 2; the fact in the form-

er case,  $\frac{8}{12}$ , and the *quotients* in the latter  $\frac{2}{3}$  will constitute *Fractions*, equal to the first *Fraction* given.

The *Arithmetick* of *Fractions* consists in the *Reduction*, *Addition*, *Subtraction*, and *Multiplication* thereof.

THE REDUCTION OF FRACTIONS is to bring *integers* into *Fractions*, or contrarywise *Fractions* of divers denominations into one, or what you'll want or desire.

When three or more *Fractions*, which have unequal *denominators*, are given to be reduced, we must multiply the *numerator* of each *Fraction*, and all the *denominators*, except its own, continually one into another; so are the several products, arising from such continual *Multiplication*, a new *numerator*. And by multiplying all the *denominators* together continually, the product is a common *denominator* to all the new *numerators*. Thus are reduced *proper Fractions*. For Example:

Reduce  $\frac{3}{4}$   $\frac{4}{5}$  into one common *denominator*. Thus:

$$\frac{3}{4} \quad \frac{4}{5}$$

for three times 5 is 15, and 4 times 4 is 16, new *numerators*, and 4 times 5 is 20. So that  $\frac{15}{20}$   $\frac{16}{20}$  are common *denominators*, and equal to  $\frac{3}{4}$  and  $\frac{4}{5}$ .

Likewise reduce  $\frac{2}{4}$ ,  $\frac{3}{5}$ ,  $\frac{1}{2}$ ,  $\frac{4}{6}$ ,  $\frac{1}{4}$ , into one denomination, being reduced *per* our Rule are:

Numerator	15	120	18	144	25	200	13	440	36	720
Denominator	30	240	30	240	30	240	30	240	30	240

To reduce *Fractions of Fractions*, the Rule is to multiply all the *numerators* together, and take the product thereof for a *numerator*, and likewise to multiply all the *denominators* together, and make the total a new *denominator*. For Example:

Reduce  $\frac{1}{2}$  of  $\frac{2}{3}$  of  $\frac{3}{4}$  into a *single Fraction*; being reduced it makes  $\frac{6}{24}$ , and is a *single Fraction*.

$$\frac{\frac{1}{2} \text{ of } \frac{2}{3} \text{ of } \frac{3}{4}}{6 \text{ over } 24}$$

Again reduce  $\frac{6}{5}$  of  $\frac{4}{3}$  of  $\frac{3}{4}$  of  $\frac{5}{7}$  of  $\frac{2}{6}$ , into a *single Fraction*:

Numerator	720	720	720	720
Com. Denominator	6720			
	$\frac{720}{6720}$			

The *Reduction* of *improper Fractions* into whole numbers, is done in dividing the *numerator* by the *denominator*, so is the *quotient* the whole number, or mixed number sought. For Example:

Reduce  $\frac{26}{5}$  into its equivalent mixed number, the number will be 5 l.  $\frac{1}{5}$  or 5 l. 4 s. for if 26 be divided by 5, the *quotient* is 5  $\frac{1}{5}$ .

$$\begin{array}{r} 5)26(5\frac{1}{5} \\ \underline{25} \\ 1 \end{array}$$

Reduce  $\frac{10}{4}$  *facit* 2 l.  $\frac{2}{4}$       4)10(2  $\frac{2}{4}$

$$\begin{array}{r} 8 \\ \underline{\quad} \\ 2 \end{array}$$

Reduce  $\frac{406}{12}$  *facit* 33.  $\frac{10}{12}$

$$\begin{array}{r} 12)406(33\frac{10}{12} \\ \underline{36} \\ 46 \\ \underline{36} \\ 10 \end{array}$$

Also the improper *Fraction*  $\frac{52}{4}$  will be reduced into the whole number 13.

$$\begin{array}{r} 4)52(13 \\ \underline{4} \\ 12 \\ \underline{12} \\ 0 \end{array}$$

To reduce a *mix'd number*, as 4  $\frac{11}{12}$  into an *improper Fraction* of the same value. Multiply the *integer* 4, by 12, the *denominator* of the *Fraction*; and to the product 48 add the *numerator*; the sum 59, set over the former *denominator*  $\frac{59}{12}$ , constitutes the *Fraction* required.

To reduce a *whole number* into an *improper Fraction*, multiply the given number by the intended *denominator*, and place the product for a *numerator* over it. For Example :

Reduce 15 into a *Fraction*, whose *denominator* shall be 12. *Facit.*  $\frac{180}{12}$  for 15 multiplied by 12 *Facit*  $\frac{180}{12}$ .

$$\begin{array}{r} 15 \\ 12 \\ \underline{\quad} \\ 180 \end{array}$$

To find the value of a *Fraction* in the known parts of its *integer*. Suppose it were required to know what is  $\frac{1}{6}$  of a *pound*; multiply the nu-

12.

merator 9 by 20, the number of known parts in a *pound*, and divide the product by the *denominator* 16, the *quotient* gives 11 s. Then multiply the remainder 4 by 12, the number of known parts in the next inferior denomination; and dividing the product by 16, as before, the *quotient* is 3 d. So that  $\frac{1}{6}$  of a *pound* = 11 s. 3 d.

Thus much for *Reduction of Fractions*. We'll proceed now to *Addition*.

**ADDITION of vulgar Fractions.** 1. If the given *Fractions* have different *denominators*, reduce them to the same; then add the *numerators* together, and under the sum write the common *denominator*. Thus, for Example.

$$\frac{2}{3} + \frac{4}{5} = \frac{10}{15} + \frac{12}{15} = 1 \frac{22}{15}. \text{ and } \frac{2}{3} + \frac{1}{6} + \frac{1}{4} + \frac{4}{7} + \frac{1}{7} + \frac{5}{7} = 1 \frac{42}{42} = 1 \frac{1}{42}.$$

2. If *Compound Fractions* are given to be added; they must first be reduced to simple ones; and if the *Fractions* be of different denominations, as  $\frac{6}{5}$  of a *pound*, and  $\frac{6}{3}$  of a *shilling*, they must first be reduced to *Fractions* of the same denomination of *pounds*.

3. To add mixed numbers: The *integers* are first to be added; then the fractional parts; and if their sum be a *proper Fraction*, only annex it to the sum of *integers*. If it be an *improper Fraction* reduce it to a mixed number, adding the *integral* parts thereof to the sum of *integers*, and the *fractional* part after it. Thus,  $5 \frac{2}{3} + 4 \frac{1}{2} = 10 \frac{1}{6}$ .

For the **SUBTRACTION of Fractions**. The Rule is — when the numbers given are both single *Fractions*, and have one and the same *denominator*, to subtract the lesser *denominator* from the greater, and place the remainder over the common *denominator*, so is such new *Fraction* the difference between the *Fractions* given. For Example :

Subtract  $\frac{3}{8}$  from  $\frac{7}{8}$ , the difference is  $\frac{4}{8}$ , or  $\frac{1}{2}$ .

But when they have unequal *denominators*, they must be reduced into *Fractions* of the same value, which shall have a common *denominator*, and then find the difference. For Example :

Subtract  $\frac{6}{7}$  from  $\frac{7}{8}$  rest  $\frac{1}{56}$ , for  $\frac{6}{7}$  and  $\frac{7}{8}$ , being reduced, will  $\frac{48}{56}$  and  $\frac{49}{56}$ , so the difference you see to be  $\frac{1}{56}$ .

When one of the numbers given is a whole number, or a mixt number, or if either of them are mixed numbers, reduce such whole or mixt numbers into an *improper Fraction*, or *Fractions*, and then work as before.

Subtract  $7 \frac{3}{5}$  from 12, the remainder is found  $4 \frac{2}{5}$ , for these two *Fractions* will be found to be  $\frac{12}{5}$ , and  $\frac{62}{5}$ , whose difference is  $\frac{22}{5}$  or  $4 \frac{2}{5}$ .

F f

In

In like manner 3 l.  $\frac{2}{3}$ , being to be subtracted from 5 l.  $\frac{3}{4}$ , the remainder will be found  $\frac{2}{3}$ , or 2 l.  $\frac{1}{3}$ , as by the subsequent operation.

$$\begin{array}{r} l. \qquad \qquad l. \\ 5 \frac{3}{4} \qquad \qquad 3 \frac{2}{3} \\ 4 \qquad \qquad \qquad 3 \\ \hline 2 \frac{3}{4} \qquad \qquad 3 \frac{1}{3} \\ \hline 69 \qquad \qquad 12 \text{ Denom.} \\ 44 \qquad \qquad \end{array}$$

So there is  $\frac{2}{3}$ , or 2 l.  $\frac{1}{3}$ , (as before).  
25 Numerator. For 4 multiplied by 3 is 12 for (Numerator).

From 12 take  $7 \frac{2}{3}$  Thus:

$$\begin{array}{r} \frac{12}{1} \qquad \frac{3 \frac{2}{3}}{3} \qquad 12 \\ \qquad \qquad \qquad 5 \\ \hline \qquad \qquad \qquad 60 \\ \qquad \qquad \qquad 38 \\ \hline \end{array}$$

Rest  $\frac{22}{5}$  For answer remains  $2 \frac{2}{5}$ , or  $4 \frac{2}{5}$ .

When a whole number is given to be subtracted from a mixt number, subtract the said whole number from the whole part of the mixt number; and unto the remainder annex the fractional part of the mixt number given, so is the mixt number so found the difference sought. For Example:

Received  $2 \frac{2}{3}$  of a pound, laid out 7 pounds, what remains?

$$\begin{array}{r} 24 \\ 7 \text{ Subtract} \\ \hline 17 \frac{2}{3} \text{ Remains.} \end{array}$$

When a Fraction is given to be subtracted from an integer, subtract the numerator from the denominator, and place that which remains over the denominator, which new Fraction is the difference sought. So  $\frac{2}{3}$  being subtracted from an integer, or 1, the remainder is  $\frac{1}{3}$ .

When a Fraction is given to be subtracted from a whole number greater than 1, subtract the said Fraction from one of the integers given by the last rule; the remaining Fractions being annexed to the number of integers lessened by 1, will give the remainder. Thus  $\frac{2}{3}$  being subtracted from 6, the remainder is  $5 \frac{1}{3}$ .

To subtract a whole number and a Fraction from a whole number and a Fraction, the Fractions must be first reduced into one denomination, then one numerator subtracted from the other; and the integers subtracted, as in whole numbers. For Example:

Received 30 l.  $\frac{3}{4}$ , laid out 10 l.  $\frac{1}{2}$ , first reduce  $\frac{3}{4}$  and  $\frac{1}{2}$  (into one denomination).

$$\begin{array}{r} 30. \frac{3}{4} \qquad \qquad \frac{3}{4} \qquad \qquad \frac{2}{8} \text{ or } \frac{1}{4} \\ 10. \frac{1}{2} \qquad \qquad \frac{1}{2} \\ \hline \text{Rem} \quad 20. \frac{1}{4} \end{array}$$

When Fractions of Fractions are to be subtracted, they are to be reduced into single Fractions, then subtract as before.

Subtract  $\frac{1}{2}$  of  $\frac{2}{3}$  from  $\frac{3}{4}$  of  $\frac{4}{5}$ . Being reduced they are ( $\frac{1}{3}$  and  $\frac{2}{5}$ )

$$\begin{array}{r} \qquad \qquad \qquad 4 \\ \hline 5 \qquad \qquad \qquad 5 \text{ Rest } \frac{4}{15} \\ \frac{1}{3} \qquad \qquad \qquad \frac{2}{5} \\ \hline \qquad \qquad \qquad 15 \end{array}$$

Those Fractions are always accounted the greatest, whose numerator multiplied by the denominator of the other Fraction makes the greatest number. Thus  $\frac{7}{8}$  is greater than  $\frac{3}{5}$ ; for 7 times 5 is greater than 8 times 3.

In Multiplication of vulgar Fractions. 1. If the Fractions proposed be both simple, multiply the numerators one by another for a new numerator, and the denominators for a new denominator. Thus  $\frac{2}{3}$  into  $\frac{3}{5}$  produces  $\frac{2}{5}$ .

We must observe in this place, that as whole numbers multiplied by whole numbers increase the product; so proper Fractions multiplied by proper Fractions diminish the product. For as 1 multiplied by 1 makes but 1, so that which is less than 1 being multiplied by  $\frac{2}{3}$  of a pound makes but  $\frac{2}{3}$  a pound,  $\frac{3}{4}$  by  $\frac{2}{3} = \frac{1}{2}$  or  $\frac{1}{2}$ .

2. If one of them be a mixed or whole number, it must be reduced to an improper Fraction, and then proceed as in the last rule. Thus  $7 \frac{2}{3}$  being multiplied by  $5 \frac{1}{3}$ , the product will be found 42.

$$\begin{array}{r} 7 \frac{2}{3} \text{ by } 5 \frac{1}{3} \qquad \qquad 1 \frac{1}{2} \text{ by } 2 \frac{2}{5} \\ \hline 2 \qquad \qquad \qquad 5 \\ \hline 15 \qquad \qquad 28 \qquad \qquad \text{for } 28 \text{ by } 2 \\ \hline 2 \qquad \qquad 5 \qquad \qquad \qquad 15 \qquad \qquad 5 \\ \hline \qquad \qquad \qquad \qquad \qquad 10 \end{array}$$

Though there may be other rules for the Multiplication of mixed numbers, that used by joiners, carpenters, and bricklayers, commonly called Cross Multiplication, is at present very much in use. Thus if it be required to multiply 120 feet  $\frac{2}{3}$  by 48 feet  $\frac{1}{2}$ , first multiply the whole numbers continually; thus 120 by 48, and place the product orderly one under the other.

Thus

Thus the whole numbers make 5760, then multiply alternately, or cross-ways, viz. take  $\frac{1}{4}$  of 48, which is 12, also take  $\frac{1}{2}$  of 120, which is 60, orderly to be added to the former. Lastly, add all together, and to the sum add the product of the two Fractions, as in this Example, the product of the multiplication of  $\frac{1}{4}$  by  $\frac{1}{2}$ , which is  $\frac{1}{8}$ , so the total product required will be  $5832\frac{1}{8}$ , as you see by the operation in the margin.

$$\begin{array}{r}
 120\frac{1}{4} \\
 48\frac{1}{2} \\
 \hline
 960 \\
 480 \\
 \hline
 5760 \\
 12 \\
 60 \\
 \hline
 5832\frac{1}{8}
 \end{array}$$

In like manner multiply  $4\frac{1}{2}$  by  $4\frac{1}{2}$ , or 4 s. 6 d. by (4 s. 6 d.)

	s.	d.	
$4\frac{1}{2}$	4	6	by 4 s. 6 d.
$4\frac{1}{2}$	4	6	
<hr/>			
16	16		
2	2		
$2\frac{1}{4}$	$2\frac{1}{4}$		
<hr/>			
$20\frac{1}{4}$	20	3	

For by multiplying cross-ways, saying 6 times 4 is 24 d. which is 2 s. and so alternately again it is 2 s. and the Fraction being  $\frac{1}{4}$  of a shilling is 3 d. so that 4 s. 6 d. multiplied by 4 s. 6 d. is 20 s. 3 d.

In like manner multiply 3 feet 6 inches by 3 feet 6 inches.

Feet
$3\frac{1}{2}$
$3\frac{1}{2}$
<hr/>
9
$1\frac{1}{2}$
$1\frac{1}{2}$
$\frac{1}{4}$
<hr/>
$12\frac{1}{4}$

Facit 12 Feet  $\frac{1}{4}$

Operation by Fractions by the last Rule.

l.	s.	d.	
5	5	5	5 d. is $\frac{5}{12}$ of $\frac{1}{2}$ viz. $\frac{5}{24}$ .
20			
<hr/>			
105			
<hr/>			
20	105	20	
20	240	5	
<hr/>			
400	4200	100	
12	210		
<hr/>			
25200			
4800 New Den.	100		
<hr/>			
253100	New Num.		
<hr/>			
48100			

48	$2\frac{5}{8}$ by $2\frac{5}{8}$	253
48		253
<hr/>		
2304		759
		1265
		506
		<hr/>
		64009

Answer  $\frac{64009}{2304}$  equal to 27 l. 15 s. 7 d.  $\frac{5}{8}$   $\frac{5}{12}$ .

The proof of this question by the Rule of Three direct.

l.	l.	s.	d.	l.	s.	d.
1	5	5	5	5	5	5
20	20			20		
<hr/>				<hr/>		
20	105			105		
12	12			12		
<hr/>				<hr/>		
240	1265			1265		
				1265		
				<hr/>		
				6325		
				7590		
				2530		
				1265		
				<hr/>		
				1600225		



By this operation 'tis evident, that  $\frac{105}{114}$  is equal to 13l. 9s. 4d.

Having thus clearly demonstrated the *Arithmetick* of whole numbers and *Vulgar Fractions*, I proceed to that excellent invention called *DECIMAL Arithmetick*, first invented by *Johannes Regiomontanus*, and used by him in his tables of signs.

**DECIMAL FRACTIONS**, are those whose denominator is 1, with one or more *cyphers*; as 10, 100, 1000, 10,000, &c. Thus  $\frac{5}{10}$ ,  $\frac{46}{100}$ ,  $\frac{125}{1000}$ , &c. are *Decimal Fractions*.

In the writing of *Decimal Fractions*, we usually omit the denominator, as only consisting of unity with *cyphers* annexed; and in lieu thereof a point, or comma is prefixed to the numerator. Thus  $\frac{5}{10}$  is wrote .5;  $\frac{46}{100}$ , .46; so .125 expresses an hundred twenty-five parts of any thing supposed to be divided into 1000 parts.

As *cyphers* on the right hand of integers do increase their value *Decimally*; as 2, 20, 200, &c. so when set on the left hand of *Decimal Fractions*, they decrease the value *Decimally*, as 5, 05, 005, &c. when set on the left hand of integers, or on the right hand of *Decimals*, they signify nothing but only to fill up places; thus 5000, or 0005, is but five units.

To reduce *Vulgar Fractions* into *Decimals*, add *cyphers* at pleasure to the numerator, and divide by the denominator. Thus  $\frac{5}{8}$ , being propounded to be reduced to a *Decimal*, will be changed into .625, that is  $\frac{625}{1000}$ , for annexing *cyphers* unto the numerator 5, it will be 5000, which being divided by the denominator 8, the quotient will be 625, before which, prefixing a point, it will be .625, that is  $\frac{625}{1000}$  the *Decimal* sought; as it appears in the operation.

$$\begin{array}{r} 8 \overline{)5000(625} \\ \underline{48} \phantom{00} \\ 20 \phantom{00} \\ \underline{16} \phantom{00} \\ 40 \phantom{00} \\ \underline{40} \phantom{00} \\ 0 \end{array}$$

The common operation in *Decimals*, are performed as in the vulgar rules, regard being had only to the particular notation, to distinguish the integral from the fractional part of a sum.

In *Addition*, and *Subtraction* of *Decimal Fractions*; the points being all placed under each other, the figures are to be added; or subtracted as in common *Arithmetick*; and when the operation is done,

so many figures of the sum, or the remainder are to be noted for *Decimals*, as there are places of *Decimals* in the greatest given number, an example will make this clear.

Addition of Decimals		Subtraction.
.43791		from 67.9
.792	59.271	take 29.8754
.6124	15.040	Rem. 38.0246
.053	3.791	
.10	12.009	from 25.1462
.2	7.5	take 13.07
2.19531	97.062	Rem. 12.0762

For **MULTIPLICATION** of *Decimals*, the rule is, so often as two numbers are given to be multiplied, and are both mixt numbers, or both *Decimal Fractions*, or one of them a whole number, and the other a *Decimal* or mixt number, to write them down exactly one underneath the other, as is done in *Multiplication* of whole numbers; and when you have gotten the product, to see how many places of *Fractions* are found both in the *Multiplicand* and *Multiplier* jointly, just so many places you must cut off from the product, by a point, comma, or line, towards the right-hand, as there are places of *Decimals* in both factors. Thus,

$$\begin{array}{r} \text{multiply } 246.25 \quad .87 \\ \text{by } 35 \quad .9 \\ \hline 123125 \quad .783 \\ 73875 \quad \hline \hline 8618.75 \end{array}$$

When the *Multiplication* is finished, if there arise not so many places in all, as ought to be cut off, (which may often happen when the product is a *Fraction*) in such case as many places as are wanting, so many *cyphers* must be prefixed to the product, on the left hand thereof, to compleat the product. For example;

$$\begin{array}{r} \text{Multiply } .0375 \text{ by } .05 \\ \hline .05 \\ \hline 1875 \end{array}$$

Now here being but four figures, I prefix two *cyphers* to compleat the product of

$$\begin{array}{r} \text{Multiply } .0375 \text{ is } .001875 \text{ Product} \\ \text{by } .05 \\ \hline \text{Product } .001875 \text{ as by Rule.} \end{array}$$

In *DIVISION* of *Decimals*, proceed in all respects as in dividing of integers; and when the operation is done, mark as many places in the quotient for *Decimals*, as with the number of *Decimals* in the divisor, are equal to the *Decimal* places of the dividend.

$\begin{array}{r} .22)8.030(3.65 \\ \underline{66} \\ 143 \\ \underline{132} \\ 110 \\ \underline{110} \\ 0 \end{array}$	$\begin{array}{r} 22)8.030(365 \\ \underline{66} \\ 143 \\ \underline{132} \\ 110 \\ \underline{110} \\ 0 \end{array}$
--	--

$\begin{array}{r} 22)8.030(.0365 \\ \underline{66} \\ 143 \\ \underline{132} \\ 110 \\ \underline{110} \\ 0 \end{array}$	$\begin{array}{r} 72.2)8321.9(1.13 \\ \underline{732} \\ 1002 \\ \underline{732} \\ 2709 \\ \underline{2196} \\ 513 \end{array}$
--	--

But there are certain cases in *Division* of *Decimals*, which require some further management: as first, where the divisor is a *Decimal Fraction*, and the dividend an integer; add or annex as many or rather more *cyphers* to the dividend, than there are places in the divisor: Thus,

$$.365)22.000(60.2$$

For there being three places of *Decimals* in the divisor, and four in the dividend, there will be but one in the quotient.

2. Where the divisor is a mixt number, and the dividend a whole number, add, at least, as many *cyphers* to the dividend, as there are places in the divisor. Thus,

$$3.65)22.0000(6.02$$

3. Wherever the divisor is bigger than the dividend, annex *cyphers* to the latter. Thus,

$$.365)22.0000(6.02$$

To work the *RULE* of *THREE* in *Decimals*, the operations are the same as in whole numbers, only in *Decimals* respect must be had to the *Decimal* Rules before taught, especially when you come to the answer in your quotient, by duly separating the *Decimals* from the integers. For example,

If 9 lb.  $\frac{1}{4}$  of coffee cost 3l. 15s. how much will 278 lb.  $\frac{1}{2}$  cost?

*Note*, When the fractional parts of the numbers in this question are converted into *Decimals*, then they will stand thus.

If 9.25 lb. of coffee cost 3.75l. what will 278.5 lb. of coffee cost.

	$\begin{array}{r} 278.5 \\ \underline{3.75} \\ 13925 \\ 19495 \\ \underline{8355} \\ 1044.375 \end{array}$
$\begin{array}{r} 9.25)104.4375(112.9 \\ \underline{925} \\ 1193 \\ \underline{925} \\ 268 \\ \underline{1850} \\ 8375 \\ \underline{8325} \\ 50 \end{array}$	$\begin{array}{r} 50 = 1 + \\ \underline{9.25} \end{array}$
	<p><i>Answer</i> 112l 9s 1d. +</p>

Further, If 9 C. wt. of sugar cost 25l. 7s. what will be the price of 17 C. wt.?

C.	l.	C.
9	25.35	17
	17	
	17745	
	2535	
	9)430.95(47.88	
	36	
	70	
	63	
	79	Answer 47l. 17. 8d.
	72	
	75	
	72	
	3	

*Decimals* are of a very great use in the mensuration of superficies and solids, which is accomplished in the following manner, viz.

There

There is a chamber whose floor is 22 feet 9 inches long, and 9 feet 6 inches broad, what is the content in feet and inches? Thus *decimally*,

Length 22.75 feet and breadth 9.5 feet what is the content?

$$\begin{array}{r}
 \overset{125}{1000} \overset{25}{100} \overset{1}{10} \\
 22.75 \\
 \underline{9.5} \\
 11375 \\
 20475 \\
 \underline{\hspace{1em}} \\
 216.125
 \end{array}$$

*Answer* 216 Feet and  $\frac{1}{8}$  of an inch.

*Further*, How many yards of wainscot does that room require, whose height is 12 feet 3 inches, and compass 104 feet 6 inches?

3 Inches in *Decimals* is .25  
 6 Inches in *Decimals* is .5  
 Therefore multiply 104.5  
 by 12.25

$$\begin{array}{r}
 5225 \\
 2090 \\
 2090 \\
 1045 \\
 \underline{\hspace{1em}}
 \end{array}$$

In feet 1280.125

To answer the question in yards.

Divide by 9)1280.125(142.236

$$\begin{array}{r}
 9 \dots\dots \\
 \underline{\hspace{1em}} \\
 38 \\
 36 \\
 \underline{\hspace{1em}} \\
 20 \\
 18 \\
 \underline{\hspace{1em}} \\
 21 \\
 18 \\
 \underline{\hspace{1em}} \\
 32 \\
 27 \\
 \underline{\hspace{1em}} \\
 55 \\
 54 \\
 \underline{\hspace{1em}} \\
 1 \\
 \underline{\hspace{1em}}
 \end{array}$$

*Answer* 142 yards,  $\frac{236}{1000}$  or 142 yards, 2 feet, 3 inches.

To find the length of the circumference of a circle, the diameter being known. Let there be a circle whose diameter is 42, what is the length of the circumference?—Multiply always the diameter by 22, and divide the product by 7, your *quotient* is the answer. Thus

$$\begin{array}{r}
 42 \\
 22 \\
 \underline{\hspace{1em}} \\
 84 \\
 84 \\
 \underline{\hspace{1em}} \\
 7)924(132 \\
 \dots \\
 \underline{\hspace{1em}} \\
 0 \quad \text{Answer } 132
 \end{array}$$

The circumference being given, to find the diameter as in the former circle, the circumference being 132, and the diameter required.—The circumference must be multiplied by 7, and the product divided by 22, and the *quotient* is the diameter. Thus,

$$\begin{array}{r}
 \text{Circumference } 132 \\
 7 \\
 \underline{\hspace{1em}} \\
 22)924(42 \text{ the diameter required.} \\
 88 \cdot \\
 \underline{\hspace{1em}} \\
 44 \\
 44 \\
 \underline{\hspace{1em}} \\
 0
 \end{array}$$

The diameter of a circle being given to find the *Area*, or content thereof. Multiply the diameter by itself; again, multiply by 11, and divide by 14, and your operation is perfect. Thus,

The diameter 42, the content of the circle required.

Diameter

Diameter 42  
 multiply'd by 42  


---

 84  
 168  


---

 multiply'd by 11  


---

 1764  
 1764

Divide by 14) 19404 (1386 Content required.  
 14...  


---

 54  
 42  


---

 120  
 112  


---

 84  
 84  


---

 0

Having thus compleated our *Arithmetick*, either of *Integers* or *Fractions*, both *Vulgar* and *Decimal*, we must proceed to the extraction of *Square* and *Cube Roots*.

**SQUARE ROOT** is a number considered, as the root of a second power or *square number*; or a number by whose multiplication, into itself, a square number is generated; which square number is the product of a number multiplied by itself. Thus 4 the product of 2 multiplied by 2; or 16 the product of 4 multiplied by 4, are square numbers; therefore the number 2, being that by whose multiplication by itself, the square number 4 is produced; is in respect hereof called a *Square Root*, or the *Square Root* of 4. Since as unity is to the *Square Root*, so is the *Root* to the square number.

For the extraction of *Square* and *Cube Roots*, they have the squares and cubes of all digits in readiness, as exhibited in the following Table.

Roots	1	2	3	4	5	6	7	8	9
Square	1	4	9	16	25	36	49	64	81
Cubick	1	8	27	64	125	216	343	512	729

To extract a *Square Root* out of a given number.  
 1. Divide the given number into classes of two

figures a piece; and include each class between two dots, commencing with the place of units, or the right-hand figure; the root will consist of so many parts or figures as you have classes. By the way observe, it may happen that for the last class, on the left-hand there shall only be one figure left.

2. Then the left-hand class being the square of the first figure of the root sought; look in the table of roots for the square figure answering to that number: or if that square number be not precisely there, to the next lesser number: this root write down for this first figure of the quotient, and subtract its square from the left-hand class to the remainder, bring down the next class towards the right.

3. Write down the double of the quotient-figure, under the left-hand figure of the second class; and seek how oft the decuple is contained in the figure over it: the quotient gives the second figure of the root.

4. Write the same quotient under the right-hand figure of the same class; and subtract the product of the whole number underwritten, multiplied by the first figure of the *Root*, from the number over it, as in Division.

5. The operation being repeated according to the third and fourth steps, that is to say, the remainder being still divided by the double of the *Root* as far as extracted, and from the remainder, the square of the figure that last came out, with the decuple of that aforesaid divisor augmented thereby, being subtracted; you will have the *Root* required. For example:

*Note*, That by *Decuple* is understood a term of relation or proportion, implying a thing to be ten times as much as another.

To extract the *Root* of 99856, point it after this manner, 99856, then seek the number, whose square shall equal the first figure 9, viz. 3, and write it in the quotient; then having subtracted from 9, 3 x 3, or 9, there will remain 0; to which set down the figures as far as the next point, viz. 98 for the following operation.

99856 (316  
 9  


---

 098  
 61  


---

 3756  
 3756  


---

 0

Then

Then taking no notice of the last figure 8, say, How many times is the double of 3, or 6, contained in the first figure 9? Answer 1, wherefore having wrote one in the quotient, subtract the product of  $1 \times 61$ , or 61 from 98, and there will remain 37, to which connect the last figure 56, and you will have the number 3756 on which the work is next to be carried on. Wherefore also neglecting the last figure of this, viz. 6, say, How many times is the double of 31 or 62 contained in 375, (which may be guessed at from the initial figure 6, and 37, by taking notice how many times 6 is contained in 37 :) Answer 6; and writing 6 in the quotient, subtract  $6 \times 626$ , or 3756, and there will remain 0; whence it appears that the business is done, the *Root* coming out 316.

Otherwise with the divisors set down, will it stand thus:

$$\begin{array}{r}
 \cdot \cdot \cdot \\
 99856(316 \\
 \underline{9} \\
 6) 98 \\
 \underline{61} \\
 62) 3756 \\
 \underline{3756} \\
 \hline
 \end{array}$$

o and so in others.

Again, if you was to extract the *Root* of 22178791: First having pointed, seek a number, whose square (if it cannot be exactly equalled) shall be the next less square, (or nearest) to 22, the figures to the first point, and you will find it to be 4, for  $5 \times 5$ , or 25, is greater than 22; and  $4 \times 4$ , or 16, is less; wherefore 4 will be the first figure of the *Root*. This therefore being writ in the quotient, from 22, take the square  $4 \times 4$ , or 16; and to the remainder 6, adjoin the next figures 17, and you will have 617; from whose division, by the double of 4, you are to obtain the second figure of the *Root*, viz. neglecting the last figure 7, say, How many times 8 is contained in 61? Answer 7; wherefor write 7 in the quotient, and from 617 take the product of 7 into 87, or 609, and there will remain 8, to which join the two next figures 87, and you will have 887; by the division whereof by the double of 47, or 94, you are to obtain the third figure; in order to which, say, How many times is 94 contained in 88? Answer 0; wherefore write 0 in the quotient, and adjoin the two last figures 91, and you will have 88791, by whose division by the double of 470, 940, you are to obtain the last figure, viz. say, How many times 940 in 8879? Answer 9; wherefore write 9 in the quotient, and you will have the *Root* 4709.

But since the product  $9 \times 9409$ , or 84681 subtracted from 88791 leaves 4110, the number 4709 is not the *Root* of the number 22178791 precisely, but a little less.

$$\begin{array}{r}
 \cdot \cdot \cdot \cdot \cdot \\
 22178791(4709,43637, \text{\&c.} \\
 \underline{16} \\
 \hline
 617 \\
 \underline{609} \\
 \hline
 88791 \\
 \underline{84681} \\
 \hline
 411000 \\
 \underline{376736} \\
 \hline
 3426400 \\
 \underline{2825649} \\
 \hline
 60075600 \\
 \underline{56513199} \\
 \hline
 356190400 \\
 \underline{282566169} \\
 \hline
 73624231
 \end{array}$$

If it then be required to have the *Root* approach nearer; carry on the operation in decimals, by adding to the remainder two *cyphers* in each operation; thus the remainder 4110, having but two *cyphers* added to it, becomes 411000; by the division whereof, by the double of 4709, or 9418, you will have the first decimal figure 4; then having writ 4 in the quotient, subtract  $4 \times 94184$ , or 376736, from 411000, and there will remain 34264; and, so having added two more *cyphers*, the work may be carried on at pleasure, the *Root* at length coming out 4709.43637, &c.

But when the *Root* is carried on half way or above, the rest of the figures may be obtained by division alone: as in this example, if you had a mind to *extract* the *Root* to nine figures, after the five former 4709.4 are *extracted*, the four latter may be had, by dividing the remainder by the double of 4709.4.

Thus if the *Root* of 32976, were to be extracted to five places, in numbers; after the figures are pointed, write 1 in the quotient, as being the figure whose square  $1 \times 1$ , or 1, is the greatest that is contained in 3, the figure to the first point; and having taken the square of 1 from 3, there will remain 2; then having set the next figures, viz. 27 to it, (viz. to 2,) seek how many times the double

of 1, viz. 2 is contained in 22, and you will find indeed that it is contained more than ten times; but you are never to take your divisor 10 times, no, nor 9 times in this case; because the product of  $9 \times 29$ , or 261, is greater than 229, from which it should be taken, or subtracted: wherefore write only 8, and then having wrote 8 in the quotient, and subtracted  $8 \times 28$ , or 224, there will remain 5, and having set down to this the figures 76, seek how many times the double of 18, or 36, is contained in 57, and you will find 1, and so write 1 in the quotient; and having subtracted  $1 \times 361$ , or 361 from 576, there will remain 215. Lastly, To obtain the remaining figures, divide this number 215, by the double of 181, viz. 362, and you will have the figures 59, which being writ in the quotient, give the *Root* 181.59. Thus:

$$\begin{array}{r}
 \dots \\
 32976 \overline{)181.59} \\
 \underline{\phantom{32976}1} \\
 2)229 \\
 \underline{\phantom{2}224} \\
 36)576 \\
 \underline{\phantom{36}361} \\
 362)215(59, \&c.
 \end{array}$$

After the same manner are *Roots* extracted out of decimal numbers. Thus the *Root* of 329.76 is 18.159; and the *Root* of 3.2976 is 81.159; and the *Root* of 0.032976, is 0.18159, and so on. But the *Root* of 3297.6 is 57.4277; and the *Root* of 32.976 is 574247; and thus the *Root* of 9.9856 is 3.16.

Before we proceed to the *Extraction of Cube Roots*, we must understand what is a *Cube* or *Cubic Root*.

A *CUBE ROOT*, is the origin of a *Cubic Number*, which *Cubic Number* is a number arising from the multiplication of a square number by its *Root*.

Thus, if the square number 4 be multiplied by its *Root* 2, the factum 8, is a *Cube*, or *Cubic Number*; and the number 2, with respect thereto a *Cube Root*. Hence, since, as unity is to the *Root*, so is the *Root* to the *square*; and as unity is to the *Root*, so is the *square* to the *Cube*; the *Root* will also be to the *square*, as the *square* to the *Cube*; that is, unity, the *Root*, the *square*, and the *Cube* are in continual proportion; and the *Cube Root* is the first of two numbers that are mean proportionals between unity and the *Cube*.

A *Cube Number* is either simple or compound. The simple *Cube Numbers*, together with their respective *Roots* are expressed in the table at the beginning of extraction of *Square Roots*.

A *COMPOUND CUBE NUMBER*, is that which being produced by itself, it never less than 1000, so 405224 is a *compound Cube Number*, being produced thus:

$$\begin{array}{r}
 74 \qquad \qquad \qquad 5476 \\
 74 \qquad \qquad \qquad \quad 74 \\
 \hline
 296 \qquad \qquad \qquad 21904 \\
 518 \qquad \qquad \qquad 38332 \\
 \hline
 5476 \text{ the Square} \qquad 405224 \text{ Cube Number.}
 \end{array}$$

The *Extraction of a Cube Root*, and of all other *Roots* may be comprehended under one general rule, viz. every third figure beginning from unity, is first to be pointed, if the *Root* to be extracted be a *Cubic one*; or every fifth, if it be a *Quadrato Cubic*, (or of the fifth power,) and then such a figure is to be writ in the quotient, whose greatest power, (that is, whose *Cube*, if it be a *cubic power*;) or whose *Quadrato Cube*, if it be the fifth power shall either be equal to the figure or figures, before the first point, or next less under them; and then having subtracted that power, the next figure will be found by dividing the remainder augmented by the next figure of the resolvend, by the next least power of the quotient, multiplied by the index of the power to be extracted, that is, by the triple square, if the *Root* be a *Cubic one*; or by the *Quintuple Biquadrate* (that is five times twice the square) if the *Root* be of the fifth power, &c. And having again subtracted the power of the whole quotient from the first resolvend, the third figure will be found by dividing that remainder, augmented by the next figure of the resolvend, by the next lesser power of the whole quotient, multiplied by the index of the power to be extracted.

But to leave nothing unobserved, before we proceed farther on this subject, we must let our pupils know what we mean by *powers*.

*Power* in *Arithmetick* is the produce of a number, or other quantity, multiplied into itself. Thus the produce of the number 3 multiplied by itself, viz. 9, is the second power of 3; the factum of 9 multiplied by 3, viz. 27, is the third power; and the product of 27 again multiplied by 3, viz. 81, is the fourth power, and so on to infinity. In respect hereof, the first number 3 is called the *root* or first power. The second power is called the *square*, with respect to which, 3 is the *square root*, (as is seen in the table.) The third power 27, is called the

*Cube*



the last product, add the remainder if there were any. If the sum come out the number first given, the work is just.

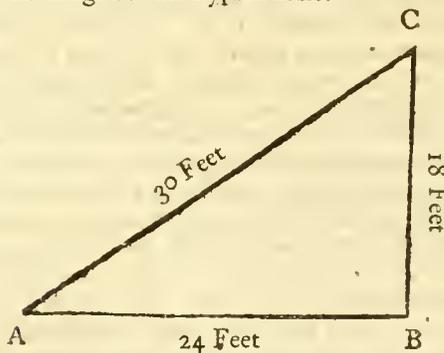
Now to reduce this into practice, especially as to solving some *arithmetical* and *geometrical* questions; I proceed thus.

1. If I would find a mean proportional between two given numbers, I multiply the given numbers, the one by the other, and extract the *square root* of the product. so shall that square root be the mean proportional sought. For example:

Let the given number be 16 and 64, according to my rule, I multiply 16 by 64, and the product is 1024, the *square root* of which is 32, so that 32 is the mean proportional between 16 and 64. Thus:

$$\begin{array}{r}
 16 \quad \left. \vphantom{16} \right\} \text{multiply} \\
 64 \quad \left. \vphantom{64} \right\} \\
 \hline
 96 \\
 \hline
 1024 \text{ (32 square root)} \\
 9 \\
 \hline
 62 \overline{)124} \\
 \underline{124} \\
 \hline
 0
 \end{array}$$

Again, am I desired to find a third side to two sides of right-angled plain triangle given? For example in the triangle A, B, C, the base A, B, is 24, and the perpendicular B, C, is 18, now I am to find the length of the hypotenuse.



To answer this proposition, I must first square the base A B 24, which is 576; then square the perpendicular 18, which makes 324; then add these two sums together, and the product is 900, and the square root of 900 is 30, which gives the length of A C. This proportion is of great use in measuring of heights, distances, and other mathematical figures.

2. As to Solid Measures.—If the side of a cube, be 12 inches, how many cubical inches are contained in that cube? To answer which I multiply the length by the breadth, and that product by the depth; as in this example:

$$\begin{array}{r}
 12 \\
 12 \\
 \hline
 144 \text{ square inches} \\
 12 \\
 \hline
 1728 \text{ cubical inches.}
 \end{array}$$

In like manner, if the side of a cube of stone be 2.53 feet, the solid content of that cube will be 16.194277 feet. Thus:

$$\begin{array}{r}
 2.53 \\
 2.53 \\
 \hline
 759 \\
 1265 \\
 506 \\
 \hline
 6.4009 \\
 2.53 \\
 \hline
 192027 \\
 320045 \\
 128118 \\
 \hline
 16.194277 \text{ feet.}
 \end{array}$$

Note, That Solid in Geometry, is the 3d species of magnitude, having three dimensions, length, breadth and thickness.

To measure a pyramid. A PYRAMID is a solid figure, whose base is a polygon, and whose sides are plain triangles, their several tops meeting together in one point at the top. Now if the superficial content or the base of a pyramid be 5.756 feet, and the height thereof 14.25, (which said height is the length of the perpendicular line, that falls from the top of the pyramid to the base) what is the solid content of that pyramid? The operation must be thus:

If the area of the base of the pyramid be multiplied by  $\frac{1}{3}$  of the height thereof, the product shall be the solid content of the pyramid, therefore  $\frac{1}{3}$  of 14.25 is equal to 4.75, and 5.756, the base be multiplied by 4.75 = 27.341 feet, the solidity of the pyramid required.

5.756	3)14.25(4.75
4.75	124.
28780	22
40292	21
23024	15
27.34100 solid feet	15
	0
	—

To measure a globe. A **GLOBE**, is a perfect round body contained under one plain; in the middle of the globe there is a point, called the center, from whence all frait lines drawn to the out side, are of equal length, and called semi-diameters, the double of any one of which, is equal to the diameter of the globe. Now if the diameter of the globe of stone be 1 75 feet, how many feet solid are contained in that globe? The operation must be conducted by multiplying first the diameter 1.75, by itself, the product will be 3.0625, which multiplied again by the said 1.75, gives for the product 5.359375, to wit, the cube of the diameter; which being multiplied by .5238, the product thence arising will be 2.8074, which is the solidity of the globe propounded. Thus:

. 1.75	
1.75	
875	
1225	
1.75	
3.0625	
1.75	
153125	
214375	
30625	
5.359375 cube:	
.5238	
428-5000	
16078125	
10718750	
26796875	
2.8072406250	the solidity of the globe.

Of SURDS.

**SURDS** in *Arithmetick* are called an *irrational* and *incommensurable number*: or a number that cannot be expressed, or is incommensurate with unity. See *Surds* in *Algebra*. p. 14.

When any number or quantity has its root proposed to be extracted, and yet is not a true figurate number of that kind; that is, if its *square root* be demanded, and it is not a true square; if its *cube root* be required, and itself be not a true cube, &c. then it is impossible to assign, either in whole numbers or in fractions, any exact root of such number proposed. And whenever this happens, it is usual in *Arithmetick*, to mark the required root of such numbers or quantities, by prefixing before it the proper mark of radicality, which is  $\sqrt{\quad}$ : Thus  $\sqrt{2}$ : 2 signifies the square root of 2, and  $\sqrt[3]{16}$ , or  $\sqrt{(3) 16}$ , signifies the cubick root of 16; which roots, because they cannot be expressed in numbers exactly, (for no effable number, either integer or fraction, multiplied into itself, can ever produce 2; or being multiplied cubically, can ever produce 16) are properly called *surd roots*.

There is also another way of notation now much in use, whereby roots are expressed without a radical sign, by their indexes: thus, as  $x^2$ ,  $x^3$ ,  $x^5$ , &c. signifies the square, cube, and fifth power of  $x$ ; so  $x^{\frac{1}{2}}$ ,  $x^{\frac{1}{3}}$ ,  $x^{\frac{1}{5}}$ , signify the square root, cube, &c. of  $x$ . The reason of which is plain enough; for since  $\sqrt{x}$ :  $x$  is a geometrical mean proportional, between 1 and  $x$ , so  $\frac{1}{2}$  is an Arithmetical mean proportional between 0 and 1; and therefore as 2 is the index of the square of  $x$ ,  $\frac{1}{2}$  will be the proper index of its square root, &c.

We must observe also, that for convenience or brevity's sake, quantities or numbers, which are not *surds*, are often expressed in the form of *surd roots*. Thus  $\sqrt{4}$ ,  $\sqrt[2]{27}$ ,  $\sqrt[3]{27}$ , &c. signify 2,  $\frac{3}{2}$ , 3, &c.

But though these *surd roots* (when truly such) are inexpressible in numbers, they are yet capable of *Arithmetical operations*, (such as *Addition*, *Subtraction*, *Multiplication* and *Division*, &c.

*Surds* are either *simple* or *compound*.

*Simple surds* are those which are expressed by one single term, as  $\sqrt{c}$ .

*Compound surds* are those formed by the *Addition* or *Subtraction* of *simple Surds*: as  $\sqrt{5} + \sqrt{2}$ :  $\sqrt{5} - \sqrt{2}$ , or  $\sqrt[3]{7} + \sqrt{2}$ : which last is called

called an universal root, and signifies the cubick root of that number, which is the result of adding 7 to the square root of 2.

To reduce rational quantities to the form of any *surd root* assigned. For example, if 3 were to be brought to the form of  $\sqrt[4]{\phantom{x}} : 12$ , you must raise 3 up to its fourth power, and then prefixing the note of radicality to it, it will  $\sqrt[4]{\phantom{x}} : 81$ , or  $81^{\frac{1}{4}}$ , which is the same form with  $\sqrt[4]{\phantom{x}} : 12$ . And this way may a simple *surd* fraction, whose radical sign refers only to one of its terms, be changed into another, which shall respect both *numerator* and *denominator*. Thus  $\frac{\sqrt{2}}{25}$  is reduced to  $\sqrt{2} : \frac{2}{25}$  and  $\frac{5}{3}$ , to  $\sqrt[3]{\frac{125}{4}}$ ; where the radical sign affects both *numerator* and *denominator*.

To reduce *Surds* to the lowest term possible. Divide the *surd* by the greatest *square*, *cube*, *biquadrate*, &c. or any other higher power which you can discover, is contained in it, and will measure

it without any remainder; and then prefix the root of that power before the *quotient*, or *surd*, so divided; this will produce a new *surd* of the same value with the former, but in more simple terms.

This reduction is of great use, whenever it can be performed; but if no such *square*, *cube*, *biquadrate*, &c. can be found for a divisor, find out all the divisors of the powers of the *surd* proposed; and then see if any of them be a square, cube, &c. or such a power as the radical sign denotes; and if any such can be found, let that be used in the same manner as above, to free the *surd* quantity in part from the radical sign. Thus if  $\sqrt{\phantom{x}} : 288$  be proposed; amongst its divisors will be found the squares, 4, 9, 16, 36, and 144; by which, if 288 be divided, there will arise the *quotients* 72, 32, 18, 8, and 2; wherefore instead of  $\sqrt{\phantom{x}} : 288$ , you may put  $2\sqrt{\phantom{x}} : 72$ , or  $3\sqrt{\phantom{x}} : 32$ , or  $4\sqrt{\phantom{x}} : 18$ , or  $6\sqrt{\phantom{x}} : 8$ , or lastly,  $12\sqrt{\phantom{x}} : 2$ , and the same may be done in *species*.

## A R M Y.

**U**NDER this general name may be included all bodies of men that carry arms under commissioned officers. So that, tho' it is most commonly confined in discourse to a large body of land forces; we shall here treat of it in its general sense, including a naval armament of ships, sailors and marines, under proper officers. But shall begin with the *Land Army*.

A *land army* is a large body of soldiers consisting of horse and foot; and a *naval army* is a number of ships of war, equipped and manned with sailors and marines, under the command of an admiral, with other inferior officers under him.

A *land army* is composed, as I have already observed, of both horse and foot, the horse being called *cavalry*, and the foot *infantry*.

The *CAVALRY* (from the *French* *cavalerie*, and from the corrupt *Latin*, *caballus*, horse) is a body of soldiers, who fight or march on horseback.

The *cavalry* is divided into *horse* and *dragoons*. The *horse* are either regimental or independent troops, to which latter sort belong the *horse-guards*, and in *France*, the great *gendarmes*, properly called the *gendarmerie*, the *mousquetaires*, the *chevaux legers*, and *horse-grenadiers*.

The *horse-guards*, by the *Spaniards* called *guardas a cavallo*, by the *French*, *gardes de corps*, or *du corps*, and by the *English*, usually *life-guards*; are the guards of the king's person and body. They

are divided into four troops; to which are now added, by establishment, two troops of *grenadiers*, consisting of 80 men, all under the command of a captain.

Each troop of *horse-guards* is divided into four divisions or squadrons; two of which consisting of 100 men, commanded by a principal commission'd officer, two brigadiers, and two sub-brigadiers, with two trumpets, mount the guard one day in six, and are relieved in their turns.

Their duty is, by parties from the guard, to attend the king's person, when he goes out near home.—When he goes out of town, he is attended by detachments out of all the three troops.

One of the three captains of the *horse-guards* attend on the king when he walks on foot, immediately next his person; carrying in his hand an ebony staff, or truncheon with a gold head.

One division of the *grenadiers* mounts with a division of the troop, to which they belong; and go out on small parties from the guard, perform centinel duty on foot, attend the king also on foot, &c.

The *gardes de corps*, or *life-guards* in *France*, consist of four companies of horse. The first was antiently *Scotch*, and still retains the name; tho' it now consists wholly of *Frenchmen*. Not only the name, but they also retain the antient phrase or formula of answering when called upon, *I am here*.

The *Scotch guard* was first established in *France* by *Charles VII.* who chose himself a guard out of such *Scots* as were sent by the earls of *Bucan*, *Douglas*, and other *Scotch* lords, to drive out the *English*.

The *grand gens d'armes*, are also a troop of gentlemen, to the number of about 250, who guard the king's person. The king himself is their captain, and one of the prime peers the captain-lieutenant. When the king marches with all his household troops, the *gens d'armes* close the march. Their device is a thunder-bolt falling from heaven, with the motto, *QUO JUBET IRATUS JUPITER*.

The *MUSQUETEERS* are also of the king of *France's* horse-guards; there are two troops of *musqueteers*, distinguished into the grey and black *musqueteers*, from the colour of their horses. These are young gentlemen of distinction, instructed at the king's expence in all the rules of the military art of discipline.

These three bodies of cavalry of the king of *France's* household, *viz.* the *gardes du corps*, the *grand gens d'armes*, and the *musqueteers*, are composed of none but of persons of distinction.

That body of horse called by the *French*, *gendarmerie*, is also of the king's household, and consists of sixteen companies, *viz.* the *Scotch gens d'armes*; the *English gens d'armes*; the *Burgundy gens d'armes*, and the *Flemish gens d'armes*, which four companies compose the king's *gens d'armes*.

The other companies take their names from the princes who command them, as captains, *viz.* the queen's *gens d'armes*; the queen's *light horse*: the dauphin's *gens d'armes*; the dauphin's *light horse*: the duke of *Burgundy's gens d'armes*; the duke of *Burgundy's light horse*: the duke of *Orleans's gens d'armes*, &c. Each troop at a medium, consists of seventy-six *gens d'armes* or *light horse*.

*Light horse* in *England* includes all the horse, except those of the life guard.—The denomination arose hence, that anciently they were lightly armed, in comparison of the royal guards, which were armed at all points.

The regimental cavalry is composed of what we call here *troopers*, and in *France*, *cavaliers*.

The best qualities for a *TROOPER* is to be bold and resolute, strong and healthy, of a daring and sprightly temper, ambitious of honour, and fearful of nothing but shame and disgrace.

The troopers are formed into *troops*, each troop consisting commonly of 50 private troopers, besides a *captain*, a *lieutenant*, a *cornet*, and a *quarter-master*.

A *CAPTAIN* should be endued with a great and generous soul, preferring his honour above all things, life not excepted. When he first appears at the head of his *troop*, he is to salute the subal-

terns, and having produced his commission, assure them of his friendship; and then invite them to his quarters.

A *captain* must choose a trumpeter who understands how to found well, and particularly one who has been trained up in the war, and in whom he can confide. A man thus qualified, when sent to the enemies camp, or any of their garrisons, may give an account how the enemy is posted, the nature of their entrenchments, ditches, out-works, and of their guards and the avenues to their camp.

The *LIEUTENANT* of a *troop*, ought to be a person trained up in the cavalry, and well experienced in that part of the *military art*. When they engage the enemy as by squadron, his post is on the right or left, according to the seniority of his commission. When the captain is commanded upon the grand guard, or any other guard, as soon as he comes to his post, the *lieutenant* having drawn up the *troop*, shall continue at the head of it on horseback, while the *captain* receives orders, and goes with the *quarter master* to place the vedettes or out-posts, on horseback, and to view their posts, and instruct them how they are to behave themselves, till the *captain* returns to give the other necessary orders for his guard.

The duty of a *CORNET* consists principally in carrying the standard upon a review, or other public appearance, or to bear it in the day of battle, and in an engagement to defend it; to salute the prince, and in his absence the general, and his post is in the centre of the *squadron*, about half a horse's length behind the field-officer.

A *QUARTER-MASTER*, ought to be a man of good parts, activity and experience, since the oeconomy of the subsistence, and service of the troops, depend upon him. He is to receive orders and the word, which he should commit to writing, and then carry them to his officers. He is to shew his orders to the magistrate, and acquaint him with the captain and other officers of his retinue, and to view their quarters, that they may have no cause to complain. The quarters being timely provided, he shall mount and meet the troop as it draws near; and if the billets be delivered to him, he is to conduct the *captain* and the *troop* to his quarters, and drawing up the troop in one single rank, cause the billets to be drawn out of his hat, and admonish the *troopers* to be civil to their landlords. He is to keep an exact list of the quarters, that he may visit their horses; and if any of them have received any damage, he is to take care to have them speedily cured.

When the trumpet sounds to horse, he is to mount first and hasten the troopers, and repair to the *captain's* quarters. Upon a march, his post is upon

upon the flank of the *troop* or squadron, and he is to ride from the front to the rear, and from the rear to the front, to view the ranks, and make them keep their due distance. In time of action he is to be upon the flank, with his sword drawn, to prevent the men falling into disorder, and to kill the first who shall offer to fly.

TROOPS are formed into squadrons; three troops to each squadron: and those squadrons into regiments; three squadrons to each regiment, which commonly consists of 300 men: tho' there are some in Germany of 2000 men.

Among us a regiment of men is commanded by a *colonel*; and in France by a *maître de camp*.

There are *colonels*, *colonel-lieutenants*, and *lieutenant colonels*. A *colonel* is an officer, who has the command in chief of the regiment. A *colonel-lieutenant*, is he who commands a regiment of guards, whereof the king, prince, or other person of the first eminence is colonel. And a *lieutenant-colonel*, is the second officer in a regiment; who is at the head of the *captains*, and commands in the absence of the *colonel*. In the horse, the *lieutenant-colonel* is the first captain of the regiment.

The DRAGOONS are also ranked in the *cavalry*. The *dragoons* are a body of soldiers, who march on horseback, and fight on foot; tho' most commonly on horseback.

The *dragoons* are usually posted in the front of the camp, and march first to the charge, like a kind of *enfants perdus*. They are by some reputed as belonging to the infantry, and in that quality have colonels and serjeants; but they have cornets too, like cavalry.

The CUIRASSIERS belong also to the cavalry, so called from wearing a *cuirass*, which is a piece of defensive armour, made of an iron plate well hammered; serving to cover the body from the neck to the girdle, both before and behind. The *cuirass* was not brought in use till about the year 1300. Good part of the German cavalry are *Cuirassiers*.

The Ottoman cavalry are called *SPAHIS*, chiefly raised in Asia, and the aga or commander of the *Spahis*, *Spahi Agasi*.

The most considerable part of an army consists in the foot, or INFANTRY, divided also into companies, battalions and regiments.

A COMPANY is a little body of infantry, commanded by a captain. The number of men in a company is uncertain; in the ordinary regiments it is fifty centinels, besides three serjeants, three corporals, two drums, &c. A company in the guards is eighty private men. In the French guards, the company is 120, in the Swiss guards 200. Companies not imbodyed into regiments are called *independent companies*.

The officers of a *company of infantry* are a *captain*, a *lieutenant*, an *ensign*, and a *serjeant*.

A CAPTAIN of infantry must understand perfectly the duties of a *lieutenant*, *ensign*, and *serjeant*. He must at least know the lines of defence, and how to gain a flank'd angle, to carry up a trench to it, to make a good lodgement upon it, and to flank it well; to order his place of arms and batteries conveniently: to begin the sap at the foot of the *glacie*, on the edge of the ditch; to make a descent into a place that is easy to be defended; to carry a gallery a cross a ditch, after he has made a good lodgement to support it, well empaled and flank'd; so that the enemy may not attack it without danger; and in fine to know how to lodge himself on a breach; for though there are engineers who are to order these things, yet they are generally tedious, and many eyes can see more than two. Besides as a *captain* is sometimes obliged to do the duty of a *major*, or *major of brigade*, he must therefore be laborious and vigilant, and understand their duties, rights, privileges and prerogatives. Moreover he is to know all the other duties of those posts to perfection; the articles of war; how cases have been decided upon controversies formerly stated; the posts of all regiments, and what is due to his own.

A LIEUTENANT of infantry ought to know the duty of a soldier to perfection; and, allowing him to have the qualifications of an *ensign*, he is farther to know how to discourse pertinently of the methods of war; as how to gain an advantage in all places and exigencies; of making a good encampment; of intrenching in all sorts of places; of cantoning without noise or confusion, because he commands the company in the absence of the *captain*. He must know all the soldiers of the company, and hold intelligence with some of them, to take care that they keep their arms clean, to send their sick to the hospital, and to see that they be diligently attended.

AN ENSIGN should be perfect in all the duties of a soldier, and be expert in handling his arms, and he should teach and cause them to be taught before him.

A SERJEANT should be perfect in the exercise of the fire-lock, and the usual evolutions, that he may instruct raw and ignorant soldiers; and he is to see that the word of command, when given to the battalion, be punctually obeyed.

A *Serjeant* is to be diligent in his duty, both upon a march, and in garrison. He must see all his soldiers quartered before he quarters himself.

The COMPANIES of INFANTRY are formed into *battalions*.

A BAT.

A **BATTALION**, is a little body of *infantry*, rang'd in form of battle, and ready to engage. A *battalion* usually contains from 5 to 800 men: but the number of men it consists of is not determined: tho' in *England* it is generally understood to consist of 700 effective men. *Battalions* are usually drawn up with six men in a file, or one before another.

A **REGIMENT** usually consists of several *battalions*; though some consist but of one, which is too few; others of four, or five, which are too many. The *French regiments* consist commonly of three *battalions*, or fifteen *companies*.

A *Regiment* is commanded by a *colonel*, a *lieutenant-colonel* and a *major*.

The **COLONEL** of a regiment of *infantry* should be a man of credit and authority; grave in his behaviour; lofty in his deportment; yet without vanity and haughtiness; courteous to all men, particularly, to the officers of his own regiment. He must frequently view and examine all the companies in his regiment, commending those captains who have good ones, and privately reprimanding those who have bad; and he is to be frequently present, when the regiment performs their exercise, and to encourage such who do better than the rest.

The duty of a **LIEUTENANT COLONEL** is much the same with that of a *colonel*.—In the absence of the *colonel* he is to command the regiment, and then the *major* is to receive orders from him.

A **MAJOR** of a regiment of *infantry* should have a profound experience in war; especially in the foot service. — He is to understand how to attack a place; and when the regiment marches into the field, he is to give notice of the effective strength of it, and is to acquaint the *general*, or his *sovereign*, if he discovers any evil design among the officers.—Besides the knowledge of drawing up the forces, forming *battalions*, and exercising them, the *major* of a regiment is to see, that in marching they observe their distances, that they carry their arms well, that the ranks be strait, and every thing done with decency, and a good grace.—In the field he should have two or three horses, war-horses, and pads; because it is his business to carry orders, and to be every where upon occasion.—The *major* must also have an *adjutant*, who ought to be well mounted, and be a person of experience, ability, courage, and judgment; because he is the *major's* right-hand, to ease him of part of the great burden of his employment, and upon all occasions in his absence, whether from wounds, sickness, or any other occasion to perform all the duty of a *major*. — Care is to be taken that there be a good *drum-major* to the regiment, who is to teach the others how to behave on all publick occasions.

The **SQUADRONS** of *cavalry*, and the *battalions* of *infantry* are formed into *brigades*.

The **BRIGADE** of an *army*, consists of ten or twelve squadrons, or of five or six *battalions*, and in this manner, an *army* is sometimes divided into eight *brigades*; four of horse and four of foot. Each *brigade* is commanded by an officer called *brigadier-general*, who has under him an officer called *brigadier-major*, or *major* of a *brigade*, to assist him in the management, and ordering his *brigades*, in which he acts as a *major-general* does in an *army*.

An **ARMY** is commanded by a *general*, who has under him *lieutenant-generals*, *majors-general*, *brigadiers*, &c.

A **GENERAL** is an officer whose command is not limited to a single regiment, but extends to a body of forces, composed of several regiments.

A Prince can never be too cautious in the choice of his *generals*, since the preservation or loss of kingdoms often depends upon the conduct of those intrusted with the command of *armies*.

The principal qualities requisite in a **GENERAL**, are courage, conduct, and zeal; and if a natural inclination to war attends these qualities, there are scarce any difficulties which may not be surmounted.

The duties of a *general* are to order an encampment, to post the camp-guard, to march an *army*, to draw it up, to give battle, to attack enemy's quarters or towns, to form a blockade, and lay siege to any place. He must understand what train of artillery is requisite in proportion to the strength of his *army*, and what he is capable of attempting; and also from whence he is to have his provisions and ammunition; what money will be allowed to pay his men to defray the charge of works, for his provisions, artillery, and hospitals, and for secret services; upon which matters of the greatest importance frequently depend.

A **LIEUTENANT-GENERAL** is next in rank to the *general*; he commands in battle one of the lines or wings; a detachment in a march, or a flying camp, also a quarter at a siege, or one of the attacks, when it is his day of duty.

**MAJOR-GENERAL**, is a general officer, who receives the *general's* orders, and delivers them out to the *majors* of *brigades*, with whom he concert what troops are to mount the guard, what to go on parties, what to form detachments, or to be sent on convoys, &c.

There are other general officers attending an *army*, as *general* of the artillery, *engineer-general*, *muster-master*, or *commissary-general*, &c.

**GENERAL of ARTILLERY**, more properly called *master of the artillery*, is an officer, who has under his command and direction the train of *artillery*, which follows an army, and all the batteries at a siege. He has under him a great number of subaltern officers.

**MUSTER-MASTER**, or *commissary-general*, is an officer in the army, who takes account of every regiment, their number, horses, arms, &c.

Having thus formed an **ARMY**, both of *cavalry* and *infantry*, appointed and commissioned all the officers both general and private, instructed them in their several duties; we must not keep it idle in its quarters; therefore we will order to beat the *generale*, in order for an *encampment*. To order which, I'll send the *major-general* of the day, to mark out the camp; for if my army was to continue long in it, it would be my duty, as a *General* to mark the camp myself.—For the well ordering of this, I suppose my *major-general* to know the number and post of the troops, which compose the army, what train of artillery there is, and what provisions.—He'll take with him the *quarter-master general* of the army, the *quarter-master general* of the horse, the *quarter-masters* of each regiment of horse, the *major*s of foot regiments and their *quarter-masters*, a *commissary* of the artillery, and a *commissary* of the provisions.—The head officers of the army must each of them send one of their guard, to take up their quarters; and the *provost-marshal* or his *lieutenant*, with part of their men, must attend the *major-general*, to be the first upon the quarters to prevent any body from foraging.

The *provost-marshal* of an army is an officer appointed to seize and secure deserters, and all other criminals. The *provost-marshal* is to go often abroad round the army to hinder the soldiers from pillaging; it is his office to indict offenders, and to see the sentence, passed upon them, executed. He likewise regulates the weights and measures, and the price of all provisions, &c. in the army. For the discharge of his office, he has a *lieutenant*, a *clerk*, and a troop of *provosts*, or *marshals* on horse-back; as also an executioner.

The *major-general* must also take a guard sufficient to conduct him safe to the ground, on which he designs to encamp, and carry horse and foot enough with him, if he is apprehensive he shall meet with any opposition from the enemy; and if he is not, he then may leave the army a league, or three miles distant from the place he designs for the camp; but if he is, then he must not leave them above a quarter of a league, or little more than a mile behind him. If he is not acquainted with the way, he must take guides with him, and some of-

ficers of the train of artillery, with pioneers, and cart-loads of tools, to make the way easy for the army to march; and if there be much work to be done, a guard must be left to secure the pioneers. He must detach a party before him to go and view the ground, and on the right and left to prevent ambuscades, and to appoint them a place of rendezvous, which is generally on a rising ground, the way he comes to them, if he has not a particular reason for not shewing himself. If the detachments are not returned, when he comes up to the place of rendezvous, he must halt there till he has intelligence of them, and send out parties the way they should come; and he must not take the ground till he has heard of them, or at least till the ground has been nicely viewed. He is to regard the convenience of forage, of springs, brooks, marshes, of woods, the goodness of the way, the convenience of filing off to march the next day, and the distance of the place from whence the army sets out, that the march may not be too long or too short.

If the *major-general* has more troops than are necessary for the guard of the quarters, he shall order them to dismount, and let their horses graze. He shall leave a small guard on that side by which he came; and if from an eminency he cannot discover all round the quarters, he then shall ride over all the ground, and in the mean time the *quarter-master general* shall mark out the ground, and divide it among the *quarter-masters*; and if there remains any after the general officers have their ground, it must be given to officers of regiments for their baggage, they being obliged to encamp with their corps; and the *quarter-master-general* is to make his report to the *major-general*, that he may lodge the *general's* guard by his quarters, and the others who are to be about him. He shall shew to the *major*s of *brigades* the ground that is allotted to each of them, and the *quarter-master-general* of the horse where he is to encamp. He shall also appoint the place for the cannon, and the park for the train and provisions.

A *quarter-master-general* is a general officer, whose business is to provide good quarters for a whole army. A *quarter-master* of horse, quarters for a troop of horse. And a *quarter-master* of foot, for a regiment of foot.

The park of the *train of artillery* is generally near the cannon; but in case of danger the safest place is about the camp; because an army may be routed by losing its ammunition. The horses of the *artillery* are to encamp, or graze, near the park. The provisions are for the most part near the *artillery*, and the bread carts are drawn up in a ring to inclose their horses; but it is better to inclose the ammunition with them, if you fear the enemy.

The *cavalry* is to encamp the nearest to water, and to orchards, or hedges, if there are any, that they may have time to mount, and not be surprized in case of an alarm; and ways should be cut a-cross them towards the general's side, to receive orders, and towards the open plain, to march out to the field of battle. The camp of the horse is covered with that of the foot, leaving the space of fifty foot between them; but if the foot are so weak that they cannot cover the camp of the horse, then they are to encamp on that side that is most exposed to the enemy. The troops are to have their back towards the quarters, and to face outwards; and their file, or rows of huts, being three paces from their arms, which are always in the front. The *serjeants* have the front hut, and the officers encamp in the rear.

In an encampment for a night, fifty paces in depth, of three foot to a pace, and four paces in breadth are allowed for every company, for the soldiers huts; and if the company exceed not seventy men, ground is to be allowed only for one row, or file of huts. The *subalterns* are next behind the huts, the *captains* behind them, the field officers behind the *captains*, and a convenient interval for a large street is left, clear between every two regiments. But the horse have fifty paces in depth for sixty horse, and fourteen paces in breadth for three rows of huts; and if there are hedges, they have as much space allowed them as is requisite to tie their horses. If the enemy be stronger in horse, and the *major-general* apprehends that the camp may be attacked, he must order ditches and trenches to be cut in their way, to prevent their charging in good order, to gain an opportunity for the foot to engage upon an advantage; but if the enemy be stronger in foot, then the *major-general* should encamp on the edge of a plain, that the horse may draw up there, and the enemy's foot be afraid to engage where they can have no advantage against the horse.

A convenient place must be chosen by the *major-general*, to draw up the army in case of an alarm, and there the forces are to rendezvous: and besides the general field of battle, every regiment must have its particular ground to draw up on, from whence it must not march, till it has formed the battalion, or squadron; otherwise a small number of the enemy's forces, having gained the field of battle, would defeat a great army, should they be divided into small bodies, and those ill-formed. It is dangerous to appoint but one field of battle for all the forces; because, should all the avenues to the camp be left unguarded, the enemy might give an alarm in one place to draw the army thither, and then attack it in another. It would therefore be

convenient to appoint the best field of battle for half the army, and two or three others for the rest of the forces, there to expect the *general's* orders. If the safety of the troops only be regarded, it is best to have but one field of battle, but if we consider the loss of the baggage, something may be hazarded to save the whole. When there is cause to fear such an attempt, the best way is to encamp in battle, so that every battalion and squadron drawing up before their own tents, will there be in order; and if the enemy is near, and has no defile to pass, the troops are to continue loose, and shall rest upon their arms, being drawn up. If there be the least danger to be apprehended, the eldest regiment in the army, the artillery, the provisions, and a great part of the foot, must encamp near the *general's* quarters. Those troops, which are to have the van next day, must encamp on the most advanced part of the camp, on the way they are to march, and so likewise if the quarters are divided.

But when an army is to encamp for any time, the *general* for the most part orders the encampment. He is then to consider what provisions are in or near the place, and what conveniency of securing and bringing them to the army; and if there be corn how it may be made into meal. If there be no provisions, he must consider how to get them, and take care that they be not cut off by the enemy. The conveniency of forage, water, shelter, wood, and wholesomeness of the air, to prevent diseases, are also to be considered: if he must entrench, a convenient ground must be sought out. In this case the manner of encamping shall be according to the method of entrenchment; and the head of the camp shall be at least a hundred paces from it, without extending the camp too far: and the intrenchment is to be made as near as can be on the highest ground all about the camp, provided it be not at too great a distance; and though it seems, when of the greatest extent, to require the greatest guard, yet fewer men will maintain it, than when it is smaller, and the enemy has the advantage of the ground.

The ditch of the entrenchment must be at least nine feet over at the top, and three or four at the bottom, and six in the depth: but experience has taught us, that there may be more hopes in fighting in an open field, than behind a less intrenchment than we represent, even though our army be weaker than the enemy: for the soldiers placing most of their hopes in the strength of the intrenchment, if one part be forced they abandon the rest; and the assailants, being persuaded that all the difficulty consists in forcing the intrenchment, think nothing can stand before them, and with this confidence they increase their courage.

However this intrenchment is good, when the ditch is 12 feet wide at the top, four at the bottom, and eight in depth; and when the earth is thrown up out of it, makes a proportion 1 *parapet*, with a *banket* behind it for the musketeers to stand on. At every eight feet distance there must be *redans*, or indented works; and it is observable that twenty shots flanking do more execution, than sixty right forwards. No redoubts are to be made there, because if the enemy should once possess them, it would be hard to dislodge them. It is also dangerous to make any forts, because the loss of one of them would open a way for the enemy into the intrenchment; but if there be any higher ground that might command the camp, or advantagious place within it, which might facilitate the rallying the forces, in case they were routed; three forts may be made, provided there may be no fear of losing them. The ditch of them must be fourteen or sixteen feet over at the top, and five or six at the bottom, and nine or ten in depth: Pallisadoes and stockades must also be fixed on the edge of the ditch faced with fods, and *fraised* where there are no fods; the earth must be held together with fascines, and well beaten down, and *chevaux de frise* placed in the intervals. Men vary in their opinion concerning the placing pallisadoes. If they are placed in the ditch, they may serve to help up planks to come at the parapet, and there may be *ponts volans*, or flying bridges, laid on, so that the ditch will be useles: but as it has this disadvantage, it has also an advantage, which is, that the enemy cannot break in with their cannon, as they can on the edge of the ditch; and therefore where there is more danger of a surprize, than a regular attack, I would advise to place it on the edge of a ditch; and in the bottom, where they apprehend being attacked in form.

When the *army* is encamped, and the enemy is not very near, an eighth part of the *army* is generally upon guard, and disposed according to the easiness, difficulty, or the consequence of the avenues, for the guard of horse. During the day time, if the enemy be feared but one way, one half or two thirds of those that mount the guard shall be posted on that side, about a quarter of a league from the camp, or somewhat further if it be a champaign country. About an eighth part is detached from that guard, seven or eight hundred paces further upon some eminence, if there be any, which small guard detaches one or two vedets to be posted on the most advantageous ground for discovery. All guards are to be posted that the main guard may not be cut off from the camp, nor the small guards from the greater.

*Note*, There are several kinds of guards, as, 1. *Advanced Guard*, a party of horse or foot, which marches before a corps, to give notice of approaching danger. When an army is upon the march, the *grand guard* which should mount that day, serves as an *advanced guard* to the army. That a small body also of fifteen or twenty horse, commanded by a lieutenant beyond, but within sight of the *main*, or before the *grand guard* of a camp, are called the *advanced guard*. 2. The *Grand Guard*, which consists of three or four squadrons of horse, commanded by a field-officer, and posted before the camp on the right and left-wing towards the enemy, for the security of the camp. 3. The *Quarter Guard*, which is a small *guard*, commanded by a subaltern officer, and posted by every battalion of a camp 100 yards before its front. 4. The *Standard Guard*, a small guard of foot, which a regiment of horse mounts in their front under a corporal. 5. The *Main guard*, from whence all the other *guards* are detached. Those who are to mount the *main guard*, meet at the respective captain's quarters, and from thence go to the parade; where after the whole *guard* is drawn up, the small *guards* are detached for the posts and magazines; and then the subaltern officers draw lots for their *guards*, and are commanded by the captain of the *main guard*. 6. The *Picquet Guard*, which is a number of horse and foot, who keep themselves always in a readiness in case of an alarm; the horses being saddled, and the riders booted all the while: the foot draw up at the head of the battalion at the beating of the tattoo, but afterwards return to their tents, where they remain in a readiness to march on any sudden alarm. This *guard* is to make resistance in case of an attack 'till the army can get ready: A *Vedette* is a centinel on horseback, detached from the main body of the army, to discover and give notice of the enemy's designs.

If the country be inclosed, the *main-guard* must be so near the camp that it cannot be cut off, but yet at such a distance, that if the enemy appears, they may give timely notice; and to prevent the army being surprized, they must send out little *guards* of two or three hundred horse on the right and left, who shall post *vedettes* for their security. The commander shall from time to time visit the *advanced guard* and *vedettes*; and the time of the *guard* be so divided in relieving them, that every man in his turn may be upon the *advanced-guard*, who are not to dismount, except in a very open place, and then the horses must not be unbridled. The *main-guard* may unbridle half the horses, the other remaining in readiness. If the country be inclosed, scouts must be sent from time

to time, some going strait forward, others a-crofs from one finall *guard* to another, to take care that the enemy do not slip in between. When the *main-guard* is ordered, the rest of the *cavalry* shall be divided into two or three other *guards*, to be disposed about the camp; and they may be stronger or weaker, as there is occasion.

The *guards of foot* are generally at the head of their own battalions, but if there be a steeple, tower, or strong house near the camp, a *guard of foot* shall be sent to it: so likewise, if there be any pass upon a river, or any deep valley, about half a quarter of a league from the camp, and the country be not much enclosed, a *guard of foot* shall be sent there at night only. If the pass be at a distance, some foot may be sent, supported by a *guard of horse*; but if the place be too dangerous for the foot, a few horse may be sent to inform of the enemy, or scouts may be sent thither often. Every regiment ought to send 50 men, according to its strength, every night upon the *guard*, at the head of the camp, commanded by a *captain* and *lieutenant*, or one of them, if there be cause to fear any thing.

When the *major general* appoints the *guard* for the day, he shews the place where they are to retire at night, which is generally within two or three hundred yards of the camp. He is to visit them once in a night, to see if they are posted according to his orders; that is, whether the officers are there, and their number complete; whether the detached *guards* are on horseback, and half the *main-guard*, and the rest in their rank, and horses bridled; whether the necessary number of *vedettes* be posted for the security of the camp, and whether from time to time they send out their scouts, who are to be sent from one *vedette* to another, when there is a possibility that the enemy may step between them and the *vedettes*; or else the *vedettes* being coupled, as they ought to be at night, one of them goes as far as the others on the right; and when he returns, his comrade goes as far as the *vedettes* on the left, and thus they continue all night. Scouts are also going continually about the camp from one guard to another.

The *guard* of an intrenched camp is quite different; the intrenchment is divided among all the foot, who post centinels on it, so that there can be no passing between any two of them; and the *guard of horse* is weaker than when the camp is open. It is posted within the intrenchment in two or three bodies, near the barriers that are upon the great avenues, and only send a small *guard* 50 paces without the lines, who continually patrol, and send out scouts on the right and left, and strait forwards.

Now we shall order the *major-general* of the day to make the dispositions for the *march*; which he learns from the number of the battalions and squadrons of which the *army* is composed; what enemies may be met in the march, and whether in front, on the right or on the left; whether the way be plain or woody, or incumbered with hedges, ditches, marshes, or rivers; whether there be one or several roads or defiles; how many men, horses, or waggons can march in front; and which is the soundest and easiest way for the artillery.

If the enemy be in front, and the army in a champaign ground, he must march in order of battle, with the cannon in front, the horse on the wing, and the foot in the center; then the second line, and after the two lines the train of artillery, thro' as many defiles \* as he can, that they may be the less time in passing. Next the train of artillery, the provisions, and all the baggage of the *army* opposite to its regiments upon the same line with the train of artillery; that is, the baggage of the first line foremost, and in the rear the baggage of the second line, then the baggage of the *rear-guard*, or *corps de reserve*; which *rear-guard* shall march after the baggage, leaving only one squadron in the rear of them to prevent any disorder, or running away; but upon expedition the artillery and baggage march in two or more columns.

If the enemy be in front, and the country be woody, or enclosed with hedges or ditches, advanced parties of scouts must march before, supported by some *platoons* † of musqueteers, and those by squadrons or detachments of horse, if the country will prove fit for the horse. If the country be en-

\* A DEFILE is a narrow pass or way through which a company of horse or foot can pass only in file; by making a small front, so that the enemy may take an opportunity to stop their march, and to charge them with so much the more advantage, in regard that the front and rear cannot reciprocally come to the relief of one another. The word is derived from the *French*, *Defile*, to unthread or unstring.

† PLATOON is a small square body of 40 or 50 men drawn out of a battalion of foot, and placed between the squadrons of horse to sustain them; or in ambuscades, streights and defiles, where there is not room for whole battalions or regiments. The grenadiers are generally posted in *platoons*. The word is formed by corruption of the *French*, *Pilaton*, a bottom or clue of thread.

closed, so that the horse cannot come to do service, a battalion is to march after the first squadron, and so all the horse and foot are mixed; and as there are generally more squadrons than battalions, the squadrons shall be equally divided among the battalions, and each squadron have platoons of musqueteers; and in this manner the *van-guard* and main body shall march, then the heavy cannon, the ammunition, provisions and baggage.

The field-pieces are to march with the \* *van-guard*, and the heavier pieces with the main battle, and many *Platons* in the intervals between the baggage, for fear the enemy should cut it off in the wood; then the *rear-guard* shall march. It is dangerous to place the heavy cannon between the battalions and squadrons in a country that is enclosed; because, if they were drawn up in order of battle on a sudden, and the *van-guard*, should be attacked, it might hinder the march of the troops, and can do them no great service. However, if the country be enclosed in some places, and open in others, they must draw up in battle when they come into the plain, if the enemy be at hand, and turn to their former order when they have passed it. If there are several roads, they must draw up in two or three columns †, and at the head of every one of them a cart loaded with tools, and a number of pioneers and soldiers.

The better to regulate the *march*, some *general officers* should keep in the *rear* of the baggage, each according to his post, except among the foot, where the baggage of the *rear-guard* march according to the seniority of the regiment, and those of the elder regiments march foremost, though they make a retreat. The *futlers* and other trades, who do not belong to any particular regiment, march after the baggage of the main battle. Every regiment of foot sends a man out of each company to guard its baggage, under the command of a *serjeant*; and each troop of horse one trooper. The *provost-marshal*, and all the other *provosts* are to march with their men, to see that the soldiers keep their ranks, and to prevent disorder.

A *captain*, or conductor of the baggage, is appointed, who puts the baggage into the marching

order, and makes the *guards* observe it as they march; and every regiment puts up a flag of the same colour and shape, that their baggage may the better be kept together; and some of them are carried to the *major-general* of the day, who orders them to be placed at the head of every column of troops and baggage.

If the enemy be on the right wing, and the country plain, they must march thus. Those who are to compose the *van-guard* in the order of battle, are to be on the right of those who are to compose the *main battle*; the *main battle* on the left of the *van-guard*, and the *corps de reserve* on the left of the *main battle*; each of those bodies making a file, with the horse at the head and in the rear, and the foot in the center, so that when the army halts, and each line faces to the right, the order of battle will be formed, provided the *van-guard* observes its due distance in marching, and the troops of the *main-battle* keep opposite to the intervals of the *van-guard*. The troops that guard the baggage are to be on the left of all the rest, making the largest front they can, that their file may extend almost as far as those of the *army*, and they are to have but one squadron on the left. In this order of marching, all the cannon must march on the right of the *van-guard*, that it may be at the head of the *army* in case of battle.

If the country be enclosed or cut with trenches, and the enemy on the right, the *army* must march almost in the same order as in the plain, provided the roads will admit it, or can be made without much labour, as in the summer when all lands are enclosed; and all that is altered at that time is, that a column on the right, which composes the *van-guard*, shall be stronger in foot, than that which composes the *main battle*, and each squadron of the *van-guard*, shall have *platoons* of musqueteers. The cannon must march between two columns, because it cannot do great service in a country that is enclosed: and if it were upon the right of all, the enemy might take it, or nail it, before it could be relieved.

If there be two defiles, all the troops are to march through that on the right, and the baggage

\* The VAN, or *van-guard* of an *army* is the first line, and is the same with the front of an *army*, and gives the first charge upon the enemy. Every *army* being composed of three parts, a *van-guard*, *rear-guard*, and *main body*. The *rear-guard* is that part which march last, following the *main body* to stop deserters. The *main body* marches between both, and is ordinarily the *general's* post. The *corps de reserve*, are the forces disposed in the third or last line of an *army*, and destined to sustain the rest, as occasion requires, and are not to engage but in case of necessity.

† A COLUMN in war denotes a deep *file*, or row of troops; or a division of an *army*, which marches at the same time, and towards the same place, at intervals large enough to avoid confusion. An *army* marches in one, two, three, or more *columns*, according as the ground will allow, and the *general* sees expedient.

through that on the left; part of the field pieces in the intervals of the *van-guard* part with the *main battle*, and some few with the *rear-guard*. The heavy cannon is to march in the column of the baggage, but not quite at the head of it, lest the enemy send some troops to attack it, but after the baggage of the *van-guard*, that it may be the better covered by troops.

The *van-guard* files off first, then the *main body*, and next the *corps de reserve*. If there should happen to be one *defile*, then all the *van-guard* marches off first; the artillery, the provisions, and the *general's* baggage next, then the *main-battle*, and all the other baggage, and then the *corps de reserve*. But this is a very dangerous way of marching if the enemy be near, because the line being divided by the baggage, they cannot come to succour one another: and on the other hand, should all the troops march together, and the baggage after them, it would be too much exposed, and the loss of it be as detrimental to the *army*. as the defeat of a considerable part of the troops; therefore to avoid this inconvenience, the baggage should in this case march through another *defile*, than that the troops march through, tho' it were a league distant; and so they ought to have a guard of a sixth or fourth part of the *army*, according to the force which it may be expected, that the enemy would send to attack it. In such a march it should have many small parties of horse if they can be had; if not, of foot, to scour on the right, and discover if the enemy comes to attack it, at which time surprizes are most dangerous, because it is difficult for troops when they are put into disorder in a *defile*, to rally. Parties should be frequently sent out towards the enemy, that if one should happen to be cut off, the other might give notice of it.

If the enemy be in the rear, the order prescribed must be inverted; and when there are *defiles* in the way, great care must be taken to make them easy, that the troops may come to each others succour, if the *rear* should be attacked. The field-pieces must be lodged on the edge of the *defile*, to favour the retreat of the hindmost troops, unless it be woody; if not, then many field-pieces are more necessary than at another time.

When there is little cause to suspect the enemy, and the country is champain, the *van-guard* marches in two columns, then the *main battle*, and the *corps de reserve* after it; in the same order, the baggage between the two columns, with the artillery and provisions in the front; or else the *van-guard* may march in three columns, the *main battle* in the same manner, and the artillery, provisions, and baggage after it, and last of all the *rear-guard*, or *corps de reserve*.

If the country be inclosed, and there is but one *defile*, then let the *van-guard* and *main battle* march next the artillery, provisions and baggage, and then the *rear-guard*. If there are many *defiles*, the *van-guard* and *main battle* may march in as many columns, then the baggage after them, and the *rear-guard* last; or else the troops and baggage may pass through several *defiles*. When the order of marching is resolved, the *major-general* is to acquaint the *general* with it, to know whether it meets with his approbation.

The enemy is in fight, and I must prepare for a battle. Let all my officers be called to receive the orders for a general engagement. First let me instruct them how they are to behave themselves in fight. Every respective officer ought to encourage and animate the soldiers in the combat, more by their courage, intrepidity and valour, than by their discourses; since a good example makes a stronger impression on their mind than a studied and florid discourse. The horse-officers should be well mounted, and have horses with good mouths.

An officer should not ride a fleet horse on the day of battle, except he rides him usually at other times, lest he gives occasion to have it said, that he chose that horse to run away the faster. He must take care to have his horse's buttocks within the front rank, and the ranks so close, that they may not be broke; for the strength of a squadron consists in being kept close. In pursuit of the enemy the squadron must be kept in order of battle, and if they come to a *defile*, make a halt, till all are past, and then form again. When a battalion or squadron is formed in the face of an enemy, the best way is to form them by ranks, and not by files. Where there are ditches or hedges, an officer of horse must take care not to get too far from the foot, lest he should want their assistance; and therefore platoons should be always placed between the squadrons. When the enemy is routed, the men must not stay for plunder, for by that means the enemy will gain ground and get off safe: or the enemy might rally, and change the face of affairs. There are rules for plundering as well as for every thing else, and detachments are generally appointed for it. Prisoners taken in battle are to be put into the hands of men detached to secure them. If soldiers will not refrain from plunder when they are ordered another way, one of them should be shot, as an example to the rest.

A BATTLE, is an action which passes between two *armies* ranged in order of *battle*, and who engage in a country sufficiently open for them to encounter in front, and at the same time; or at least for the greater part of the line to engage, while

while the remainder is in fight, by reason of some difficulty, which hinders it from entering so readily into an action, with a front equal to that which may be opposed to it by the enemy.

Other great actions, tho' generally of a longer duration, and even frequently attended with great slaughter, are only called *skirmishes*.

A *battle* lost, almost always draws with it the loss of the artillery of the army, and frequently also that of the baggage: consequently as the *army* beaten cannot again look the enemy in the face, till it have repaired those losses, it is forced to leave the enemy a long time master of the country, and at liberty to execute all its schemes. Whereas a great fight lost is rarely attended with a loss of all the artillery, and scarce ever of the baggage, because the two armies not meeting in front, they can only have suffered in the part that has been engaged.

The history of *battles* are only the history of the faults and oversights of *generals*.

Therefore we must so contrive the order of *battle*, that all the troops may support one another without confusion, that when one body is broke it may not bear down another; and they should make the largest front, as well to prevent being out flanked by the enemy, if they are in more open order, as to enclose them if they are in a narrow compass. And yet they must not be extended so much, that when one body is broken, there may be none left to support it, and to oppose them that have routed it; or that the battalions and squadrons should be so distant, that if two of the enemies should happen to join one of ours, those on the right or left of it, could not come to its relief before the enemy had broke it.

To keep a due proportion, we must draw our army in two lines, *viz.* the first and second line, which must be of equal force, and the *corps de reserve*. The foot shall be placed in the center, and the horse on the wings. The squadrons from one hundred and fifty men each, at least, to two hundred at most, and but three deep. The battalions of five, six, or seven hundred at most, and drawn up three deep. If our *army* consist of forty squadrons, and eighteen battalions, we should place sixteen squadrons, and eight battalions in the first line; sixteen squadrons and seven battalions in the second, and eight squadrons and three battalions in the rear-guard, or *corps de reserve*. Or else in the first line place fourteen squadrons and nine battalions; in the second, sixteen squadrons

and five battalions; and in the *rear guard*, ten squadrons and four battalions. Or else in the first line, let there be sixteen squadrons and ten battalions; in the second, seventeen squadrons and six battalions, and for the *rear-guard*, seven squadrons and two battalions.

The eldest corps has the right, the next the left, and so on according to seniority, till the youngest meet in the center. The first line is more honourable than the second, and the second than the *rear-guard*. The guards are always in the line of battle, and the *carabineers*\* and *fusileers* are on the wings, somewhat advanced before the other troops. The space of two hundred paces is allowed for the distance between the first and second line, and one hundred between the second and the rear-guard.

The battalions and squadrons of the second line are placed opposite to the intervals between those of the first line, that they may march through the enemy; and those of the first line, if broken, may pass through the intervals of the second without disorder to either. The intervals are to be half the breadth of the front of the battalion or squadron that it sustains, when doubled from three to six. It has been found of service to place all the foot almost in the two first lines, as being very near useless in the *corps de reserve*, because they cannot come time enough to relieve the troops that are bore down. More foot should be placed in the first line than the second, and their place be supplied in the second by some squadrons, which would do great execution, coming up to charge between the two battalions, after they had spent their fire: besides, the foot would be greatly encouraged, who love to be sustained by the horse, and the horse would charge with more alacrity, after the foot have given their first volleys; and the fire of the battalions has more effect when the first troops have the onset, than when they are mixed, and in confusion; and it often happens that the battalion of the second line do not spend half their fire, being come up to push of bayonet before they make their discharge.

The cannon must be placed in brigades before the first line, reserving some few pieces an hundred paces behind the *corps de reserve*, guarded by a small number of men to favour a retreat, or prevent being attacked in the rear. If there be any rising ground, either in the front, or on the right or left, the utmost efforts must be made to gain it, in order to plant the cannon there, and prevent the enemy taking the same advantage of it; and some-

\* The CARABINIERS are a sort of light horse, carrying longer *carabines* than the rest; and used sometimes on foot: The French of late have formed entire corps of these *carabineers*, which cannot but have good effect: this being a sort of soldiery chosen out of the whole cavalry, and better paid than the rest. FUSILIERS are foot-soldiers, armed with firelocks which are generally slung. There is a regiment of fusiliers for the guard of the artillery.

times a general battle has been changed into an engagement of regiments against regiments to possess an advantageous ground; and the time being spent till night, both parties are obliged to draw off, each finding their troops much weakened, not knowing the damage on either side.

The *army* being drawn up, 'tis best to charge the enemy before they are in order of battle; but if their ground be more advantageous than ours, as being to mount a rising ground, or to pass a brook, ditch, or hollow way, it is better to expect their coming than to attack them, except we be much superior to them in number, and our cannon be posted to advantage.

When the first line or *van-guard* advances, let the second move also, keeping equal pace with the first, and leaving a small interval between them, lest the first should be broke before the second can march up to relieve it; or if it should break the first line of the enemy, lest their second line may relieve it before ours can march up to sustain our *van-guard*.

The *corps de reserve* must advance gently towards the enemy, that the broken troops may have time to rally, and they must engage all at once, and it must be always observed to give them time to recover their spirits.

While there remains any hope of getting the battle, the rally'd forces must charge again; but if their number be so small in comparison of the conquerors, that all hopes are lost, then retreat in the best order, and rally again as near the field of battle as you can, that you may be in a condition to oppose any small bodies of the enemy that shall pursue you, and with the remains of your troops throw yourself into the next considerable town, which in all probability they will first attack.

A *general's* conduct is as often commended in a *retreat*, as in a *battle*, and his intrepidity and courage as much signalized. As it cannot be reasonably expected he should fight in too great a disadvantage, proceeding either from the too small number of his forces, when compared with those of the enemy, or from the situation of his army, or from his provisions being cut off, or from the imminent danger of being surrounded by the enemy, so as to be forced to surrender, or to be cut to pieces, &c. and that the reputation of a *general* is almost always lost by a flight; he must have some means left to extricate himself from those difficulties with honour, which cannot be done otherwise than by what is called an honourable retreat, which, under the above mentioned disadvantages, must be made with all possible expedition, even tho' the *army* should lose some soldiers that could

not keep up with it, and a *general* must not quit all, or any part of his cannon, except the utmost necessity compels him to it: but for the baggage, if the retreat be not easy, he must incumber himself with as little as may be; and if he is so hard pressed that he must unavoidably come to a battle, he must chuse an advantageous opportunity for himself, endeavouring to draw up behind a wood or hill, that he may fall upon the enemy's flank; or else as they pursue him, making a quick countermarch, after passing a defile, that he may engage one part of the enemy's *army* before it can all join together. In such cases of compulsion there is no counting the number of men; for, though you are but half, or the third part of their number, yet you may lay hold of such an opportunity, and with such resolution, that you may defeat them.

If you are so weak that nothing can be done by fighting, or speedy marching; or, if a too powerful number of the enemy have got before, and hinder your passing; then the last resolution to be taken, is to preserve what may be saved, dividing the army into four or five bodies, which must march several ways to make their escape.

All orders of battle for a retreat differ according to the diversity of circumstances that occur; the usual method of retreating is in columns, except a small body in the rear. And in an army of 15,000 or 20,000 men, it usually consists of eight or ten squadrons, and two or three battalions, which are to march in a line in an open country, only keeping two squadrons behind to amuse the enemy. In an enclosed country the battalions and squadrons must be internix'd, and detached musqueteers must bring up the rear. Secrecy in setting forwards, diligence in marching, care in mending the ways, and cunning in fighting, are all the advantages in this part of war; and a *general* who manages a retreat, in the different manners here prescribed, is always commended and admired for his prudence and conduct.

But, as we suppose our *Army* to have gained a *complete victory*, which has inspired our forces with new courage, we'll not quit the field 'till we have attempted something farther; therefore we'll march to the *SIEGE* of the next town of the enemy, where they could rally and recruit their routed forces; which the better to effect, we'll view the ground round about it, especially on that side the enemy may come, and we'll order parties abroad to give intelligence of their march; and according to the information we receive, we'll either expect their coming, in an advantageous post, or go to meet them, which last is the surest way; for if we wait for them in one certain place, we give them an opportunity

portunity of relieving the town some other way, which is not to be done, since we are not so weak, as to expect to fight to a great disadvantage, for if we were, we ought to secure ourselves by a strong line of circumvallation.

The order of battle behind a line is quite different from the others; for a third part, or thereabouts, are posted to man the line, and some are to be posted for the most part in *redans*, or angles salant, they being the most considerable places for defence of the line. The rest of the forces must be drawn up in two lines, the first thirty paces from the entrenchment, and the second one hundred paces from the first line; and we must intermix the battalions and the squadrons. It would be convenient that every squadron had four or five files, somewhat detached from the rest, to be ready to charge any that begin to pass the line, if we had not numbers sufficient to oblige the whole squadron to charge them, unless we should detach small parties of fifteen or twenty men for this purpose.

All the forces must never be posted to guard any one part of the line, unless we be thoroughly assured that the enemy's troops are in one body, and have not detached any number to attempt another place. The defence of a camp that is intrenched is the same with that of a circumvallation, (see *Fortification*) and the chief care is that the enemy do not fortify themselves within the intrenchments; to prevent which, they must be continually charged as fast as they enter, and not be allowed time to draw up in order of battle.

A sufficient number of workmen must be ready to repair the line, when the enemies have thrown it down, and are repulsed, lest they make a fresh attack; or else in order to throw down the line to fall after them if they are much weakened, and discouraged. Many cannon are of great use for the defence of the lines; and to be planted in those parts which command most of the plain, and in the *redans*, from whence they sweep the length of the intrenchment.

If the enemy attempts to make us *raise* the SIEGE; and our trenches are opened, and no lines of circumvallation drawn, which, should have been done, then if we are not much superiour to them, we must draw off all our men to bend our united force against theirs; but if we are much stronger, we'll leave them as many men as may secure the trenches, and meet the enemy with the rest; marching not too far, lest they should throw succours into the town, who, joining with the garrison, could gain our trenches.

But perhaps we march to raise a Siege, and design to take the advantage of the circumvallation

being not finished, to fight the enemy; then we must march directly up to the place, having first sent parties to bring advice whether they come to meet us, taking particular care that they do not fight us when we are half passed a defile, and that we do not attack them in an advantageous post — In such a case we must turn to the right or left, and march another way to the place. — We must not march so close that they may attack our flank or rear, but keep at a due distance; that if they quit their post, they may find us in a posture to receive them. — If we have no mind to fight, we'll keep ourselves in an advantageous post, and at night detach two or three considerable parties to relieve the place, and order them to take the greatest compass we think fit, and while they are endeavouring to throw themselves into the place, we'll make a shew of intending to fight, that the enemies may not divide their forces.

If our parties should happen to be defeated, and we obliged soon to retire, either for want of provisions, or for any other reason, or the circumvallation finished before our return, then we'll hazard a battle, if the place be worth it. — To this purpose we'll send a party or two to alarm the enemy in the night, and oblige the enemy to divide their forces, then march with our army the way we think we are least expected. — If the enemies have taken up their quarters and are not intrenched, we'll endeavour to surprize one of them, and throw in our succours that way; and so weakening their *army*, we may be in a condition to fight them. — But if their quarters be intrenched, we'll endeavour to chop in between them, and throw in our succours that way. — If we are much their superiors, then we'll attack one of their quarters; or if they all get into one, and we have put succours into the place we'll encamp between them and their country to starve them; or if they come out, to fight them in their retreat.

If the line of circumvallation be finished, and we design to force it, in order to throw succours into the town, we must encamp as close as we can, that is, out of cannon-shot, and at night divide the *army* into one main body, and several small ones, so to make two attacks; but they must not be so far asunder, that if the enemy sallies out upon one body and beats it, the other cannot come to its relief; and we'll march in the night, that the enemy may not discover our design.

The properest time for attacking is half an hour before day-break; for then the enemy not being able to distinguish between a true and false attack, will not know how to use their cannon, and the fire of their small arms will do less execution by night.

In attacking the lines, several platoons, each commanded by a serjeant, must march before, who are to be followed by two or three hundred men, each carrying a fascine and his arms, who, when they have cast their fascines into the ditch, endeavour to mount the line.—After this a hundred men must go with pick-axes and other tools, to throw down the line that the horse may enter; and in case of a repulse, other attacks may be made with ease the same way.—The men must be sustained by battalions always firing while the others work.—Two or three thousand men may be employed in every attack, and ordered to fall on near one another, or at a small distance, and the horse to be divided to sustain them: and a strong *Corps de Reserve* is to stand ready out of cannon shot, but the nearer the better, if a place can be found under covert.—The battalions, which sustain that which falls on, must not be directly in the rear of it, but on the right and left, and at a greater distance: by this means they will see how those, who attack proceed, and the better judge what they are to do themselves, and cannot be disordered by such as run away, or the wounded men, who retire.

It would be proper to send a squadron to sustain them near at hand, and the rest are to be kept just out of musquet shot, causing them to advance, as the foot make themselves masters of the line.—The regiments, which sustain should have some tools; because if the enemy in a consternation quit any other place than that which was attacked, those regiments may possess themselves of it.

But perhaps after a *victory*, or without a *victory*, we enter the enemy's country, or to ravage it, or to put it under *contribution*, or to hinder the junction of an army designed to rendezvous there, or to fight one already joined.

If to ravage the country: we must divide our *army* into several bodies, but not so small as that either of them may be beaten.—If to take a post, to lay it under contribution; we must chuse one commodious for forage, that has good air, and so seated, that we may have provisions from our own country, in case the place where we are cannot furnish our forces; and we must take care to secure a retreat, if the enemy should come upon us with stronger force; and it is safest to intrench.—If to hinder the junction of an *army*; we must hasten into our quarters, to surprize those who shall not be quick enough to retire, and then pursue the rest as far as can be.—If to fight an *army* already formed; we must be cautious, and know the strength of it, and the place where it lies, lest in our march we meet with it, in a disadvantageous place.

When we enter an enemy's country, we must consider the nature of the rivers we pass; as whether a great shower of rain, or the sun melting the snows, may not prevent us from repassing. Or if we would force any considerable pass into it, as one on the mountains, or over a river, or an intrenchment, all depend on expedition, especially in gaining passes on mountains, from whence it is not an easy matter to drive those, who have once lodged themselves.

If the enemy are there before us, and are not numerous, we must endeavour to surprize them; but if we fail herein, and are obliged to do it by open force, we must strive to gain an eminence above them, or if they are not very strong, and are shut up with batteries, we must attack them with *petards*, *scaling ladders*, and *hand grenades*.—If a tower or castle secures a *pass*, we must use the *petard*, or fix the *miner* to it: and remember that in all difficult places we must forecast to secure a retreat; and if we leave a *pass* behind us, to place a sufficient guard there.

If we are to force a *pass* upon a river, we must chuse a convenient place for a passage on our side, and if there be any rising ground, place our cannon upon it, to prevent the enemy's troops from drawing up.—Having viewed the place, we must make a shew of passing in several places; and when our cannon is planted, throw up a *parapet* on the bank of the river, about a thousand fathoms in length, placing musqueteers behind it, then launch our tin boats, and send over some men, part soldiers and part workmen, to throw up a half moon.—This being done, we are to send more to defend it, in case we be attacked, and other workmen to make another half moon, on the right, or on the left of the first.—If we are not pressed by the enemy while we are making the first half moon, we may carry on a horn-work, the wings of it to be flanked by the first *parapet*, and the cannon lodged there.—But if the river be so broad that a musquet cannot defend the wings of the horn-work, it must be defended by half moons made beyond the water. In the mean time we must labour hard at the bridge, and when finished cause the troops to pass, if the enemy be not on the spot; if they are, the horn-work must be finished, that they may not fall upon the troops as they pass.—When it is finished as strong as it shall be thought necessary, we must put as many foot in it, as it will conveniently hold, and some field pieces; then the cannon upon the hill keeping the enemy at a distance; the cavalry may also pass.—But yet this is not to be done, but when their *army* is much weaker than our own, for if they were as strong as we, then when half our

men were over they would fall in with them, and our cannon or musquets would do them no harm; and though they could not force our intrenchment, yet they would cut off all without it.—Therefore if their *army* be near as strong as ours, we must finish the horn-work, and at the same time making another bridge and another horn-work, at some distance from the first, draw a line from one to the other. The last and surest way is to secure a pass at some distance from the place where we lie, that the enemy may not presently have notice of it; and to keep part of our forces, as long as we can before them, to give them the least occasion to suspect we have detached any troops.

If there be any brook, morass, ditch, hollow way, rising ground, or other difficult *pass*, or any eminence at hand, on which the enemy may conveniently lodge themselves, and plant cannon on the other side the river, where we design to pass; it will be requisite to make some redoubts on the *passes*, if the enemy are not there already; for if they are much weaker than we, they may come and intrench themselves there, and by securing the second *pass*, make the first useless.

But perhaps we are to guard such a *pass*: therefore we must view all places along the river, which are fit for that purpose, and throw up forts and redoubts before them. if we can, and cause the country people to be upon guard, if we are afraid to divide our *army* too much, that we may have notice of the approach of the enemy, and be ready to receive them, and by our spies and other means get intelligence, when they make a detachment to surprize another *pass*.

If they draw up their field pieces on the edge of the water, and have planted their heavy cannon on higher ground, determined to pass, without any intrenchment, under the fire of their cannon and small arms, which they suppose will keep us at a distance; then, if we have not an advantageous place to plant our cannon, we must post ourselves a musket-shot from their passage, either above or below it, that so making an empalement, to cover us from their artillery, we may fire upon the *pass* without being exposed. If there are any hedges or trees, we should take the advantage of that covert, for it is dangerous to lodge cannon in the sight of great batteries. If there be a hollow way, ditch, ridge of ground, or hedge, we'll lodge as many foot as we can there, and strengthen our lodgement the best we can. Yet if all our efforts cannot prevent the enemy from passing, as soon as a part which is weaker than our *army* is over, we'll rush in upon them, that in the confusion the remainder on the

other side may not fire upon us, lest they kill their own men. If they make a parapet on the edge of the water on their side, and detach some men to make a half moon, and their bridge, and our cannon and small shot cannot hinder them, then if the place be convenient for horse, we must send some small parties, stronger than those that are pass'd; for if we send great bodies, they will receive more damage from the enemies beyond the water than we can receive by those that are pass'd.

If there be any likelihood of carrying the half-moon the enemies have made at the pass, we must attack it with vigour, and if we are repulsed, endeavour then to prevent their throwing up other works, by posting our cannon and small shot advantageously for that purpose. But if they have got a good safe half-moon, and are not over-hasty, it will be difficult to obstruct their passage; because their workmen whom they send to make other intrenchments, will retire to the ditch of the half-moon, if we press upon them, and they that sustain them will force us with their volleys, and the assistance of those beyond the water to retire, and then the men will return to their work; and as often as we attack them they will kill more of our men than we can of theirs. However though these little attacks cost us some men, yet if by that means we can retard the work 'till night, it will be a great advantage to us; for then being out of sight of their fire, we may make lodgments for musqueteers, and raise batteries as near their works as possible, so that they who are lodged in them, will, by their fire in the morning, hinder the enemies from extending their works; and in order to prevent their working by night, we must make frequent sallies, as often as they go about it, which will not be very dangerous, or keep a continual firing from our small arms, charged with partridge shot; but if we cannot hinder their passing, it will be easier to retire by night than by day. If we find the pass well secured with works, then if there be a morass, ditch, or ridge, or any other advantageous ground, we'll entrench ourselves upon the ridges of it, to obstruct their second passage.

When both armies have a design to possess themselves of an advantageous post, it often occasions a battle. The precaution to be used, in that case, is to send our scouts towards them, and not to march without a good number of small parties out before us, to prevent meeting the enemy in a dangerous place. A strong detachment is to be sent from the *Army* to take possession of the post, and expect the enemy there, provided our detachment be strong enough, to maintain it 'till the whole

*army*

*army* come up. If we know that the enemy must pass a difficult defile, we must send some parties thither to spoil the ways, and to skirmish with them.

When we find ourselves invested by an *army* stronger than ours, whereby our *provisions* are cut off, and no hope of getting any, without hazarding a battle, we must then make an attempt, either in order, to get clear out of our post, or else to bring in the *convoy*; though it has happened sometimes, that by a too great confidence, or rather presumption in a *general*, an *army* has been so well hedged in, that it was impossible to fall out, without its being exposed to be cut to pieces, as it happened to the *Czar*, Peter I. upon the *Pruth*, where his whole *army* must have perished for want of provisions, or fallen by the swords of the *Turks*, if the *Czarina Catherine*, his wife, had not found the secret of amusing the *Grand Vizir* with advantageous proposals, to give time to the *Czar* to extricate himself out of that great dilemma, as he did, to the disappointment of *Charles XII.* King of *Sweden*, who came one day too late to make the advantage he expected, from the distress of his most formidable enemy; which disappointment so enraged the hero, that he could not help reproaching the *Grand Vizir* with perfidy and cowardice.

If we design to bring in the *convoy*,\* we must order it to come with the greatest secrecy, through such a road, as we'll judge more proper for us to meet it, without hazarding a disadvantageous battle. To effect which we must march out with all our forces; for though we ventured but little before the coming of the *convoy*, yet the loss of it would lose all, if our safety depended on its coming safe. But if we think there is as much difficulty to bring in the *convoy* safe as in leaving our post; or though it should come safe it would subsist our *army* but for a few days, and that there might be the same hazard soon after in bringing another, so that the delay would be no advantage to us, then it would be more prudent to make an effort at first than to stay any longer; because an *army* always declines, and for the most part loses courage and strength.

In order to force our way, we must either leave our baggage, in the place we quit, with a guard;

or, if the place cannot be defended without leaving a considerable part of the *army*, take all with us, for fear of weakening ourselves, and if we apprehend that our baggage may incumber us, and hinder the retreat we hope to make without it, we must save the best, and burn the rest. Having first viewed the easiest way, we must set forward towards the evening, and at the same time send parties to alarm the enemy in several other places, that they may be doubtful which way we draw off. If we carry our baggage with us, then we must keep between it and the enemy, that is, when the enemy is in the rear, and the baggage before us; and on the left if they are on the right; and so on the right if they are on the left. If the enemy be before us, we must march on, fighting courageously, and the same if they attack us briskly in the rear, or on the flank; but if they come on but slowly, to retard us 'till all their forces come up, then we must not stop at all, but defend ourselves, retreating, never losing time to sustain the troops that are attacked, though some of them be lost: Nay, it is sometimes absolutely necessary to lose a small part to save a greater; but this resolution is never to be taken unless the greatest extremity compels us to it.

If we would prevent the *army* of the enemy crossing our country, we must endeavour to cut it off in the van at some pass, or fall upon its rear, when half passed some *defile*, giving it a check by this means, till the country is in arms, and all our forces are joined: and we must endeavour as much as possible to avoid coming to a battle, unless we have a great advantage, because by fighting in our own country, the loss of one battle may lose all.

The judgment, prudence, and conduct of a *general*, are also evidenced in the surprize of an *army*, or of *quarters*. To surprize an *army*, he must understand the situation of the camp, whether it is intrenched or not; its strength in horse, foot, and cannon; how posted; the manner of the encampment; what guard is kept within and without; where the guards, centinels, and vedets are posted, and care must be taken to avoid or surprize them. As soon as the enemy has taken the alarm, he must fall on with the greatest fury imaginable, that they may not have time to form themselves. If the

\* A CONVOY, in this place, is a body of forces sent to guard a supply of provisions, arms, or ammunition, going to a camp, to an *army*, or to a besieged town. There are two sorts of *convoy*, viz, a *small* and a *grand* *convoy*; a *small* *convoy* consists only in a few waggons, or horses loaded with ammunition or provisions, and is escorted with a small detachment of infantry. A *grand* *convoy* consists of a very considerable number of waggons and horses loaded with ammunition, provisions, and often with money for the payment of the *army*, accompanied sometimes with a train of artillery, and escorted with strong detachments of both cavalry, and infantry, the cavalry on the right and left, and the infantry in the front and on the rear.

camp is intrenched, there must be carried *fascines* \* to fill up the ditches, pont volans, hand-granades and hatchets.

If he will surprize any particular quarters of horse or foot, if they are in a place that is enclosed, he must use the same method practised to surprize garrisons, but if in an open place, he must act according to their strength, guard, and situation.

In order to break a bridge which is advantageous to the enemy, we must strive to make ourselves masters of one or both ends, if they are not well fortified. If we dare not attempt the lodgments the enemies have made, we are to endeavour to burn the bridge with fireships, if it be a bridge of boats, or send some good swimmers to cut the ropes, or drive down a strong vessel, heavy laden, to break them. If it be a wooden bridge upon piles, men may be sent in cover'd boats to saw them, or else to daub them with pitch and other combustible matter, and then set fire to it. We may also build a small body of stone-work upon boats, in the midst whereof there shall be a mine, loaded at top with the largest stones we can get, and over that a piece of timber to bear under the upper part of the bridge, or upon the piles, and to open a trunk to give fire to the mine, which shall spring while the boats are under the bridge. If we cannot make sure of the trunk for firing, a good swimmer may carry a boat, and tie or hook it to one of the main pillars; and having set fire to a *saucisse*, swim away as fast as he can. The boats which have the mines, may be conducted by other boats; and so the men in them, having fastened the boats that have the mines, and giving fire, may get off without danger.

We would not send our army into quarters, before having besieged a town in form, were we not to consider, that sieges and the manner of besieging belong properly to *Fortification*, and consequently is to be included in our treatise on that subject, under the letter *F*. Therefore we'll conclude this with some general remarks on armies.

The author of the *Considerations sur les Causes de la Grandeur des Romains*. c. 3. p. 24. is of opinion, that a prince with a million of subjects, cannot keep an army of 10000 men, without ruining himself. It was otherwise, say they, in the antient republics: The proportion of soldiers to the rest of the

people, which is now about one to an hundred, might then be as about one to eight. The reason seems owing to equal partition of lands, which the antient founders of commonwealths made among their subjects; so that every man had a considerable property to defend, and means to defend it with. Whereas amongst us the lands and riches of a nation being shared among a few, the rest have no way of subsisting, but by trades, arts, and the like; and have neither any free property to defend, nor means to enable them to go to war in defence of it, without starving their families. A large part of our people are either *artizans* or *servants*, and so only minister to the luxury and effeminacy of the great. While the equality of land subsisted. Rome, though only a little state, being refused the succours, which the *Latins* were obliged to furnish after the taking of the city, in the consulate of *Camillus*, presently raised ten legions within their own walls: which was more, *Livy* assures us, than they were able to do in his time, though masters of the greatest part of the world. A full proof, adds the historian, we are not grown stronger; and that what swells our city, is only luxury, and the means and effects of it.

A LEGION was a kind of regiment or body of forces, of a number whereof the Roman armies were chiefly composed. The number of soldiers and officers whereof the legion was composed, was different at different times. In the time of *Romulus* each legion contained 3000 foot, and 300 equites or horse: these were divided into three bodies, which made as many orders of battle. Each order consisted of ten companies or *maniples*, ranged at some distance from each other, though in the same front. Each body had two general officers to command it, called *Tribunes*, and each *maniple* two *centurions*.

The TRIBUNES were in the Roman armies, much the same with our *colonels*.

A CENTURION was an officer of infantry who commanded a *century*, or hundred men. The first centurion of the first cohort of each legion, was not under the command of any tribune, as all the rest were; and had four *centuries* under his direction. He guarded the standard and the eagle of the legion.

\* FASCINES are small branches of trees, or bavin's bound up in bundles, which being mixed with earth, serve to fill up ditches, to screen the men, make the parapets of trenches, &c. some of them are dipt in melted pitch or tar, and being set on fire, serve to burn the enemies lodgments or other works. A pitch'd fascine is a foot and a half about; a fascine for defence, two or three foot. Pont volans, or flying-bridge, is a kind of bridge made of two small bridges laid one over another, and so contrived by means of cords and pulleys placed along the side of the under bridge, that the upper may be pushed forwards, till it join the place where it is designed to be fixed: the whole length of both not to be above five fathom, lest they should break with the weight of the men.

In the time of *Marcus*, these four divisions of the *legions* were united into one, and augmented; and *cohort*s were appointed from five to six hundred men, each under the command of a tribune. Each *cohort* consisted of three *maniples*, each *maniple* of two centuries; and the *legion* was divided into ten *cohort*s, who made as many distinct battalions, disposed in three lines; so that the *legion* then consisted of five or six thousand men.

When the *army* was ranged in order of battle, the *cohort*s, or battalions were disposed in the following manner. The first *cohort* took up the right of the first line, as the companies of grenadiers do in our regiments; the rest followed in their natural order; so that the third was in the center of the first line of the *legion*, and the fifth on the left. The second between the first and third; and the fourth between the third and fifth. The five remaining *cohort*s formed a second line in their natural order; thus the sixth was behind the first, and so of the rest.

The first, third, and fifth *cohort*s were esteemed the best, at least it appeared so from the post they took up, which were looked on by the *Romans* as the most important.

The *cohort*s, called *Prætorian*, from their place or station, in the palace called *Prætorium*, were the foldiers of the Emperor's guards. Their institution was owing to *Scipio Africanus*, who first established a company of the bravest men in his *army*, pick'd out for the purpose, to be his guard, and never to stir from his side in battle. *Dion* tells us, that their number was at length increased to ten thousand. They were commanded by an officer, created by *Augustus*, called *Præfectus Prætorii*, the prefect of the palace.

The STANDARD bore by the *legions* was various. At first a *wolf*, in honour of that, which suckled *Romulus*; afterwards a *hog*, by reason, says *Festus*, war is only undertaken with a view to peace, which was concluded by sacrificing a *hog*. Sometimes they bore the *Minotaur*, to remind their *general* that their designs were to be kept secret and inaccessible as the *Minotaur* in the labyrinth. They also bore a *horse*, a *boar*, &c. *Pliny* tells us, that *Marius* was the first, who changed all those *standards* into *eagles*.

The ARMS of the antient *Roman Armies*, were a lance or javelin, a sword and a small argian buckler, which *Romulus*, during his wars with the *Sabines*, a bold and warlike nation, changed into a broad buckler; and what contributed most to render the *Romans* masters of the world, was, that having successively warred against all nations, they renounced their own methods, arms, &c. whenever they met with better.

The *armies* of the Grand Signior consist chiefly of *Janizaries*, *Spahis*, and *Timariots*.

The JANIZARIES, reputed the Grand Seignior's foot guards, are the best infantry in the *Turkish armies*; first instituted by *Anurath I.* called the conqueror, who chusing out one fifth part of the *christian* prisoners taken from the *Greeks*, and instructing them in the discipline of war, and the doctrine of their religion, he sent them to *Hagi Bektasche* (a person whose pretended piety rendered him much revered among the *Turks*) to the end that he might confer his blessing on them, and at the same time give them some marks to distinguish them from the rest of the troops. *Bektasche*, after blessing them in his manner, cut off one of the sleeves of his fur gown, and put it on the head of the leader of this new militia; from which time, viz. the year of CHRIST 1361, they have retained the name of *Jenitcheri*, and the fur cap.

As in the *Turkish armies* the *European* troops are distinguished from those of *Asia*; the *Janizaries* are also distinguished into *Janizaries of Constantinople* and of *Damascus*. Their dress consists of a *dolymann*, or long gown, with short sleeves, which is given them annually by the Grand Signior, on the first day of *Ramazan*. They wear no turban, but in lieu thereof a kind of cap which they call *zarcolla*, and a long hood of the same stuff, hanging on their shoulders. On solemn days they are adorned with feathers, which are stuck in a little case in the forepart of the bonnet.

Their arms in *Europe*, in a time of war, are a sabre, a carabine, or musquet, and a cartouch-box hanging on the left side. At *Constantinople*, in a time of peace, they wear only a long staff in their hand. In *Asia*, where powder and fire-arms are less common, they wear a bow and arrow, with a poniard, which they call *haniare*.

The *Janizaries* are children of tribute levied by the *Turks* among the christians, and bred up to the military life. They are taken at the age of twelve years, to the end that forgetting their country and religion, they may know no other parent but the Sultan. However, generally speaking, they are not at present raised by way of tribute; for the *carach* or *tau*, which the *Turks* impose on the christians, for allowing them the liberty of their religion, is now paid in money, excepting in some places where money being scarce, the people are unable to pay in specie, as in *Mingrelia*, and other provinces near the *Black Sea*.

The officer who commands the whole body of the *Janizaries*, is called *Janizar Agasi*; *Agas* of the *Janizaries*; who is one of the chief officers of the empire.

The

The *SPAHIS*, as we have observed already, compose part of the cavalry of the *Ottoman army*; their commandant is called *Spahi Agasi*.

The *TIMARIOTS*, are those who enjoy lands on the footing and tenure of *Timar*, which is a tract or portion of land which the *Grand Signior* grants to a person on condition of serving him in war on horseback.

The *Timariots* are obliged to serve in war personally with as many men and horses for service as their *Timar*, by the estimation made thereof, contains 2500 *aspers*, or about six pounds sterling; and to maintain them constantly mounted and armed after their manner, to be ready to march at all hours when commanded, and that on pain of death, nothing, not even sickness itself, being allowed to excuse them.

Besides this service, they likewise pay an acknowledgment of one tenth of their revenue. If they have any children of age to bear arms, and fit for the service after their decease, or in defect thereof, if they have any relations that have the least interest, the *Timar* is used to be continued to them on the same conditions; otherwise it is transferred to others.

If the revenue thus held of the *Grand Seignior* exceed 15000 *aspers*, or 36 *l.* sterling, they who hold it are not called *Timariots*, but *Subassi* or *Zaims*, and have the administration of justice in the place.

The *Timariots* have different appointments from 4 or 5000 *aspers*, equal to about 12 *l.* sterling, to 20,000 *aspers*: but unless their *Timar* exceed 8000 *aspers*, they are never obliged to march, except when the *Grand Seignior* goes to the army in person, on which occasion none are exempted.

The origin of the *Timariots* is referred to the first Sultans, who being masters of the fiefs or lands of the empire, erected them into baronies or commanderies, to reward the service of their bravest soldiers; and especially to raise and keep on foot a number of troops without disbursing any money. But it was *Soliman II.* that first established the order and discipline among these barons or knights of the empire; but avarice, the ordinary fault of the orientals, has occasioned their declension of late years. The vice-roys and governors of provinces manage their matters so at court, that *Timars*, even out of their jurisdiction, are given to their domesticks, or to such as will give the most money for them.

There are two kinds of *Timariots*, the one appointed by the *Porte*, the other by the Viceroy of the country; but the revenues of both are less than those of the *Zaims*. Those who receive their patents from the Viceroys, have from 3 to 6000 *aspers* \* per Ann.

This cavalry is better disciplined than that properly called the *Spahis*, though the *Spahis* be the neatest and briskest. These last only fight in platoons; whereas the *Zaims* and *Timariots* are divided into regiments, and commanded by colonels, under the direction of *Bashaws*. The *Bashaw* of *Aleppo*, when in the army, is *colonel-general* of this militia.

Shepherds, water-carriers, and other such undisciplined mob, compose the rest of the *Ottoman* forces or armies.

The armies of the Empire consist of divers bodies of troops furnished by the several circles.

The gross of the *French armies* under the *Mervingian*, or first race of their Kings, consisted of infantry. Under *Pepin* and *Charlemain*, the armies consisted almost equally of cavalry and foot; but since the declension of the *Carlovingian* or second line, the fees being become hereditary, the national armies, says *Le Gendre*, are chiefly cavalry. The late King of France, *Lewis XIV.* has often brought twelve armies into the field, making up in all 500,000 men.

IN ENGLAND the land forces anciently consisted of a kind of MILITIA composed chiefly of tenants to the crown and vassals of lands, which were held *in capite* from their sovereign. But when our Kings were engaged in the conquests upon the continent, we find them hiring mercenary troops to enable them to meet the enemy abroad, without exposing this island, by drawing off the militia, its natural strength. And since the Revolution in 1688 this nation has been obliged by its connections with the powers in Germany, to maintain a standing army, not only at home, but also of German mercenary auxiliaries, for the most part of the time.

These measures so eclipsed the militia, with their discipline and service, that it was reduced almost to a state of annihilation; till the present ministry, (convinced of the necessity of an internal defence by a regular and well-disciplined militia to guard the nation from the invasions of our enemies, and to deliver us from the expence and hazard of hiring foreign

\* The *aspers* is a little Turkish silver coin, worth something more than an English halfpenny. The only impression it bears is that of the Prince's name under whom it was struck. The pay of the *Janizaries* is from two to twelve *aspers* per diem. Most of the *Grand Seignior's* revenues are paid in *aspers*.

*troops* to guard our coasts, in certain cases) are endeavouring, under the sanction of the parliament, to re-establish that force, which was once the glory of the nation and the terror of *Europe*. For, tho' our greatest strength consists in our *naval forces* or *armies*; yet this is only to be considered in regard to our quarrels with maritime states; and our defence by sea. Our *land-forces* have always maintained a dignity beyond those of other nations in the wars of *Europe*, both for their equipment, courage and conduct.

However, it must be confessed, that our greatest strength consists in its *naval forces* or *armies*; which NAVAL ARMIES are a number of ships of war, equipped and manned with sailors and marines, under the command of an *admiral*, with other inferior officers under him.

An ADMIRAL is a great officer, who commands the *naval forces* of a kingdom or state, and takes cognizance by himself, or officers appointed by him, of all maritime causes.

*Du Cange* assures us, that the *Sicilians* were the first, and the *Genoese* the next after them, who gave the denomination of *admiral* to the commanders of their *naval* armaments, and that they took it from the *Saracen* or *Arabic Amir*, a general name for any commanding officer; though there are no instances of *admirals* in this part of *Europe*, before the year 1284; when *Philip* of *France*, who had attended *St. Louis* to the wars against the *Saracens*, created an *admiral*.

The *French* have at present an *admiral* in chief, called the *great admiral of France*, who is always a person of the first rank, and of an illustrious birth; and two *vice-admirals*, one of the *Levant*; the other of the *Ponant*. The two *vice-admirals* have also under them *rear-admirals*, *lieutenant-generals*, and chief *descadres*. When the *grand* or *high-admiral* commands in person, the *vice-admirals* command each his division.

A *French* fleet is commonly divided into three divisions; the white division; the blue division; and the white and blue division. But when the *high* or *grand-admiral* does not command in person, it is always the *vice admiral* of the *Levant* who commands in the *Mediterranean*, and that of the *Ponant* on the *Ocean*. The *grand-admiral* carries a squared flag, at the main top-mast, of blue silk, embroidered with a golden *sun*, with the late king's *device* or *motto*, *nec pluribus impar*. The *vice-admiral*, when the *admiral* commands in person, carries his *flag* at the mizen top-mast. The king of *France* has always 50000 seamen registered,

who are obliged to pass in review before the commissary of the marine appointed for that purpose in each department or district of the marine provinces, viz. *Britanny*, *Normandy*, *Poitou*, *Aunis*, *Provence*, *Guienne*, *Languedoc*, &c. on the first notice given them by the said commissary; who chooses from among those who appear before him, as many boat-swains, gunners, carpenters, caulkers, and common sailors as he wants, without being obliged to press vagrants or men unacquainted with sea affairs, into that service. Each man of war, besides its complement of sailors, has on board one or two companies of marines, which are independent companies always kept in pay, and exercised for that purpose; besides a detachment or brigade of *guards marines*, who are young noblemen, brought up to the sea at the king's expence, and commanded by a *brigadier*. Out of that body of the *guards marines*, are taken all the officers of the navy, and they are promoted according to the report made by their superior officer to the king, of their courage, knowledge, and experience.

In every sea-port there is a commandant of the marine, who is commonly called a captain of *haut bord*, as they call it, or of a first-rate man of war, and who commands all the marines of that department or district; an intendant of the marines, who is judge of the court of *admiralty* in that place; and a commissary of the marine, who has under him a comptroller, a treasurer, and several *commis* or clerks of his office, which they call *le bureau des classes*, because there is kept the register of all the sailors of that department, wherein every sailor is registered according to his rank and employment.

The LORD HIGH ADMIRAL of *England*, in some antient records called *Capitaneus marinarum*, is judge or president of the court of *admiralty*.

He takes cognizance by himself, his lieutenant, or deputies, of all crimes committed on the sea, or the coast thereof, and all the civil and marine transactions relating thereto: as also of what is done in all great ships riding in any river, beneath the bridges thereof next the sea. We have had no high-admiral for some years; the office being put in commission, or under the administration of the *lords commissioners of the admiralty*.

*Admiral* is also used here, for the commander in chief of a single fleet or squadron. Thus we say, the *admiral* of the red, the *admiral* of the white, and the *admiral* of the blue. The term *admiral*, is also applied to all flag-officers: in which sense it includes *vice-admirals*, and *rear-admirals*. No nation in the whole world has ever produced a greater number of braver *admirals*, and other sea-officers than *England*. Their heroic actions have been

admired and applauded under both hemispheres ; and their single appearance has always alarmed the coasts of the most formidable enemies of the *English* name ; and no doubt but our posterity will remember with as much pleasure and gratitude, *Jenning, Norris, Hosier, Wager, Vernon, Haddock,*

*Shovel, &c.* as we do *Drake, Cavendish Blake, Rooke, Matthews, Warren, Anson, Boscawen, &c.* For whose expeditions and actions, and what else relates to the *British navy, see* LENTICK'S NAVAL HISTORY.

## A S T R O L O G Y.

**A**STROLOGY (*Gr.* αστρον, a star, and λογος, a discourse) is defined the art of prognosticating or foretelling events by the aspects, positions and influences of the heavenly bodies.

Where, by *aspect* is to be understood an angle formed by the rays of two planets meeting on earth, able to execute some natural power or influence. All which will be better explained by the inspection of the following table : where you have

### The CHARACTERS of the

Six Northern SIGNS	Six Southern SIGNS	PLANETS	ASPECTS
♈ Aries	♎ Libra	♄ Saturn	♌ Conjunction
♉ Taurus	♏ Scorpio	♃ Jupiter	* Sextile
♊ Gemini	♐ Sagittarius	♂ Mars	Δ Trine
♋ Cancer	♑ Capricorn	☉ Sun	□ Quartile
♌ Leo	♒ Aquarius	♁ Earth	♁ Opposition
♍ Virgo	♓ Pisces	♀ Venus	
		♿ Mercury	
		♃ Luna	

This art, or conjectural science, is principally divided into *natural* and *judiciary*.

**NATURAL** ASTROLOGY confines its study to explore natural effects ; as, change of weather, winds, storms, hurricanes, thunder, floods, earthquakes, and the like.

In this sense, **ASTROLOGY** is admitted to be a part of *natural philosophy*. **MR. GOAD, MR. BOYLE,** and **DR. MEAD** plead for its use in this light. The former endeavours to account for the diversity of seasons from the situations, habitudes and motions of the planets ; and to explain an infinity of *phenomena* by the contemplation of the stars. The honourable **MR. BOYLE** admits that all physical bodies are influenced by the heavenly bodies : and the doctor's opinion, in his treatise concerning the *Power of the Sun and Moon, &c.* is in favour of this doctrine.

But these predictions and influences are ridiculed and entirely exploded by the most admired modern philosophers, of which the reader has a learned specimen in **ROHAULT'S** *Traët. Physic.* Par. 2. c. 27.

**JUDICIAL** or **JUDICIARY** ASTROLOGY is a further pretence to discover or foretel *moral* events, or such as have a dependance on the *freedom of the will*.

In this part of *Astrology* we meet with all the idle conceits about the horary reign of planets, the doctrine of horoscopes, the distribution of the houses, the calculation of nativities, fortunes, lucky and unlucky hours, and other fatalities.

The professors hereof maintain, ' that the heavens are one great volume or book, wherein **GOD** has wrote the history of the world ; and in which every man may read his own fortune, and the transactions of his time. This art, say they, had its rise from the same hands as *astronomy* itself : while the antient *Affyrians*, whose serene unclouded sky favoured their celestial observations, were intent on tracing the paths and periods of the heavenly bodies ; they discovered a constant settled relation or analogy between them and things below ; and hence were led to conclude these to be the *parææ*, the *destinies*, so much talk'd of, which preside at our births, and dispose of our future state.'

This study is so flattering to human curiosity, that it got early admission into the favour of mankind, especially of the weak, ignorant and effeminate : and their foibles induced the avaritious, crafty, and designing knaves to recommend and promote it for their private interests and advantage.

We first meet with an account of ASTROLOGY in *Cbaldea*; and therefore at *Rome* it was known by the name of the *Babylonish calculation*: against which, *Horace* very wisely cautioned his readers, in *Lib. 1. Ode XI.* where he writes,

—*nec Babylonios*

*Tentaris numeros.*

i. e. consult not the tables or planetary calculations used by *Astrologers* of a *Babylonish* origin. This was the opinion of the *Romans*. But others ascribe the invention of this deception to the *Arabs*.

Be that as it will; *judiciary astronomy* has been too much used by the priests of all nations, to create their own authority. The *Egyptians*, the *Chaldeans*, the *Greeks* and *Romans* furnish us with innumerable instances to confirm the assertion. The *Bramins* amongst the *Indians*, who take upon them to be the arbiters of good and evil hours, and set an extravagant price upon their pretended knowledge of planetary predictions, maintain their authority by the same means. And if one had time to unveil the attempts made in this art by *Christians*, it would be found that *Astrology* has yet its admirers and advocates almost in every society or family; as you will see in the sequel of this treatise. For, tho' they have not all pursued or adopted the same technical method; it is certain that whoever pretends to discover futurity by any other means than divine revelation, may be properly reduced under the name of *judiciary Astrologers*.

They who pretend to reduce this practice into a system, present the world with certain schemes formed upon the *aspects* of the planets: and attribute certain qualities or powers to each sign.

Thus to discover the influence of the heavens over the life of a person, they erect a *theme*, at the given time of the moment he or she was born; whereby the *Astrologers* pretend to discover the *star* that presided, or in what part of the hemisphere it was placed when such person was born into the world.

This erection of their *theme*, they pretend to perform with the assistance of the *celestial globe*, or of the *planisphere*, with regard to the *fixed stars*; but as to the planets, they do it with *astronomical tables*. To accomplish which, they have recourse to a *semi-circle*, which they call *position*, by which they represent the six great circles passing through the intersection of the *meridian* and *horizon*, and dividing the *equator* into twelve equal parts. The spaces included between these circles, are what they call the *twelve houses*: which they refer to the twelve triangles marked in their *theme*; placing six of those houses above the *horizon*, and six underneath the *horizon*.

The first of the *houses* under the horizon toward the east, they call the *horoscope*, or *house of life*; the second, the *house of wealth*; the third, the *house of brothers*; the fourth, the *house of parents*, &c. as is clearly explained in the two following verses.

*Vita, lucrum, fratres, genitor, natiqve, valetud',  
Uxor, mors, pietas, & munia, amici, inimici.*

Thus turned into *English* metre by some students in *Astrology*,

*The first house shews life, the second wealth doth  
give;*

*The third how brethren, fourth how parents live;  
Issue the fifth; the sixth diseases bring;*

*The seventh wedlock, and the eighth death's sting;*

*The ninth religion; the tenth honour shews;*

*Friendship the eleventh, and the twelfth our woes.*

The *Astrologers* draw their table of the *twelve houses*, into a triple quadrangle prepared for the purpose, of which there are four principal angles, two of which fall equally upon the *horizon*, the other upon the *meridian*, which angles are subdivided into twelve triangles for the *twelve houses*, and in those houses they place the *twelve signs* of the *Zodiac*, attributing to each of them their particular quality, *viz.*

ARIES, denoted by this figure, ♈, is in their extravagant opinion, a masculine, diurnal, cardinal, equinoctial, easterly sign, hot and dry, the day-house of *Mars*.

TAURUS, ♉, is a feminine, nocturnal, melancholy, bestial, furious sign, cold and dry.

GEMINI, ♊, is a masculine sign, hot and moist, diurnal, aerial, human, double bodied, &c.

CANCER, ♋, is a feminine, nocturnal, phlegmatic sign, by nature cold and moist, the only house of *Luna*.

LEO, ♌, is a sign, masculine, diurnal, bestial, choleric and barren; a commanding, kingly sign, hot and dry, the only house of the *sun*.

VIRGO, ♍, is a feminine, nocturnal, melancholy, and barren sign.

LIBRA, ♎, is a sign masculine, cardinal, equinoctial, diurnal, sanguine and human, hot and moist.

SCORPIO, ♏, is a feminine, nocturnal, cold and phlegmatic northern sign.

SAGITTARIUS, ♐, is a sign, masculine, choleric and diurnal, by nature hot and dry.

CAPRICORN, ♑, is a feminine, nocturnal, melancholy, solstitial, moveable, cardinal and southern sign.

AQUARIUS, ♒, is a masculine, diurnal, fixed, sanguine, and human sign.

PISCES, ♋, is a feminine, nocturnal, phlegmatic, northerly, double-bodied sign, the last of the twelve.

Having thus housed their signs, and directed them in their operations, they afterwards come to enquire of their *tenants*, what planet, and fixed star they have for *lodgers*, at the moment of the nativity of such person; from whence they draw conclusions with regard to the future incidents of that person's life. For example, if at the time of that person's nativity they find *Mercury* in 27 degrees, 52 minutes of *Aquarius*, and in the *sextile aspect* of the *horoscope*; they pretend to foretel that infant will be a person of great sagacity, genius and understanding, and therefore capable to learn the most sublime sciences.

*Astrologers* imagine also, for the same ridiculous purpose, to be in the same houses, different positions of the signs and planets, and from their different aspects, opposition and conjunction, and according to the rules and axioms they have prescribed to themselves and invented, have the sacrilegious presumption to judge, in *dernier resort*, of the fate of mankind, though their pretended art or science is quite sterile or barren in proofs and demonstrations.

The PLANETS have allowed them, every one, except *Sol* and *Luna*, two signs for their houses; to SATURN, the *Capricorn* and *Aquarius*; to JUPITER, *Sagittarius* and *Pisces*; to MARS, *Aries* and *Scorpio*; to SOL, *Leo*; to VENUS, *Taurus* and *Libra*; to MERCURY, *Gemini* and *Virgo*; and to LUNA, *Cancer*.

The *Planets* by their continual mutation through the twelve signs, make several angles or aspects, the most forcible of which are these five.

♌ *Conjunction*, ♋ *Trine*, ♎ *Quadrante*, \* *Sextile*, ♌ *Opposition*.

A CONJUNCTION is when two *planets* are in one and the same degree and minute of a sign; and this is, say our jugglers, either good or bad, as the *Planets* are either friends or enemies.

A TRINE is when any two *planets* are four signs, or 120 degrees distant, as *Mars* in 12 degrees of *Aries*, and *Sol* in 12 degrees of *Leo*. Here *Sol* and *Mars* are said to be in trine aspect. And this is an aspect of perfect love and friendship.

A QUADRATE aspect is when two *planets* are three signs, or 90 degrees distant, as *Mars* in 10 degrees of *Taurus*, and *Venus* in 10 degrees of *Leo*. This particular aspect is of imperfect enmity, and *Astrologers* say, that persons signified thereby, may have jars at some time, but such as may be reconciled again.

A SEXTILE aspect is when two *planets* are two signs, or 60 degrees distant, as *Jupiter*, in 15 de-

grees of *Aries*; and *Saturn*, in 15 degrees of *Gemini*; here *Jupiter* is in a *sextile* aspect to *Saturn*. This is an aspect of friendship.

AN OPPOSITION, is when two *planets* are diametrically opposite, which is, when they are six signs, or 180 degrees (which is one half of the circle) asunder, and this is an aspect of perfect hatred.

A PARTILE aspect, is when two *planets* are in a perfect aspect to the very same degree and minute.

DEXTER aspects, are those which are contrary to the succession of signs, as a *planet* in *Aries* casts its *sextile dexter* to *Aquarius*.

SINISTER aspect is with the succession of signs, as a *planet* in *Aries* casts its *sextile sinister* in *Gemini*.

*Astrologers* play a great many other diverting tricks, hence we read of the application, prohibition, separation, translation, refrenation, combustion, exception, retrogradation &c. of *planets*.

The APPLICATION of *planets* is performed by them, three ways. 1. When a light *planet* being direct and swift in motion, applies to a *planet* more ponderous, and slow in motion, as *Mercury* in 8 degrees of *Aries*, and *Jupiter* in 12 degrees of *Gemini*; and both direct; here *Mercury* applies to a *sextile* of *Jupiter*, by direct application. 2. When they are both retrograde, as *Mercury* in 20 degrees of *Aries*, and *Jupiter* in 15 degrees of *Gemini*; here *Mercury*, the lighter *planet*, applies to the *sextile aspect* of *Jupiter*; and this is by retrogradation. 3. When one of the *planets* are direct, and the other retrograde; as suppose *Mercury* were retrograde in 18 degrees of *Aries*, and *Jupiter* direct in 14 degrees of *Gemini*; here *Mercury* applies to a *sextile* of *Jupiter*, by a retrograde motion.

PROHIBITION, is when two *planets* are applying either by body or aspect; and before they come to their *partile* aspect, another *planet* meets with the aspect of the former, and so prohibits it.

SEPARATION, is when two *planets* have been lately in *conjunction*, or *aspect*, and are separated from it.

TRANSLATION of light and virtue, is when a lighter *planet* separates from the body or aspect of a more weighty one, and immediately applies to another superior *planet*, and so translates the light and virtue of the first *planet* to that which it applies to.

REFRENATION, is when a *planet* is applied to the body or aspect of another; and before it comes to it, falls retrograde, and so refrains by its retrograde motion.

COMBUSTION. A *planet* is said to be combusted of *Sol*, when it is within 8 degrees 30 minutes of his body, either before or after their conjunction; but *Astrologers* complain, that a *planet* is more afflicted

affected when it is applying to the body of *Sol*, than when it is separating from *combustion*.

RECEPTION, is when two planets are in each others dignities, and it may be either by house, exaltation, triplicity, or term.

RETROGRADATION, is when a planet moves backward from 20 degrees to 9, 8, 7, and so out of *Taurus* into *Aries*.

FRUSTRATION is when a swift planet applies to the body or aspect of a superior planet; and before it comes to it, the superior planet meets with the body or aspect of some other planet.

To the seven planets, viz. *Saturn*, *Jupiter*, *Mars*, *Sol*, *Venus*, *Mercury* and *Luna*, *Astrologers* add two certain nodes or points, called the *Dragon's-Head*, distinguished by this sign ☉, and the *Dragon's-tail* by this other ☊. In those two extremities of the beast, our students in *Astrology* place such virtues, that they can draw from thence wealth, honours, preferments, &c. enough to flatter the avarice, ambition, vanity, &c. of the fools who follow them.

I am sensible that the admirers of this art support their principles and defend their doctrine by examples founded upon their own experience, and upon the authority of history. But the weakness of their arguments have been so often exposed, that it can't be required here to refute them. Let *Tully's* reproof suffice; who during the darkest clouds, and greatest obscurity of Paganism, while religion itself seemed to countenance *Astrology*, inveighs severely against it. *Quam multa*, says he, *lib. 2 de divinat. ego Pompeio, quam multa Crasso, quam multa huic ipsi Cæsari a Chaldæis dicta memini, neminem eorum nisi senectute, nisi domi, nisi cum claritate esse moriturum? Ut mihi per Mirum videatur quemquam extare, qui etiam nunc credatis, quorum prædicta quotidie videat re & eventis refelli.* i. e. "I so well remember the *Chaldæans* predictions to *Pompey*, to *Crassus*, and to this same *Cæsar*, that none of them should die, but full of years and glory, and in his house, that I am surprized, that there are yet some persons capable to believe those, whose predictions are every day contradicted and refuted by the event."

Instead of *astrological calculations*, we find certain vain, ridiculous, and insignificant figures, invented by the *Chaldæans*, *Persians*, *Ægyptians*, and *Arabs*, called in the *Arabic* language TALISMANS; which are the seal, figure, character or image of a heavenly sign, constellation or planet, engraven on a sympathetic stone, or on a metal corresponding to the star, &c. in order to receive its influences; and to which *Astrologers* attribute some ridiculous, marvellous effects; as those of curing distempers; of rendering persons invulnerable, &c. So that a figure of lead, called *Saturn* by the *alchemists*, and impressed with

the character of *Saturn*, being tied to the neck of a person, who has the plague, which, say they, is a *Saturnian* distemper, will effectually cure him.

The TALISMANS of the *Samothracians*, so famous of old, were pieces of iron formed into certain images, and set in rings, &c. They were held preservatives against all kinds of evils. There were other *Talismans* taken from vegetables, and others from minerals. Are not the amulets still in vogue amongst us the remains of this superstition?

In general we use to distinguish three kinds of *Talismans*: *Astronomical*, which are known by the signs or constellations of the heavens engraven thereon, with other figures and some intelligible characters: *Magical*, which bear very extraordinary figure, with superstitious words, and names of angels unheard of; and *mixt*, which consist of signs and barbarous words, but have no superstitious ones, or names of angels.

All the miraculous things wrought by *Apollonius Tyanaeus*, are attributed to the virtue and influence of *Talisman*; and he is even said to have been the inventor of *Talismans*.

*Astrologers* have also made use of all their best artifices, and employed all the rules of their pretended art, to render those years of our age, which they call *climactericks*, dangerous and formidable.

CLIMACTERICK, from the *Greek*, κλιμακτης, q. d. by a scale or ladder, is a critical year, or a period in a man's age, wherein, according to those jugglers, there is some notable alteration to arise in the body; and a person stands in great danger of death.

The first *climacterick*, say they, is the seventh year of a man's life; the rest are multiplies of the first, as 21, 49, 56, 63, and 84; which two last are called the *grand climactericks*, and the dangers here supposed more certain.

*Marc Ficinus* gives us the foundation of this opinion: he tells us there is a year assigned for each planet to rule over the body of a man, each in his turn; now *Saturn* being the most maleficent planet of all, every seventh year, which falls to its lot, becomes very dangerous; especially those of 63 and 84, when the person is already advanced in years.

Some hold, according to this doctrine, every seventh year an established *climacterick*; but others only allow the title to those produced by the multiplication of the climacterical space by an odd number, 3, 5, 7, 9, &c. Others observe every ninth year as a *climacterick*.

*Hevelius* has a volume under the title of *Annus Climactericus*, describing the loss he sustained in the burning of his observatory, &c. which it seems happened in his first *grand climacterick*. *Suetonius* says, *Augustus* congratulated his nephew upon his having passed

passed his first grand climacterick, whereof he was very apprehensive.

Some pretend that the climacterick years are also fatal to political bodies; which perhaps may be granted, when it is proved that they are so to natural ones; for I must confess that I cannot discover the reason of such danger, nor what relation it can have with the number above-mentioned. Though this opinion has a great deal of antiquity on its side. *Aulus Gellius* says, it was borrowed from the *Chaldeans*, who might probably receive it from *Pythagoras*, whose philosophy turned much on numbers, and who imagined an extraordinary virtue in the number 7.

Authors on the subject, are *Plato*, *Cicero*, *Macrobius*, *Aulus Gellius*, among the antients; *Argol*, *Magirus*, and *Salmatius* under the moderns. *St. Augustin*, *St. Ambrose*, *Beda*, and *Bactius* countenance the opinion.

*Astrologers* have also brought under their inspection the days of the years, which they have the presumption to divide into lucky and unlucky days, calling even the sacred text, and the common belief of christians, in former ages, to their assistance on this occasion. They pretend that the fourteenth day of the first month was a blessed day among the *Israelites*, authorized therein, as they pretend, by the several passages out of *Exod. xiii. 18, 40, 41, 42, 51. Levit. xxiii. 5. Numb. xxviii. 16.* Four hundred and thirty years being expired of their dwelling in Egypt, even in the self same day departed they thence.

As to evil days and times, they refer to *Amos v. 13, and vi. 3. Eccles. ix. 12. Psal. xxxvii. 19. Obad. xii. Fer. xlvi. 21.*—and to *Job* cursing his birth day, *chap. iii. ver. 1 to 11.* In confirmation thereof, they also quote a calendar, extracted out of several antient Roman Catholick prayer books, written upon vellum before the invention of printing, wherein were inserted the unfortunate days of each month, as in the following verses.

JANUARY. *Prima dies mensis, & septima truncat ut exis.*

FEBRUARY. *Quarta subit mortem, prosternit tertia fortem.*

MARCH. *Primus mandentem, disruptit quarta bibentem.*

APRIL. *Denus & undenus est mortis vulnere plenus.*

MAY. *Tertius occidit, & septimus ora relidit.*

JUNE. *Denus pallescit, quindenus fœdera nescit.*

JULY. *Ter denus maculat, Julii denus labefaculat.*

AUGUST. *Prima necat fortem, perditque secunda cohortem.*

SEPTEMBER. *Tertia Septembris, & denus fert mala membris.*

OCTOBER. *Tertius & denus, est sicut mors alienus.*

NOVEMBER. *Scorpius est quin'us, & tertius est vita tinētus.*

DECEMBER. *Septimus exanguis, virosus denus ut anguis.*

This poetry tastes much of the rusticity and ignorance of those times, and is a convincing proof that *Christianity* had yet a very strong tincture of the *Pagan* superstitions, which the purity of the Gospel has not been capable yet to blot out among us.

That such ridiculous notion of lucky and unlucky days, owes its origin to *Pagan* superstition, may be proved from the *Roman* historians, who mention that that very day four years, the civil wars were begun by *Pompey* the Father; *Cæsar* made an end of them with his sons, *Cneius Pompeius* being then slain; and that the *Romans* accounted *February* the 13th an unlucky day, because on that day they were overthrown by the *Gauls* at *Allia*, and the *Fabii* attacking the city of the *R. cii*, were all slain save one: from the calendar of *Ovid's Fastorum*. *Aprilis erat Mensis Græcis auspiciatissimus*; and from *Horace*, *Lib. 2. Ode 13.* Curling the tree that had like to have fallen upon him.

*Ille nefasto te posuit Die.*

What has contributed much to confirm the *Pagans* as well as the *Christians* in their opinion on this subject, are the several remarkable events that happened at some particular days. As, *Alexander the Great*, being born the 6th of *April*, conquered *Darius*, and died the same day. The emperor *Bassianus Caracalla*, being born the 6th of *April*, and died the same day. *Augustus* having been adopted the 19th of *August*, began his consulate, conquered the *Triumviri*, and died the same day.

As for the *Christians*; they have observed that the 24th of *February* was four times fortunate to *Charles V.* emperor. That *Wedesday* was a fortunate day to pope *Sextus V.* for on a *Wedesday* he was born; on that day made a monk; on the same day made a general of his order; on that day created cardinal; on that day elected pope; and also on that day inaugurated. That *Thursday* was a fatal day to *Henry VIII.* king of *England*, and his posterity, for he died on *Thursday*; king *Edward VI.* on *Thursday*; queen *Mary* on *Thursday*; and queen *Elizabeth* on *Thursday*. The *French* have observed that the feast of *Pentecost* had been lucky to *Henry III.* King of *France*, for on that day he was born; on that day elected king of *Poland*, and that day he succeeded his brother *Charles IX.* on the throne of *France*.

Here

Here, among ourselves are too many *Astrologers*; especially of the female kind, who are more careful to observe a *lucky* or *unlucky day*, than to keep their family in good order; who study a stranger on the fire-grate, the motions of a cat, the howling of a dog, the death-watch, the itching of their elbow, knee, feet, or of something else, with great attention; who are two or three hours poring over an empty tea-cup, to see if they can discover in it a husband, who shall keep a coach and six, or if a secret intrigue is to succeed according to expectation, or a love-letter to be answered, and an infinity of other ignorant, stupid, scandalous, ridiculous, and unchristian-like observations; when they should be otherwise employed. These errors and scandalous practices proceed from a vitiated education; and in some families this sort of *Astrology*, divination, or what you'll be pleased to call it, is a kind of hereditary distemper, which circulates with the blood throughout whole generations, and has its first origin from the *auguries* of the *pagans*, which were prefaces taken concerning futurity, from birds, beasts, and the appearances of the heavens.

*Varro* distinguishes four species of **AUGURY** according to the four elements. *Pyromancy*, or *augury by the fire*; *Aëromancy*, or *augury by the air*; *Hydromancy*, or *augury by the water*; and *Geomancy*, or *augury by the earth*.

**PYROMANCY.** The ancients imagined they could foretel futurity by inspecting fire and flame; to this end they considered its direction, or which way it turned, (which answers very well to the prognostications we draw from the manner our fire burns.) Sometimes they add other matters to the fire, *e. gr.* a vessel full of urine, with its neck bound about with wool, watching narrowly on which side it bursts, and thence taking their *augury*. Sometimes they throw pitch on it, and if it took fire immediately, esteemed it a good *augury*.

**HYDROMANCY.** *Varro* mentions the *Persians* as the first inventors of *hydromancy*, or divination by throwing of water; adding, that *Numa Pompilius* and *Pythagoras* made use thereof.

**GEOMANCY**, is performed by means of a number of little points or dots made on paper at random; and considering the various lines and figures, which those points present; and thence forming a judgment of futurity, or deciding any question proposed.

*Polydore Virgil*, lib. I. c. 23. *de Invent. Rer.* defines *Geomancy* a kind of divination performed by means of clefts or chinks made in the ground, and takes the *Persian Magi* to have been the inventors.

The particular branches of *augury*, are *Alectromancy*, *Anthropomancy*, *Belomancy*, *Catoptromancy*, *Capnomancy*, *Gastromancy*, *Aruspicina*, *Libanomancy*, *Lecanomancy*, &c.

**ALECTROMANCY**, from *αλεκτωρ*, a cock, and *μαντεια*, divination, is an antient kind of *divination*, performed by means of a cock.

This art was in use among the *Greeks*, and the usual manner of it was this. A circle was made on the ground, and divided into twenty-four equal portions or spaces; in each of which spaces was written one of the letters of the alphabet, and upon each of these letters was laid a grain of wheat. This done, a cock was turned loose in the circle, and careful observation made of the grains he pecked. The letters corresponding to those grains were afterwards formed into a word; which word was to be the answer desired.

It was thus that *Libanus* and *Jamblicus* sought who should succeed the emperor *Valens*; and the cock answering to the spaces *ΘΕΟΔ*, they concluded upon *Theodore*, by a mistake instead of *Theodosius*.

**ANTHROPOMANCY**, from *ανθρωπος*, man, and *μαντεια*, divination, is a method of divination performed by inspecting the *viscera* of a person deceased.

**BELOMANCY**, from *βελος*, arrow, and *μαντεια*, divination, is a kind of divination, by means of arrows practised in the east, but chiefly among the *Arabians*.

*Belomancy* has been performed in different manners: one was to mark a parcel of arrows, and put eleven or more of them into a bag; these were afterwards drawn out, and according as they were marked, or not, they judged of future events.

Another way was to have three arrows, upon one of which was wrote *God orders it me*; upon another, *God forbids it me*; and upon the third, nothing at all. These were put into a quiver, out of which they drew one of the three at random; if it happened to be that with the first inscription, the thing they consulted about was to be done; if it chanced to be that with the second inscription, it was let alone; but if it proved that without inscription, they drew over again.

*Belomancy* is an ancient practice, and probably that which *Ezekiel* mentions, c. xxi. 21. at least *St. Jerom* understands it so, and observes that the practice was frequent among the *Affyrians* and *Babylonians*. Something like it is also mentioned in *Hosea*, c. iv. only that *staves* are there mentioned instead of arrows, which is rather *rhabdomancy*, than *belomancy*. *Grotius*, as well as *St. Jerom*, confounds the two together, and shews that it pre-  
vaile

vailed much among the *Magi*, *Chaldeans*, and *Scythians*; whence it passed to the *Sclavonians*, and thence to the *Germans*, whom *Tacitus* observes to make use of it.

**CATOPTROMANCY**, from *κατοπτρον*, *speculum*, and *μαθεια*, *divination*, is a kind of divination among the antients; so called, because consisting in the application of a mirrour.

*Pausanias* says, it was in use among the *Achaians*, where those who were sick, and in danger of death, let down a mirrour, or looking glass, fastened by a thread into a fountain before the temple of *Ceres*; then looking in the glass, if they saw a ghastly, disfigured face, they took it as a sure sign of death: on the contrary, if the face appeared fresh and healthy, it was a token of recovery. Sometimes glasses were used without water, and the images of things future represented in them.

**CAPNOMANCY**, from *καπνος*, *smoke*, and *μαθεια*, *divination*, is a kind of divination by means of smoke, used by the antients in their sacrifices. The rule was, when the smoke was thin, and light, and rose strait up, it was a good omen; if the contrary, it was an ill one.

There was another species of *Capnomancy* consisting in the observation of the smoke rising from poppy, or jessamin-seed, cast upon light coals.

**GASTROMANCY**, from *γαστηρ*, *belly*, and *μαθεια*, *divination*, is a kind of divination practised among the antients, by means of words coming, or seeming to come out of the belly.

There is another kind of divination called by the same name, *Gastromancy*, which is performed by means of glasses, or other round, transparent vessels; at the bottom whereof certain figures appear by magic art. It is thus called, by reason the figures appear, as in the belly of the vessels.

**ARUSPICINA**, is the doctrine or discipline of the *Aruspices*.

The *Aruspices* were an order of priests among the ancient *Romans*, who foretold things to come, chiefly by inspecting the entrails of beasts killed in sacrifice. The antients were so fond of this art, that nothing of public or private affairs should be transacted without it. In *Aruspicina* it was observed whether the beast came willingly to the altar or not. Whether the entrails were of a natural colour, and not ulcerated, or whether any part were defective or wanting; and when *Augustus* found two galls in his sacrifice, the credulity of the people concluded a hope of peace with *Anthony*, and the amity of persons in choler with each other.

*Cato*, who was himself an *augur*, had so bad an opinion of the solidity of the *Aruspicina*, that he

used to say, he wondered how one *Aruspex* could look at another without laughing in his face.

The *Augurs* made a college of community, which at first consisted of three persons, one for each tribe; then of four, when *Servius Tullius* increased the tribes to that number;) then of nine four of them *Patricians*, and five *Plebeians*: lastly, *Sylla* made the number fifteen. They bore an *augural* staff or wand, called *lituus*; as the ensign of their office and authority. No affair of moment, could be resolved on, without first consulting them; and their advice, be what it would, was, by a decree of the senate, appointed to be exactly and religiously observed; but in all appearance, their advice was always agreeable to the sentiments of the senate; else I am of opinion, that they had made no scruple to follow a contrary one: or, which is the more likely, those advices were dictated by the senate, and that mummery of consulting the *augurs* was only to render their decrees more solemn to the people, who are always easily imposed upon by an outward shew of religion; for it is not reasonable to suppose, that the most sensible part of that warlike and judicious nation could have been thus led by the nose, or believed blindly all their superstitious ceremonies, and the pious frauds and impostures, invented with no other design than to abuse the ignorance, and too great credulity of the vulgar.

To this chimerical doctrine of the heavenly bodies, we may add in this place, all the other tricks, impostures, and *legers de main*, made use of by *Astrologers*, jugglers, and fortune-tellers, to decoy us into their nets, and pick our pockets. There is scarce a corner in our streets, which, notwithstanding the salutary laws made against such scandalous and criminal practices, is not pestered with the emissaries of *students* in *ASTROLOGY*, and who take care to inform young buxom lasses in a longing condition for a man; wives tired of their husbands; barren ladies, who want to be rendered prolific; young widows, who would be glad to be married again; that in such a place lives a student in *astrology*, or *star-gazer*, who resolves all lawful questions (as he calls them) by the help not only of the *stars* and *planets*, but likewise of *Brizomancy*, *Chiromancy*, &c.

**BRIZOMANCY**, is the pretended art of foretelling future events by *dreams*.

*Macrobius* mentions five sorts of *dreams*, viz. 1. a *vision*; 2. a discovery of something between sleep and waking; 3. a suggestion cast into our

fancy, called by *Cicero*, *visum*; 4. An ordinary dream; and, 5. A divine apparition or revelation in our sleep; such as were the *dreams* of the prophets, and of *Joseph*; as also of the *Magi* of the east.

The fictitious art of interpreting *dreams*, had its origin among the *Egyptians* and *Chaldeans*, those countries being fertile in superstitions of all kinds. The same art was brought from thence among the *Romans*, who judging some *dreams* worthy of observation, appointed persons on purpose to interpret them. Those who pretend that *dreams* are significatives of things to come, bring in confirmation of their opinion, an infinite number of *dreams*, which have been the fore-runners of very singular events; viz *Calphurnia*, *Julius Cæsar's* wife, dreaming the night before his death, that she saw him stabbed in the capitol. *Artorius*, *Augustus's* physician, dreaming before the battle of *Philippi*, that his master's camp was pillaged. The emperor *Vespasian* dreaming an old woman told him, that his good-fortune would begin, when *Nero* should have a tooth drawn, which happened accordingly. *Cæsar* dreaming he committed incest with his mother, was crowned emperor of *Rome*: and *Hippias*, the *Athenian* tyrant dreaming the like, died shortly after, and was interred in his mother earth. *Mauritius*, the emperor, who was slain by *Phocas*, dreaming a little before, that an image of Christ which was over the brazen gate of his palace, called him and charged him with his sins, and in the end demanded of him, whether he would receive the punishment thereof in this life or the next; and he answering in this, the image commanded he should be given, with his wife and children, into the hands of *Phocas*. Whereupon *Mauritius* awaking in great fear, asked *Philippus* his son-in-law, whether he knew any soldier in the army called *Phocas*; he answered, there was a commissary so called; and *Phocas* was his successor, having killed him, with his wife and five children. *Arlet*, while with child of *William the Conqueror*, dreaming that a light did spread from her womb, that shone all over *England*. *Maia*, *Virgil's* mother, prince of the *Latin* poets, dreaming she was delivered of a laurel branch, &c.

But it is ridiculous to compare the *dreams* minded by the vulgar, and which they want to be interpreted by conjurers and fortune-tellers, to these sorts of *dreams*; since what they want to know, is, what is meant when they dream that they see *ants*, *armed men*, *asses*, *black-birds*, *birds fighting*, *candles burning*, *children born*, *a cross*, *dragons*, *eagles*, *broken eggs*, *fire*, *fies*, *fountains*, *white horses*, *king or queen*, &c. that they commit *adultery*, *eat apples*, *cut bacon*, *eat bacon*, *bathe in a clear fountain*, *in stinking water*, *eat beans*, *have a long beard or hairs*,

*hear bells ring*, *hear a cock crow*, *fall in the dirt*, *hear a dog bark*, *lose their eyes*, *or their teeth*, *gather grapes*, *fall on the ground*; and an infinity of other silly questions, which the impostor interpreter has the impudence, in defiance of all laws and authority, to call lawful questions, and on whose interpretation the ignorant querist has but too often the folly to build an imaginary fortune. The ridiculous infatuation of *dreams* is so predominant here, even among persons who should know better, and especially the fair sex, that seldom a conversation passes without some *dreams* or other being brought on the tapis, to be interpreted by the company. I dreamed last night, says one, that I had lost some of my teeth: That's a sign, says another, that you will lose some of your relations. I am afraid I shall; replied the dreamer, for my cousin, or uncle, or brother such a one, is very ill: That's a very sure sign, says a third, for I dreamed once the same thing, and my poor husband (fetching then an affected sigh) died soon after: Not so sure neither, objected a fourth, for I dream often that I lose my teeth, and my husband is yet alive, and not likely to die soon as I know of, tho' he is a very great rogue to me.

What surprizes me most, is, that this ridiculous notion is so strongly inculcated in the minds of children, from their very cradle, that it is utterly impossible to root it out afterwards. If parents are not themselves ashamed of that scandalous infatuation, which is a plague to all those they are acquainted with, they should however have tenderness enough for their children, to forbear instructing them in the principles of that scandalous and ridiculous doctrine, which contributes so much toward disturbing their domestic peace and tranquility, and render them insupportable to themselves, and to those who are to live with them. Often the first salute a husband receives from his wife, in a morning, is the recital of her *dreams*, and half the day is spent in nothing else but relating and interpreting them. All the gossips she is visited by, must pass their verdict upon it, and the husband often obliged, to avoid being teased with it, to forsake his house, till some other incidents have forced the dreamer to forget her *dream*. Such practice smells so much of *paganism* and *idolatry*, that it is a scandal to *Christianity*, as entirely contradictory of the orders of the Divine Providence. Why does not our clergy thunder from the pulpit against it, and represent it as an artifice of the tempter of mankind, to decoy our souls into his net?

*Avicen* makes the cause of dreams to be an ultimate intelligence moving the moon in the middle of that light with which the fancies of men are illuminated

minated while they sleep. *Aristotle* refers the cause thereof to common sense, but placed in the fancy. *Averroes* places it in the imagination. *Democritus* ascribes it to little images, or representations, separated from the things themselves. *Plato* among the specific, and concrete notions of the soul. *Albertus*, to the superior influences which continually flow from the sky, through many specific mediums. And some physicians impute the cause thereof to vapours and humours, and the affections and cares of persons predominant when awake: for, say they, by reason of the abundance of vapours which immoderate feeding exhales, the brain, being therewith stuffed, forms infinite monsters, and strange chimeras, whereof the greatest eaters and drinkers may well satisfy us. Some dreams, continue they, are governed partly by the temperature of the body, and partly by the humour which abounds most in them; to which may be joined, the apprehensions which have preceded the day before, which is discovered in hounds, and some other creatures, which bray and bark in their sleep. As for dreams, conclude they, proceeding from the humours and temperature of the body, we see the *Cholericks* dream of burning, combats, yellow colours, &c. The *Phlegmaticks*, of water, baths, of sailing upon the sea, &c. The *Melancholicks*, of thick fumes, desarts, fantasies, hideous faces, &c. The *Sanguines*, of merry feasts, dances, &c. They that have the hinder part of their brain stopped with clammy humours, called by physicians *Ephialtes incubus*, or, as we call it, the *Night mare*, imagine, in dreaming, that they are stifled. And they that have the orifice of their stomach charged with malignant humours, are affrighted with strange visions, by reason of those venomous vapours that mount into the brain, and distemper it.

**CHIROMANCY**, from *χρη*, hand, and *μανεια*, divination; is the art of divining the fate, temperament, and disposition of a person, by the lines and lineaments of the hand; otherwise called *Palmistry*.

We have a number of authors on this vain and trifling art; as *Pythagoras*, *Helenus*, *Ptolomæus*, *Hermes*, *Avicen*, *Racis*, *Artemidorus*, *Fludd*, and *Johannes de Indagine*; *Taisnerus*, and *M. De la Chambre* have done the best.

This last insists on it, that the inclinations may be known by inspecting the hand, there being a very near correspondence between the parts of the hand,

and the internal parts of the body, the heart, liver, &c. whereon the passions and inclinations much depend. He adds, however, that the rules and precepts of *Chiromancy* are not sufficiently warranted, the experiments whereon they stand, not being well verified. He concludes, that there must be a new set of observations, made with justness and exactitude; in order to give *Chiromancy* the form and solidity which an art or science demands.

This fictitious art is only practised by *gyppies*, *vagabonds*, and silly old women; who have, however, cunning enough to make the vulgar believe that the seven planets predominate over the seven mountains, which this art places in the palm of a man's hand; and that the lines therein have a doctrine of community with the length of life; and that riches, accidents, or other events, are to be judged of thereby.

Of all these fanciful arts of the ancients, diffused among the moderns, there are none which have so much foundation in nature as *Physiognomy* and *Metoposcopy*.

**PHYSIOGNOMY**, (from *φυσις*, nature, and *γνωσκω*, I know,) is the art of knowing the humour, temperament, or disposition of a person, from observation of the lines of his FACE, and the characters of his features.

There seems to be something in *Physiognomy*, and perhaps, there is an apparent correspondence between the face and the mind; that the features and lineaments of the one, are directed by the motions and affections of the other; that there is even a peculiar arrangement of the muscles of the face, a peculiar disposition of the countenance to each particular affection, and to each particular idea of the mind.

In effect, the language of the face, *Physiognomy*, is as copious, nay, perhaps, as intelligible, and distinct as that of the tongue, and speech. However, we can very well say, with *Tullius*, *Lib. 1. Epist. ad quantum fratrem*, *Eist. 1. Frons, oculi, vultus, persæpe mentiuntur*, i. e. the forehead, eyes, and face, very often lie.

**METOPOSCOPY** is no more than a branch of *Physiognomy*, with this single difference, that *Metoposcopy* is the art of discovering the temperament, inclinations and manners of persons, by inspecting the lines of their foreheads.

## A S T R O N O M Y.

**A**STRONOMY (*Greek*, ἀστρον, a star, and νόμος a rule or regulation) is the doctrine of the heavenly bodies, or the method of attaining the knowledge of the heavens and their *phænomena*.

By *Heaven* here we are to understand that universe or circular region, that encompasses all the terrestrial globe, and contains the *stars, planets and comets*.

The ancient *Astronomers* supposed that there were as many heavens, or at least, different regions in that immense circle, as there were found different motions: and that each of these regions was a solid body; according to the *system of Ptolemy*, as described in the *copper-plate*.

By the same rule others multiplied the number according to their observations on the celestial motions. So that *Eudoxus* made them 23, *Calippus* 30, *Regiomontanus* 33, *Aristotle* 47, and *Fra. Castor* no less than 70 heavens.

The figure of this *heaven or universe* is considered either as it appears to the naked eye, or as it is conceived by the understanding. Hence *Astronomy* is divided into *spherical and theoretical*.

*SPHERICAL Astronomy* represents the *heavens* as a concave, in whose center is the earth or rather the eye, about which the visible frame revolves, with stars and planets fixed in the circumference.

This is more properly described by the *sphere* in the copper-plate: where you'll find the diameter of the earth's orbit is so small in respect of the diameter hereof, that the center of the *sphere* is not sensibly changed by any alteration of the spectator's place in the several parts of the *orbit*: but still, in all the points of the earth's surface, and at all times, the inhabitants have the same appearance of the *sphere*; that is, the fixed stars seem to possess the same points in the surface of the *sphere*.

The better to determine the places of the heavenly bodies in the *sphere*, several circles are imagined to be described on the surface thereof; hence called circles of the *sphere*; which are ten in number, *viz.* six greater, and four lesser.

The greater are, the (a) *horizon*, (b) *meridian*, (c) *equator*, (d) *ecliptick*, (e) the *colures*, and the (f) *azimuths*; which are all equal, and cut each other into equal portions or semicircles, and cut the whole *sphere* into two equal parts, or *hemispheres*, having their center in the center thereof.

The *lesser circles* are, the two (g) *tropicks*, and the two (h) *polaris*; which divide the *sphere* into two unequal parts.

Of the four *greater circles*, there are three, *viz.* the *horizon, meridian, and equator*, whose poles, or the points they are understood to be drawn or described from, are of very great consequence in the *sphere*, and are called *cardinal points*. The two first are the *arctick*, or *North pole*, which is that visible to us; and its opposite the *antarctick*, or *South pole*. These two points, each 90 degrees distant from the *equator*, are called, by way of excellence, the *poles of the world*, and are the two extremities of the *axis* whereon the *sphere* revolves; whence their name *πολος*, from *περὶ, vertere*, to turn. The next to these, are the *Zenith* and *Nadir*, called *vertical points*; one directly over our heads, which is the *Zenith*; and the other, *viz.* the *Nadir*, directly under our feet.

The *ZENITH*. is a point in the surface of the *sphere*, from which a right line, drawn through the spectator's head, passes through the center of the earth. Hence there are as many *zeniths* as there are different places on the earth where the heavens may be seen; and upon the changing our place, we also change our *zenith*.

The *NADIR*, is that point diametrically opposite to the *zenith*. The *nadir* is the *zenith* to our *antipodes*; as our *zenith* is the *nadir* to them. These two points are also the *poles of the horizon*.

The other *points*, are the *EQUINOCTIAL*, wherein the *ecliptick* and *equator* intersect; particularly that whence the *sun* ascends towards the *North pole*, is called the *vernal point*; and that by which he descends to the *South pole*, the *autumnal point*. Which points are considered as the *poles of the Meridian*.

The *HORIZON*, in *Greek* ὀρίζων, from ὀρίζω, *termino, definio*; and in *Latin*, *finitor, finisher*) is a *circle*, which when, from an even and open place, we turn our eyes round about us, terminates every where our sight, and seems to join the heavens and earth together; and serves, as I have already observed to divide the *sphere*, or the world, into two equal parts, or *hemispheres, viz.* superior, and inferior; and is supposed to be described from the two points opposite to us, *i. e.* the *zenith* and *nadir*: So that when we change place, we also change the *horizon*, because the *zenith* and *nadir* are changed.

The **MERIDIAN** (the second great circle in order) is a circle of the sphere, passing through the zenith, nadir, and poles of the world, and dividing the sphere into two hemispheres, the one eastern, and the other western.

It is called *meridian*, from the Latin, *meridies*, noon, or mid-day: for when the sun is in this circle, the day is half spent, in those places situate under it; the sun being then at an equal distance from the east and west.

The **EQUATOR**, (the third of the great circles we have imagined) is a circle of the sphere equally distant from the two poles of the world, or having the same poles with those of the world. It is called *equator*, because when the sun is therein, the days and nights are equal; which happens about the twentieth day of *March*, and again about the twenty-third of *September*; whence, also, it is called *equinoctial*.

Every point of the equator is a quadrant's distance from the poles of the world; whence it follows, that the equator divides the sphere into two hemispheres, in one of which is the northern, and in the other the southern pole; which are both joined by an imaginary line, called the *axis* of the world.

The equator, by its conversion from east to west, measures the day. For the equator being cut into 360 parts, or degrees, and the day divided into 24 hours, 15 of those degrees are elapsed in the space of an hour. Hence we have frequent occasion for the conversion of degrees of the equator into time; and, again, for the re-conversion of parts of time into parts of the equator. For performance whereof, see the treatise of *Geography*.

We must observe here, that from the various position of the equator to the horizon, we use to distinguish a triple situation of the sphere. For those are said to have the sphere direct, who dwell under the equator; because the equator cuts their horizon at right angles. On the contrary, the sphere is oblique to those who inhabit the parts between the equator and the poles of the world; because the equator cuts their horizon in an oblique manner. And those who are placed under the poles, have the sphere parallel; because the equator is parallel to their horizon; or rather, is the same as their horizon, and is parallel to the tropicks and poles.

Between these four great circles, is a fascia, or broad circle, called **ZODIACK**, whose middle is in the ecliptick, and its extremes two circles parallel thereto, at such a distance from it, as to bound or comprehend the excursions of the sun and planets. It is called *zodiac*, from the Greek ζῳον, an animal; on account of the constellations therein.

The sun never deviates from the middle of the zodiack, i. e. from the ecliptick, (which is a line

drawn in the middle of the zodiack) the planets all do it, more or less. Their greatest deviations, called *latitudes*, are the measure of the breadth of the zodiack; which is broader, or narrower, as the greatest latitude of the planets is made more or less. Accordingly, some make it 16, some 18, and some 20 degrees broad.

The **ZODIACK** cutting the equator obliquely, makes an angle therewith of 23 degrees and an half; or, more precisely, of 23° 29', which is what we call the *obliquity of the zodiack*, and is the sun's greatest declination.

The zodiac is divided into twelve portions, called *signs*; and those divisions, or *signs*, are denominated from the constellations which antiently possessed each part. *Ausonius* has comprehended the names of those signs, in the two following verses:

*Sunt Aries, Taurus, Gemini, Cancer, Leo, Virgo,  
Libraque, Scorpius, Arcitenens, Caper, Amphora,  
Pisces.*

But the zodiack being immoveable, and the stars having a motion from west to east, those constellations no longer correspond to their proper signs; whence arises what we call the *precession* of the equinoxes; a term applied to the equinoxes, which, by a very slow, insensible motion, change their places, going backwards, or westward, i. e. in *antecedentia*, as Astronomers call it, or contrary to the order of the signs.

When a star, therefore, is said to be in such a sign of the zodiack, it is not to be understood of that sign, or constellation of the firmament; but only of that twelfth part of the zodiack, or *dodecatemora* thereof.

*Cassini* has also observed a track in the heavens, within whose bounds most of the comets, though not all of them, are observed to keep, which, for this reason, he calls the zodiack of the comets.

This he makes as broad as the other zodiack, and marks it with signs, and constellations, like that; as *Antinous, Pegasus, Andromeda, Taurus, Orion, the lesser Dog, Hydra, the Centaur, Scorpion, and Sagittary*.

The points of the ecliptick whereby the sun's ascent above the equator, and its descent below it are terminated, are called *solstitial points*. The first point, which is the beginning of the first degree of *Cancer*, is called the *Æstival* or *summer point*; and the latter, which is in the beginning of the first point of *Capricorn*, the *winter point*: therefore the time when the sun is in one of the *solstitial points*, that is, when he is at his greatest distance from the equator, which is 23 degrees and an half, is called *solstice*, because he then appears to stand still,

still, and not to change his place in the degrees of the zodiac, any way; not that he does not follow, then, his usual course from east to west, but because he is no longer perceived to advance towards the *septentrion*, or *meridian*; an appearance owing to the obliquity of our *sphere*, and which those who live under the *equator* are strangers to.

The SOLSTICES are two in each year, the *summer solstice*, and the *winter solstice*. The *summer solstice* is when the sun is in the *Tropick*, which is on the 22d of *June*; when he makes the longest day. The *winter solstice* is when he enters the first degree of *Capricorn*, which is on the 22d of *December*; when he begins to return towards us, and makes the shortest day.

This is to be understood as in our northern hemisphere; for in the southern, the sun's entrance into *Capricorn* makes the *summer solstice*; and that into *Cancer* the *winter solstice*.

Besides these two *solstitial points* placed in the beginning of *Cancer* and *Capricorn*, there are two others in the beginning of *Aries* and *Libra*, called EQUINOCTIAL; which are the two points where in the *Equator* and *ecliptick* intersect each other. That in the first point of *Aries* is called the *vernal*; and the other, in the first point of *Libra*, the *autumnal point*. In these four points, *viz.* the two *solstitial*, and the two *equinoctial*, the four seasons of the year begin; *viz.* the *spring*, the *summer*, the *autumn*, and the *winter*.

Through these points passes two circles, the last of the greater ones, called COLURES, from *κολοῦρος*, *mutilis*, or *truncatus*, and *viz.* Tail, *q d.* appearing with the tail cut off; because never seen entire above the horizon. One of them, because passing through the *solstitial point* of the *ecliptic*, is called *solstitial colure*; the other *equinoctial*; because it passes through the *equinoctial point*. These two *colures* are imagined to intersect each other at right angles, in the poles of the world.

The four lesser circles, which divide the *sphere* into two unequal segments, are the two *tropicks*, and the two *polars*.

The TROPICKS, *i K*, are two circles parallel to the *equator*, at such distance therefrom, as is equal to the sun's greatest recess from the *equator* towards the poles; or to the sun's greatest declination; or the obliquity of the *ecliptick*. Of the two *tropicks*, that drawn through the beginning of *Cancer* is called the *tropick of Cancer*; and that through the beginning of *Capricorn*, the *tropick of Capricorn*.

They have their names from the Greek *τροπή*, *turn*, *conversion*; as being the limits of the sun's way, or declination towards the north and south; so that when the sun is arrived at either of them, he turns the other way.

Hence, 1. Since the declination of the *ecliptick* is the arch *BD*, *AC* will be the distance of the *tropicks*; which is double the greatest declination.

2. Wherefore, if the sun's meridian altitude be observed, both in the winter and summer *solstice*, and the latter be subtracted from the former, the remainder will be the distance of the *tropicks*; half whereof is the greatest declination of the *ecliptick*.

The POLAR CIRCLES, are two lesser circles of the *sphere*, parallel to the *equator*, at the distance of 23 degrees from each pole, serving to mark the beginning of the frigid zones. The *polar circles* are particularly denominated from their respective neighbouring poles, the *arctick* and *antarctick*.

These several *circles* are represented in their natural order, in an artificial *sphere* called *armillary*, from its consisting of a number of *fasciæ*, or rings of brass, or other matter; called, by the *Latins*, *Armilla*, from their resembling of bracelets, or rings for the arms. This *Armillary Sphere* serves to give an idea of the office and position of each circle thereof, and to solve various problems relating thereto. See *Armillary Sphere* in the second plate of ASTRONOMY.

*Armillary Spheres* are of different kinds, with regard to the position of the earth therein; whence they become distinguished into *Ptolemaic* and *Copernican Spheres*; in the first whereof the earth is in the center, and in the latter near the circumference, according to the position which that *planet* obtains in those systems.

The *Ptolemaic Sphere*, is that commonly in use. In the middle, upon the *axis* of the *Sphere*, is a ball *t*, representing the earth, on whose surface are the circles, &c. of the earth. The *Sphere* is made to revolve about the said *axis*, which remains at rest; by which means the sun's diurnal and annual course about the earth, are represented, according to the *Ptolemaick Hypothesis*: and even, by means whereof, all problems, relating to the *Phænomena* of the sun and earth, are solved as upon the celestial globe, and after the same manner.

The *Copernican Sphere*, is very different from the *Ptolemaic*, both in its construction and use; but so intricate, and inconsiderable, there needs no description thereof.

Having thus far proceeded on the doctrine of the *Sphere*, and mentioned here the *Ptolemaic* and *Copernican Spheres*; let us now attempt the several *Systems* or *Hypotheses* of the WORLD; but more particularly, those of PTOLEMY, COPERNICUS, and TYCHO BRÄHE.

The invention of *Astronomy* remains yet a problem, though *Belus*, king of *Assyria*; *Atlas*, king

of *Mauritania*, &c. are complimented with having been the first inventors and cultivators of it.

Some authors give the honour to the *Chaldeans*; and pretend, that a *Chaldean Astronomer*, and *Astrologer* are synonymous. Others carry its invention as high as *Adam*.

*Rudbeck*, compliments the *Swedes*, in his *Atlantica*, with the invention of *Astronomy*.

*Porphyry* would have the origin of *astronomy* traced as far as the building of *Babel*; because, as he writes, there were found in *Babylon*, when taken by *Alexander*, celestial observations for the space of 1903 years, which therefore must have commenced within 115 years of the flood, or 15 years of the building of *Babel*.

*Achilles Tatius*, with far greater foundation, considers the *Egyptians* as the first inventors of *Astronomy*, who took care to have their knowledge therein transmitted to posterity, by having it engraven on columns and pyramids. *Lartius* informs us, that from the *Egyptians*, *Astronomy* passed to the *Greeks*, and that *Thales Milesius* first, about the 19th *Olympiad*, and after him *Eudoxus* and *Pythagoras*, travell'd into *Egypt* to be instructed therein.

*Pythagoras*, after he had lived in a close community with the *Egyptian* priests for seven years, and had been initiated into their Religion, where he was let into the true system of the Universe; passed afterward into *Greece* and *Italy*, where he taught the first elements of that curious, though very intricate science. He had made so considerable a progress in it, that he went further in his discoveries, than his masters; for he was the first who placed the *sun* in the center of the system, and made the *earth* and *planets* to turn round him. Supposing the diurnal motion of the *sun* and *fixed stars* to proceed from the *earth's* motion round its own axis, and consequently apparent only, and not real. After *Pythagoras*, *Astronomy* sunk into neglect; most of the observations brought from *Babylon* were lost, and *Ptolemy* could recover but a very small number of them. However, *Philolaus* and *Aristarchus Samius*, with a few more of his disciples, continu'd to cultivate *Astronomy*.

It continu'd in that languishing state, till the *Ptolemies*, kings of *Egypt*, declar'd themselves its protectors, by erecting an academy at *Alexandria*, which produced several eminent Astronomers; and, among the rest, *Hipparchus*, who undertook to number the *stars*, and to leave the heavens as an inheritance to posterity. He foretold the *eclipses*, both of the *sun* and *moon*, for six hundred years; and on his observations is founded *Ptolemy's* *Μεγαλοσινολογία*.

*Astronomy* was a-fresh introduced into *Europe*, after several ages exile, by the *Saracens*, who had got a tincture of it, in their conquest of *Egypt*, and brought what they knew of it from *Africa* into *Spain*, where it was cultivated by the greatest geniuses, and patronized by the greatest princes; even so far, that *Alphonfus*, king of *Castile*, made *Astronomy* one of his most serious occupations, and enriched it with those tables which still bear his name. *Copernicus* re-established the ancient *Pythagorean* system, and *Tycho* published a catalogue of 770 fixed stars from his own observations. *Kepler*, from *Tycho's* labours, soon after discovered the true theory of the *World*, and the physical laws by which the heavenly bodies move. *Galileo* first introduced *Telescopes* into *Astronomy*, and by their means discovered the *Satellites* of *Jupiter*, the various *Phases* of *Saturn*, the *Spots* in the *Sun*, and his *Revolution* upon his axis. *Hevelius*, from his own observations, furnished a catalogue of fixed stars, much more compleat than *Tycho's*. *Huygens* and *Cassini* discovered the *Satellites* of *Saturn*, and his ring. And *Gassendus*, *Horrox*, *Eullialdus*, *Ward*, *Ricciolus*, *Gascoign*, &c. each contributed very considerably to the improvement of *Astronomy*.

Sir *Isaac Newton* first demonstrated, from physical considerations, the great laws that regulate all the heavenly motions, sets bounds to the planets orbs, and determines their greatest excursions from the *sun*, and their nearest approaches to him.

The *PTOLEMAICK* System places the *earth*, at rest, in the center of the universe; and makes the heavens solid and uncorruptible, revolve round the same from east to west, and carry all the heavenly bodies, stars, and planets along with them. See the *Plate*.

It is called *Ptolemaick* System; not because *Ptolemy* is the author of it, but because he perfected it; after the *Egyptians* and *Chaldeans*, had, long before him, placed the *earth* likewise at rest in the center of the universe; and imagining they had observed eight different motions in the *Heavens*, viz. the motion of the fixed stars from east to west in 24 hours; and the motion of the seven planets from west to east, they thought fit to distinguish eight different heavenly orbs, which moved round the *earth*, viz. the orb of the fixed stars, and seven orbs for the seven planets.

*Plato*, *Aristotle*, *Eudoxus*, *Calippus*, and almost all the most famous Astronomers who preceded *Ptolemy*, followed this system, and were pleased to call the orb or heaven of the fixed stars *primum mobile*, under the supposition, that by its motion the inferior orbs of the planets were carried in the space

of

of 24, or rather 23 hours, 56 minutes, 4 seconds from east to west.

They had also appointed a certain period of time for the planets to perfect their course from west to east, each in its respective orb, against the motion of the *primum mobile*, viz. Saturn accomplished his in almost thirty years, Jupiter in twelve, Mars in two, the Sun in one, Venus in a little more than seven months, Mercury in three months, and the Moon in one month.

The Astronomers, who succeeded these, particularly *Arsatalis* and *Timocharis* (who flourished at Alexandria about 330 years before the birth of Christ,) having compared their own observations, with those of their predecessors imagined to have discovered in the fixed stars, a motion from west to east: confirmed therein, by pretending to have observed, that the first and the most westward star in the horn of *Aries*, which the antient Astronomers had discovered in the greater circle of latitude, passing through the poles of the Zodiac and the vernal equinoctial point, had, according to the order of the signs, or by consequence, advanced further with the rest of the stars, which was confirmed two hundred years afterwards by *Hypparchus*, and also by *Ptolemy* himself, in the year of Christ, 130; therefore above the firmament, or the heaven of the stars, which *Ptolemy* supposed to be carried round its orb, by its proper motion, in the space of 36000 years, they thought proper to imagine a ninth heaven, as a *primum mobile*, which, in the space of 24 hours, could carry the other heavens along with him, from east to west; which opinion was defended afterwards by *John de Sacrobosco* and others. But in the thirteenth century *Thebitius* and *Alphonsus*, king of *Castile*; and in the fourteenth, *George Puerbach*, and *John Regiomontanus* thought to have discovered in the firmament or eighth sphere, a third motion, which they called *trepidation*.

The sectators of king *Alphonsus* conceived three motions in the eighth sphere; the first they called *raptus*, whereby the eighth sphere, together with the rest of the inferior orbs, were carried by the *primum mobile*, in the space of 24 hours, from east to west. They were pleased to give it a second motion which they called *proper*, whereby, in the space of 49000 years, it was carried from west to east; and the third they divided into two librations, whereby the same eighth sphere seemed to waver or librate through an arch of two degrees and twenty minutes, sometimes to the east, and sometimes to the west. They attributed the first titubation, or libration to a ninth sphere, and the last, to a tenth, calling those two spheres the *Chryselline Heavens*; the first served to account for that slow motion of the fixed stars above-mentioned,

and the second was to solve the motions of *libration* and *trepidation*.

This system is so absurd and contrary to the simplicity of nature, and often contradictory to appearances, that it soon gave way to the solar system.

This gives motion to the earth, and was taught by *Pythagoras* and his disciples, and defended by *Plato*: but it could no be so well ascertained, as it has been since the improvement of astronomical observations: By which Cardinal *Cusanus* brought this system into great reputation.

But *Nicholas Copernicus*, a prebend of *Thorn* in *Poland*, in 1530, established it upon such sure and demonstrable principles, that the learned world gave it the name of the *Copernican system*; and is that hypothesis, on which all his successors in this study has endeavoured to improve ever since.

The most celebrated Astronomers in the *Copernican school*, were originally *Rothmanus*, *Kepler*, *Galileo* and *Des Cartes*, who reduced this system into such an easy method, that some have ventured to call it the *Cartesian system*. See the *Copper Plate*.

The Sun (a) is placed in the middle of our vortex, or system, as a fixed star. Around the Sun move in several orbits, first *Mercury* (b), who accomplishes his course in the space of three months; then *Venus* (c), who perfects hers in eight months. Afterwards comes the great orbit (e), which the earth runs round in its annual motion. About the earth in a particular orbit moves the Moon (d), or rather *Ellipsis*, and who accomplishes her course in the space of a month. The great orbit of the earth is received into the circle of *Mars*, which *Mars* over-run in the space of two years; to this succeeds the circle of the orbit of *Jupiter*; and to *Jupiter*, *Saturn*, or the orbit of *Saturn*; so that *Jupiter*, in his orbit, in the space of twelve years, and *Saturn* in his, in the space of thirty, accomplish their courses or periods. Besides as the Moon moves round the earth, likewise four small Moons, or satellites move round *Jupiter*, and five round *Saturn*.

*Des Cartes* improved upon this system, and adds that there are in our vortex or system, in whose center the Sun is placed, several smaller vortices, viz. those of *Saturn*, *Jupiter*, and of the earth itself. In the earth's vortex, the Moon moves, as in an *ellipsis*; and in the vortex of *Saturn*, and of *Jupiter* moves *Saturn*, and *Jupiter*'s satellites. The same *Des Cartes* believes, that what we have conceived of our vortex can also be applied or attributed to all the others, which we may imagine round the fixed stars; for every one of the fixed stars seem to him as so many Suns, which have every one of them their vortex.

The

The *Copernican* and *Cartesian* system, being thus clearly demonstrated, we'll proceed to the explication of its different *phenomena*.

1. When the earth by its diurnal motion, is carried from *west* to *east*, the *sun* appears to us to be carried from *east* to *west*, whence proceeds the vicissitude of the day and night.

2. The earth moves not only round its *axis*, but proceeds also each day in the great *orbit* or *zodiack*, according to the order of the *signs*, in the same manner a globe rolled on a plane, proceeds according to the length of the plane, while its superficies turns round the center or axis; or as a bird, flying from one end of a ship under sail to the other, moves also with the ship. Therefore, while the earth is between the *sun* and one of the *signs*, the *sun* appears to be in the sign opposite to that, *v. gr.* Suppose the earth to be between *Aries* and the *sun*, the *sun* appears then to be in *Libra*; if the earth be in *Cancer*, or between the *sun* and *Cancer*, the *sun* will be seen in *Capricorn*. In a word if the earth be in the northern *signs*, the *sun* will appear in the southern *signs*, and *vice versa*.

3. In this hypothesis the *axis* of the earth, must always be conceived parallel to itself, and to the *axis* \* of the *equator*; for if it was parallel to the *axis* of the *ecciptick*, there would be a perpetual and universal *equinox*: That is to say, that the days would be always, and every where, equal to the nights; and there would happen no changes in the seasons. But as the *axis* of the earth, being parallel to the *axis* of the *equator*, or of the world, exceeds 23 degrees and an half from the *axis* of the *ecciptick*, and therefore inclines to the *plane* of the *ecciptick*, so as to form an angle of 66 degrees, 30 minutes, and to keep always its parallelism with the *axis* of the world, or to move always in the same sensible parts of *heaven*; hence proceeds, while the earth by its annual motion is carried round the *sun*, that succession in the vicissitude or changes of seasons; for example:

If at the beginning of *summer* (while the *sun* appears in *Cancer*, and the earth is in *Capricorn*) the earth be placed in OE, (Fig. 2.) and its *axis* (SM) be parallel to the *axis* of the world; and therefore distant 23 degrees 30 minutes from the *axis* of the *ecciptick*, and consequently inclined to the plane of the annual *orbit* of the earth, agreeable to the angle, BOEH, 66 degrees and an half, the ray of the *sun*

perpendicular to the earth, or the ray carried from the *sun's* center to the earth's center will touch the superficies of the earth, not in the terrestrial *equator*, but in the *tropick* of *Cancer*, remote 23 degrees 30 minutes from the *equator* towards the *pole arctic*, and therefore the illuminated hemisphere will comprehend the whole circle polar, *arctic*; and exclude the whole *antarctic*.

Let the earth be transferred into A. at the beginning of *autumn*, and the *axis* of the earth, SM, always remain parallel, as well to itself, as to the *axis* of the world: as the *sun* appears at that time in *Libra*, the earth being then in *Aries*, the ray conducted from the *sun's* center to the earth's center, perpendicular then, to the *axis* of the world, will fall on the superficies of the earth at the beginning of *Libra*, and be distributed to both poles.

Let's now imagine the earth in H, at the beginning of *winter*, the perpendicular ray of the *sun* (the parallelism of the *axis*, SM, always remaining) will fall on the *tropick* of *Capricorn*; and therefore the illuminated, or lighted hemisphere, will contain within itself the *antarctic* pole, and exclude the *arctic*.

Lastly, The earth being placed in V. at the beginning of the *spring*, *i. e.* at the beginning of *Libra*, at which time the *sun* appears in *Aries*, the ray conducted from the *sun's* center to the earth's center will reach the superficies of the earth at the beginning of *Aries*, and then both poles will be again illuminated; but as the illuminated face of the earth looks at the *sun*, it cannot be conspicuous to us who are placed without the *figure*.

Thus the COPERNICANS explain, and elucidate the vicissitudes of the seasons.

The space BC, or DE, in the sphere of the fixed stars, which is equal to the annual *orbit* of the earth, appearing almost as a point, by reason of its too great distance from us; hence it follows, that the *axis* of the earth, in each point of its great *orbit*, should always appear directed to the same points, or parts of the world; so that there should always appear the same altitude of the pole, the same vertical stars, and of the same magnitude, with respect to the same part of the world, although the earth, by its annual motion in the *zodiack*, should approach nearer these or those stars, or nearer the north or south.

\* A PARALLELISM, of the earth's *axis*, is that situation, or motion of the earth's *axis*, in its progress through its orbit, whereby it still looks to the same point of the heavens, *viz.* toward the *pole star*; so that if a line be drawn parallel to its *axis*, while in any one position; the *axis*, in all other positions or parts of the *orbit*, will always be parallel to the same line. This *parallelism* is the necessary result of the earth's double motion; the one round the *sun*, the other round its own *axis*. Nor is there any necessity to imagine a third motion, as some have done, to account for this *parallelism*.

If this *hypothesis* should appear ridiculous, or impossible, to some, the *Copernicans* would tell them, that they should remember the great absurdities found in the *Ptolemaic system*; as the prodigious rapidity with which the *primum mobile* must accomplish its diurnal course; then the revolution of the inferior spheres, against the motion of the *primum mobile*, though they are daily carried along with it. Which absurdities are corrected, by the *Copernican hypothesis*; since, by the diurnal motion of the earth, that incredible velocity of the *sun*, as well as that of the fixed stars, whereby the remotest should be carried with 400,000 times more rapidity (than a ball from a cannon) is rendered vain and useless. How easier it is, say they, for the small sphere of the earth, so fit for motion, by its round figure, to move round the *sun*; than for a huge machine, whose exterior figure is utterly unknown, to be carried with such incredible velocity round so small a *pole* as the earth.

When it is said, in the *Copernican hypothesis*, that the earth, while carried through its great annual orbit, keeps the *parallelism* of its axis; this is not to be so strictly understood, as if that axis did not change a little its *situation*, and could not by a very slow motion, *viz.* in the space of 25816 *Egyptian* years, according to *Copernicus*, describe a certain circle, towards the poles of the *zodiack*, against the order of the *signs*, or from east to west; the semidiameter of which circle, is, according to the said *Copernicus*, 23 degrees and 40 minutes: Whence it must follow, that the interfections of the *ecliptick*, and of the *equator*, or the *equinoctial points*, are carried, by the same motion, against the order, or in *precedentia* of the *signs*; a motion called, by *Copernicus*, the *precession of the equinoxes*.

Hence he has drawn the appearance of the motion of the fixed stars, by which they seemed to be carried, according to the order, or in *consequentia* of the *signs*, from west to east, and changed the apparent mutation of distance of the fixed stars, from the *equinoctial points* toward the east, into a real motion of *precession of the equinoxes*.

PRECESSION, in this place, is a term applied to the *equinoxes*, which by a very slow, insensible motion, change their places, going backward, or westward, *i. e.* in *antecedentia*, as Astronomers call it, or contrary to the order of the *signs*. The *pole*, the *solstices*, the *equinoxes*, and all the other points of the *ecliptick*, have a retrograde motion; and are continually moving from east to west, or from *Aries* towards *Pisces*, &c. by means whereof the *equinoctial points* are carried farther and farther back, among the preceding signs of stars, at the rate of about 50 seconds each year; which retrograde motion is called the *precession, recession, or retrocession of the equinoxes*.

Hence, as the fixed stars remain immoveable, and the *equinoxes* go backward, the stars will seem to move more and more eastward with respect thereto; whence the longitudes of the stars, which are reckoned from the first point of *Aries*, or the *vernal equinox*, are continually increasing.

Hence the motion of the *axis* of the earth has sometimes appeared unequal; since from the time of *Timocharides* to that of *Ptolemy*, the fixed stars seemed, every hundred years, to have moved a degree, according to the order of the signs. From *Ptolemy* to *Albategnius*, they run one degree every 66 years. At present, they accomplish one degree, according to *Tycho Brahe*, in 70 years; so that their revolution is finished in 25806 *Julian* years. But in *Ricciolus's* opinion, they employ 72 years in running a degree; therefore they cannot accomplish their revolution in less than 25920 years.

To rectify this irregularity of motion, and keep still the fixed stars immoveable, *Copernicus* has imagined an irregularity in the motion of *precession of the equinoxes*; whose *anomaly* should be restored in 1717 *Egyptian* years.

Note, That ANOMALY, in Astronomy, is the distance of a planet from the *aphelion*, or *apogee*; or an irregularity in the motion of a planet, whereby it deviates from the *aphelion* or *apogee*.

But as the obliquity of the *ecliptick* had been observed to vary otherwise, by the ancient Astronomers, and its *anomaly* to take twice the time of the *anomaly* of the *equinoxes*, before it could be finished, *viz.* 3434 *Egyptian* years; he has explained both inequalities, by the sole motion of the poles of the earth; and by imagining the *axis* of the earth to be carried from north to south, and from south to north, in the interval of 24 minutes only; and from east to west, and from west to east, through an arch of 2 degrees, and 20 minutes; so that by those *complicate motions*, the extremity of the *axis* forms a *corolla intorta*, in the two revolutions of the *anomaly* of the *equinoxes*, and in one of the obliquity of the *zodiack*, following the order of the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9: Whence it is understood, that seven, or more, of those *corolla's*, are contained in an entire revolution of 25816 *Egyptian* years; during which time, the *axis* of the earth is carried round the poles of the *zodiack*, against the order of the *signs*.

Now as to what relates to the *stations, directions, and retrogradations* of the planets, it may be explained in this *hypothesis*, with an admirable facility, and without being obliged to have recourse to *Epicycles*. *Venus* and *Mercury* have sooner finished their courses round the sun, than the earth; because they describe their circles nearer the sun; and the earth sooner than *Mars, Jupiter, and Saturn*. Whence it happens, that the earth passes, some-

times, between the superior planets and the sun, the same as *Venus* and *Mercury* pass between the sun and the earth. For example,

Let the *sun* be *k*, and the annual circle of the earth *b h j c T l*; the circle of some of the superior planets, viz. of *Saturn*, *Jupiter*, or *Mars*, be *o d q R E P*, an arch of which, or at least a portion thereof, a planet should visit while the earth is running through its whole circle. Let also the firmament be *M F G N*.

If the *earth* be placed in *N*, and the planet in *O*, it will be seen in the point of the firmament *M*. Let the earth advance from *L* to *B*, and the planet from *O* to *D*, so that the earth should be very near to pass between that planet and the sun; then the planet will be seen in *G*; and because it will appear to have hastened its motion from the point *M*, to the point *C*, such motion shall be called a direct motion.

If afterwards the *earth* arrives from the point *B* to the point *H*, and the planet from the point *D* to the point *q*; this will again be seen in *G*, and be called stationary, which will be its first station. But if the earth was to pass to *I*, and the planet to *R*, the planet will appear in *D*; and thereby appearing to have retrograded against the order of the signs, it will be then called *retrograde*.

If the *earth* being in *C*, the planet be in *E*, it will be seen again in *D*, and appear stationary; therefore this will be its second station.

Lastly, When the *earth* will be arrived from the point *C* into *T*, and the planet into *P*, it will appear in *N*; and as it seems then to have advanced according to the order of the signs, it will be called again *direct*.

In this manner, the *station*, *direction*, and *retrogradation* of the superior planets, *Mars*, *Jupiter*, and *Saturn* are very easily accounted for, according to the *Copernican hypothesis*: Where we are to observe, that there is a greater quantity of *retrogradation* in *Mars* than in *Jupiter*, and in *Jupiter* than *Saturn*.

As to the other planets, called *inferior*, viz. *Venus* and *Mercury*; as they are nearer the *sun* than the *earth*, they also perfect their course with a greater celerity than she can; whence they appear sometimes placed between her and the *sun*; and hence seem sometimes to advance, sometimes to stand still, and sometimes to be retrograde.

Let us then place the *earth* to run in its orbit the part *T B C D E F*, *Fig. 2.* while *Mercury* runs the whole circle *G L M N O*. If the *earth* be in *T*, and *Mercury* in *G*, he'll be seen in the point of the firmament *F*. But if the *earth* be arrived at the point *B*, and *Mercury* at the point *l*, *Mercury* will be seen in *P*. And because the progress

will seem then to be made with a greater celerity, it will be called *direct*. But where he'll gain the point *H*, the *earth* being in *C*, then he is to be *stationary*, because he seems to stay almost in the same point *P*. This is his first *station*.

But if the *earth* occupies the point *D*, and *Mercury* the point *N*, he'll appear in *q*; and thus will be *retrograde*, because he'll be supposed removed against the order of the *signs*. But if the *earth* being in *E*, *Mercury* is in *O*, he'll be thought *stationary*, because he'll be seen in the same point *q*. And then it will be his second *station*.

Lastly, When the *earth* will be in *f*, and *Mercury* in *G j*, *Mercury* will be referred to the point *I*, and then become *direct*, because the progress will then appear made according to the order of the *signs*.

What is said here of *Mercury*, is to be understood of *Venus*; this excepted, that these mutations are not so frequent in her, because she takes more time than *Mercury* to run through her orbit.

After these arose divers great men, as *Cassendus*, *Hewelius*, *Bullialdus*, *Ricciolus*, the two *Cassini's*, *Mr. Huygens*, *Horrox*, *Bishop Ward*, *Mr. Flamsteed*, *Dr. Halley*, *Dr. Gregory*, *Dr. Keil*, and, above all, that superlative genius *Sir Isaac Newton*; who all with the greatest pains and diligence, applied themselves to make observations, to invent instruments, and to investigate the physical causes of celestial *phenomena*; in which they so happily succeeded, especially the last great man, that the nature, extent, order, and constitution of all and every part of the SOLAR SYSTEM, both of PLANETS and COMETS, became so well defined, stated, and established, as to admit of no contest or scruple, with any man properly qualified to understand it; and which therefore ought for the future to be called the NEWTONIAN SYSTEM of the world.

This SYSTEM (no longer now to be called an *hypothesis*) is represented in a plate with the orbits of all the planets and comets (hitherto determined) and at their proper distances from the *sun*, represented by the central point, with the ORRERY.

In the sixteenth century the *Copernican system* was attempted to be antiquated by *Tycho Brahe* a noble Dane; from whose works in *Astronomy* the world is favoured with a third system, called after his name the *Tychonic system*. See the first plate of ASTRONOMY.

In this system, three things move round the *earth*, as round their centre; the *moon*, which is the nearest to it, by a monthly motion; the *sun*, which is more distant from it, by an annual course; and the firmament, or the sphere of the fixed stars, the remotest of all three, by a slow motion of 25000 years.

Round the *sun* five errant stars, or planets, have their particular motions, *viz.* *Mercury*, of three months; *Venus*, of eight months, &c. with this order, or rule, that the *sun*, by his annual motion, running through the *Zodiac*, carries them all along with him. Besides, as *Mercury* and *Venus*, by their revolutions round him, do not embrace the *earth*; *Mars*, *Jupiter*, and *Saturn*, embrace it by theirs; but especially *Mars*, which, while in B, becomes nearer the *earth* than the *sun* himself.

But there is no mention made, in the *Tychonick system*, of a diurnal motion; those who follow his *hypothesis*, place a *primum mobile* above the *firmament*, whereby the whole machine of the world may be moved by a diurnal motion; or suppose those three *mobiles*, the *moon*, the *sun*, and the *sphere* of the *fixed stars*, while by a slow motion they move from west to east in the *zodiac*, to be also moved daily from east to west, in a circle, almost parallel to the equator. Moreover they conceive that the five errant stars, besides their proper motions, they have round the *sun* from west to east through the *zodiac*, are also carried daily from east to west, in a plain parallel to the equator, not by themselves, but by the *sun* who serves them instead of a *primum mobile*.

The *Tychonicians* have this common, with the *Copernicans*, that they both acknowledge the heaven's fluid; and in fact the *Tychonick system* is nothing else but that of *Copernicus* inverted, for if the *sun* with *Venus* and *Mercury* was restored to the centre of the world, the earth would accomplish its annual period through the circle assigned to the *sun*, and the planets, or the sphere of the fixed stars would be understood to remove at such a distance, that the circle of *Saturn* would be every where equally distant from the fixed stars; and then the system would be the same as described by *Copernicus*.

As to the number of heavens, *Tycho's* partisans admit of three, *viz.* the *Empyreum*, the *Firmament*, and the *Planetick*, which number they pretend to support with the authority of the Apostle, who is said, *Eph. ii. Corinth. c. xii. v. 12.* to have been caught up to the third heaven; *i. e.* as they interpret it, to the *Empyreum*. But those among them who place a *primum mobile* above the firmament, ought to reckon four heavens, and therefore cannot be assisted therein by the text of the apostle, which, on the contrary, the *Copernicans* and *Cartesians* borrow to support their *hypothesis*. For our *vortex* is the first heaven of the *Cartesians*; that vast region of the fixed stars conspicuous to us, establishes another with respect to us; and all that is extended beyond that immense region may form the *empyreum*, or a *third heaven*.

*Tycho* and his disciples had proceeded thus far in the explanation, as well of the diurnal motions of the heavenly bodies from east to west, in a plane parallel to the equator, as of the monthly, annual, &c. from west to east in the *zodiac*; but there remained still, for them, to explain the *station, direction*, and *retrogradation* of the planets, when *Kepler*, by an admirable invention, undertook that arduous task.

This famous *Astronomer* (considering the whole planetick region thus drawn, the *sun* in such a manner as for the *axis* to keep always its *parallelism*, and for each planet, besides, to have, at the times fixed, its particular motion round the *sun*) shews how to compose a spiral motion from those two, *viz.* of abduction from the *sun*, and of conversion round the *sun*. For example:

Let the earth be T, and the orbit of the sun, in which he is moved, SSSS. If *Jupiter* be in A, and by a composite motion, as we have said, be carried into B, it will become *stationary*; because it is not understood to move, nor according to the order of the signs, nor against it. If afterwards it passes from the point B to C, it will be direct, because it advances according to the order of the signs; and from the point C to the point D becomes again *stationary*. But from the point D to E, because carried against the order of the signs, it will be called *retrograde*.

However the planets do not accomplish a whole spiral every year; but that time is required which is necessary for a conjunction of the *sun* with the planet, particularly if the beginning of the spiral motion, is taken from the conjunction; or for an opposition, if the beginning of the spiral motion is expected from an opposition. Therefore we must imagine eleven of those spirals in the circle of *Jupiter*; twenty-nine in the circle of *Saturn*, &c. which spirals are greater in *Jupiter* than in *Saturn*, and again greater in *Mars* than in *Jupiter*; whence those spirals are not soon perfected in *Mars* as in *Jupiter*; nor so soon in *Jupiter* as in *Saturn*.

Let us proceed to demonstrate the distances, magnitudes, motions, &c. of the celestial bodies; premising a few observations on the figure and dimension of the earth.

The figure of the earth is demonstrated to be nearly spherical, thus: the moon is frequently seen eclipsed by the shadow of the earth; and in all eclipses that shadow appears circular, what way soever it be projected, whether towards the east, west, north, or south, howsoever it in diameter varies according to the greater or less distance from the earth.

Hence it follows that the shadow of the earth, in all its situations, is really conical; and consequently the

the body that projects it, *i. e.* the earth, is nearly spherical. We say it is nearly spherical; for the inequalities of its surface prevent its being perfectly so; besides *Huygens* and *Sir Isaac Newton* have shewn that the earth is higher and bigger under the equator than at the poles: so that its figure, nearly, is that of an oblate spheroid, swelling out towards the equatorial parts, and flatted or contracted towards the poles. The reason of this inequality is deduced from the diurnal rotation of the earth on its axis.

This roundness of the earth is farther confirmed by its having been frequently sailed round: all the circumnavigators sailing continually from east to west, at length arrived in *Europe*, whence they set forth; and in the course of their voyage observed all the phenomena, both of the heavens and earth, to correspond and confess this spherical figure.

The antients had various opinions as to the figure of the earth. *Anaximander*, held it cylindrical; *Leucippus*, in form of a drum. But the principal opinion was, that it was flat; that the visible horizon was the bounds of the earth, and the ocean the bounds of the horizon: that the heavens and earth above this ocean, were the whole visible universe, and that all beneath the ocean was *hades*: of which opinion were, not only divers of the antient poets and philosophers, but also some of the Christian fathers, as *Lactantius*, *St. Augustin* bishop of *Hippo*, &c.

The MAGNITUDE OF THE EARTH, we are to consider next; and the number of miles its diameter contains, has been variously determined by several authors. antient and modern. The way to arrive at it is, by finding the quantity of a degree of a great circle of the earth. But this degree is found very different, according to the different methods and instruments made use of, as well as the different observers.

The method observed by *Mr. Norwood*, and the *French* astronomers, *Picard*, *Cassini*, &c. *viz.* by measuring the difference between two remote places on the same meridian, is undoubtedly the best; and was performed with such exceeding accuracy, especially by *M. Cassini*, that hardly any thing further or better can be expected. According to that author the ambit, or circumference of the earth is 123,750,720 *Paris* feet; or 134,650,777 *English* feet; or 25031½ of our statute miles; whence supposing the earth spherical, its diameter must be 7967 statute miles; and consequently its radius, or semi-diameter, may be taken in a round number 200,000,000 feet; its surface will be 199,444,206 miles; which being multiplied into ⅓ of its semi-diameter, gives the solid content of the globe of the earth 264,856,000,000 cubic miles.

*Mr. Whiston* reckons the ambit of the earth to be 123,249,600 *Paris* feet, or 131,630,573, or thereabouts, *English* feet.

We are now to explain the doctrine of the FIXED STARS.

First, we will begin with the motion of these stars. These stars are called fixed; not from their being fixed in a solid concave; but because we observe always the same distance between them.

They have two kinds of motions: one called the first, common, and diurnal motion, or the motion of the *primum mobile*: by this they are carried along with the firmament wherein they appear fixed, round the earth, from east to west, in the space of twenty-four hours.

The other, called the second, or proper motion, is that whereby they go backwards, from west to east, round the poles of the ecliptick, with an exceeding slowness, as not describing above a degree of their circle in the space of 71 or 72 years, or 51 seconds in a year. Some have imagined, that when they have got round to the points whence they first departed, nature will have finished her course, and the stars, having performed their career, the heavens will remain at rest, unless the Being, who first gave them motion, appoints them to begin another circuit. On the footing of this calculation, the world should last about 30,000 years, according to *Ptolemy*; 25816, according to *Tycho*; 25920, according to *Riccioli*; and 24800, according to *Cassini*.

In effect, the latitudes of the fixed stars, we find, by comparing the observations of the antient Astronomers with those of the moderns, continue still the same; but their longitude is, by the second motion, always increasing. Thus, for example, the longitude of *Cor Leonis* was found by *Ptolemy*, *A. D.* 138, to be 2° 30'; in 1115 it was observed by the *Persians* to be 17° 30'; in 1364, by *Alphonsus*, 20° 40'; in 1586, by the prince of *Hesse*, 24° 11'; in 1601, by *Tycho*, 24° 17'; and in 1690, by *Mr. Flamsteed*, 25° 31' 20": whence the proper motion of the stars, according to the order of the signs, in circles parallel to the Ecliptick, is easily inferred.

It was *Hipparchus* first suspected this motion, upon comparing the observations of *Tymocharis* and *Aristyllus* with his own. *Ptolemy*, who lived three centuries after *Hipparchus*, demonstrated the same by undeniable arguments. Some, it is true, have imagined a change in the latitude of the stars; but such an opinion has but little countenance from observation. *Tycho Bruhe* makes the increase of longitude in a century 1° 25'; *Copernicus* 1° 23' 40" 12"; *Bullialdus* 1° 24' 54"; *Hevelius* 1° 24' 46" 50"; whence, with *Mr. Flamsteed*, the annual increase

increase of the *longitudes* of the *fixed stars* may be well fixed at 50".

From these *data*, the increase of the *longitude* of a *star*, for any given time, is easily had; and hence the *longitude* of a *star*, for any given year, being given, its *longitude* for any other year is readily found.

The next thing which falls under our consideration, with regard to the *fixed stars*, is their *magnitudes*, which appear to be very different; which difference probably arises, not from any difference in their real *magnitudes*, but from their distances, which are different. From this difference the *stars* become distributed into seven several classes, called *magnitudes*.

The first class, or *Stars of the first magnitude*, are those nearest us, and whose diameters are therefore biggest. Next these, are those of the *second magnitude*; and so on, to the *sixth*, which comprehends the smallest *stars* visible to the naked eye; all beyond, are called *telescopic stars*. Not that all the *stars* of each class appear justly of the same *magnitude*; there is a great latitude in this respect, and those of the *first magnitude* appear almost all different in lustre and size. Other *stars* there are, of *intermediate magnitudes*, which Astronomers cannot refer to this, rather than the next class, and therefore place them between the two.

*Procyon*, for instance, which *Ptolemy* makes of the *first magnitude*, and *Tycho* of the *second*, *Flamsteed* lays down as between the *first* and *second*. Thus, instead of six several *magnitudes*, we have really six times six. Some authors assert, that the *stars* of the *first magnitude* subtend an angle of at least a minute; but the *earth's orbit* seen from the *fixed stars*, only subtends an angle of 20 seconds; and hence they conclude that the diameters of the *stars* are vastly greater than that of the *earth's* whole *orbit*. Now a sphere whose semidiameter only equals the distance between the *sun* and the *earth*, is, by some, supposed to be ten millions of times greater than the *sun*; consequently the *fixed stars* must be much more than ten millions of times greater than the *sun*. But Mr. *Whiston* is of opinion, that this is a mistake, and that the diameters, even of the largest *stars*, viewed through a telescope, which magnifies, for example, a hundred times, subtend no visible angle at all, but are mere lucid points.

The incertitude, as to the *magnitude*, and distance of the *fixed stars* from us, proceeds from their having no *parallax*\*; since all Astronomers, both

antient and modern, agree, that the doctrine of the distances of the celestial bodies consists in their *parallaxes*, and that it is impossible we should have any just observation without it.

Among the *fixed stars*, there is a long, white, luminous track, which seems to encompass the heavens like a swath, scarf, or girdle, called *Via Lactea*, or *Galaxy*, of Γαλαξίας, milk. It passes between *Sagittary* and *Gemini*, and divides the sphere into two parts. It is unequally broad, and in some parts is single, in others double. And it is an assemblage of an infinite number of minute *stars*, to be discovered only by a *telescope*.

The number of the *stars* appears to be vastly great, almost infinite; yet Astronomers have long ago ascertained the number of those visible to the eye; which are found vastly fewer than one would imagine. *Hipparchus*, 125 years before the *Incarnation*, made the number of visible *stars* to be 1022. These were reduced into 48 *Constellations*; and he laid it down, that if there sometimes appeared more in winter nights, it was owing to a deception of the sense. *Ptolemy* added four *stars* to *Hipparchus's catalogue*, and made the number 1026. In the year of Christ 1437, *Ulug Beigh*, grandson of *Tamerlane*, made a new *catalogue*, and gives 1017. But in the seventeenth century, when *Astronomy* began to be retrieved, their number was found to be much greater.

To the forty-eight *Constellations* of the antients were added twelve new ones, discovered towards the south pole, and two towards the north; besides several others not universally admitted, as the *Flower-de-lis*, the *Royal Oak*, &c.

*Tycho Brahe* published a catalogue of 777 *stars*, from his own observations; which *Kepler* from *Ptolemy* and others increased to 1163, *Ricciolus* to 1468, and *Bayer* to 1725: Dr *Halley* 373, observed by him within the *Antarctic Circle*. *Hevelius*, from his own observations, and those of Dr. *Halley*, and the antients, made a catalogue of 1888 *stars*; and Mr. *Flamsteed* has since made a catalogue of no less than 3000 *stars*, all from his own most accurate observations. Of these 3000, it is true, there are many only visible through a *telescope*; nor does a good eye scarce ever see more than a hundred at the same time in the clearest heaven: the appearance of innumerable, more frequent in clear winter nights, arrives from our sight's being deceived by their twinkling, and from our viewing them confusedly, and not reducing them to any order. Yet for all this, the *stars* are really almost

\* A PARALLAX is an arch of the heavens intercepted between the true place of a star, and its apparent place. The true place of a star, is that point of the heavens wherein it would be seen by an eye placed in the center of the earth. The apparent place, is that point of the heavens, wherein the star appears, to an eye on the surface of the earth.

infinite. *Riccioli* makes no scruple to affirm, in his new *Almagest*, that a man who should say there are above twenty thousand times twenty thousand, would say nothing improbable; for a good telescope directed to any point in the heavens, discovers numbers, that are lost to the naked sight.

In the single constellation of the *Pleiades*, instead of six or seven stars seen by the best eye, *Dr. Hook*, with a telescope twelve foot long, told seventy-eight; and with larger glasses many more of the same magnitude. *F. de Reita*, a Capuchin, affirms, that he has observed above 2000 stars in the single constellation of *Orion*. The same author found above 188 in the *Pleiades*: and *Huygens*, looking at the star in the middle of *Orion's* sword; instead of one, found it to be twelve. *Galileo* found 80 in *Orion's* sword; 21 in the nebulous star of his head; and 36 in the nebulous star *Præsepe*.

The ancients portioned out the firmament into several parts, or *Constellations*\*, reducing certain number of stars under the representation of certain images, in order to aid the imagination, and the memory. In the book of *Job*, mention is made of the name of certain constellations, *Pleiades*, *Orion*: the same may be observed of *Homer* and *Hesiod*.

The ancients only took in the visible firmament, which they distributed under 48 *Constellations*; twelve whereof took up the *Zodiac*; the names they gave them are, *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*, *Scorpius*, *Sagittarius*, *Aquarius*, *Capricorn*, *Pisces*; from whence the signs of the *Ecliptic* and *Zodiac* take their names; though now no longer contiguous to the *Constellations*.

The stars on the northern signs of the *Zodiac*, were disposed into 21 *Constellations*, viz. *Ursa major* and *minor*, *Draco*, *Cepheus*, *Bootes*, *Corona septentrionalis*, *Hercules*, *Lyra*, *Cygnus*, *Cassiopeia*, *Perseus*, *Andromeda*, *Triangulum*, *Auriga*, *Pegasus*, *Equuleus*, *Delphinus*, *Sagitta*, *Aquila*, *Ophioculus*, or *Serpentarius*, and *Serpens*; to which have been added since, *Antinous*, and *Coma Berenices*.

The stars on the southern side of the *Zodiac* were distributed into 15 *Constellations*; their names *Cetus*, *Eridanus*, *Fluvius*, *Lepus*, *Orion*, *Canis major* and *minor*, *Argo*, *Hydra*, *Crater*, *Corvus*, *Centaurus*, *Lupus*, *Æra*, *Corona Meridionalis*, and *Piscis Australis*: to which have been since added the following viz. *Phœnix*, *Grus*, *Indus*, *Pavo*, *Piscis Australis*, *Piscis volans*, *Toucan*, *Hydrus*, and *Xiphias*.

Of these *Constellations* the 15 last, with the greatest part of *Argo*, *Navis*, *Centaurus* and *Lupus* are not visible in our horizon.

In these *Constellations* the stars are ordinarily distinguished by that part of the image wherein they

are found. *Blayer* distinguishes them farther by the letters of the *Greek* alphabet; and many of them again have peculiar names, as *Arcturus* between the feet of *Bootes*; *Gemina* or *Lucida* in the *Corona Septentrionalis*; *Palitium* in the *Bull's-Eye*; *Pleiades* in the back, and *Hyades* in the forehead of the *Bull*; *Castor* and *Pollux* in the head of *Gemini*; *Capella*, with the *Hædi* in the shoulder of *Auriga*, *Regulus*, or *Cor Leonis*; *Spica Virginis* in the hand, and *Vindemiatrix* in the shoulder of *Virgo*; *Antares*, or *Cor Scorpii*; *Fomabaut* in the mouth of *Piscis Australis*; *Regel* in the foot of *Orion*; *Sirius*, in the mouth of *Canis major*; and the *Pole-Star*, the last in the tail of *Ursa minor*.

The other stars not comprehended under these *Constellations*, yet visible to the naked eye, the ancients called *Informes*, or *Sporades*, some whereof the modern *Astronomers* have since reduced into new figures or *Constellations*. Thus *Hevelius*, v. gr. between *Leo* and *Ursa minor*, makes *Leo minor*; and between *Ursa minor* and *Auriga*, over *Gemini*, makes *Lynx*, under the tail of *Ursamajor*, *Canes Venatici*, &c.

The stars in the constellation of *Aries*, in *Ptolemy's* catalogue, are 18; in *Tycho's*, 21; in the *Britannic* catalogue, 65. In *Taurus*, the second in order, in *Ptolemy's* catalogue, 44; in *Tycho's*, 41; in the *Britannic* catalogue, 135. In *Gemini*, the third, in *Ptolemy's* catalogue, 24; in *Tycho's*, 29; in the *Britannic* catalogue, 89. In *Cancer*, the fourth, in *Ptolemy's* catalogue, 13; in *Tycho's*, 15; in *Bayer* and *Hevelius's*, 29; in *Mr. Flamsteed's*, 71. In *Leo*, the fifth, in *Ptolemy's* catalogue, 32; in *Tycho's*, 37; in the *Britannic* catalogue, 97. In *Virgo*, the sixth, into which the sun enters in the beginning of *August*, in *Ptolemy's* catalogue, 32; in *Tycho's*, 39; in the *Britannic* catalogue, 89. In *Libra*, the seventh sign, so called, because when the sun is in it, at the autumnal equinox, the days and nights are equal, as if weighed in a ballance, there are 45 stars. In *Scorpio*, the eighth, in *Ptolemy's* catalogue 20; in *Tycho's* 10; in *Flamsteed's*, 49. In *Sagittarius*, the ninth, in *Ptolemy's* catalogue, 31; in *Tycho's*, 16; in the *Britannic* catalogue, 50. In *Capricorn*, the tenth, in *Ptolemy* and *Tycho's* catalogues, 28; in that of *Hevelius*, 29; in the *Britannic* catalogue, 51. In *Aquarius*, the eleventh, in *Ptolemy's* catalogue, 45; in *Tycho's*, 40; in the *Britannic* catalogue, 99. In *Pisces*, the twelfth sign, in *Ptolemy's* catalogue, 38, in *Tycho's*, 33; in the *Britannic* catalogue, 109. Of the other 36, 21 are placed on the north of the *zodiac*, and 15 on the south.

The first of those on the north, is *Ursa major*, a constellation placed near the pole, which consists, according to *Ptolemy's* catalogue, of 35 stars; ac-

\* i. e. An assemblage of stars under the name and figure of some animal or other thing, called also an *asterism*.

ording to *Tycho's*, of 56; and according to the *Britannic catalogue*, of 215. *Ursa minor*, plac'd also in the neighbourhood of the north pole, of 8, according to *Ptolemy* and *Tycho*; and of 14, according to *Flamsteed*. In *Draco*, the second northern constellation, there are, according to *Ptolemy*, 31; according to *Tycho*, 32; according to *Bayer*, 33; and according to *Flamsteed*, 49. In *Cepheus*, the third, there are, in *Ptolemy's catalogue*, 13; in *Tycho's*, 11; in *Hevelius's*, 40; in the *Britannic catalogue*, 35. In *Bootes*, the fourth, in *Ptolemy's catalogue*, 23; in *Tycho's*, 28; in *Bayer's*, 34; in *Hevelius's*, 52; in *Flamsteed*, 55. In *Corona Borealis*, the fifth, in *Ptolemy's catalogue*, 8; in *Tycho's*, 8; in the *Britannic catalogue*, 21. In *Hercules*, the sixth, in *Ptolemy's catalogue*, 29; in *Tycho's*, 28; in the *Britannic catalogue*, 95. In *Lyra*, the seventh, in *Ptolemy and Tycho's catalogues*, 10; in the *Britannic catalogue*, 19. In *Cygnus*, the eighth, in *Ptolemy's catalogue*, 17; in *Tycho's*, 19; in the *Britannic catalogue*, 107. In *Cassiopeia*, the ninth, in *Ptolemy's catalogue*, 13; in *Tycho's*, 28; in *Flamsteed's*, 56.

In *Perseus* (the tenth) in *Ptolemy's catalogue* 29; in *Tycho's* 29; in the *Britannic catalogue* 67. In *Andromeda* (the eleventh) there are two stars of the second magnitude, and very conspicuous; another is called *Umbiliculus Andromedæ*, and another *Lucida pedis Andromedæ*. In *Triangulum* (the twelfth) in *Ptolemy and Tycho's catalogue* 4; in the *Britannic catalogue* 24. In *Auriga* (the thirteenth) in *Ptolemy's catalogue* 14; in *Tycho's* 23; in *Hevelius* 40; in the *Britannic catalogue* 68.

In one of these constellations, called also *Eriethonius's* shoulder, there is a very bright star, called *Capella*, and near it three others lesser, placed in the form of an isosceles triangle, called *Hædi*.

In *Pegasus* the fourteenth, in *Ptolemy's catalogue* 20; in *Tycho's* 19; in the *Britannic catalogue* 93; in *Equuleus* (the fifteenth) in *Ptolemy's catalogue* 4; in *Tycho's* 4; in *Flamsteed's* 10. In *Dolphinus* (the sixteenth) in *Ptolemy's catalogue* 10; in *Tycho's* 10; in *Flamsteed* 18. In *Sagitta* (the seventeenth) in *Ptolemy and Tycho's catalogue* 5. In *Flamsteed's* 23. In *Aquila* (the eighteenth) in *Ptolemy's catalogue* 15; in *Tycho's* 17; in the *Britannic catalogue* 70. In this constellation there is a star of the first magnitude. In *Serpentarius* (the nineteenth) in *Ptolemy's catalogue* 29; in *Tycho's* 25; in the *Britannic catalogue* 69. In *Serpens* (the twenty-first) in *Ptolemy's catalogue* 17; in *Tycho's* 19; in the *Britannic catalogue* 59.

The stars on the southern side of the zodiac are distributed into 15 constellations, viz.

In *Cetus* (the first) in *Ptolemy's catalogue* there are 22 stars; in *Tycho's* 21; in *Hevelius's* 22; in the *Britannic* 78. In *Eridanus Fluvius* (the second)

in *Ptolemy's catalogue* 30; in *Tycho's* 19; in *Flamsteed's* 68. In *Lepus* (the third) in *Ptolemy's catalogue* 12; in *Tycho's* 13; in the *Britannic* 19. In *Orion* (the fourth) in *Ptolemy's catalogue* 37; in *Tycho's* 62; in the *Britannic* 80.

In this constellation there are two stars of the first magnitude, a reddish one in the shoulder, called *Bellatrix*; and another yellowish in the foot. There is, besides, in it the *Balteus*, or *Girdle*, consisting of three stars. The ancients supposed that *Orion* raised tempests at its rising and setting; hence its name *Orion* from the Greek  $\omega\rho\iota\omega$ , to make water.

In *Canis major* (the fifth) in *Ptolemy's catalogue* 18; in *Tycho's* 13; in the *Britannic* 32.

In the mouth of *Canis major* there is a star, the most brilliant or shining of all, called *Sirius*, at which, when the *Sun* arrives, then the *Canicule*, or dog-days begin.

In *Canis minor* (the sixth) in *Ptolemy's catalogue* 17. In *Argo* (the seventh) in *Ptolemy's catalogue* 8; in *Tycho's* 11; in the *Britannic* 25. In *Hydra* (the eighth) in *Ptolemy's catalogue* 25; in *Dr. Halley's* 68. In *Cancer* (the ninth) in *Ptolemy's catalogue* 7; in *Tycho's* 8; in the *Britannic* 11. In *Corvus* (the tenth) in *Ptolemy's catalogue* 7; in *Tycho's* 7; in the *Britannic* 10. In *Centaurus* with *Lupus* (the eleventh) in *Ptolemy's catalogue* 19; in *Tycho's* 4; in the *Britannic* 13.

*Ara* (the twelfth) consists of 7 stars; whereof 5 are of the fourth magnitude, and 2 of the fifth. This constellation is not visible in our hemisphere; no more than *Corona Meridionalis*, nor *Piscis Australis*.

The changes which have happened in the stars, are very considerable. The first was in the year 125, before the Incarnation, when *Hipparchus* discovered a new star to appear.

In the year 1572, *Tycho Brabe* observed another new star in the constellation *Cassiopeia*. Its magnitude at first exceeded that of the biggest of our stars, *Sirius* and *Lyra*; it even equalled that of *Venus*, when nearest the earth, and was seen in fair day-light. It continued sixteen months, toward the latter part whereof it began to dwindle, and at last totally disappeared, without any change of place in all that time. *Leonicus* tells us of another star appearing in the same constellation, about the year 905, which resembled that of 1572; and quotes another ancient observation, whereby it appears that a new star was seen about the same place in 1264. *Dr. Keil* takes those to have been all the same star; and does not know but it may make its appearance a-new 150 years hence.

*Fabricius* discovered another new star in the neck of the *Whale*, which appeared and disappeared several times in the years 1640 and 1662: its course and motion is described by *M. Bouillaud*. *Simon Marius*

*Marius* discovered another in *Andromeda's* Girdle in 1612 and 1613; tho' *M. Bouillaud* says, it had been seen before in the 15th century. Another was observed by *Kepler* in *Serpentarius*. Another of the third magnitude in the Constellation *Cygnus*, near the-bill, in the year 1601, which disappeared in 1626, and was observed again by *Hevelius* in 1659, till the year 1661, and again in 1666 and 1671, as a *star* of the sixth magnitude.

It is certain from the ancient catalogues that many of the ancient *stars* are not now visible. This is particularly notorious in the *Pleiades* or seven *stars*, whereof six are now visible to the eye; a thing long ago observed by *Ovid*. *M. Montaner*, in his letter to the *Royal Society*, in 1670, observes that there are now wanting in the heavens two *stars* of the second magnitude, in the stern of the ship *Argo* and its yard, which had been seen till the year 1664. When they first disappeared it is not known; but he assures us, that there was not the least glympse of them in 1668. He adds, he has observed many more changes in the fixed *stars*, even to the number of an hundred.

Some are of opinion that those temporary *stars*, which upon their disappearing have never been found to return again, are probably conjectured to be of the number of *COMETS*, which make long excursions from their suns, or the center of the upper planetary systems, *i. e.* from the fixed stars; returning too seldom to have their returns perceived.

The fixed *stars* shine with their own light.

*Aristotle*, lib. I. *Meteor.* c. 7. imagined that *COMETS* were only a kind of transient fires or meteors, consisting of exhalations raised to the upper region of the air, and there set on fire; far below the moon's course; but from the time of *Tycho Brahe*, all *Astronomers* have been of opinion, that *Aristotle* was mistaken, and have all approved *Seneca's* sentiments, who, lib. 7. *natural. quest.* c. 22. places a *comet* among the eternal works of nature; and considers it as an heavenly body, or star, or planet, placed in another vortex ever since the creation. Besides it is incredible that bituminous and sulphurous exhalations could remain inflamed in the air, for so long a time, as we see a *comet* appear; add to it, that a *comet* has no *parallax*, which is a convincing proof of its immense distance from us; for the moon has a sensible *parallax*. For example:

Let the earth be A, fig. 2. in which two spectators will be placed, *viz.* in B and C: he who will be in C, will see the moon D in J, and Mars E in H; and he in B will see the moon D in F, and Mars E in G. Therefore both will judge that the moon and Mars do not exist in the same part of the heavens or firmament, or near the same stars; but

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will refer them to different parts of heaven, and to different stars; and the nearer the earth a star is supposed to be, the greater will be the diversity of aspect. Hence if the star be the remotest from the earth, such as is L, so that the magnitude of the earth, with respect to that distance, should not be sensible, or be like a point, then the star will be seen in the same place by both spectators; which is the reason why *comets* have no *parallax*, because seen in the same place from several spectators, and from several place, *viz.* from London, Paris, Rome, Constantinople, &c. therefore the *comets* are at an immense distance from us.

If any body was placed in the center of the world, he would see the right place of a star. As if the earth was in the center of the world, and a person placed in that center, the moon would appear to him under those stars it is really placed; but he who inhabits the superficies of the earth, must see the moon under other stars, unless it be placed in its vertical; in which case, the lines of the true and apparent place concur. For example.

Let the center of the earth be A, Fig. 2; and the moon D; the person placed in A, will see the moon in E; and he in B, see it in D: for the arch ED, is the difference of the true and apparent place, which is called *parallax*. But if one of the spectators be placed in A, and the other in C, to whom the moon should be vertical; then because the ray of the true, and the ray of the apparent place, coincide in the same point, there will be no *parallax* in the moon, because it will be referred in E, by both spectators. Therefore, from a *parallax*, the distance of a star from the arch is investigated; and where there is no *parallax*, *i. e.* where the terrestrial semidiameter, or the diversity of aspect from which the *parallax* is required, has no sensible magnitude, with respect to the distance of some celestial body, because of its great distance from the earth; that celestial body must be supposed far above the planets of our vortex; which is the case of the *comets*, which have no *parallax*.

Or perhaps, it would be still better to say, with *Pythagoras*, and the *Pythagoreans*, that the *comets* are some planets, which, though obscured with the too great radiancy of the sun, and thereby hidden from us, are, nevertheless, some time distanced from the sun, and come in sight.

*Des Cartes*, tert. part. princip. num. 119. conjectures, that *comets* P, are only stars, formerly fixed like the rest, in the heavens; but which becoming by degrees covered with maculæ, or spots, and at length wholly robbed of their light, cannot keep their place, but are carried off by the vortices of the circumjacent stars; and in proportion to their magnitude

nitude and solidity, moved in such manner, as to be brought nearer the orb of *Saturn*, and thus coming within reach of the sun's light rendered visible.

*Bernulli*, in his system of *comets*, supposes some primary planet revolving round the sun in the space of four years, and 157 days; and at the distance from his body of 2583 semidiameters of the *great orbit*: this planet, he concludes, either from its vast distance, or smallness, to be invisible to us; but, however, to have, at several distances from him, several *satellites* moving round him, and sometimes descending as low as the *orbit* of *Saturn*; and that these, becoming visible to us, when in their *perigæum*, are what we call *comets*.

Others will have the motion of *comets* made in the excentrick circle of the *earth*, so that when they are in the *apogee* of that circle, they cannot be seen, because of their great distance from us; and are only visible, when near the *perigee*; and that it might very well happen, that even in the *perigee* they are not visible, since then they would be wrapp'd up in the rays of the sun, being never but in day-time on the horizon.

Some pretend to refute all these *hypotheses* from the very *phenomena* of the *comets*; objecting, 1. That those *comets*, which move according to the order of the signs, either advance slower than usual, or retrograde, a little before they disappear, if the *earth* be between them and the sun; and more swiftly, if the *earth* be situated in a contrary part: on the contrary, those which proceed contrary to the order of the signs, proceed more swiftly than usual, if the *earth* be between them and the sun; and more slowly and go retrograde, when the *earth* is in a contrary part. 2. So long as their velocity is increased, they move nearly in great circles; but towards the end of their course, deviate from those circles; and as often as the *earth* proceeds one way, they go the contrary way. 3. That they move in ellipses, having one of their *foci* in the center of the sun; and by *radii* drawn to the sun, describe areas proportionable to the times. 4. That the light of their bodies, or *nuclei*, increases in their recess from the *earth* towards the *sun*; and, on the contrary, decreases in their recess from the sun towards the *earth*. 5. That their *tails* appear the largest and brightest immediately after their transit through the region of the sun; and that they always decline from a just opposition to the sun towards those parts which the bodies, or *nuclei*, pass over, in their progress through their *orbits*. 6. That this declination, *ceteris paribus*, is the smallest when the heads, or *nuclei*, approach nearest the sun; and still less, near the *nucleus* of the *comet*, than towards the extremity of the *tail*. 7. That

the *tails* are somewhat brighter, and more distinctly defined in their convex, than in their concave part; and that they always appear broader at their upper extremity, than near the center of the *comet*; which *tails* are transparent, the smallest stars appearing through them.

Some are of opinion, that Sir *Isaac Newton* solves all these *phenomena*, by his supposing that the *comets* are compact, solid, fixed, and durable bodies; in one word, a kind of planets, which move in very oblique *orbits*, every way, with the greatest freedom, preserving in their motions, even against the course and direction of the planets: their *tails* being a very thin, slender vapour, emitted by the head, or *nucleus* of the *comet*, ignited, or heated by the sun. From whence they draw the following conclusions, with him.

1. That it is evident, that the *comets*, which proceed according to the order of the signs, a little before they disappear, must move more slowly, or appear retrograde, if the *earth* be between them and the sun; and swifter, if the *earth* be in a contrary part: on the contrary, those proceeding against the order of the signs, &c. for since their course is not among the fixed stars, but among the planets; as the motion of the *earth* either conspires with them, or goes against them, their appearance, with regard to the *earth*, must be changed, and, like the planets, they must sometimes appear swifter, sometimes slower, and sometimes retrograde. 2. When the *comets* move the swiftest, they must proceed in straight lines; but in the end of their course, decline, &c. because in the end of their course, when they recede almost directly from the sun, the part of the *apparent motion*, which arises from the *parallax*, must bear a greater proportion to the whole *apparent motion*. 3. The *comets* must move in *ellipses*, having one of their *foci* in the center of the sun; because they do not wander precariously from one fictitious *vortex* to another, but, making a part of the solar system, return perpetually, and run a constant round. 4. The light of their *nuclei* must increase in their recess from the sun, and *vice versa*; because as they are in the regions of the planets, their access toward the sun, bears a considerable proportion to their whole distance. 5. Their *tails* must appear the largest, and brightest, immediately after their transit through the region of the sun; because then their heads being the most heated, will emit the most vapours; which *tails* must still decline from a strict opposition to the sun, towards those parts, which the heads pass over in their progress thro' their *orbits*; because all smoke and vapours emitted from a body in motion, tends upwards obliquely, still receding from that part towards which the smoking body proceeds. 6. That declination will

be still the least near the *nucleus* of the *comet*, and when the *comet* is nearest the sun; because the vapour ascends more swiftly near the head of the *comet*, than in the higher extremity of its *tail*; and when the *comet* is at a less distance from the sun, than at a greater. 7. The *tail* is brighter, and better defined, in its convex part, than in its concave: because the vapour in the convex part, which goes first, being somewhat nearer and denser, reflects the light more copiously. The *tail* must also appear broader towards the higher extremity of the *comet*, than towards the head; because the vapour in a free space perpetually rarefies and dilates. Lastly, the *tail* must be transparent, because consisting of infinitely thin vapour, &c.

There is no certain time fixed for the appearance of the *comets*. The duration of their appearance is also very uncertain; for, some are seen for a few days only; others, for several months.

All the *comets* seem to have a diurnal motion from *east* to *west* towards the *earth*, and in that sense to describe circles parallel to the *equator*. Besides that apparent motion they have in common with the other heavenly bodies, they have another proper, and peculiar to them under the *firmament*, which cannot be regularly determined; for some are carried to the *east*, some to the *west*, and others otherwise.

The celerity of this peculiar motion is not equal in all the *comets*, but is rather various and unequal; since some of them run several more degrees of a great circle than others; neither is the celerity of the motion of each *comet* always equal: for the arch B, which it runs each day, is sometimes greater, and sometimes less, in such manner, however, that if several right lines were drawn from the center of the *earth*, to be carried through the places wherein the *comet* is seen at that hour, those lines would divide another right line into almost equal parts, which should touch the circle described by the *comet*, in that place where its motion appears the most rapid. Neither is the way they run through always equal, since some describe a greater space in the heavens than others. But, however, let that space be what it will, none, or very few, have been known to have described above one half of the great circle under the *firmament*, i. e. to have run more than half the heavens.

When a *comet* is seen to dart its rays toward that place of the heavens where its motion seems to carry it, those rays are called the *beard* of the *comet*; when, on the contrary, those rays are extended towards that part of the heavens whence its proper motion seems to recede, they are called the *tail* of the *comet*; but when they are equally dispersed on all sides, some call it the *hairs* of the *comet*. Thus

the *comet* which was seen in 1664, at the beginning of *December*, in the meridional part of the world, to whose respect the sun was *east*, darting its rays towards the *west*, where its proper motion inclined, was called *bearded*; being turned afterwards towards the sun, it shewed its *hairs*; and, lastly, having the sun on the *west*, its rays being then darted towards the *east*, formed a *tail*.

*Robault* believes that those rays, whereof the *beard*, *tail*, or *hairs* of a *comet* are imagined to be made, are the rays of light reflected by the body of the *comet*, i. e. proceed from reflection.

*Apollonius Myndius* was the first who took *comets* for regular stars; and ventured to foretel, that one day the periods, and laws of their motion, would be discovered. *Astronomers*; however, are still divided on that head; *Newton*, *Flamsteed*, *Halley*, and all the *English* *Astronomers*, seem satisfied of the return of *comets*. *Cassini*, and others of the *French*, think it highly probable. *De la Hire*, and others, oppose it.

The SUN is the first heavenly body, placed within our *system* that demands our attention.

The sun by his force and action, communicates all the motion and strength to the other heavenly bodies. The heat and light of the sun demonstrate its being of a fiery nature.

The fiery nature of the sun, is proved by its rays being collected by concave mirrors, or convex lenses, burning, consuming, and melting the most solid bodies, or else converting them into ashes.

Hence it follows, that its surface is every where fluid, that being the condition of flame.

The figure of the sun, is a spheroid, higher under its *equator*, than under the *poles*; which is proved thus: the sun has a motion about its own *axis*, and therefore the solar matter will have an endeavour to recede from the centers of the circles wherein it moves, and that with the greater force, as the peripheries of the circles are greater. But the *equator* is the greatest circle, and the rest towards the *poles* continually decrease: therefore the solar matter, though at first in a spherical form, will endeavour to recede from the center of the *equator*, further than from the centers of the *parallels*. Consequently, since the gravity whereby it is retained in its place, is supposed to be uniform throughout the whole sun; it will really recede from the center more under the *equator*, than under any of the *parallels*. And hence the sun's diameter drawn through the *equator*, will be greater than that passing through the *Poles*; and therefore its figure is not perfectly spherical, but *spheroidal*.

According to the *Copernican hypothesis*, which is now generally received, and which has even demonstration on its side, the sun is the center of the *cometary*

*metary* and *planetary* systems; round which, all the *planets*, and our *earth*, among the rest, revolve, in different periods, according to their different distances from the *sun*.

But it evidently appears, from the *phenomena* of the *sun's maculae*, or spots, that he has a *rotation* round its *axis*, like that of the *earth*, whereby the natural days are measured, only slower. Some of these spots have made their first appearance near the edge, or margin of the *sun*, and have been seen some time after on the opposite edge; whence, after a stay of about 14 days, they have re-appeared in their first place, and taken the same course over-again; finishing their entire circuit in 27 days time; which is hence deduced to be the period of the *sun's rotation* round its *axis*. This motion of the spots is from *west* to *east*, whence we conclude that of the *sun*, to which the other is owing, to be from *east* to *west*.

Besides this *rotation* of the *sun* round his *axis*, it has an *apparent* annual motion round the *earth*, whereby he is seen to advance, insensibly, towards the eastern stars; though it be demonstrated that there is no such thing, and that such appearance is occasioned by the annual motion of the *earth*.

What's worthy our observation in this apparent annual motion of the *sun*, is, 1. That he always appears to move in the same *plane*, or *ecliptick* line, and never to change his course; and that the *earth's* center is always inherent on the same *plane*, while it accomplishes its course round the *sun*; which is agreeable to this general rule, that all impulsive force must always operate according to the direction of a right line: and as the annual motion of the *earth* proceeds from a projectile impulsion, according to a right line, and from a perpetual attraction towards the center of the *sun*, it is absolutely necessary that the *earth*, as well as the rest of the *planets*, should form her course on the same plane, by a line of direction of an impulsive force, and which should pass through the center of the *sun*.

2. That his motion is inequable, tho' in the same *ecliptick*; for a little after the *vernal*, and some time before the *autumnal equinox*, his motion is moderately swift; but a little after the *winter's solstice*, the same motion is swifter; and after the *summer's solstice*, slower. This inequality of motion is occasioned by the *earth*, not describing a circle round the *sun*, but an *ellipsis*.

3. That the *apparent diameter* of the *sun* is greater in *winter*, while his motion is swifter, than in *summer*, while slower; because as the *earth*, as we have observed already, performs its course in an *ellipsis*, and in the same *ellipsis* is always removed from the *sun*, at an unequal distance, as well when it ascends from the *perihelion* to the *aphelion*, as when it descends from the *aphelion* to the *perihelion*; and as

the *earth* is in its *perihelion* a little after the *winter solstice*, and in its *aphelion* a little after the *summer solstice*, the *apparent diameter* of the *sun*, or of his reciprocally proportional *distance* from the *earth*, must be either *greater* or *lesser*, as the *distance* is *greater* or *lesser*. Therefore it is found, towards the beginning of *winter*, very great; middling, towards the beginning of the *spring* and *autumn*; and very small about the beginning of *summer*.

4. That the *ecliptick* being divided into two parts by the *equinoctial points*, the *sun* stays longer in its northern part, than in the southern part; that is to say, the *elliptical orbit* of the *earth* is divided by the *equinoctial points* into two unequal parts; for the *perihelion* is not at a very great distance from the *winter solstice*: therefore the *equinoctial points* must almost coincide, not with the great *axis*, but with the right side, and thereby render the spaces unequal. Therefore the *apparent motion* of the *sun*, which in equal times describes equal spaces, must be unequal, and appear to stay several days longer in the six *northern*, than in the *southern signs*; and though this difference be of almost eight days, it nevertheless will decrease, in the succeeding years, so as to be reduced to nothing at last; and again decrease and increase, by course, as long as the annual motion will last.

5. That, however, the space of the entire annual revolution, which we call *year*, is equal to each other, and consists of 365 days, 5 hours, 49 minutes; since whatever be the inequality of the parts, when compared to each other, there is nothing taken, thereby, from the whole revolution: for the whole space of the same *ellipsis* is the same, and we begin to enumerate the areas from what place soever, because the beginning and the end of the numeration will be the same. There is, however, some inequality betwixt the time of the *anomaly* restored, or of the revolution from the point, of the *ellipsis*, to the same point, (which is equal to the *starry year*) and the time of the *tropical year*; for the *starry year*, or the revolution of the *earth* from a fixed star to the same star, is not always of the same magnitude with the *tropical year*.

6. That the *obliquity* of the *ecliptick*, or the angle wherein it cuts the *equator* is usually fixed at  $23^{\circ} 29'$ ; which, therefore, is the greatest *declination* of the *ecliptick* from the *equator*.

The method of observing the greatest *declination* of the *ecliptick* is thus: about the time of one of the *solstices*, observe the *sun's meridian altitude*, with the utmost care for several days successively; from the greatest *altitude* observed, subtract the *height* of the *equator*, the remainder is the greatest *declination* in the *solstitial point*. Ricciolus, e. gr. at Bologna, in the year 1646, observed the *sun's meridian*

altitude, on the 20th of June, to be  $68^{\circ} 59' 55''$ ; on the 21st,  $69^{\circ} 0' 10''$ ; and on the 22d,  $68^{\circ} 59' 55''$ . The greatest, then was,  $69^{\circ} 0' 10''$ ; from which the altitude of the equator,  $45^{\circ} 29' 50''$ , being subtracted, left  $23^{\circ} 30' 20''$ , for the greatest declination.

But the most essential, and the most worthy our observation of all the sun's phenomena, is his parallax, either diurnal or monthly, since thereby we discover his true distance, and his true magnitude, and with it the true distances and magnitudes of the other planets.

The great distance of the sun renders his parallax too small, to fall even under the nicest immediate observation: indeed many attempts have been made both by the ancients and moderns; and many methods invented for that purpose. The first, that of Hipparchus, followed by Ptolemy, &c. was founded on the observation of lunar eclipses. The second was that of Aristarchus, whereby the angle subtended by the semidiameter of the moon's orbit seen from the sun, was sought from the lunar phases: but these both proving deficient, Astronomers are forced to have recourse to the parallaxes of the planets nearer us, as Mars and Venus; for from their parallaxes known, that of the sun, which is inaccessible by any direct observation, is easily deduced. For from the theory of the motion of the earth and planets, we know at any time the proportion of the distances of the sun and planets from us; and the horizontal parallaxes are in a reciprocal proportion to those distances: knowing therefore the parallax of a planet, that of the sun may be found from it. Thus Mars when opposite to the sun, is twice as near as the sun is: his parallax therefore will be twice as great as that of the sun: And Venus, when her inferior conjunction with the sun, is sometimes nearer than he is; her parallax therefore is greater in the same proportion.

Thus from the parallaxes of Mars and Venus, Cassini found the sun's parallax to be ten seconds, which implies his distance to be 22000 semi diameters of the earth. In an observation of the transit of Venus over the sun, which will be seen in May 1761. Dr. Halley has shewn a method of finding the sun's parallax, and distance to a five hundredth part of the whole.

Before we proceed, it is very proper to explain what is understood by planets, their distinction, &c.

PLANET, in Astronomy, is a celestial body, revolving round the sun as a center, and continually changing its position with respect to other stars, whence its name *πλανήτης*, wanderer, in opposition to a star, which remains fixed.

The planets are usually distinguished into primary and secondary.

The primary planets, called also simply, and by way of eminence, planets, are those which move round the sun as their proper center; and are again subdivided into superior and inferior planets. The superiors are those further off the sun than our earth is. Such are Mars, Jupiter, and Saturn. The inferiors are those nearer the sun than our earth is, and situate between the earth and the sun. Such are Venus and Mercury.

Secondary planets, are such as move round some primary planets, as their respective center, in the same manner as the primary planets do round the sun. Such are the moon moving round our earth; and those others moving round Saturn and Jupiter, properly called Satellites.

The Moon is a dark and spherical body, which has no light of itself, but only shines with that she receives from the sun; whence only that half turned towards him is illuminated; the opposite one remaining in its native darkness. The face of the moon visible on our earth is that part of her body turned towards the earth; whence according to the various positions of the moon, with regard to the sun and earth, we observe different degrees of illumination; sometimes a large, and sometimes a less portion of the enlightened surface being visible, which different degrees of illumination proceed also from the superficies of the moon being rough, uneven, and not smooth.

From the nature of the moon, we'll proceed to her various motions.

Cassini is of opinion, that the moon revolves, every month, round her proper axis; with the same face always turn'd towards the earth. Which can be easily understood, if we consider that a man, who runs round the circumference of a circle he has describ'd on an area, always looks on the center of that circle, since in that whole course he must revolve round himself.

2. The moon is observed to be carried every day, with the rest of the heavenly bodies, from east to west.

3. The moon advances; every day, very near thirteen degrees, from west to east; so that she finishes, or accomplishes her course in the space of 27 days, and almost 8 hours; which interval, we call a periodical month; because then the moon, moved from west to east, accomplishes her period, i. e. from a determinate part of the heavens, to the same, or returns from one fixed star, to the same fixed star. But if we compare the moon with the sun, who does not remain, like a fixed star, in the same sensible place, but every day runs almost a degree in the zodiack, from west to east; she is longer in passing from one conjunction to another, than in returning from a determinate point of the heavens to the same point: therefore as the sun will

will be advanced 26 degrees, or thereabouts, in the space of a *periodical month*, the *moon* must add two days, or more, to the *periodical month*, in order to compleat the *synodical month*, and overtake the *sun*, *i. e.* the space from one *syzygy* to the other: whence the *synodical month* consists of 29 days, 12 hours, 44 minutes, and 3 seconds; though commonly the minutes and seconds are neglected, and the *synodical lunar months* are reckoned to consist alternately of 29 and 30 days.

However, this motion of the *moon* does not describe a perfect circle, for it is an *elliptical*, or approaching to the *elliptical*. For if we follow *Des Cartes's* hypothesis, the *vortex* of the *moon* being pressed on both sides by *Mars* and *Venus*, must be *elliptical*. Hence the *moon* occupies a lesser diameter of that *vortex* near the *syzygies*, *i. e.* near the conjunction and opposition with the *sun*, and a greater, when near the quadratures.

As the *plane* of the *moon's orbit*, and the *plane* of the *ecliptick*, cut each other in a right line, as, and in the same manner as the same *ecliptick* divides the *equator* in the *equinoctial points*; hence ensues, that they are inclined to each other in an angle of about five degrees. The points of these *intersections* are called *nodes*, by *Ptolemy*; whereof that where the *moon* ascends above the *plane* of the *ecliptick* northward, is called the *ascending node*, and the *head of the dragon*; and the other, the *descending node*, and the *dragon's tail*; and the interval of time between the *moon's* going from the *ascending node*, and returning to it, a *dracontick month*.

If the line of the *nodes* was immoveable, that is, if it had no other motion but that whereby it is carried round the *sun*, it would still look towards the same point of the *ecliptick*, *i. e.* would always keep parallel to itself; but it is found by observation, that the line of the *nodes* constantly changes place, and

shifts its situation from *east* to *west*, contrary to the order of the signs, and by a retrograde motion finishes its circuit in about 19 years; in which time each of the *nodes* returns to the point of the *ecliptick* whence it before receded. Hence it follows, that the *moon* is never precisely in the *ecliptick*, but twice each period, *viz.* when she is in the *nodes*; throughout the rest of her course she deviates from it, being nearer or further from the *ecliptick*, as she is nearer or further from the *nodes*.

We call the *moon's* distance from the *nodes* her *latitude*, which is measured by an arch of a circle drawn through the *moon*, perpendicular to the *ecliptick*, and intercepted between the *moon* and the *ecliptick*. The *moon's latitude*, when at the greatest, never exceeds five degrees, and about 18 minutes; which *latitude* is the measure of the angles of the *nodes*.

*M. Cassini* observes, that while the *moon* is performing her revolution round the *earth*, she varies her distance from it, in three different manners. For, 1. She runs every day its *apogee*, 6 minutes, 42 seconds, towards the *east*, and her *excentricity* contains 42 parts of a *mile*, into which the semi-diameter of the *orbit* of the *moon* is supposed to be divided. This *excentricity* is less, when the *sun* is at an equal distance from the *moon's perigee* and *apogee*; but when the *sun* approaches nearer the *moon's apogee* or *perigee*, that *excentricity* increases; and when the *sun* is existant in the *moon's apogee* or *perigee*, the lesser or simple *excentricity* is increased by a half part of it. The space of time wherein the *moon*, going from the *apogee*, returns to it again, is called the *Anomalistick month*.

*Tycho Brahe* has discover'd, that the *moon* changes her motion, according to her different distance from the *Syzygies* \*. That in the first quarter, that is, from

\* *Syzygy*, (from the Greek συζυγία, *conjunctio*) is a term equally used for the *conjunction* and *opposition* of a planet with the *sun*. On the *phenomena* and circumstances of the *syzygies*, a great part of the *lunar theory* depends. For, 1. The force, which diminishes the gravity of the *moon* in the *syzygies*, is double that, which increases it in the *quadratures*: so that in the *syzygies* the gravity of the *moon* from the action of the *sun*, is diminished by a part, which is to the whole gravity, as 1 to 89,36; for in the *quadratures* the addition of gravity is to the whole gravity, as 1 to 178,73.

2. In the *syzygies* the disturbing force is directly as the distance of the *moon* from the *earth*, and inversely as the cube of the distance of the *earth* from the *sun*. And as the *syzygies* the gravity of the *moon* towards the *earth*, receding from its center, is more diminished, than according to the inverse ratio of the square of the distance from that center. Hence, in the motion of the *moon* from the *syzygies* to the *quadratures*, the gravity of the *moon* towards the *earth* is continually increased, and the *moon* is continually retarded in its motion; and in the motion from the *quadratures* to the *syzygies*, the *moon's* gravity is continually diminished, and its motion in its orbit accelerated.

3. Further, in the *syzygies* the *moon's orbit*, or circle round the *earth*, is more convex, than in the *quadratures*; for which reason, the *moon* is less distant from the *earth* at the former, than the latter. When the *moon* is in the *syzygies*, her *apsides* go backwards, or are retrograde. When the *moon* is in the *syzygies*, the *nodes* move in *antecedentia* fastest; then slower and slower, till they become at rest when the *moon* is in the *quadratures*.

Lastly, When the *nodes* are come to the *syzygies*, the inclination of the *plane* of the *orbit* is least of all. These several irregularities are not equal in each *syzygy*, but all somewhat greater in the *conjunction* than the *opposition*.

from the conjunction to her first *quadrature*, \* she abates somewhat of her velocity; which in the second quarter she recovers: In the third quarter she again loses; and in the last again recovers. This *Tycho* call'd the *Moon's variation*.

There are other very considerable irregularities in the *moon's* motion, in that of her *apogee*, and in the *nodes*: for when the *earth* is in it's *aphelion*, the *moon* is in her *aphelion* likewise; in which case, she quickens her pace, and performs her circuit in a shorter time: On the contrary, when the *earth* is in its *perihelion*, the *moon* is so too; and then she slackens her motion; and thus revolves round the *earth* in a shorter space when the *earth* is in its *aphelion*, than when in its *perihelion*: so that the *periodical months* are not all equal.

The irregularity of the *moon's apogee* is discover'd by its being found to move forwards, when it coincides with the line of the *Syzygies*, and backwards, when it cuts that line at right angles. Nor is this progress and regress in any measure equal; in the conjunction and opposition it goes briskly forwards, and in the quadratures moves either slowly forwards, stands still, or goes backward.

The motion of the *nodes* is not uniform; but when the line of the *nodes* coincides with that of the *Syzygies*, they stand still; when the *nodes* are in the quadratures, *i. e.* when their lines cut that of the *Syzygies* at right angles, they go backward, from east to west; and this *Sir Isaac Newton* shews, with the velocity of  $16'' 19''' 24''''$  in an hour.

Astronomers determine the period of the *moon's* revolution round the *earth*, or the *periodical month*, and the time between one opposition and another, or the *synodical month*, by computing the time between two eclipses, or oppositions; and dividing this, by the number of lunations that have pass'd in the mean time: hence they find the *quotient* to be the quantity of the *synodical month*. They likewise compute the *sun's* mean motion during the time of the *synodical month*, and add this to the entire circle described by the *moon*. Then, as the sum

is to  $360^\circ$ , so is the quantity of the *synodical month* to the *periodical*.

Or, 1. The quantity of the *periodical month* being given; by the *Rule of Three* we may find the *moon's* diurnal and horary motion, &c.

2. If the *sun's* mean diurnal motion be subtracted from the *moon's* mean diurnal motion, the remainder will give the *moon's* diurnal motion from the *sun*.

3. Since in the middle of a total eclipse the *moon* is in the *node*; if the *sun's* place be found for that time, and to this be added six signs, the sum will give the *place of the node*.

4. The *nodes* have a motion, and proceed in *antecedentia*, *i. e.* from *Taurus* to *Aries*, from *Aries* to *Pisces*, &c. if then to the *moon's* mean diurnal motion be added the diurnal motion of the *nodes*, the same will be the motion of the latitude; and thence by the *Rule of Three* may be found in what time the *moon* goes  $360^\circ$  from the *Dragon's Head*, or in what time she goes from, and returns to it; that is, the quantity of the *Dracontic month*.

5. If the motion of the diurnal *apogee* be subtracted from the mean motion of the *moon*, the remainder will be the *moon's* mean motion from the *apogee*; and thence, by the *Rule of Three*, is determined the quantity of the *Anomalistical month*.

To find the *moon's* age, we must add to the day of the month the *epoch* of the year, and the months from *March* inclusive. The sum, if under 30 must be subtracted from it; if over, the excess is the *moon's* age. If the month has but 30 days, the excess above 29 is the *moon's* age.

To find the time of the *moon* being in the meridian, we must multiply her age, if under 15 days by 4, and divide the product by 5; the quotient gives the hour, and the remainder multiplied by 12 the minute. If her age exceeds 15, we must subtract 15, and proceed with the remainder as before. To find the time of the *moon's* beginning to shine, we must multiply her age, if under 15 by 48, and divide the product by 60: the quotient

\* The *QUADRATURE*, *Fig. 7.* of the *moon*, is her aspect, or situation, when she is  $90^\circ$  distant from the *sun*: Or her *quadrature* is when she is in the middle point of her orbit, between the points of *conjunction* and *opposition*, which happens twice in her revolution, *viz.* in the first and third quarters.

When the *moon* is in her *quadrature*, she exhibits that *phasis* which we call the *half moon*, *i. e.* she shines with just half her face, and is said to be bisected, or *dichotomized*. It is very difficult to fix the precise moment, when the *moon* is bisected, or in her true *dichotomy*. Observation informs us, that when she is 30 minutes distant from the *quadratures*, she appears bisected; but she appears so too in the *quadratures* themselves, and sometimes afterwards, as *Ricciolus* acknowledges, in his *Almagest*. So that she appears *dichotomized*, or cut in two, at least for the space of a whole hour, in which time any moment may be taken for the true point of *dichotomy*, as well as any other. But the infinite number of moments of time, give an infinite diversity of distances. The moment in which the true *dichotomy* happens, being thus uncertain, but it being granted, without, that it happens before the *quadrature*; *Ricciolus* takes the middle point between the *quadrature* and the time when it is first dubious, whether the *moon* be *dichotomized*, or not, for the true *dichotomy*.

gives the hour; and the remainder the minute. If her age be above 15 days, we must subtract the time thus found from 24; the remainder gives the time of shining in the morning.

We'll proceed to ECLIPSES of the SUN and MOON.

ECLIPSE, from the Greek εκλειψις, from εκλειπω, I fail, in Astronomy, is a privation of the light in one of the luminaries, by the interposition of some opaque body, either between it and the eye; or between it and the sun.

When the moon passes between the earth and the sun, and deprives us of his aspect, that is called an eclipse of the sun, which is always the greater, the greater is the part it steals from our sight, which may also sometimes be total, if the eclipse covers it entirely.

Eclipse of the sun, Fig. 4. is distinguished into total and partial.

As the moon is found to have a parallax of latitude, eclipses of the sun only happen when the latitude of the moon, viewed from the sun, is less than the aggregate of the apparent semidiameter of the sun and moon. Therefore solar eclipses happen when the moon is in conjunction with the sun, in or near the nodes, i. e. at the new moons. Consequently the memorable eclipse of the sun, at our saviour's passion, happening at the time of full moon, when the sun and moon are in opposition, was preternatural.

If there is not an eclipse of the sun every new moon, though the new moon covers the sun from the earth, it is because the moon's way is not precisely under the ecliptick, but placed obliquely thereto; only intersecting it twice in every period; so that eclipses can only be occasioned in such new moons, as happen in these intersections or nodes, or very near them. In the nodes, when the moon has no visible latitude, the occultation is total, Fig. 5; and with some continuance, when the disk\* of the moon in Perigæo, appears greater than that of the sun in Apogæo, and its shadow is extended beyond the surface of the earth; and, without continuance, or moderate distances, when the cusp or point of the moon's shadow barely touches the earth. Out of the nodes, but near them, the eclipses are partial.

The other circumstances of solar eclipses are, 1.

That none of them are universal; that is, none of them are seen throughout the whole hemisphere, which the sun is then above; the moon's disk being much too little, and much too near the earth to hide the sun from the disk of the earth, which is fifteen times bigger than it. 2. Nor does the eclipse appear the same in all parts of the earth, where it is seen; but when in one place it is total, in another it is partial. Farther, when the moon being in her Apogæe, appears much less than the sun, as happens most sensibly, when he is in Perigæo; the cusp of the lunar shadow not reaching the earth, she becomes in a central conjunction with the sun, yet not able to cover his disk; but lets his whole limb appear like a lucid ring or bracelet, hence called an annular eclipse. 3. It does not happen at the same time in all places where it is seen; but appears more early to the western parts, and later to the eastern. 4. Its beginning is always on the western side the sun, and on the same side it ends. 5. In total eclipses of the sun the moon's darkened disk is seen covered with a faint dawning light; which is commonly attributed to the reflection of the light from the illuminated part of the earth. Lastly, in total eclipses of the sun, the moon's limb † is seen surrounded by a pale circle of light; which the late Astronomers take for a manifest indication of a lunar atmosphere.

To calculate an eclipse of the sun, we must find, 1. The mean new moon, and thence the true one, together with the place of the luminaries for the apparent time of the true one. 2. Compute the apparent time of the new moon observed for the apparent time of the true new moon. 3. Compute the latitude seen, for the apparent time of the new moon seen. 4. Thence determine the digits eclips'd. 5. We must find the times of the greatest darkness, immersion, and emersion; and thence determine the beginning and ending of the eclipse.

Flamsteed has invented a method of representing the solar eclipses, which, by a geometrical construction, removes all the difficulties and impediments of the Calculus; which is this:

There must be understood innumerable lines conducted from the circles of the earth (through a plane which should touch the lunar orbit; which plane must be level to the right line which connects

\* DISK, in Astronomy, is the body or face of the sun or moon, such as it appears to us. The Disk is conceived to be divided into twelve equal parts, called digits; by means whereof it is, that the magnitude of an eclipse is measured, or estimated. Such an eclipse was so many digits or parts of the sun, or moon's disk. Mercury and Venus are sometimes seen in the sun's disk, transiting the sun's disk. In a total eclipse of either of those luminaries, the whole disk is obscured or darkened; in a partial eclipse only part of them.

† The LIMB signifies the outermost border, or edge of the sun or moon, when the middle or disk is hid in an eclipse of either luminary. Astronomers observe the lower and the upper limb of the sun, in order to find its true height, which is that of its center,

the centers of the *sun* and of the *earth*) to the center of the *sun*. All those lines shall cut the said plane, and will shew the terrestrial sphere, projected with its circles on that plane: so that the eye placed in the *sun's* center, must see the *earth*, and its annual, as well as diurnal motion, accomplished in the same plane, in the same manner we see from the *earth*, the *moon* and the *sun*, with all their mutations, as if they were but plain superficies, and had their spherical circles described in plain *disks*: then from the projection of such spherical terrestrial superficies, will arise in this plane, a circle of basis, called the *disk of the earth*; and which is to be every where equal to the plane of the *ecliptick*: then will arise, likewise, a right line extended on each side through its center, which will represent the axis of the *earth*, projected in that plane, inclin'd on each angle to the plane of the *ecliptick*, according to the difference of the seasons. And the *parallelism* of the terrestrial axis, on reason of its different situation to our plane, will make the inequality of the angle in the same plane. There will arise, likewise, in the same plane, by the diurnal motion of each point in the superficies of the *earth*, innumerable *eclipses*, by whose different situations the place in the plane given will be determined, and separated from them all.

Therefore, if in the *solar eclipses* we can discover in that plane, the lines, and the ways which the *moon* will pass through, we'll discover, also, the place of our hemisphere which is to be at that time darkened, by its interposition; which can be done in the following manner:

Having found the lesser distance of the center of the *earth*, or of the *disk* and *penumbra* of the center, and likewise the distance of its smaller line in our plane, from the area of the *ecliptick*, let be drawn from the point of the lesser distance in the plane, a line perpendicular to it; this line will trace the passes or way of the *penumbra*, in the base, or *disk* of the circle. Then we must mark in that right line the hours, with their quarters and minutes of our meridian, which answer to the *phenomena* of the *eclipse*; marking, likewise, in the *ecliptick* line of our plane, the hours, with their parts, so that each hour, and each smaller part of the hour, mark the point where your place, described in the *ellipse*, is fixed: In this manner, and by those moments of time given, in our right, and elliptical line, we'll discover the *phenomena* of the *eclipse* which are to appear in our place. Take from a scale of equal parts, especially that from whence you have taken your whole delineation, the semidiameter of the *penumbra*, and having carried one flank of your compasses through the paths of the *penumbra*, and direct the other towards the path

of your place, if it cannot reach it, there will be no occultation of the *sun* in your place; but if, on the contrary, you perceive that it not only reaches it, but even goes beyond it, then there will be an *eclipse*; *total*, if there be an interfection between the trace of the *penumbra*, and that of your place; and only *partial*, if there be no such interfection. Likewise, you'll have the middle of the *eclipse* at that very time, when having applied the flanks of the compasses to the axis of the parallel *ecliptick*, you'll observe the same hour in both traces, or paths. Lastly, you'll find the end of the *eclipse*, when it will be proper to mark the same hour, in the path of the center of the *penumbra*, and in the path of your place; whence the beginning, middle, and end of an *eclipse* may be accomplished by a projection of lines, without the assistance of a *calculus*, or *parallaxes*.

IMMERSION, or incidence of an *eclipse*, we have so often mentioned in this place, is the moment when part of the *sun* or *moon's disk* first begins to be hid. And EMERSION, or expurgation of an *eclipse*, is the time when the eclipsed luminary begins to reappear, or emerge out of the shadow.

ECLIPSE of the *moon*, Fig. 6. is a deficiency of light in that planet, occasioned by a diametrical opposition of the *earth*, between the *sun* and *moon*.

When all the light of the *moon* is intercepted, or when her whole *disk* is covered, the *eclipse* is said to be *total*; when only part, *partial*. When the *total eclipse* lasts for some time, it is said to be total with continuance; when only instantaneous, total without continuance. *Eclipses of the moon* only happen in time of full *moon*; because it is only then the *earth* is between the *sun* and *moon*. Nor do they happen every full *moon*, by reason of the obliquity of the *moon's* way with respect to the *sun's*; but only in those full *moons*, which happen either in the *nodes*, or very near them, where the aggregate of the apparent semidiameters of the *moon*, and the *earth's* shadow, is greater than the latitude of the *moon*, or the distance between their centers.

The most considerable circumstances in the *eclipses* of the *moon*, are, 1. That as the sum of the semidiameters of the *moon*, and *earth's* shadow, is greater than the aggregate of the semidiameters of the *sun* and *moon*, it is evident *lunar eclipses* may happen in a greater latitude of the *moon*, and at a greater distance from the *nodes*; and consequently are more often observed in any one part of the *earth*, than solar ones; though with respect to the whole *earth* the latter are as frequent as the former. 2. *Total eclipses*, and those of the longest duration, happen in the very *nodes* of the *ecliptick*; by reason the section of the *earth's* shadow, then falling on the

*moon*, is considerably greater than her *disk*. There may likewise be *total eclipses* within a little distance of the *nodes*; but the further, the less their duration; further off still, there are only partial ones, and at length none at all: as the latitude and the semidiameter of the *moon*, together, are either less, equal, or greater than the semidiameter of the shadow. 3. All *lunar eclipses* are universal, *i. e.* are visible in all parts of the globe which have the *moon* above their horizon; and are every where of the same magnitude, and begin and end together. 4. In all *lunar eclipses* the eastern side is what first *immerses*, and also *emerges*; so that though at first the *moon* be more westerly than the *earth's shadow*, yet her proper motion being swifter than the same, she overtakes, and out-goes it. 5. The *moon*, even in the middle of an *eclipse*, has usually a faint appearance of light; which *Gassendus*, *Ricciolus*, *Kepler*, &c. attribute to the light of the *earth's atmosphere* transmitted thither. Lastly, she grows sensibly paler, and dimmer, before ever she enters within the *earth's shadow*, which is attributed to the *earth's Penumbra*; this PENUMBRA, is a faint, or partial shade, observ'd between the perfect shadow, and the full light of an *eclipse*. The *penumbra* arises from the magnitude of the *sun's body*; were he only a luminous point, the shadow would be all perfect; but by reason of the diameter of the *sun*, it happens, that a place which is not illuminated by the whole body of the *sun*, does yet receive rays from a part thereof. A *penumbra* must be found in all *eclipses*, whether of the *sun*, *moon*, or the other planets, primary or secondary; but it is most considerable with us in *eclipses* of the *sun*. In *eclipses* of the *moon* the *earth* is encompassed, indeed, with a *penumbra*, but it is only sensible to us on the *earth* near the total shadow. The *Penumbra* extends infinitely in length, inasmuch as to each point of the diameter of the *sun* there answers a point infinite in length, into which no rays enter from that point, though they do from others. *M. de la Hire* examines the different degrees of the *penumbra*, and represents them geometrically, by the ordinates of a curve, which shall be among themselves, as the several parts of the *sun's disk*, wherewith a body planted in the *penumbra* is enlightened.

Before we can expect to be masters of a sure method of calculating the times, places, magnitudes, and other *phenomena* of the *eclipses* of the *moon*, we must endeavour to find, 1. The length of the *earth's shadowy cone* 2. The apparent semidiameter of the *earth's shadow*, in the place of the *moon's passage*, for any given time. And 3. The arch between the centers, (*Fig. 12.*) and the arch C. after the *moon's latitude* at the time of

her opposition, together with the angle at the *node* B, has been given

The length of the *earth's shadowy cone* is found, by finding the *sun's distance* from the *earth* for the given time. Suppose for example, the *sun's greatest distance* from the *earth* 34996 semidiameters of the *earth*; and the *sun's semidiameter* to be to that of the *earth*, as 153 to 1; then will the length of the shadowy cone be found 230 $\frac{1}{4}$ . Hence, as the *moon's least distance* from the *earth* is scarce 64 semidiameters, the *moon*, when in opposition to the *sun* in or near the *nodes*, will fall into the *earth's shadow*, though the *sun* and *moon* be in their *apogees*; and much more, if they be in or near their *perigees*, by reason the shadow is then longer, and the *moon* nearer the base of the cone.

By finding the *sun* and *moon's distance* from the *earth*, and thence their *horizontal parallaxes*, is found the apparent semidiameter of the *earth's shadow*, in the place of the *moon's passage* for any time given; if the *parallaxes* be added together, and the apparent semidiameter of the *sun* be subtracted from the sum, then the remainder is the apparent semidiameter of the shadow. Thus suppose the *moon's horizontal parallax* 56' 48'', the *sun's* 6''; the sum is 56' 54'': from which the *sun's* apparent semidiameter, 16' 5'', being subtracted, leaves 40' 49'' for the semidiameter of the shadow. *M. de la Hire* omits the *sun's parallax* as of no consideration; but increases the apparent semidiameter of the shadow by a whole minute. for the shadow of the atmosphere, which would give the semidiameter of the shadow, in our instance, 41' 13''.

Since in the spherical triangle A I I, (*Fig. 35.*) rectangular at I, the side A L is given, as also the angle A L I, as being the complement of L A I, or B, to a right angle: the arch between the centers, A I, is found by spherical trigonometry: and since the angle L A I is equal to B, each of them, with A B, making a right angle; and the *moon's latitude* A C is given; the arch L I will likewise be found by spherical trigonometry.

We determine the bounds of an *eclipse of the moon*, by adding the apparent semidiameters of the *moon*, in *perigæa*, and of the shadow, supposing the *sun* in *apogæo*; by which we shall have the side M O (*Fig. 36.*) Then in the spherical triangle M N O, having given the angle at the *node*, whose quantity is the *moon's greatest latitude* in the conjunction, the right angle E, and the leg M O, we must find the *moon's distance* from the *node* N O, which is the utmost bound, beyond which the *eclipse* cannot reach. Adding, after the same manner, the apparent semidiameters of the *moon* in *apogæo*, and of the shadow of the *sun* in *perigæo*. for the sake

of having the arch  $LK$ , in the triangle  $NLh$ , the distance of the *moon* in the ascending *node* will be found by spherical trigonometry; which is the bound within which the *moon* will necessarily be eclipsed. For example; the semidiameter of the shadow, when the *sun* is in *apogæo*, and the *moon* in *perigæo*, according to *Kepler*, is  $49' 40''$ , and the apparent semidiameter of the *moon* in *perigæo*  $16'' 22'$ ; consequently,  $MO$  is  $66'$ , or  $1^\circ 6'$ ; and therefore there will be no *eclipse* at all, if the *moon's* latitude be greater than  $1^\circ 6'$ . Now as the same angle  $N$ , is supposed by *Kepler* to be  $5^\circ 18'$ ;

Log, of sine $N$	89655337
Sine $MO$	82832433
Whole sine	100000000
Log. of Sine * $ON$	93177096

The Remainder corresponding to which, in the tables, is  $11^\circ 59' 50''$ . If, therefore, the *moon's* distance from the ascending *node* be greater than  $12^\circ$ , no *eclipse* can happen. And, in like manner, the semidiameter of the shadow in the *sun's* *perigæe*, and the *moon's* *apogæe*, is  $43' 50''$ , and the *moon's* semidiameter in her *apogæe*  $15'$ : consequently  $Lh$  is  $58' 50''$ ; and therefore there will be an *eclipse*, if the *moon's* latitude do not exceed  $58' 50''$ : But here, as before, the argument of the latitude is found  $1^\circ 40'$ .

If we will determine the quantity of an *eclipse*, or the number of the digits eclipsed, we must add the *moon's* semidiameter to the semidiameter of the shadow, and subtract, from the sum, the arch between the centers; the remainder gives the scruples, or parts of the diameter, eclipsed.

To find the time of half duration of an *eclipse*, or the arch of the *lunar* orbit which her center describes from the beginning of the *eclipse* to the middle thereof; we must add the semidiameters of the shadow  $AP$ , and the *moon*  $PM$ , together; the sum gives  $AN$ . From the square of  $AN$ , we must subtract the square of  $AI$ , the remainder is the square of  $IN$ ; and the square root of this residue is the arch  $IN$ , required. But we will, perhaps, have the scruples of half duration of total darkness, in a total *eclipse*. Then we'll subtract the *moon's* semidiameter  $SV$ , from the semidiameter of the shadow  $AV$ ; the remainder is  $AS$ . In the triangle  $AIS$ , which is rectangular at  $I$ ; therefore we have the arch  $AS$ , given by the last method;

and the arch between the centers  $AI$ ; where the arch  $IS$  is found, as in the last problem.

We'll proceed still further, and find, the beginning, middle, and end of a *lunar* *eclipse*. Which to perform, we'll say, as the *moon's* horary motion from the *sun*, is to 3600 horary seconds; so are the seconds of the arch  $LI$ , (*Fig. 35.*) to the horary seconds equivalent thereto: then subtracting these scruples, or seconds, in the first and third quadrant of the anomaly, from the time of full *moon*; and adding it to the same in the second and fourth, the result is the time of the middle of the *eclipse*. Then we'll say again, as the *moon's* horary motion from the *sun*, is to 3600 scruples, or seconds; so are the seconds of half duration  $IN$ , to the time of half duration; the double of which gives the whole duration. Lastly, We'll subtract the time of half duration from the time of the middle of the *eclipse*, the remainder will be the beginning of the *eclipse*. And if we add the same to the same, the sum will be its end.

To calculate an *eclipse* of the *moon*, proceed in the following manner:

1. To find whether there will be an *eclipse*, or not. For the given time of the mean full *moon*, we must compute the *moon's* distance from the *node*.
2. The time of the true full *moon* must be computed, with the *sun* and *moon's* true place reduced to the *ecliptick*.
3. For the time of the true full *moon*, we are to compute the *moon's* true latitude, the distance of each luminary from the earth, with the *horizontal* *parallaxes*, and apparent semidiameters.
4. For the same time we must find the *sun* and *moon's* true horary motion.
5. The apparent semidiameter of the shadow. And, 6. The arch between the centers  $AI$ , with the arch  $LI$ .
7. Compute the scruples of half duration. And thence,
8. Determine the beginning, middle, and end of the *eclipse*. Lastly, find the scruples eclipsed, and thence the quantity of the *eclipse*.

From the *moon* let us descend to the lower planets.

MERCURY, is so small a planet, that it can scarcely be distinguished, though almost equal in radiancy or brightness to the fixed stars; but is never seen, but when in a very great digression from the *sun*, and is seldom discovered round, even by the telescope, but only divided into two parts, like the *moon* while in the quadratures.

The mean distance of *Mercury* from the *sun* is to that of our *earth* from the *sun*, as 387 to 1000, its

\* SINE, is a right line drawn from one extremity of an arch, perpendicularly upon the radius, drawn from the other extremity. Or the sine is half the chord of twice the arch. That arch, is a part of any curve line, for example, of a circle, ellipse, or the like. And that chord, is the base, or line that joins the two extremes of the arch.

excentricity 8 degrees. The inclination of its orbit, that is, the angle formed by the plane of its orbit, with the plane of the ecliptic, is 6 degrees 52 minutes. Its diameter to that of the earth, as 3 to 4; and therefore the globe of *Mercury* will be to that of the earth, as 2 to 5. According to Sir *Isaac Newton*, the heat and light of the sun on the surface of *Mercury*, is seven times as intense as on the surface of our earth in the middle of summer: which, as he found by experiments made for that purpose by a thermometer, is sufficient to make water boil.

The revolution of *Mercury* round the sun, or his year, is performed in 87 days 23 hours; his diurnal revolution, or the length of his day, is not yet determined; nor is it certain, whether he has such a motion round his own axis or not. The force of gravity on his surface, is seven times as strong as on the surface of the earth. Its density, and consequently the gravitation of bodies towards the center cannot be accurately determined; but, no doubt, it must exceed that of our earth, by reason of the excess of heat there.

*Mercury* changes his phases, like the moon, according to his several positions, with regard to the sun and earth. As to his situation, *Mercury* is sometimes observed betwixt the earth and the sun; and sometimes beyond the sun. Its greatest distance from the sun, with regard to us, never exceeds 28 degrees, whence it is seldom visible; being commonly either lost in the sun's light, or, when the most remote from the sun, in the crepusculum. The best observations of this planet are those made when it is seen on the sun's disk; for in its lower conjunction it passes before the sun like a little spot, eclipsing a small part of his body, which was first observed by *Cassendi* in 1632; but not without a telescope.

Next to *Mercury* stands *VENUS*, constantly attending the sun, and never departing from him above 47 degrees. When she goes before the sun, that is, rises from him, she is called *Phosphorus*, or *Lucifer*, or the morning star; and when she follows him, that is, sets after him, *Hesperus*, or *Vesper*, or the evening star.

The diameter of *Venus* is to that of the earth, as 10 to 19; her distance from the sun is  $\frac{7}{10}$  of the earth's distance from the sun; her excentricity 5; the inclination of her orbit  $3^{\circ} 23'$ ; her periodical course round the sun performed in 224 days, 17 hours; and her motion round her own axis, in 23 hours. Her greatest distance from the earth according to *Cassini*, is 38000 semidiameters of the earth; and her smallest 6000. Her parallax is 3 minutes.

*Venus*, when viewed through a telescope, is

rarely seen to shine with a full face, but has phases just like those of the moon; being now gibbous, now horned, &c. and her illumin'd part constantly turned towards the sun, i. e. it looks towards the east, when *Phosphorus*; and towards the west, when *Hesperus*.

The phenomena of *Venus* evidently shew the falsity of the Ptolemaic system: for that system supposes, that *Venus's* orb, or heaven, incloses the earth; passing between the sun and *Mercury*. And yet all our observations agree, that *Venus* is sometimes on this side the sun, and sometimes on that; nor did ever any body see the earth between *Venus* and the sun; which yet must frequently happen, if *Venus* revolv'd round the earth, in a heaven below the sun. *Venus* is easily distinguished, by her brightness, and whiteness, which exceeds that of all the other planets, and which is so considerable, that in a dusky place she projects a sensible shadow. Her place is between the earth and *Mercury*.

The visible conjunctions of *Venus* with the sun, are not so frequent as those of *Mercury*, by reason of the slower motion of *Venus*, whereby she seldom attains to the places given. And because her periodical times, compared with the periodical times of the earth, are less commensurable, and therefore very seldom co-incident.

*MARS*, is one of the three superior planets, and of those three the nearest to us; being placed between the sun and *Jupiter*. Its mean distance from the sun, is 1524 of those parts, whereof the distance of the sun from the earth is 1000; its excentricity 141; the inclination of its orbit, that is, the angle formed by the plane of its orbit with the plane of the ecliptic, 1 degree, 52 minutes; the periodical time, in which it makes its revolution round the sun, 686 days, 23 hours.

It must be observed, that in the Copernican and Tychoinic hypotheses, the earth is contained within the circumference of this circle; and that hence *Mars* is, at certain times, in opposition to the sun; that is, when near the earth; and sometimes *Mars* is nearer to it than the sun himself; as it is evident in both systems: and then he appears bigger to us, than while in conjunction with the sun, tho' in conjunction, as well as in opposition, it shines in full orbit; but in conjunction he is superior to the sun, and at a greater distance from us; but nearer, when in opposition, in the quadratures, he has the same phases the moon has, but they are very little sensible to us.

*Mars* always appears with a ruddy troubled light, whence we conclude it is encompassed with a thick, cloudy atmosphere, which by disturbing the rays of light in their passage and repassage through, it occasions that appearance.

JUPITER, is one of the superior planets, situate between *Saturn* and *Mars*, remarkable for its brightness, which by its proper motion seems to revolve round the earth in about 12 years. It has a rotation round its own axis in 9 hours 56 minutes; and a periodical revolution round the sun in 4332 days, 12 hours, 20' 9". It is the biggest of all the planets; its diameter, to that of the sun appears, by astronomical observations, to be as 1077 is to 10000; to that of *Saturn*, as 1077 to 889; to that of the earth, as 1077 to 104. The force of gravity on its surface is to that on the surface of the sun, as 797,15 is to 10,0000; to that of *Saturn*, as 797,15 to 534,337; to that of the earth, as 797,15 to 407,832. The density of its matter is to that of the sun, as 7404 to 10000; to that of *Saturn*, as 7404 to 6011; to that of the earth, as 7404 to 3921. The quantity of matter contained in its body is to that of the sun, as 9,248 to 10,000; to that of *Saturn*, as 9,248 to 4,223; to that of the earth, as 9,248 to 0,0044.

The mean distance of *Jupiter* from the sun is 5201 of those parts, whereof the mean distance of the earth from the sun is 1000, tho' *Kepler* only makes it 5196 of those parts. *Cassini* calculates *Jupiter's* mean distance from the earth to be 115,000 semidiameters of the earth. *Gregory* computes the distance of *Jupiter* from the sun to be five times as great as that of the earth from the sun; whence he gathers, that the diameter of the sun, to an eye placed in *Jupiter*, would not be a fifth part of what it appears to us; and therefore its disk would be twenty-five times less, and his light and heat in the same proportion.

*Jupiter* appears almost as large as *Venus*, but is not altogether so bright. He is eclipsed by the moon, by the sun, and even by *Mars*. He has three appendages, called *Zones* or *Belts*, which *Sir Isaac Newton* thinks are formed in his atmosphere. In these are several *maculae* or spots, carried from east to west (in a part conspicuous to us) in the space of 9 hours 56 minutes, the discovery of which is controverted between *Eustachio*, *P. Gotignies*, *Cassini*, and *Campani*.

In 1610, the 7th of *January*. at one the following night, *Galileo* discovered, round *Jupiter*. four little planets or moons, which move round him, and which he called the *Astra Medicæ*, and we the *Satellites* of *Jupiter*. Those nearer to him move with a greater celerity, than those at a greater distance. *Simon Marcus* has defined their revolutions in the following manner. Revolves:

The first and innermost	The second.
d h ' "	d h ' "
1 18 28 30	3 13 18 00

The third.	The fourth.
d h ' "	d h ' "
7 03 56 34	16 18 09 15

*Cassini* observed that the first or innermost of these *Satellites* of *Jupiter*, was five semidiameters of *Jupiter*, distant from *Jupiter* itself, and made its revolution in one day, 18 hours, and 32 minutes. The second, which is somewhat greater, he found eight diameters distant from *Jupiter*, and its revolution 3 days, 13 hours, and 12 minutes. The third, which is the greatest of all, is distant from *Jupiter* 13 semidiameters, and finishes its course in 7 days, 3 hours, and 50 minutes. The last, which is the least of all, is distant from *Jupiter* 23 semidiameters; its period is 16 days, 18 hours, and 9 minutes.

*Jupiter's Satellites*, when they enter its shadow (like the moon when she enters the earth's shadow) are eclipsed, because they are opake bodies, and receive their light from the sun. The three first cause three eclipses in each revolution. 1. When the *Satellite* enters the disk of *Jupiter*. 2. When the shadow of the *Satellite* darkens the disk of *Jupiter*. 3. When the superior part of *Jupiter* hides the *Satellite*. 4. When the *Satellite* is immersed in *Jupiter's* shadow. Therefore the first *Satellite* causes eclipses within seven days; the second eight; the third four; and all together twenty-eight. The first *Satellite*, when arrived at the node, causes four eclipses within seventeen days.

*Cassini* has invented proper tables for the computation of the eclipses of the *Satellite* next *Jupiter*, which indicates the very moment of the eclipse.

SATURN is of all the planets the farthest from the earth and the sun, on which account, though the biggest of all the planets it appears the smallest, and to shine but with a feeble light. Its period, or the space of time wherein he revolves round the sun (which makes his year) according to *Kepler*, is 29 years, 174 days, 4 hours, 58 minutes, 25 seconds, and 30 thirds; whence his diurnal motion must be 2 minutes, 0 seconds, 36 thirds; though *De la Hire* makes his diurnal motion 2 minutes, 1 second. The inclination of his plane to that of the *ecliptic*, *Kepler* makes 2° 32'; *De la Hire* 2° 33'. Its mean distance from the sun is 326925 semidiameters of the earth; and from the earth 210,000 of the same. Its smallest diameter, according to *Huygens*, is 30 seconds. The proportion of its diameter to that of the earth, as 20 to 1; of its surface to that of the earth, as 400 to 1; of its solidity to that of the earth, as 1 to 8000.

The distance of *Saturn* from the sun being ten times greater than that of the earth from the same, it

it is found that the apparent diameter of the sun seen from him, will not exceed 3 minutes, which is but little more than twice the diameter of *Venus*.

It is doubted, whether or no *Saturn*, like the other *planets*, revolves round its axis: it does not appear, from any astronomical observations, that he does; and there is one circumstance that should seem to argue the contrary, *viz.* that whereas the earth, and other *planets*, which we know do revolve on their axes, have their *equatorial diameters* greater than their *polar*; nothing like this is observed in *Saturn*.

The supposed various and extraordinary *phases* of *Saturn*, have long perplexed the Astronomers. But *Huygens* has reduced all his *phases* to three principal ones, *viz.* *round, brachiated, and anastated.*

*Saturn* has a *ring* peculiar to himself, which surrounds his middle like an arch, or like the horizon of an *armillary sphere*, without touching him any where; the diameter whereof is more than double that of the planet which it surrounds; the former containing 45 diameters of the earth, the latter only 20. When raised enough to be out of the shadow of the body of *Saturn*, it reflects the light of the sun very strongly. Dr. Keill observes, that the thickness of the *ring* takes up one half of the space between its outer, or convex surface, and the surface of the planet. This *ring* is found to be an opaque, solid, but smooth, and even body.

*Saturn* performs his course round the sun, attended with five *Satellites*, or *secondary planets*; the first of which was discovered by *Cassini*, at the Royal Observatory at *Paris*, anno 1672, to be distant from the center of *Saturn*, a diameter and two thirds of the *ring*, and to accomplish his course round *Saturn* in the space of 4 days, 12 hours, and 27 minutes. The second had been long before discovered by *Huygens*, and is a great deal bigger than the first. This is distant from *Saturn's* center, four diameters of the *ring*, and revolves round him in 16 days, 23 hours. The third was observed by *Cassini*, anno 1671, towards the latter end of *October*, in a great digression from *Saturn*, but soon vanished from his sight, and could not be seen again till towards the 15th of *December*, and soon disappeared again, till the beginning of *February*, 1673; when it continued visible for thirteen days successively.

Dr. *Halley*, in the *Philosophical Transactions*, gives us a correction of the theory of the motion of the fourth *Satellite*. Its true period he makes 15 days, 22 hours, 41 minutes, 6 seconds; its diurnal motion,  $22^{\circ} 34' 38'' 18'''$ ; its distance from the center of *Saturn*, 4 diameters of the *ring*; and its orbit to be little or nothing distant from that of the

*ring*, intersecting the orbit of *Saturn* under an angle of 23 degrees and a half.

The ORRERY, which is a machine (see the figure thereof in the Copper Plate) that represents the true SOLAR SYSTEM, and gives a just idea of the number, motions, order, and positions of the heavenly bodies.

This machine is also called a *Planetarium*, and is fixed in a frame of ebony, contained by twelve vertical planes, on which are represented the twelve signs of the *zodiac*. The upper surface is flat, of polished brass, on whose outward circumference are screwed in twelve brass pillars, which support a large flat silvered ring marked 12, representing the *ecliptic*, with several circles drawn upon it. The three innermost are divided into twelve parts for the signs of the *zodiac*, each of which is divided into thirty degrees, and among these degrees are graven in their proper places, the *nodes*, *aphelia*, and greatest north and south *latitudes* of the *planets*. Between the next two circles are the *cardinal points*. The next three circles have the *months* and the *days* of the month, according to the *new stile*.

Upon the brass-surface of the machine are graduated silver-circles, which carry the *planets* (represented by silver-balls) upon arbours or stems, that raise them up to the height of the plane of the *ecliptic*; and turning about the handle or winch of the ORRERY, all the *planets* move at their proportional distances from a little gilt ball in the middle, which represents the *sun*; and perform their revolutions according to their periodical times. There are fixed indices of blued steel, which shew the *longitudes* of the *planets*, by pointing to the divisions of the silvered rings or circles, as they move round. But as these circles, being *concentric*, give only the mean distances, the true orbits, according to their *eccentricities*, are graven on the outside of each circle, with the periodical times taken from the tables, to shew what the revolutions are, nearer than can be performed by any machine.

The *nodes* and *aphelia*, with the places of greatest north and south *latitudes*, are also marked on those orbits.

In the middle of this large circle, designed to represent the *ecliptic*, is fixed a globe, 1. to represent the *sun*. Next the *sun* is a small ball, 2. to represent *Mercury*. Next to this is *Venus*, 3. represented by a larger ball. And, at a greater distance from the *sun*, you see the *earth*, 4. represented by an ivory ball, surrounded, at some distance, by a ring, which expresses the orbit of the *moon*, making an angle with the circle that represents the *ecliptic*, and thereby shewing the inclination they have to each other in the heavens, and also the line of the *nodes*. Within the same ring is another ivory ball, 5. with

5, with a black cap or case, to represent the *moon*; the cap is contriv'd always to cover that hemisphere, which is turned from the *sun*, and thereby distinguisheth the enlightened part from the dark side, and, consequently, her age. 6. Represents *Mars*. 7. Is *Jupiter* attended with his *satellites*, or four *moons*. And 8, the outmost of all the *planets*, is *Saturn* with his *ring* or *belt*, and five *satellites* or *moons*. All these are fixed upon small stems, which severally represent their *axes*, each of which hath its peculiar and proper inclination to the plane of that circle which represents the *ecliptic*. 9. Is a dial-plate. 10, 10, 10, *Meridians*; 11. The *equator*. 12. The *ecliptic* with its circles, already described. 13, 13. Two keys for locking and unlocking the diurnal and annual motions; and as to the *arctic* circle, *tropic of cancer*, and moveable *horizon*, they are named in the figure.

The principal use of the ORRERY is to render the theory of the earth and the moon easy and intelligible; and to evidence to our senses how all these appearances happen, which depend on the annual or diurnal rotation of the earth, and the monthly revolutions of the moon: as the variety of seasons, the vicissitudes and various lengths of days and nights, the manner of solar and lunar eclipses, the various phases of the moon, &c. There have been various forms invented for this noble instrument, two of which have principally obtained, viz. the hemispherical orrery, and the whole sphere: though the orrery at first was made without any sphere, with only the sun, the earth and moon revolving about it; but as this was too imperfect a state, they soon began to invest it, some with a half sphere, and others with a whole sphere to be an adequate representation of the solar system.

The hemispherical orrery, as that above described, has been made in greater numbers than any other, on account of their being made much cheaper and easier than those in a sphere of the same size; there being a vast difference between placing an hemisphere on the box of an orrery, and disposing an orrery in a large moveable sphere. But the idea given us by the former, is very imperfect and unnatural in comparison of the latter, and it is surprizing to think how they should have so great a run. An orrery, therefore, adapted to an armillary sphere, is the only machine that can exhibit a just idea of the true system of the world, with the diurnal and annual motions of the heavenly bodies; but is likewise capable of exhibiting the third motion of the earth, viz. that motion of the earth, by which the poles of the world revolve about the poles of the ecliptic, and occasions what is commonly called the precessions of the equinoxes, or more properly the retrogression of the earth's nodes.

As the distances are in their true proportions to each other, so likewise are the bodies of the planets in their just proportions to one another. But it cannot be expected, that the diameters of the planets should be in proportion to the diameters of the orbits; because taking Jupiter under three inches diameter, and the earth a little more than a quarter of an inch, it would require the system to be of the bigness of a mile and  $\frac{1}{4}$ , the orbit of Saturn 9000 feet in diameter, and so on of the rest; which would make the machine 3000 times bigger than it is. And if the bodies were suited to the dimensions given, the bodies must be 3000 times less, which would render them all invisible, but the sun; and that would be less than  $\frac{1}{10000}$ th part of an inch. For this reason, as a ball big enough to represent the sun cannot be put on, we are to suppose the sun (in respect of them) as big as the inner circle of the silver-ring, which represents the ecliptic.

As the orbit of the moon, and the orbits of the satellites of Jupiter and Saturn, are quite lost in his proportion of the orbits of the primary planets, much more are the satellites themselves; therefore the satellites are usually not put on in this position of the machine. But Saturn's ring is joined to Saturn's body, according to its proportion, and the inclination of its plane to the plane of Saturn's orbit: and as the planet is carried round, the ring always moves parallel to itself, as it does in the heavens. Thereby we see why the inhabitants of the earth, in one revolution of Saturn, see the ring twice in the most open situation of the Ansa, as at 8, and twice, as if it had no ring, that is, when the edge of the ring is towards the earth (the plane of the ring going through the observer's eye) and the successive increasing and decreasing of the visible bigness of the Ansa.

Jupiter, with his moons, is represented at 7, and the spots whereby his revolution has been observed.

When you have a compleat idea of the proportional bigness of the planets, Jupiter and Saturn are taken off, and others put on three times less than the former, in order to put satellites about them (and at the same time the moon is joined to the earth) and shew how the satellites accompany their primary planet in its course round the sun. These satellites, which are pearls upon crooked stems, do not turn by clock-work round their primaries (as has been done in some large orreries) but are only set by the hand: because, to do it, would be only a needless expence, to give a false notion of their bigness, distances, and inclination of their orbits, in respect of their primaries.

But to give a right notion of Jupiter and his satellites, and of Saturn and his satellites, there is shown

shewn for each of these *planets* a *system* a-part, where the distances from the primary, and the bigness of the *satellites*, are expressed: and in this *system*, tho' *Jupiter* is but of about an inch diameter, the outermost *satellite* is as far distant from *Jupiter's* center, as *Saturn* is from the *sun* in the *machine*; which shews the inconsistency and disproportion of making the *satellites* to move round *Jupiter* in an *orrery*. *Saturn's satellites* are still more improperly put in; because four of them move in *orbits* very much inclined to *Saturn's ecliptic* (*viz.* in an angle of above thirty degrees) and the fifth has its *orbit* almost in the same plane as *Saturn's ecliptic*, with a diameter greater than the diameter of the whole *orrery*, even when *Saturn* is three times less than the *Saturn* of the *orrery*.

The next thing which is put on, is a contrivance to shew, that all the confusion of the *planets motions* in the *Ptolemaic hypothesis* (called their stations and retrogradations) is not really, but apparently so, in the *Copernican* or true *system* of the world. And this is done by two steel *indices*, one of which being always applied to the *sun*, and successively to the top of the stem of the *planet* to be examined, whilst the other is applied to the *earth* (as a center) and the said *planet*: by turning the handle of the *machine*, the *heliocentric* and *geocentric* places of the *planet* are seen on the *ecliptic* at the same time; shewing why the *planets* seem to go backwards and forwards when viewed from the *earth*; though they go all the while regularly from west to east, as they would be seen from the *sun*.

When the *machine* is put in motion, all these bodies move round that which represents the *sun*, and, at the same time, both that, and all those which represent such of the *planets* as have been observed to have a *rotation* about their *axis*, turn round upon the said stems, and in their proper times. The *satellites*, or *moons*, also revolve about their *primaries* at the same time; and the *ring* that represents the *orbit* of the *moon* has likewise its proper motion, whereby that of its *nodes* is also expressed. The whole *machine* is put into motion by turning a small winch, 14, like the key of a clock, with very little strength. And, above this winch, is a cylindrical pin, which may be drawn a little out, or pushed in at pleasure: when it is pushed in, all the *planets*, both *primary* and *secondary*, will move according to their respective periods, by turning the handle or winch: when it is drawn out, the motions of the *satellites* of *Jupiter* and *Saturn* will be stopped, while all the rest move freely. In the place of the *sun*, you may fix a brass-lamp, with two convex-glasses, made on purpose; which, being placed with the glass directly to the *earth*, and turning round in the same time with the *earth*, throws a continual strong light upon it and the

*moon*, in whatever part of its *orbit* it is; and so not only the times in which the *eclipses* of the *sun* and *moon* will happen, are shewn, but the *phenomena* themselves are truly represented.

When you propose to use this *machine*, place a small black patch, or a bit of wafer, upon the middle of the *sun*, right against the first degree of  $\varphi$ : you may also place patches upon *Venus*, *Mars*, and *Jupiter*, right against some noted point in the *ecliptic*; put on the handle, and push in the pin which is just above it. One turn of this handle answers to a revolution of the ball, which represents the *earth*, about its *axis*; and, consequently, to 24 hours of time, as may be seen by the motion of the hour *index*, 9, which is marked, and placed at the foot of the wire, on which the ball of the *earth* is fixed: again, when the *index* has moved the space of ten hours, *Jupiter* makes one complete revolution round its *axis*; and so of the rest.

By these means the revolutions of the *planets*, and their motions round their own *axes*, will be represented to the eye. And it is worth observation, that the diurnal motion of the *planets* was discovered, by observing the motions of the spots upon the surface of the *sun*, and of the *planets* in the heavens, after the same manner as we here observe the motions of their representatives, by that of the marks placed upon them in this *machine*.

This *machine* is so contrived, that the winch may be turned either way; so that the same number of revolutions being made backwards, they will bring all the *planets* to their former aspects or situations in respect to each other.

It would be too great an undertaking here to give an account of the mechanism of the *larger sort* of ORRERIES, which represent the movements of all the heavenly bodies; nor, indeed, can it be done either by diagram or description, to render it intelligible to the most discerning reader; but, instead of that, we shall exhibit an idea of the theory and structure of an useful, concise, and portable PLANETARIUM, which any gentleman may have made for a small expence, and will exhibit, very justly, the motions of all the *primary planets* about the *sun*, by wheel-work; and those that have *secondaries*, or *moons*, may have them placed about their *primaries* moveably by the hand, so that the whole shall be a just representation of the *solar system*, or true state of the heavens, for any given time of the year.

In order to this we must compare, and find out the proportion, which the periodical times, or revolutions of the *primary planets*, bear to that of the *earth*; and they are such as are expressed in the table below, where the first column is the time of the *earth's* period in days and decimal parts; the second, that of the *planets*; the third and fourth

fourth are numbers in the same proportion to each other: as,

365,25 : 88      ♄ :: 83 : 20, for Mercury.  
 365,25 : 224,7    ♀ :: 52 : 32, for Venus.  
 365,25 : 686,9    ♂ :: 40 : 75, for Mars.  
 365,25 : 4332,5   ♃ :: 7 : 83, for Jupiter.  
 365,25 : 10759 3 1/2 :: 5 : 148, for Saturn.

If we now suppose a spindle or arbor with six wheels fixed upon it in an horizontal position, having the number of teeth in each, corresponding to the numbers in the third column, viz. the wheel AM of 83 teeth, BL of 52, CK of 40 (for the earth), DI of 40, EH of 7, and FG of 5; and another set of wheels moving freely about an arbor, having the number of teeth in the fourth column, viz. AN of 20, BO of 32, CP of 50 (for the earth), DQ of 75, ER of 84, and FS of 148; then, if those two arbors, of fixed and moveable wheels are made of the size, and fixed at the distance from each other, the teeth of the former will take those of the latter, and turn them freely, when the machine is in motion.

These arbors, with their wheels, are to be placed in a box, of an adequate size, in a perpendicular position: the arbor of fixed wheels to move in pivots at the top and bottom of the box; and the arbor of moveable wheels to go through the top of the box, to a proper height, on the top of which is to be placed a round ball, gilt with gold, to represent the sun. On each of the moveable wheels is to be fixed a socket, or tube, ascending above the top of the box, and having on the top a wire fixed, and bent at a proper distance into a right angle upwards, bearing on the top a small round ball representing its proper planets.

If then on the lower part of the arbor of fixed wheels be placed a pinion of screw teeth, a winch turning a spindle with an endless screw, playing in the teeth of the arbor, will turn it with all its wheels; and these wheels will move the others about with their planets, in their proper and respective periods of time, very exactly. For, while the fixed wheel CK moves its equal CP once round, the wheel AM will move AN a little more than four times round, and so will nicely exhibit the motion of Mercury; and the wheel FG will turn the wheel

FS about  $\frac{1}{29,5}$  round, and so will truly repre-

sent the motion of Saturn: and the same is to be observed of all the rest.

The planets are represented by the same Characters the Chemists use to represent their metals by,

†

on account of some supposed analogy between those celestial, and subterraneous bodies. Saturn is represented by the character ♄. Jupiter by ♃. Mars ♂. Venus ♀. Mercury ☿. To which we now add, Tellus, the Earth, marked ⊕, or ♁.

The instruments requisite in Astronomical observations, are Telescopes, of several sizes; Armillary and Zodiacal spheres; Celestial globes, Astronomical quadrants, Azimuthal horizons, Sextants, &c.

A TELESCOPE, is an optical instrument, consisting of several glasses, or lenses, fitted into a tube, through which remote objects are seen, as if nigh at hand. The telescopes us'd in Astronomical observations, called also Astronomical telescopes, consist of an object glass, which is that glass turned towards the object; and an eye-glass, which is that next the eye, both convex.

ARMILLARY SPHERE, is an Astronomical instrument, representing the several circles of the sphere, in their natural order; serving to give an idea of the office and position of each thereof, and to solve various problems relating thereto. It is thus called, as consisting of a number of fasciæ, or rings of brass or other matter, called by the Latins, armillæ, from their resembling of bracelets, or rings for the arm. By this it is distinguished from the globe, which though it has all the circles of the sphere on its surface, yet is not cut into armillæ, or rings, to represent the circles simply, and alone; but exhibits also the intermediate spaces between the circles.

THE CELESTIAL GLOBE, is an artificial sphere, made of metal, plaister, paper, or other matter; on whose convex surface the fixed stars are placed, at proportionable distances, together with the principal circles of the sphere. The use of this instrument is very extensive; scarce any thing in the spherical Astronomy, but may be exhibited thereby, without having recourse to trigonometrical calculation. The principal points are contained in the following problems, with their solutions; which will let the reader enough into the nature and reason of this instrument, to apply it, of his own accord, in any other cases.

To find, 1. The right ascension and declination of a star, represented on the surface of the globe. 2. The longitude and latitude of a star. 3. The sun's place in the ecliptick. 4. The declination of the sun. 5. The place of a planet, with its right ascension and declination; its longitude and latitude, for the time given. 6. To rectify the globe, or adjust it to the place, &c. so as it may represent the present state or situation of the heavens. 7. To know all the stars and planets, by means of the globe. 8. To find the sun's oblique ascension, his eastern amplitude and azimuth, with the time of rising.

rising. 9. The *sun's* oblique descension, western amplitude and azimuth, with the time of setting.

10. The length of the day and night. 11. The rising, setting, and culminating of a *star*; its continuance above the horizon, for any place and day; together with its oblique ascension and descension, and its eastern and western amplitude and azimuth.

12. The altitude of the *sun*, or a *star*, for any given hour of the day or night. 13. The altitude of the *sun* by day, or of a *star* by night, being given; to find the time of that day or night. 14

To find the interval of time between the rising of two *stars*, or their culminations. And, 15. To find the beginning and ending of the *crepusculum*, or twilight.

1. The right ascension and declension of a *star* is found, by bringing the *star* to the graduated side of the brazen meridian; then the number of degrees intercepted between the equator and the point of the *meridian* cut by the *star*, gives its declination; and the degree of the equator, which comes under the meridian together with the *star*, is its right ascension

2. By applying the center of the quadrant of altitude over the pole of the ecliptick, in the same hemisphere with the *star*, and bringing its graduated edge to the *star*; the degree on the quadrant cut by the *star*, is the *star's* latitude, reckoned from the *ecliptick*; and the degree of the ecliptick cut by the quadrant, its longitude.

3. If we seek the day of the month in the proper calendar on the horizon, we'll find against that day in the circle of signs, the sign and degree the *sun* is in for that day. This done, by finding the same sign upon the ecliptick on the surface of the *globe*, we'll have found the *sun's* place for that day.

4. The *sun's* place for the day given being brought to the meridian, the degrees of the meridian intercepted between the equinoctial and that place, are the *sun's* declination for that day, at noon.

5. Apply the center of the quadrant of altitude, on the pole of the ecliptick, of the same denomination with the latitude, and bring it to the given longitude in the ecliptick; this point is the planet's place: and bringing it to the meridian, its right ascension and declination will be found.

6. To rectify the *globe*, &c. 1. If the place be in north latitude, the north pole must be raised above the horizon; if in the south, the south pole.

2. The quadrant of altitude is to be fixed on the zenith, *i. e.* on the latitude of the place. 3. By means of a compass, or meridian line, the *globe* must be placed in such a manner, as that the brazen meridian may be in the plane of the terrestrial me-

ridian. 4. The degree of the ecliptick the *sun* is in, must be brought to the meridian, and the horary index set to 12: Thus will the *globe* exhibit the face of the heavens for the noon of that day.

5. By turning the *globe* till the index comes to any other given hour: thus will the *globe* shew the face of the heavens for that time.

7. The *stars* and planets are easily known, by means of the *globe*; if, 1. We adjust the *globe* to the state of the heavens for that time. 2. If we look on the *globe* for some one *star*, which we know, *e. gr.* the middlemost *star* in the tail of the *great bear*. 3. If we observe the position of the other most conspicuous *stars* in the same constellation; for by transferring the eye from the *globe* to the heavens, we'll easily note the same there. 4. Thus we may proceed from this to the neighbouring constellations, till we have learned them all.

8. By rectifying the *globe* for the hour of twelve, and bringing the *sun's* place to the eastern side of the horizon, the number of degrees then intercepted between that degree of the equator now come to the horizon, and the beginning of *aries*, is the *sun's* oblique ascension. The degrees on the horizon intercepted between the east point thereof, and the point wherein the *sun* is, is the ortive, or rising amplitude. The hour pointed to by the index, is the time of the *sun's* rising. Turning the *globe* till the index points to the present hour, we must lay the quadrant to the *sun's* place, the degree cut by the quadrant, in the horizon, is the *sun's* azimuth.

9. The *sun's* oblique descension, western amplitude, and azimuth, with the time of setting, is found in the same manner, as its oblique ascension, eastern amplitude, &c. excepting that the *sun's* place must be here brought to the western side of the horizon; as in the former it was to the eastern.

10. The length of day and night is found, 1. By finding the time of the *sun's* rising; which being numbered from midnight, the double thereof gives the length of the night. 2. By subtracting the length of the night from the whole day, or 24 hours, the remainder is the length of the day.

11. Having adjusted the *globe* to the state of the heavens at twelve o'clock that day, we'll find the eastern amplitude, azimuth, and the time of rising of a *star*, by bringing the *star* to the eastern side of the horizon; and by bringing the same *star* to the western side of the horizon, we'll find its western amplitude, and azimuth, and the time of its setting. The time of rising subtracted from that of setting, leaves the continuance of the *star* above the horizon; and this continuance above the horizon subtr acted from 24 hours, leaves the time of

its continuance below the horizon. Lastly, The hour to which the index points when the *star* is brought to the meridian, gives the time of *culmination*, or the transit of a *star*, or *planet*, over the meridian; or that point of its *orbit* wherein it is at its greatest altitude.

12. The altitude of the *sun*, or a *star* for any given hour of the day, or night, is found; 1. By adjusting the *globe* to the position of the heavens, and turning it till the index points at the given hour. 2. Then fixing on the quadrant of altitude at 90 degrees from the horizon, and bringing it to the *sun's* or *star's* place, the degrees of the quadrant intercepted between the horizon and the *sun* or *star*, is the altitude required.

13. The altitude of the *sun* by day, or of a *star* by night, being given; the time of that day or night is found. 1. By rectifying the *globe* as in the preceding problem. 2. By turning the *globe* and quadrant till such time as the *star*, or degree of the ecliptick the *sun* is in, cut the quadrant in the given degree of altitude; then does the index point at the hour sought.

14. By rectifying the *globe*, and bringing the quadrant to the given azimuth in the horizon, and turning the *globe* till the *star* comes to the same; the index will shew the time of the day or night.

15. If the pole of the *globe* is rais'd so many degrees above the horizon, as is the elevation of the pole of the place; if the first *star* is brought to the horizon, and the time observed the index points to; if the same be done by the other *star*; then by subtracting the former time from the latter, the remainder is the interval between the risings of the two *stars*.

16. The *crepusculum*, or twilight, is found, by first rectifying the *globe*, and setting the index to the twelfth hour, the *sun's* place being in the meridian. 2. By noting the *sun's* place, and turning the *globe* westward, as also the quadrant of altitude, till the point opposite to the *sun's* place cut the quadrant of altitude in the eighteenth degree above the horizon, the index will shew the time when the twilight commences in the morning. 3. By taking the point opposite to the *sun*, bringing it to the eastern hemisphere, and turning it till it meet with the quadrant of altitude in the eighteenth degree, then will the index shew the time when twilight ends.

AN ASTRONOMICAL QUADRANT, (see T in the first plate of ASTRONOMY) is an instrument usually made of brass, sometimes of wooden bars, only faced with plates of iron, or the like; having its limb curiously divided, diagonally, or otherwise, into degrees and minutes, and even seconds, if possible; with plain sights fixed to one side of it, or,

instead thereof, a telescope; and an index moving about the center, carrying either plain sights, or a telescope. These *quadrants* are of principal use, in taking observations of the *sun*, *planets*, or fixed *stars*. The *antients* used only plain sights, but the *moderns* have found it of great benefit to use telescopes instead of them. And the contrivance of moving the index, by the help of a screw on the edge of the limb, and of readily and easily directing it, and the *quadrant* upon its pedestal, to any desired *phenomenon*, by means of the screws and dented wheels, is a still greater improvement of the instrument, whose use is obvious; for it being adjusted, as above, and turned horizontally round on its axis, till, through the moveable telescope, the object be seen to fall in with the point of intersection of the cross bars; the degrees cut by the index give the altitude required.

*Gunter's QUADRANT*, (*ibid.*) thus called from the inventor's name, *Edmund Gunter*, besides the graduated limb, fixed sights, and a plummet, as the other *quadrants*; has likewise a stereographical projection of the sphere on the plane of the equinoctial, with the eye placed in one of the poles; by which, besides the common uses of other quadrants, several useful questions in *Astronomy* are easily solved, *viz.* To find the *sun's* meridian altitude for any given day, or the day of the month for any given meridian altitude. 2. The hour of the day. 3. The *sun's* declination from his place given, and contrarywise. 4. His Right ascension, or contrarily. 5. His azimuth, and contrarywise. 6. The hour of the night, from some of the five stars laid down on the *quadrant*.

1. The thread being laid to the day of the month in the scale next the limb; the degree it cuts in the limb, is the meridian altitude of the *sun*. Thus the thread being laid on the 15th of *May*, cuts  $59^{\circ} 30'$ , the altitude sought. And contrarily, the thread being set to the meridian altitude, will shew the day of the month.

2. Having put the bead, which slides on the thread, to the *sun's* place in the ecliptick, the *sun's* altitude must be observed by the *quadrant*; then, if the thread be laid over the same in the limb, the bead will fall upon the hour required. Thus, suppose on the 10th of *April*, the *sun* being then in the beginning of *Taurus*, we observe the *sun's* altitude by the *quadrant* to be  $36^{\circ}$ , we place the bead to the beginning of *Taurus* in the *Ecliptic*, and lay the thread over  $36^{\circ}$  of the limb; and find the bead to fall upon the hour-line marked 3 and 9; accordingly, the hour is either 9 in the morning, or 3 in the afternoon. Again, laying the bead on the hour given, (having first rectified, or put it to the *sun's* place) the degree cut by the thread on the limb,

limb, gives the *altitude*. *Note*, That the bead may also be rectified, by bringing the thread to the day of the month, and the bead to the hour-line of 12.

3. Setting the bead to the *sun's* place in the *ecliptic*, and moving the thread to the line of *declination*, the bead will cut the thread of *declination* required. Contrarily, the bead being adjusted to a given *declination*, and the thread moved to the *ecliptic*, the bead will cut the *sun's* place.

4. We must lay the thread on the *sun's* place in the *Ecliptic*, and the degree it cuts on the limb, is the *right ascension* of the *sun*. Contrarily, laying the thread on the *right ascension*, it cuts the *sun's* place in the *ecliptic*.

5. Rectify the bead for the time, (as in the second article) and observe the *sun's altitude*; bring the thread to the *complement* of that *altitude*; thus the bead will give the *Azimuth* \* sought, among the *Azimuth* lines.

6. Fit the bead to the *star* you intend to observe, and find how many hours it is off the meridian, (by the second article) then from the *right ascension* of the *star*, subtract the *sun's right ascension*, converted

into hours; and mark the difference; which difference added to the observed hour of the *star* from the meridian, shews how many hours the *sun* is gone from the meridian, which is the hour of the night. Suppose, for example, on the 15th of *May*, the *sun* being in the 4th degree of *Gemini*, I set the bead to *Arcturus*; and observing his altitude, find him to be in the west, about 52° high, and the bead to fall on the hour-line of 2 afternoon; then will the hour be 11 hours, 50 minutes past noon, or 10 minutes short of midnight. For 62°, the *sun's right ascension*, converted into time, makes 4 hours, 8 minutes, which subtracted from 13 hours, 58 minutes, the *right ascension* of *Arcturus*, the remainder will be 9 hours, 50 minutes; which added to 2 hours, the observed distance of *Arcturus* from the meridian, shews the hour of the night to be 11 hours, 50 minutes.

A *SEXTANT*, is an *astronomical instrument*, made like a *quadrant*; excepting that its limb only comprehends 60 degrees. The use and application of the *sextant*, is the same with that of the *quadrant*.

Of B A K I N G.

**B**AKING is the art of preparing bread, or of reducing meal of any kind into bread.

Who first invented this useful art, I will not pretend to say: but by the mention of *shew-bread* amongst the *Hebrews*, it was known to the *Levites*, that attended the tabernacle in the wilderness.

Some have ascribed the invention to the *Grecians*; and add, that it passed into *Italy* about the year of *Rome* 583, after the war with *Pyrrhus*. This is certain, the *Cappadocians*, and after them the *Lydians*, and the *Phœnicians*, are the most applauded *bakers* in antiquity.

At *Rome* the *bakers* were held in great esteem, and were incorporated with great privileges, and subjected to certain restrictions.

The fraternity of *bakers*, by the *Roman* laws held their effects in common, and could not dispose of any part of them. Each bake-house had a *patronus*, who had the superintendency thereof; and these *patroni* elected one out of their number each year, who had the superintendance over all the rest, and the care of the college. Out of the body of the *bakers* were every now and then one admitted among the senators.

To preserve honour and honesty in the college of *bakers*, they were expressly prohibited all alliance with comedians and gladiators; each had his shop or bake-house, and they were distributed into fourteen regions of the city. They were excused from guardianship and other offices, which might divert them from their employment.

By the *English* statutes *bakers* are declared not to be handicrafts. No man for using the mysteries or sciences of *baking*, *brewing*, *surgery*, or *writing*, shall be interpreted a handicraft, 22 H. 8. c. 13.

The *bakers*, by a law enacted in the last sessions of parliament, are prohibited the use of *allum* in their making of bread, under severe penalties.

The forms of *baking*, among the *Europeans*, is reduced to two; the one for *unleavened*, the other for *leavened bread*; though very few, the *Jews* excepted, use, at present, *unleavened bread*; as being too insipid, and even those but in the time of their *passover*, or of some other particular feast.

The other manner of *baking leavened bread*, is called *manchet-baking*; which is done in this manner: the meal, ground and bolted, is put into a trough, and being opened in the middle, to a bushel is put about three pints of warm ale, with barm,

\* The *AZIMUTH* of the *sun*, or a *star*, is an arch of the horizon, comprehended between the meridian of the place, and any given *vertical* circle. The *Azimuth* is the *complement* of the eastern and western *amplitude* of a *quadrant*.

and salt to season it : this is kneaded together with the hands through the break, or for want whereof with the feet through a cloth ; after having lain an hour to swell, it is molded into manchetts, which scorched in the middle, and pricked a-top to give room to rise, are *baked* in the oven by a gentle fire.

The common bread *making* is performed thus : the meal being in the trough, some leaven (saved from a former batch filled with salt laid up to sour, and at length dissolved in warm water) is strained through a cloth into a hole made in the middle of the heap, and worked with some of the flour to a moderate consistence : this is covered up with meal, where it lies all night, and in the morning the whole heap is stirred, and mixed together with a little warm water, barm, and salt, by which it is seasoned, stiffened, and brought to an even leaven ; it is then kneaded, or trodden, molded, and *baked*.

In the kneading of the mass, it must be observed, that it is not worked too long, else it would render the bread heavy, and hinder it to rise in the oven ; neither is it to be worked in too great a hurry, for then the mixture proving imperfect, would fill the bread with lumps of flour, render it harsh, and of an indifferent taste ; part of it being leavened, and the other unleavened ; which to avoid, the water must be poured by degrees, and the mass worked by degrees ; waiting to pour no more water, till the first poured being so incorporated with the mass, by the working of it, till it has brought it to a due consistence, neither too hard, nor too soft ; and then pour more water upon that mass already worked, and then the workman approaches, with his hand, new flour, near that mass, all ready worked, incorporating both together, and so on, till the end of the operation. The water must be neither too hot, nor too cold ; for if too hot, it renders the fermentation through the whole mass too great, and causes a disagreeable sourness in the bread ; if too cold, it hinders the fermentation, which renders the bread heavy, and gives it a sweet, unpalatable taste. In winter, the leaven is always prepared in a warm place, else it would have little or no effect ; and the mass, after it has been kneaded, is kept longer before it is put into the oven, than in the summer ; in order to give time to the leaven to ferment through the whole mass.

There is an art in heating the oven for the *baking* of bread ; for if it is too hot, it hinders the bread from rising, and makes it almost all crust ; if too cold, instead of evaporating the whole humidity, it keeps the greatest part of it within the mass, and renders the bread heavy and disagreeable : therefore a gradual heat is best ; for then the bread rising

and *baking* by degrees, acquires a due consistence, and a savoury taste.

It must be observed, also, that the leaven, arrived at an extraordinary sourness, is not to be used, not even in the smallest quantity ; for it would communicate a very disagreeable taste to the whole.

BISKET, (*i. e. bis*, twice, *coctus*, baked) which is a sort of bread, for the service of the sea, is made in the same manner as other bread, with this single difference, that it passes the oven twice. The first time it is *baked* to the consistence of common bread, and kept till it has sweated all its humidity, and then put into the oven again, to dry it quite ; otherwise it would be subject to grow mouldy, and sour. For long voyages, they bake it four times, and prepare it six months before the embarkation.

GINGER-BREAD, is a rich sort of bread, the flavour and taste whereof are heightened and improved with spices, and particularly *ginger*, whence the name. There are various forms and preparations of *ginger-bread*. The following is well recommended. “ Into a pound of almonds grate a penny white loaf, and beat them together ; to the mixture add an ounce of *ginger*, scraped fine, and anniseed and liquorice in powder, of each a quarter of an ounce : pour in two or three spoonfuls of rose-water, and make the whole into a paste, with half a pound of sugar ; mould and roll it, print it and dry it in a stove.”

Others make it with treacle, citron, lemon and orange-peel, candied-*ginger*, coriander and carraway seed, mixed up with as much flour, as will make it into a paste.

In all the other parts of the world they have little or no notion of *baking*, except in those parts where the *Europeans* have settled, and where they are numerous ; every where else they follow yet the primitive simplicity of baking their bread under the embers ; the greatest part of the eastern and western nations having not even the least notion of bread. Especially those who dry their meat by the sun, and eat it without any other cookery, as most of the *Tartars*. In the *West-Indies*, and on the coast of *Brazil*, some *Indian* nations make bread of a sort of root, they call *cassave*, or *cassibre*, which is a sort of poison of itself, before its preparation ; which is done in this manner ; they pound the root, to extract all its juice, in which consists all its malignity ; they afterwards dry it in the sun, so that it may easily be reduced into a sort of *farina*, or flour, which they mix with water, and mould it into the form of a large pancake, which they bake before the fire. When baked, it is as white as a sheet.

sheet of paper; I have eat some, and found it very palatable. They could, if they would, make a pretty tolerable good bread of maife, which they have in abundance; but they content themselves with broiling the whole ear upon the coals, and eat it so without any other preparation.

## Of BOOKS, and particularly of the BIBLE.

**B**OOK (formed from the *Saxon*, *Boc*, which comes from the Northern *Buech*, a beech tree, on which our ancestors used to write) is the production of wit and learning, digested in some form or order, and reduced into writing for instruction or entertainment; and to have it transmitted to posterity.

BOOK is distinguished from *pamphlet*, and single paper, by its greater length; and from *tone* or *volume*, by its containing the whole writing; which is often divided into several *volumes*.

*Books* are commonly divided into *divine* or *sacred*, and *human books*.

The *divine* or *sacred books* are either wrote by inspiration, as the *Pentateuch*, the *Prophets*, the *Books of Solomon*, the *New Testament*, &c. which several *books*, collected together, compose a whole one, called, THE BIBLE.

THE BIBLE is the most valuable, and most respected of all the *divine*, *sacred books*, as containing, the first precepts, given to *Moses*, by the Almighty himself, amidst the thunder and lightening of *Mount Sinai*, of the religious worship and ceremonies, he was to be adored with upon *earth*, and the first articles of a true faith.

The *Bibles* are distinguished according to their language, into *Hebrew*, *Greek*, *Latin*, *Chaldee*, *Syriack*, *Arabick*, *Coptick*, &c.

The first traduction of the *Bib'e* is that of the *Septuagint*, made 280 years before the incarnation of *Jesus Christ*, through the care of *Demetrius Phalereus*, under the reign of *Ptolemy Philadelphus*, king of *Egypt*, to perfect the famous library of *Alexandria*, which contained 200,000 *volumes*. This translation was received by the *Jews*; and our Saviour, as well as his Apostles, made use of it, in the gospel; but it was corrupted soon after the birth of our Saviour, as well by the *Jews*, as through the ignorance of the *Copyists*. *Origen* was the first, who attempted to purge it of its imperfections, and restore it to its pristine purity. In which noble and useful undertaking he was succeeded by the martyr *Lucian*. *Hesychius*, likewise applied himself to it, and *St. Jerome* perfected it.

Antient authors do not agree among themselves as to the manner of this translation. Some say that the *seventy* worked upon it separately, and that comparing afterwards their several versions together, they were all found alike in all things.

Others pretend, that they worked at it two and two. And others, that they did it altogether, consulting one another on the most difficult passages. The first manner is considered as a fable, and as mere romance, by a great many very learned divines.

We have at present *Bibles*, in the several languages above-mentioned, both manuscript and printed, and almost all according to the version of the *septuagint*, but very imperfect. *F. Simon* is of opinion that the oldest manuscript *Hebrew Bibles* are not above 6 or 700 years: nor does *Rabbi Monabem*, who quotes a vast number of them, pretend that any exceed 600 years. The best are those copied by the *Jews of Spain*, and the most common those copied by the *Jews of Germany*.

The *Bible* was translated into *Greek* by *Aquila*, under the emperor *Adrian*; but that version was very imperfect and full of omissions. *Theodotion* published a new one in 189. *Theodotion* had been a disciple of *Tatian*; he followed *Marcion*, and from his school, passed to the synagogue of the *Jews*, where he was received on condition that he should translate the *Old Testament* into *Greek*, which he did with more truth and sincerity than *Aquila* had done, though there are many additions and omissions, which he has marked with a great deal of care and attention. The numerous editions we have of the *Bible* in *Greek* can all be reduced to three, *viz.* that of *Complutum*, or *Alcala de Henares*, that of *Venice*, and that of *Rom*. The first published in 1515 by Cardinal *Ximenes*, and inserted in the *Polyglot Bible*, usually called the *Complutesian Bible*. This edition is one of the best extant, and has been reprinted in the *Polyglot Bible* of *Antwerp*, in that of *Paris*, and in the 4to *Bible*, commonly called, *Bible of Vatable*. The second is that of *Venice* in 1518, reckoned full of faults of the *Copyists*, as having been printed just as it stood in the manuscript: it has been reprinted at *Strasburgh*, *Basil*, *Francfort*, and other places. The best of them all is the third, printed at *Rome*, in 1587, with *Greek Scholia*, collected from the manuscripts in the *Roman* libraries, by *P. Morin*. This fine edition has been reprinted at *Paris* in 1628, by *J. Morin*, priest of the oratory, who has added the *Latin* translation, which in the *Roman* was printed separately, with *Scholia*. The *Greek* edition of *Rome* has been printed in the *Polyglot Bible* of *London*; to which

which are added at bottom the various readings of the *Alexandrian* manuscript.

The *Latin Bibles* are also reduced to three classes, viz. the ancient *Vulgate*, translated from the *Greek Septuagint*; the *modern Vulgate*, the greatest part of which is done from the *Hebrew* text; and the new *Latin* translations, done also from the *Hebrew* text in the sixteenth century.

The *antient Vulgate* is of very great antiquity in the *Latin* church, since it was the common, or vulgar version, before St. *Jerome* made a new one, whence it is named *Vulgate*. The *Vulgate* was held by St. *Augustine* to be preferable to all the other *Latin* versions then extant; as rendering the words and sense of the sacred text more closely and justly than any of the rest.

We have, a considerable number of editions of the *modern Vulgate*. That inserted by the order of Cardinal *Ximenes*, in the *Bible of Complutum*, is one of the best, as well as that of *R. Stephens*, printed in 1540, and reprinted in 1545; in which are added, on the margin, the various readings of several *Latin* manuscripts, which he had consulted. This edition was revised afterwards by the doctors of *Louvain*, who likewise added to it the various readings of several *Latin* manuscripts.

The correction of Pope *Clement VIII*, in 1592, is now the standard of all the *Roman* churches; from this the *Bibles of Plantin* were done, and from those of *Plantin* all the rest.

There are great numbers of *Latin Bibles*, of the third class, comprehending the versions from the originals of the *sacred books* made within these 200 years. The first is that of *Santes Pagninus*, a *Dominican*, printed at *Lyons*, in 4to, in 1528; much esteemed by the *Jews*. This the author improved in a *second edition*. In 1542, there was a beautiful edition of the same at *Lyons*, in folio; and *R. Stephens* reprinted it, with the *Vulgate*, in 1557. There is also another edition of 1586, in four columns, under the name of *Vatable*. This version of *Pagninus*, corrected by *Arius Montanus*, was inserted in the *Polyglot* of *Philip II*. and since in that of *London*.

The *Samaritan Bible*, which admits no more for holy Scripture than the *Pentateuch*, or five books of *Moses*, being the most antient of all, deserves also the first rank. This version has never been printed alone, nor any where but in the *Polyglots of London* and *Paris*. This *Samaritan Pentateuch* differs in some respect from that of the *Jews*, and is written in different characters, called *Samaritan Characters*; which *Origen*, St. *Jerome*, and other fathers, and critics, antient and modern, take to be the primitive characters of the antient *Hebrews*, though others maintain the contrary.

What we call *Chaldee Bibles*, are not properly a strict version of the scriptures, but only glosses and paraphrases upon it, which the *Jews* call *Targum*; for as during their long captivity in *Babylon* they had forgot their antient language the *Hebrew*, and now understood nothing but the language of their masters, the *Chaldeans*, there was a necessity of explaining the prophets in that language; and to this necessity is owing the first beginning of the *Chaldee Paraphrase*, to make the sense of the text understood. Each doctor made a paraphrase of some part thereof in the vulgar tongue; and as these several interpretations, in time, became very voluminous, certain *Rabbins* undertook to collect them together, and this collection they call the *Targum*. Though they do not agree about the antiquity of the *Targum*; for the more modern *Jews*, having blended their own comments, with those of the antients, no certain age or æra can be fixed for the whole work.

*Widmanstradius* printed, at *Vienna*, in 1562, the whole *New Testament* in *Syriac*, in a beautiful character: After him there were several other editions; and it was inserted in the *Bible* of *Philip II*. with a *Latin* translation. *Gabriel Sionita* also published a beautiful *Syriac* edition of the *Psalms* at *Paris*, in 1525, with a *Latin* interpretation. The whole *Bible* is printed in *Syriac* in the *Polyglots of London* and *Paris*. In which two *Polyglots* there are also *Arabick* versions of the whole Scriptures, that of the *Old Testament* being attributed by some learned men to *Saadias*; they give for reason, that *Aben Ezra*, a great antagonist of *Saadias*, quotes some passages of his version, which are the same with those of the *Arabick* version in the *Polyglots*; yet others are of opinion that *Saadias's* version is not extant. *Justinian*, bishop of *Nebio*, printed at *Genoa* in 1516, an *Arabick* version of the *Psalter*, with the *Hebrew* text and *Chaldee* paraphrase, adding *Latin* interpretations. In 1672 there was printed at *Rome*, by order of the congregation *de propagandâ fide*, an entire *Arabick* edition of the *Old Testament*. The *Arabick* version of the *Pentateuch*, of *Erpenices*, called also the *Pentateuch* of *Mauritania*, as being made by the *Jews* of *Barbary*, and for their use, is esteemed literal, and very exact; as well as the four *Evangelists*, published at *Rome* in *Arabick*, with a *Latin* version, in 1591; which have been since reprinted in the *Polyglots of London* and *Paris*. We have several authentick manuscript copies of the *Bible* in *Coptick* in the great libraries, especially that of the king of *France*.

The *Æthiopians* have also translated the *Bible* in their language; of which we have a very accurate *New Testament*, printed at *Rome* in 1548, though found fault with by those, who discover something

in it, which rises in judgment against them. The same has been reprinted in the *English Polyglot*,\* as well as the *Psalms*, *Canticles*, some chapters of *Genesis*, *Ruth*, *Joel*, *Jonah*, *Zephaniah*, and *Malachi*, all in the same language.

Some of the *Armenian* doctors about the time of *St. Chrysostom*, made an *Armenian* version of the *Bible* from the *Greek* of the *seventy*, which was first printed entire into 4to at *Amsterdam*, in 1664, by one of their bishops, with the *New Testament* in 8vo.

The *Persian Pentateuch*, printed in the *London Polyglot*, is the work of *Rabbi Jacob*, a *Persian Jew*; but we have nothing now remaining of that ancient *Persian* version of the old *Bible*, mentioned by some of the fathers. There was also a version made of the whole *Bible* (the book of *Kings* excepted) into *Gothick*, by *Aphilas*, a *Gothick* bishop; the four *Evangelists* were printed in 4to at *Dort*, from an ancient manuscript in 1665; having nothing else remaining of that version. The reason given for *Aphilas* omitting the book of *Kings* is, his being afraid that the frequent mention of the wars therein should inspire too much of the military genius into his countrymen.

*Con. Basil*, duke of *Ostravia*, had an entire *Bible* in the *Slavonick* tongue, printed at *Ostravia*, in *Volhinia*, in the year 1581, at his own expence, for the common service of all Christians, who speak the *Slavonick* language, whereof the *Muscovitish* is a dialect, for which reason this version is commonly called the *Muscovite Bible*.

It would be endless to rehearse here the vast number of versions of the *Bible* in other vulgar tongues, as *English*, *French*, *German*, *Spanish*, *Italian*, *Dutch*, &c. since we have so many catalogues of them in several authors. The first essay towards the *English* translation was made by the celebrated *Dr. Wickliff* a few years before the Reformation; who translated the *New Testament*. But there was no complete *BIBLE* in our tongue till *Miles Coverdale* obliged the Reformers with one in the reign of *Henry VIII*.

The books of the *Bible* have not always been of an equal authority. *St. Jerome* assures us that the ancient canon, or catalogue of the books of the *Old Testament*, made by the *Jews* under *Esdra*s, in a great assembly of their doctors, which they call by way of eminence, the great *Synagogue*, consisted of no more than twenty-two books; though it is pretended by some authors, that the *Jews* themselves agree that they put books therein, which had not been so before the *Babylonish* captivity: such are those of *Daniel*, *Ezekiel*, *Haggai*, and those of *Esdra*s and *Nehemiah*.

Some of the fathers have, besides, distinguished the sacred writings into *Proto-canonical*, and *Deutero-canonical*. The *Proto-canonical* are those whose authority has never been suspected, and the *Deutero-canonical*, those, whose canonicity was doubtful; for which reason, they were added to the canon after the rest. The *Deutero-canonical books*, in the modern canon, are the books of *Esther*, either the whole, or at least the seven last chapters thereof; the epistle to the *Hebrews*; that of *James*; and that of *Jude*; the second of *St. Peter*; the second and third of *St. John*; and the *Revelations*. The *Deutero-canonical parts of books*, are in *Daniel*, the hymn of the three children; the prayer of *Azariah*; the histories of *Susannah*, of *Bel* and the *Dragon*; the last chapter of *St. Mark*; the bloody sweat, and the appearance of the angel, related in *St. Luke*, chap. xxii. and the history of the adulterous woman in *St. John*, chap. viii.

Among the *canonical books of the Old Testament*, the *Pentateuch*, or five books of *Moses*, viz. *Genesis*, *Exodus*, *Leviticus*, *Numbers*, and *Deuteronomy*, are the first in order, as being, likewise, the first for antiquity, since there is no authentic account of any other book, either sacred, or profane, having been written before them. The whole *Pentateuch* is attributed to *Moses*, as author thereof; though father *Symon*, in his critical history of the *Old Testament*, produces several passages to prove that the legislator of the *Jews* was not wholly the author of the *Pentateuch*, as we now have it; which sentiment is very well supported by the interpolations at the end of the *Pentateuch*; since it is absurd to suppose *Moses* the author of the account of his own death and burial, and of the comparison between him and the succeeding prophets in *Israel*. *Esdra*s is thought the author of the interpolated passages, being supposed to have published the *Old Testament*, or at least a part of it, corrected, and enlarged, on his return from the *Babylonish* captivity. See *Dr. James's* scholastic history of the *Canon of scripture*, and *Huetii* *Demonstra Evangelica*.

At the head of the *Pentateuch* stands the book of *Genesis*, which the *Hebrews* call *Bereschith*, because it begins with that word, which in their language signifies in *principio*, in the beginning; and the *Greeks* *Genesis*, *Γενεσις*, production, generation; because it begins with the history of the production and generation of all beings. *Moses* is thought to be the author of the *Genesis*, and it contains the relation of 2367 year, viz. from the beginning of the world to the death of *Joseph*. The *Jews* are forbid to read the beginning of *Genesis* and the beginning of *Ezekiel*, before thirty years of age.

\* From πολυ many, and γλωσσε lang uage.

The *Exodus*, by the *Hebrews* called *Veellee Semoth*, *hæc nomina*, these are the names; which are the initial words of the *book*; and by the *Greek* Εξοδος, which literally imports a *going out*, or *journey*, because the history of the *Israelites* passage out of *Egypt* is related therein. The *Exodus* contains, besides, the story of what was transacted into *Egypt*, from the death of *Joseph* to the delivery of the *Jews*; as well as what passed in the wilderness, and particularly at mount *Sinai*, to the building of the tabernacle.

The *Leviticus*, called by the *Jews*, *Vajickra*; and the *Numbers*, *Vajiedabber*; contains nothing else but the ceremonial and other laws; and the *Deuteronomy*, *Elleh haddebarim*, is a repetition, or recapitulation of the law, which *Moses* had before delivered them at large. And hence *Deuteronomy* is still called by the *Rabbins*, *Repetition*. They likewise call it, *The book of reprimands*, on account of the 28th chapter, which is full of blessings promised to such as keep the law, and of curses threatened to such as transgress it. It is pretended, that *Deuteronomy* was written the fortieth year after the delivery from *Egypt*, in the country of the *Moabites*, beyond *Jordan*; *Moses* being then in the 120th year of his age. It contains in *Hebrew* eleven *Parafches*, though only ten in the edition of the *Rabbins* at *Venice*; twenty chapters, and 955 verses. In the *Greek*, *Latin*, and other versions, it contains 34 chapters. The last is not of *Moses*; some say it was added by *Joshua*, immediately after *Moses's* death, which is the most probable opinion. It was the *Greeks*, when they first translated the law, that gave the five parts into which it was divided, the name of *Genesis*, *Exodus*, *Leviticus*, *Numbers*, and *Deuteronomy*, which is the reason why all these names are *Greek*, except the *Leviticus*, which is *Hebrew*; for it does not appear that *Moses* made any division of what he wrote, into *books*; or that he gave different names and titles to the different parts of his work: nor do the *Jews*, even at this day, distinguish them in the copies they use in the *Synagogues*; but write them all running as one single work, without any other distinction beside that of little and great *Parafches*; though in other copies, used by private persons, they are divided into five parts, as among us; but they give them no other name, but the first word wherewith each division begins; much as we do in quoting a decree, or chapter of the canon law.

*Joshua* is the next in order of the *canonical books* of the *Old Testament*, and contains what happened to the *Israelites* under the conduct of that famous general *Joshua* whom *Moses* had appointed for his successor in the government of the people. The author of this *book* is not known, no more than that

of the following, called the *Judges*, which is a collection of several little histories, which at first were separate, but were afterwards collected by *Esdra*s, or *Samuel*, into a single volume; and, in all likelihood, were taken from the antient journals, annals, or memoirs, composed by the several *Judges*.

The canonicity of the *book* of *Job* has been very much disputed among the learned divines; neither can they agree, as to the author of that *book*; though the most common opinion is, that *Moses* published that work during the captivity of the *Israelites* in *Egypt*, to give them an example of patience in their miseries. The great erudition which appears throughout the whole, is certainly worthy that great man, who had been instructed in all the sciences of the *Egyptians*; but the learned in the *Hebraick* tongue, pretend, that there are several terms in it, which were not in use till after *David*; and that it is full of phrases of the *Idumean* language; which makes them conjecture, that the author who composed it was of that country. Some have believed, that there has never been such a man as *Job*; that the author of the *book*, which goes under his name, had invented the subject; but how does that sentiment agree with the prophet *Ezekiel*, who mentions *Job* with *Noah*? and with *St. James* in his epistle, chap. v. who proposes him to the *Christians* as a model of patience they are to follow, when persecuted for the faith?

Sixteen prophets are ranked among the *canonical books*, four *greater*, so called from the length, or extent of their writings; and twelve *lesser*, from the shortness of their writings. The *greater prophets* are *Ijaiab*, *Jeremiah*, *Ezekiel*, and *Daniel*; and the *lesser*, *Hosea*, *Joel*, *Amos*, *Obadiah*, *Jonah*, *Micah*, *Nahum*, *Habakkuk*, *Zephaniah*, *Haggai*, *Zechariah*, and *Malachi*. In the *Greek* church the *lesser prophets* are placed in order before the great ones, apparently because many of the *lesser prophets* are more antient than the *greater*. The *Greeks*, also, as well as the *Jews*, ranked *Daniel* among the *lesser prophets*; the *Jews* pretending that he is no more to be ranked among the *prophets* than *David*: not but that both the one and the other foretold many important things, but because their manner of life differed from that of the other *prophets*.

The *canonical books* of the *New Testament*, are the *four Evangelists*, the *Apocalypse*, or *Rev. latins*, the *Acts of the Apostles*, and the *epistles* of *St. Paul*, *St. Peter*, *St. Jude*, and *St. James*.

Among the *four Evangelists*, the *gospel* of *St. Matthew* is placed the first. He wrote it in *Hebrew*, (*Anno Christ. 41.* and the third of the Emperor *Caligula*) for the instruction of the *Jews* who believed in *Christ*, the actions of whose hu-

manity are particularly described therein ; it is for that reason, that St. *Matthew* is represented, among the four Evangelists, under the figure of a man. His gospel was so much esteemed, from the time of its publication, that St. *Barnabas* us'd to carry always a copy of it along with him in all his travels, with which he was buried, and which was found on his stomach when the place of his sepulchre was discovered under the Emperor *Zeno*. The *Nazarenes* kept it a long while without making any alteration in it ; and it was from them St. *Jerome* had a copy of it, in order to translate it into *Latin*. But in process of time it was corrupted, as well by the *Nazarenes*, as by the *Ebionites*, the *Corinthians*, and *Carpocratians*, who took occasion from the human genealogy described therein, to deny the divinity of *Christ*. St. *Jerome* says, that in his time the *Hebrew* original was kept in the library of *Cæsarea*.

St. *Mark* wrote his gospel by St. *Peter's* order, who had took a particular care to inform him of the actions and miracles of *Jesus Christ*. *Tertullian* says, that in his time it was called the *Gospel of St. Peter*. It is an abridgment of that of St. *Matthew*, St. *Jerome*, St. *Augustine*, and St. *Chrysostom*, are of opinion, that the original is *Greek* ; and Cardinal *Baronius*, that St. *Mark* writing the history of *Christ* for the use of the *Romans*, he must have done it in a language they understood ; and that in several places of his gospel there are locutions entirely *Latin* ; perhaps while St. *Mark* was at *Aquileia*, (if we believe an old tradition which is not warranted by good authors) he translated into *Greek* the gospel he had wrote in *Latin*. At *Rome*, the *Greek* tongue was very common, since St. *Paul* wrote to the faithful in that language ; but *Suetonius* assures us, that it had been much discredited by the Emperor *Claudius*, in whose time St. *Mark* wrote.

St. *Luke's* gospel was wrote against the errors of several hereticks, which, himself says at the beginning, was the occasion of his writing it ; and that he has learned the things he is a going to recount, from those who had seen them, and who had been the first ministers of the word, meaning the apostles, and St. *Paul* in particular, to whom he had been given, by the churches, for a companion in his travels. He mentions several things, in his gospel, of the birth, preaching, and miracles of *Christ*, which the other evangelists say nothing of ; even his style is more elegant than theirs

St. *John* wrote his at the intreaty of the bishops of the oriental church, to refute the errors of *Ebion* and *Cerinthus*,

St. *Luke* is the author of the *Acts of the Apostles*. The principal design of this work, is the history of St. *Paul*, though he has omitted several of the most important actions of that apostle, which we find in his epistles.

The epistle of St. *Paul* to the *Romans*, which is the first in order, was wrote at *Cenchrea*, the port of *Corinth*. This epistle contains the fundamental truths of the *christian* religion, the corruption of human nature by *Adam's* sin, the reparation by the grace of *Christ*, the efficacy of that remedy, the secret of his eternal election, which he founds entirely on the will of God, who, of the same mass of corruption, forms vessels of honour, and vessels of ignominy, without having the least right to ask him the reason of that difference. He proposes to himself all the objections, which human pride can make against that choice ; but instead of resolving them, he has recourse to the unscrutability of God's judgments, which are to be respected by mankind with humility, without attempting to fathom them with pride, as if the creator owed something to those who are all born in the same condemnation by the original sin, and might, without injustice, be left in it.

The apostle wrote the first epistle to the *Corinthians* at *Ephesus* ; and at *Rome* those to the *Ephesians*, *Philippians*, *Colossians*, the second epistle to *Timothy*, and the famous epistle to the *Hebrews* ; wherein, by the divine explication of the priesthood of *Christ*, he shews his profound erudition in the law of *Moses*, as well as in the sublime truths of the gospel. His epistle has been a subject of great controversy among the learned, who could not agree as to the author thereof, nor understand the *sacrifice* mentioned therein. From *Macedon* he wrote the first to *Timothy*.

The antient fathers have been long divided about the *Apocalypse*, or *Revelation*. The antient fathers, both *Greeks* and *Latins*, have received this book for canonical, though attributed to another *John*. St. *Jerome* says, that, in his time, the *Greek* churches questioned if it had been wrote by St. *John* the evangelist. St. *Basil*, and *Gregory Nazianzen*, absolutely rejected it, and the council of *Laodicea* never mention it in their canon of the sacred writings. *Dionysius Alexandrinus* censures it as written in bad *Greek*, and even finds solecisms and barbarisms in it, in abundance : though he allows it to contain a mystick sense, which, he says, he admires, even where he does not understand it.

On the other hand, St. *Justin*, *Irenæus*, *Theophilus Antiochenus*, *Melito*, *Apollonius*, *Clemens Alexandrinus*, and *Tertullian*, make no doubt of its being canonical. The third council of *Carthage* held in

397, placed it in the canon of the *New Testament*; and the churches both of the east and west have acknowledged it ever since. Of all their objections against the authority of this book, that seems the best grounded, which is drawn from those words, *c. ii. v. 18. write to the angel of the church of Thyatira*; there was not, say they, any *Christian* church at *Thyatira* at that time. *St. Epiphanius*, who grants them this point, is forced to have recourse to the prophetick spirit, as if *St. John* had foreseen there would be a church there in course of time. Several orthodox writers have rejected the *Apocalypse*, as countenancing the reveries of *Cerintus* touching the carnal reign of *Christ* on earth.

In the first century of the church, there were a great many other books attributed to the apostles, *viz.* the Acts, Gospel, Apocalypse, and Judgment of *St. Peter*. The Gospel and Apocalypse of *St. Paul*; his rapture to heaven, forged by the *Cainites*; his Acts; a third Epistle to the *Corinthians*, and to the *Thessalonians*, and one to those of *Laodicea*. A new Apocalypse was attributed to *St. John*; *Cerintus* being suspected to have been the author thereof. *St. Thomas*, *St. Bartholomew*, *St. James the minor*, *St. Matthias*, *St. Thaddeus*, and *St. Barnabas*, were presented with each his gospel. *Christ* himself was not spared by the impostors of those times, for under his name was published a book entitled, *Of the magick art*, addressed to *St. Peter* and to *St. Paul*.

*Books* are certainly of divine invention, since the oldest we have any warranted account of, and which consequently has been the first, is the Decalogue given to *Moses* by God himself, who wrote it on stones. Men afterwards taking the hint from it began to write *books* likewise, but on different matters; for instead of stones they made use of parts of vegetables for matter of their *books*, as of the leaves and barks; especially the leaves of palm-trees, and the rinds and barks of *Telia* or *Philira*, and the *Egyptian papyrus*; which continued long the common matter of *books*; insomuch that most of the names and terms belonging to *books*, in most languages, are taken thence: as the *Greek Bible*, the *Latin liber*, *codex*, *folium*, *tabula*, and the *English book* itself. We may add, that barks appear still in some measure retained for *books* in certain of the northern countries, as among the *Calnuck Tartars*, where a library was lately discovered by the *Russians*, of an unusual form as well as matter; the *books* were exceedingly long, but no breadth; the leaves were thick, and made of barks of trees, smeared over with a double varnish; the ink or writing being white on a black ground.

By degrees wax, then leather, were introduced,

especially the skins of goats and sheep, of which at length parchment was prepared; then lead came in use; also linen, silk, horn; and lastly PAPER itself.

We learn from scripture that the first *books* were in form of blocks and tables, under the appellation of *Sepher*, which the *Septuagint* render a *ξωες*, square tables, of which form the *book* of the covenant, *book* of the law, *book* or bill of divorce, *book* of curses, &c. appear to have been. But when flexible matter came to be wrote on, they found it more convenient to make their *books* in form of rolls, called by the *Greeks*, *ρολλακια*, by the *Latins*, *Volamina*, which appear to have been in use among the ancient *Jews*, as well as *Grecians*, *Romans*, *Persians*, and even *Indians*. The rolls or volumes, 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 kind of crime to take hold of the roll itself. The outside of the volume was called *frons*, the ends of the *umbilicus*, *cornua*, horns; which were usually carved; and adorned, likewise, with bits of silver, ivory, or even gold and precious stones. The title, *Συλλαβη*, was stuck on the outside. The whole volume, when extended, might make a yard and a half wide, and fifty long.

Of such *books* did the libraries chiefly consist, till some centuries after *Christ*. The form which, obtains among us, is the square, composed of separate leaves; which was also known, though little used among the antients, having been invented by *Attalus*, King of *Pergamus*, the same who also invented parchment; but it has now been so long in possession that the oldest manuscripts are found in it. *Montfaucon* assures us, that of all the ancient *Greek* manuscripts he has seen, there are but two in the roll-form, the rest being made up much after the manner of the modern *books*.

To the form of *books* belongs also the oeconomy of the inside; or the order and arrangement of points and letters into lines and pages, with margins, and other appurtenances; which has undergone many changes. 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 right, to run to the leftwards; in others, as the northern and western nation, from the left to the rightwards; others, as the *Grecians*, followed both directions alternately, going in the one and returning in the other, called *Boustrophedon*. In most countries the lines

run from side to side of the page ; in some, particularly the *Chinese*, from top to bottom. Again, the page in some is entire and uniform ; in others divided into columns ; in others distinguished into text and notes, either marginal, or at the bottom ; usually it is furnished with signatures and catch-words ; sometimes also with a register, to discover whether the *book* be compleat. To these are occasionally added the apparatus of summaries, or side notes ; the embellishments of red, gold, or enamelled initial letters, head-pieces, tail-pieces, effigies, schemes, maps, and the like. The end of the *book*, now denoted by *Finis*, was antiently marked with a <, called *coronis*, and the whole frequently washed with an oil drawn from cedar, or citron chips, strewed between the leaves to preserve it from rotting. There also occurs certain formula's. at the beginning and end of *books* : as among the *Jeus*, the words, *esto fortis*, which we find at the end of the *books* of *Exodus*, *Leviticus*, *Numbers*, *Ezekiel*, &c. to exhort the reader to be courageous, and proceed on the following *book*. The conclusions were also often guarded with imprecations against such as should falsify them ; of which we have an instance in the *Apocalypse*.

*Books*, with regard to their manufacture, may be divided into *manuscripts* ; those written with the hand, whether originally by the authors, called *Autographs*, or at second-hand, by *Librarii*, or *Copyists*, &c. *Printed*, those wrought off from the press. *Books in quires*, or *sheets*, those not bound, or stitched. *Books in folio*, those wherein a sheet is folded but once, or makes two leaves or four pages. *Books in 4to*, where it makes four leaves ; in *8vo*, where eight ; in *12mo*, where twelve ; in *16o*, where sixteen ; and in *24o*, where twenty-four.

There have been erected, almost ever since the first invention of *books*, at least from the time they began to increase in number, particular places for their receptions, which places, in process of time, have been changed into publick edifices, called libraries, whose origin is by several authors attributed to the *Hebrews* ; from whom the other nations took the hint, and *Osmanduas*, King of *Egypt* first ; who according to *Diodorus*, had a library built in his palace, with this inscription over the door, *Βιβλιον βασιλευς* ; nor were the *Ptolemy's*, who reigned in the same country, less curious and magnificent in *Books*. *Esdras*, v. 17. speaks of a library of the Kings of *Persia*, which some imagine to have consisted of the historians of that nation, and of memoirs of the affairs of state ; but in effect, it appears rather to have been a depository of laws,

and ordinances of the Kings. The *Hebrew* text calls it the *house of treasures*, and afterwards the *house of the rolls*, where the treasures were laid up. We may with more reason call that a *library*, mentioned in the second of *Esdras*, to have been built by *Nehemia*, and in which were preserved the *books* of the *prophets* of *David*, and the letters of their Kings.

The tyrant *Pisistratus* was the first, who erected a library at *Athens*, though *Strabo* refers the honour of it to *Aristotle*. *Xerxes* transported that of *Pisistratus* into *Persia*, which was afterwards brought back by *Seleucus Nicator* to *Athens*, long after it was plundered by *Sylla*, and re-established by *Adrian*. *Plutarch* informs us, that under *Eumens* there was a library at *Pergamus*, containing 200,000 *books*. *Tyrannion*, a celebrated grammarian, contemporary with *Pompey*, had a library of 3000 volumes. That of *Alexandria*, according to *A. Gellius*, contained 700,000 volumes, all in rolls, burnt by *Cæsar's* soldiers. *Constantine*, and his successors, erected a magnificent one at *Constantinople* ; which, in the eighth century contained 300,000 volumes, all burnt by order of *Leo Isaurius* ; and among the rest, one wherein the *Iliad* and *Odyssæe* were written in letters of gold, on the skin of a serpent.

The most celebrated libraries of antient *Rome* were the *Ulpian* and the *Palatin*. They also boast much of the libraries of *Paulus Æmilius*, who conquered *Persus* ; of *Lucillus Lucullus*, of *Asinius Pollio*, *Atticus*, *Julius Severus*, *Domitian*, *Serenus*, *Pamphilus Martyr*, and the Emperors *Gordian* and *Trajan*.

*St. Jerome*, *Anastasius*, and others, inform us, that antiently every large church had its library, which is yet practised in several christian countries ; especially in the *Abbeys* and other *Monasteries* ; each of which has its library, more or less numerous. Most of those libraries are publick ones ; that is to say, that the curious may resort thither, at any time, and entertain themselves with what *book* they please, which can be met with in that library, without costing them any thing, if even they were to copy whole volumes. The most antient, most famous, and most rich in original manuscripts, and most numerous of the whole world, is that of the King of *France*, at the same place, began by *Francis I.* augmented by Cardinal *Richelieu*, and compleated by *M. Colbert*, to which the learned and curious are also permitted to resort.

The next to this is that of the *Vatican* at *Rome*, founded by Pope *Nicholas* in 1450 ; and though it had been destroyed since by the constable *De Bourbon*, in the taking of *Rome*, it was restored to its

pristine splendor, by Pope *Sixtus V.* and considerably enriched with the ruins of that of *Heidelberg*, plundered by Count *Tilly* in 1622.

The Emperor's library at *Vienna*, according to *Lambecius*, consists of 80,000 volumes, and 15,940 curious medals. That erected at *Florence* by *Cosmo de Medicis*, is said to be one of the most compleat in *Europe*, over the gate whereof is wrote, *Labor absque labore.*

The *Bodleian Library*, at *Oxford*, exceeds that of any University in *Europe*, and even those of all the Sovereigns of *Europe*, except the King of *France*, and the Emperor of *Germany*, which are each of them older by a hundred years. It was first opened in 1602, and has since found a great number of benefactors; particularly Sir *Robert Cotton*, Sir

*H. Savil*, Archbishop *Laud*, Sir *Kenelm Digby*, Mr. *Allen*, Dr. *Pocock*, Mr. *Selden*, and others. The *Vatican*, the *Medicean*, that of *Bassarian* at *Venice*, exceed the *Bodleian* in *Greek* manuscripts, and the *Bodleian* exceeds them in *Oriental*s. The *Cotton library* consists wholly of manuscripts, particularly of such as relate to the history and antiquities of *England*, which, as they are now bound, make about 1000 volumes. It is greatly increased by the addition of Sir *HANS SLOANE'S Museum*. Most of the *English* nobility and gentry used to have an excellent taste for learning, and a great number of them have a select library of their own, which consist of the best authors both antient and modern.

## B O O K - B I N D I N G .

**B**OOK-BINDING, is the art of gathering, and sewing together the sheets of a book, and covering it with a back.

The art of binding books, when first the several sheets of the writings of authors were collected together, was not attended with great difficulties; for the leaves were only glued together, and rolled on round pieces, or cylinders of wood; which manner of book-binding, whose invention is attributed to the *Egyptians*, was continued till long after the age of *Augustus*, and is still retained by the *Jewish Synagogues*, where they continue to write the books of the law on vellums sewed together, making, as it were, only one long page, with two rollers, and their clasps of gold or silver at their extremities, the whole book being wrapped up in a piece of silk, which serves as a cover to it.

But as this manner of binding books is attended with many inconveniencies, one of the *Attali*, Kings of *Pergamus*, invented the form now in use, of square binding, or of sewing several quires one over another, as more commodious to the reader, who can open and shut his book in an instant, and without the least difficulty, and without the leaves being exposed to wear out so soon as when rolled up, especially of books written or printed on paper.

The several tools or instruments belonging to this profession, are, *folding-flicks*, *hammers*, to beat the leaves, and turn the back, a *sewing-press*, a *cutting-press*, *sheers*, a *plough*, *knives*, a *smoother*, *brushes*, *dog's-tooth*, *punchions*, and little cylinders of brass engraven in *relievo*, in various forms and

devices, for ornaments; *gold* for gilding, calf skins, parchment, whipcord, pack-thread, needles backing boards, &c.

*Folding-flicks* are slips of ivory, or box, of about two fingers broad, and eight or ten inches long, edged on each side, for the conveniency of parting the leaves asunder, when occasion requires it.

*Cutting-press* is a machine consisting of two large pieces of wood, in form of cheeks, join'd by two strong wooden screws, which being turned by an iron bar, draw together, or set asunder the cheeks, as much as is necessary for the putting in of the books. The cheeks are placed flat on a wooden stand, in form of a chest, into which the cuttings fall. A side of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks, and prevent their approaching or opening unequally upon turning the screw. Upon the cheeks is the shaft or fust, to which the cutting-knife is fastened by a screw, which has its key to dismount it on occasion, to be sharpened.

The shaft consists of several parts; among the rest, a wooden screw, or worm, which catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book, which is fastened in the press between two boards. This screw, which is pretty long, has two directories, or pieces of wood, which both as to their form and effect resemble those of the screws of the cheeks. To make the shaft slide square and even on the cheeks, so that the knife push'd along by the workman may make an equal paring, that foot of the shaft where the knife is not fixed has a kind of groove

groove, directed by a thread fastened along one of the checks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword; and at the other in a square form, which serves to fasten it to that shaft.

The *book-binder* being furnished with all his implements, begins to work first with a *folding-stick*, to fold the sheets, according to the form, viz. into 2 for *folio's*; 4 for *quarto's*; 8 for *octavo's*, &c. being directed therein by the *signatures*, or catch-words, at the bottom of the page.

The *signature* is a mark at the bottom of each sheet, to shew the number and order of the quires and sheets. The signatures consist of the capital letters of the *alphabet*, and change in every sheet. If there be more sheets than letters in the *alphabet*, to the capital letter is added a small one of the same sort, i. e. a little *a* after great *A*, &c. or *fig. 2, 3, &c.* which is repeated as often as is necessary.

The leaves thus folded, and laid over each other, in the order of the *signatures*, are beaten on a stone with a hammer, to make them smooth, and open well, and then pressed. While in the press, 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. The *French book-binders* apply a slip of parchment, the length of the *book*, on the inside of each pasteboard, so, however, as that being cut, or indented, in the places against the bands, it comes out between the edge of the pasteboard and the leaves of the *book*, to cover the back. They call this *indorsing*, and they are obliged to do it on the penalty of 30 livres, and the *re-binding* of the *book*. It is done in the press, where the back being grated with an iron instrument with teeth, to make the paste take hold, wherewith the parchment is first fastened, they afterwards add strong glue to fortify it. 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, called *backing-boards*, in order to make a *groove* for fixing the pasteboards; which being applied, holes are made, for fixing them to the *book*, which is pressed a third time, and then cut by the plough. Then the *book* is put at last 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 cut against; after which, the pasteboards are squared with a pair of sheers.

The next operation is the *sprinkling* the leaves of the *book*, which is done by dipping a brush made of hog's bristles 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, at least so far as to be disagreeable to the eye.

Some valuable *books* are gilded; which is done by putting the *book* in the press between two boards, scraping and smoothing it, to take off all the scratches, and afterwards scraping some yellow oker upon it, which when scraped must be wetted with a very small quantity of size-water, and rubbed off with some clean shavings of the *book*. The leaves being again wetted with a brush dipped in the size-water (made with the white of an egg mixed with water, and well beat together) the gold is laid upon it, and afterwards dried before the fire. When dried, it is burnished with a *dog's tooth*, or an ivory nob.

They have found lately a new invention to beautify the *tranche* of a *book*, which produces as good an effect, or rather better, than *gold* itself; which is *marbling* it, in the same beautiful manner we do marble paper, thus;

They have a trough of about four fingers deep, of the length and breadth of the largest volume, to contain the liquor, which liquor is a quarter of a pound of gum tragacanth macerated four or five days in fair water, and stirred from time to time, adding every day fresh water to it, till it be of a consistence somewhat thinner than oil, and then they strain it through a cloth into the trough.

When the gum is well settled in the trough, they extend a sheet of paper, and plunge it very shallow into the liquor, suddenly lifting it out again, in order to stir up, and raise the subsiding gum towards the surface, and for the more impregnating of the liquor. Which done, they have all the colours ranged in gallpots on the table, viz. for blue, indico ground with white lead; for green, indico and orpiment, the one ground, and the other tempered, mixed and boiled together with common water; for yellow, orpiment bruised and tempered; for red, the finest lake ground with the raspings of *Brazil* wood, which has been prepared by boiling half a day. Into all these colours they put a little ox or fish gall, which is two or three days old; and if the colours dilute not of themselves sufficiently, they add more gall; on the contrary, if they spread too much, the gall is over-dosed, and must be corrected by adding more of the colour without gall. Then they begin, by dipping a brush of hog's hair into any colour, commonly the blue first, and  
sprinklé

sprinkle it on the surface of the liquor in the trough, (which is also upon the table) if the colour were rightly prepared, it will dilate itself duly therein. This done, the red is applied in the like manner; but with another pencil; and after this the yellow; lastly, the green. For white, it is made by only sprinkling fair water, mixed with ox's gall, over the liquor.

When all the colours are thus floating on the liquor, to give them that fine cambletting we admire in marble paper, they use a pointing stick, which being applied, by drawing it from one side of the trough to the other with address, stirs up the liquor and fluctuating colours; then with a comb taken by the head with both hands, they comb the surface of the liquor in the trough from one extreme to another, permitting only the teeth to enter.

The colours being in this posture, the *book-binder* takes off his *book* from the press, keeping it closely tyed betwixt the two back-boards, lest the colours should penetrate too far into the inside of the *book*, having moistened it first with fair water, applies each side, one after another, to the colours, in such a manner, that the surface of the colours, and that of the edge of the *book*, may meet equally on all parts; the operation is done in nine or ten pulses. Then the *book* is put to dry, and when dried is polished with the *dog's tooth*, the ivory nob, or the like. This is a vast addition to the beauty of the *binding*, which being carried thus far, an ornament of silk of several colours, called a *head-band*, is placed at each extreme of the back, across the leaves, and wove and twisted, sometimes about a single, and sometimes a double piece of rolled paper.

Then remain the *covers*, which are either of *calves skin*, or of *sheep's skin*. Antiently *books* were almost all bound in parchment, and most of our valuable *books*, even since the invention of printing, have no other *binding*: but the best *binding* at present is in *calves*, though *binding* in *sheep* makes as good a figure, but is not of so long a duration.

The *calves* or *sheep skin* being moistened in water, is cut out to the size of the *book* with a knife, then smeared over with paste, made of wheat flour, and afterwards stretched over the *pasteboard*, on the

outside, and doubled over the edges within, and after having first taken off the four angles, and indented and plaited it at the *head-band*; which done, the *book* is corded, or bound firmly between two boards, with a kind of whipcord, to make the cover slick the stronger to the *pasteboards* and the back, as also to form the bands or nerves more accurately; then set to dry, and when dry, uncorded, and the leaves at each end opened. Afterwards, the *book* is washed over with a little paste and water, and then sprinkled fine with a brush, by striking it either against the hand, or a stick; unless it should be marbled, for then the spots are to be made larger, by mixing the ink with vitriol. Then the cover is glazed twice, with the white of an egg beaten, (as painters do their pictures when they are finished) and at last polished with a *polishing iron*, passed hot over the glazed cover.

Thus the binding of a *book*, properly so called, is finished, unless it should be lettered; for then a piece of red Morocco is pasted on the back, between the first and second band, to receive the title in gold letters; and sometimes a second between the next bands underneath, to receive the number of the volume. The *gilder* makes the letters on the back, and the roses, stars, &c. between the bands with punchions, engraven in relieve, which they press flat down; and the lines, embroideries, &c. with little cylinders of brass, rolled along by an iron ruler, by means of a double branch; in the middle whereof they are fitted on an iron stay or axis, that passes the middle of their diameter. But before they apply any of these tools, they glaze those parts of the leather, whereon they are to be applied, lightly over with a pencil, or sponge; and when half dry, lay over them pieces of leaf-gold, cut out near the size; and on these stamp the punchions, which are beat down with a mallet or hammer, if the figures be large, and require a great relieve, as arms, &c. or roll the cylinders, both the one and the other reasonably hot. The gilding thus finished, they rub off the superfluous gold with a hare's foot; leaving nothing covered with gold, but the places whereon the hot tools have left their impressions.

## Of BOOK-KEEPING.

**B**OOK-KEEPING, is the ART of keeping accounts, or of recording the transactions of one's affairs in such a manner, that the true state of any part, or of the whole, may be thereby known with the greatest exactness, clear-

ness, and ease; which transactions either relate to persons dealt with, or the things we deal in, which are either *money* or *goods*. As to the person we deal with, we must endeavour to be always capable to know by our *books* what he owes us, and what we

owe him; and as to the commodities we deal in, we must take care to keep an account of the quantity and value of every kind of effect, we have in our hands, with the gain and loss on that subject, within the time of the account; as also of any thing whatsoever is received by us, or any way, for our account, by our servants, whether the same be money or wares; and of every thing whatsoever is delivered from us, upon any account, whether money or wares.

Books are either kept single; as among retailers; or double, (call'd the Italian method) among great merchants. For single Book-keeping, two books are sufficient, viz. a journal, or day-book, and a ledger, or post-book. But there are several others requisite for keeping books double, viz. three essential, and thirteen auxiliaries.

The essential ones are, the waste-book, journal, and ledger. And the auxiliaries are, the cash-book, debt-book, books of numbers, of ensives, of accounts current, of commissions, orders, or advices, of acceptances, of remittances, of expences, of copies of Letters, of vessels, and of workmen.

This method of Book-keeping, in two parts, which we have learned from the Italian merchants of Florence, Venice, Genoa, &c. is universally practis'd throughout all Europe, and in the same manner, as to substance; but not as to coin; which varies according to the regulation of the coin of the state, where the merchants are; for, in England the books are kept in pounds, shillings, and pence. In France in livres, sols, and deniers. In Spain in maravedis, sometimes in rials and pieces of eight. At Lisbon, and throughout Portugal, in rees and crusado's. Throughout Germany, in florins, cruizers, and pennings. In Holland, in florins, patars, and penings. At Florence, in gold crowns, sols, and deniers. At Venice in ducats. At Messina and through Sicily in ounces, taris, grains, and picolis. In Muscovy, in rupees, altins, and grives. At Dantzick, in rixdollars. At Hamburgh, in marks, sols, and deniers lub. And thro' all the states of the Grand Signor, in piasters and aspers..

A pound English, or sterling is 20 shillings.

A shilling 12 pence.

A penny 2 halfpence, or 4 farthings.

A halfpenny 2 farthings.

A French livre is 20 sols, a sol 4 farthings, or liards.

A maravedi is half a farthing English.

A rial 6 pence 3 farthings.

A piece of eight 4 shillings and sixpence.

A rees is equal to 3 fifths of a farthing sterling.

A German florin is 3 shillings.

A Dutch florin is 2 shillings.

A Patard 1 halfpenny, 1 fourth of a farthing.

A Florence gold crown 5 shillings and 6 pence.

A Venice ducat 4 shillings and 4 pence.

At Naples the carlin is 6 pence.

Thro' Italy the sequin is 9 shillings and 2 pence.

The roup 4 pence 3 farthings.

The rix dollar 4 shillings and 6 pence.

A Hamburgh mark 1 shilling and 6 pence.

A piafter 4 shillings and 6 pence.

And an asper something more than an English halfpenny.

The WASTE BOOK may be defined a register, containing an inventory of a merchant's effects, and debts, with a distinct record of all his transactions and dealings, in a way of trade, related in a plain simple style, and in 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 in hand, his part of 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 between which, and the effects, is what the merchants call neat stock. When a man begins the world, and first sets up to trade, the inventory is to be gathered from a survey of the particulars that make up his real estate; but ever after is to be collected from the ballance of his old books, and carried to the new.

After the inventory is fairly related in the Waste-book, the transactions of trade come next to be entered down; which is a daily task to be performed as they occur. The narrative ought to exhibit transactions with all the circumstances necessary to be known, and no more. It should contain the names of persons with whom the merchant deals upon trust, the conditions of bargains, the terms of payment, the quantity, quality, and prices of goods, with every thing that serves to make the record distinct, and nothing else.

The Waste-book, if no subsidiary books are kept, should contain a record of all the merchant's transactions and dealings, in 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 impare or increase it, such as private expences, servants fees, house-rents, money gained, &c.

The JOURNAL, or DAY-BOOK, 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: whence it may be observed, that the great design of the journal is to prevent errors in the ledger.

Again,

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 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 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, as it can neither be fair nor uniform, nor very accurate, being commonly written by different

hands, and in time of business. Hence it is, that in case of differences between a merchant and his dealers, the *journal* is the book commonly called for, and inspected by a civil judge.

In the *journal*, persons and things are charged *debtors* to other persons and things as *creditors*. and in this it agrees with the *ledger*, where the same style is used, but differs from it as to forms and order; so that it agrees with the *waste-book* in those very things where it differs from the *ledger*; and, on the other hand, it agrees with the latter, in the very point wherein it differs from the former: but in order to state the comparison betwixt the *waste-book* and *journal*, we shall turn two or three examples of the *waste-book* into a *journal* form.

W A S T E - B O O K :

June 1st.		l.	s.	d.
Bought of William Pope 40 yards of black cloth, at 14s. per yard,	}	28	00	00
payable in three months,				
Bought of James Sloan 100 yards of shalloon, at 10d.				
per yard.				
Whereof paid,		02	00	00
Rest due, at two months,		02	03	04
			03	04
4th.		l.	s.	d.
Sold William Pope four pipes of port wine, at 27l. 10s.				
per pipe.		55	00	00
Whereof received		55	00	00
Rest due, on demand,		55	00	00
		110	00	00

J O U R N A L.

June 1st.		l.	s.	d.
BLACK-CLOTH Dr. to WILLIAM POPE, 28l.		28	00	00
For 40 yards, at 14s per yard, payable in three months.				
SHALLOON Dr. to SUNDRIES, 4l. 3s. 4d.		04	03	04
To Cash paid in part for 100 yards, at 10d. per yard,		02	00	00
To J. Sloan, for the rest, due at two months		02	03	04
		04	03	04
4th.		l.	s.	d.
SUNDRIES Drs. to PORT-WINE, 110l.		110	00	00
Cash, received in part for four pipes. at 27l. 10s. per pipe,		55	00	00
William Pope, for the rest on demand,		55	00	00
		110	00	00

It may be here observed, that every case or example of the *waste-book*, when entered into the *journal*, is called a *journal post*, or entrance; thus the examples above, make three direct *posts*.

A *post* is either *simple* or *complex*; a *simple post*, is that which has but one *debtor*; and one *creditor*, as the first of these above; a *complex post*, is either when one debtor is ballanced by one or more *creditors*, as in the second post; or when two or more *debtors* are ballanced by one *creditor*, as in the third post; or when several *debtors* are ballanced by several *creditors*; and then the post is said to be complex in both terms.

This being premised, the following rules are to be observed for writing in the *journal*.

1. In a *simple post*, the *debtor* is to be expressly mentioned, then the *creditor*, and lastly the sum, all in one line; after which, the narrative, or reason of the entry, in one or more lines, as in the first of these three posts above.

2. In a *complex post*, the several *debtors*, or *creditors*, are expressed in the first 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.

3. The *debtors* and *creditors* should be written in a large letter, or text hand, both for ornament and distinction.

Before we proceed to explain the *ledger*, we shall previously inquire into the nature and use of the terms *debtor* and *creditor*, as the whole art of book-keeping entirely depends on a true idea of those terms, the nature and use of which will be obvious from the following considerations.

Accounts in the *ledger* consists of two parts; which in their own nature are directly opposed to, and the reverse of one another, which are therefore set fronting one another, and on opposite sides of the same *folio*.

All the articles of the *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 accounts of the said goods, and the *sale or disposal* of them to the *right*.

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 the said goods, and the latter to the *right side* of the *cash* account.

The two parts in any case in the *waste book*, when posted to the *journal*, are denominated the one the *debtor*, 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 entrances in the *ledger*, viz. one for the *debtor*, and another for the *creditor*.

From what has been said, it is evident that 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.

Having explained the terms *debtor* and *creditor*, we shall now proceed to the *ledger*.

The *ledger* is the *principal book*, wherein all the several articles of each particular account, that lie scattered in other books, according to their dates, are collected, and placed together in spaces allotted for them, in such a manner, that the opposite parts of every account, are directly set fronting one another, on opposite sides of the same *folio*.

The *ledger's folios* are divided into spaces for containing the accounts, on the head of which are written the titles of the accounts, marked Dr. on the left hand page, and Cr. on the right; below which stand the articles, with the word *To* prefixed on the Dr. side, and the word *By* on the Cr. side; and upon the margin are recorded the dates of the articles, in two small columns allotted for that purpose. The money columns are the same as in other books: before them stand the *folio* column, which contains figures, directing to the *folio* where the corresponding *ledger* entrance of each article is made: for every thing is twice entered in the *ledger*, viz. on the Dr. side of one account, and again on the Cr. side of some other account; so that the figures mutually refer from the one to the other, and are of use in examining the *ledger*. Besides these columns, there must be kept in all accounts, where number, measure, weight, or distinction of coins is considered, inner columns, to insert the quantity.

*How the ledger is filled up from the journal.*

1. Turn to the *index*, and see whether the *debtor* of the *journal* post, to be transported, be written there: if not, insert it under its proper letter, with the number of the *folio* to which it is to be carried.

2. Having distinguished the *debtor* and the *creditor* sides, as already directed, recording the dates,

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 inserting the quantity, if it be an account of goods, &c. in the inner columns, and the referring figure in the folio column.

3. 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 on the *creditor* side, and the word *By* prefixed to it.

4. The *post* being thus entered in the *ledger*, return to the *journal*, and on margin mark the *folios* of the accounts, with the *folio* of the *debtor* above, and the *folio* of the *creditor* below, and a small line between them thus  $\frac{2}{4}$ . These marginal numbers of the *journal*, are a kind of index to the *ledger*, and are of use in examining the books, and on other occasions.

5. 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 *debtor* of it, the next for the *creditor* the third for the *debtor* 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: and supposing that, thro' inadvertency, some former space has been allowed too large, you are not to go back to subdivide it, in order to erect another account in it.

Though these rules are formed for *simple posts*, where there is but one *debtor* and one *creditor* yet they may be easily applied to *complex ones*.

As examples, how articles are to be entered in the *ledger*, take the two accounts of CASH and WILLIAM POPE, so far as mentioned in the above *waste-book* and *journal*.

1759	CASH	Dr.	Fo.	l.	s.	d.	1759	CONTRA	Cr.	Fo.	l.	s.	d.
June 1	To port-wine, received in part for four pipes, at 27l. 10s. per pipe		6	55	00	00	June 1	By shalloon, paid in part for 100 yards, at 10d. per yard.		12	2	00	00
		WIL. POPE Dr.						CONTRA.	Cr.				
June 1	To port-wine, as per journal.		6	55	00	00		By black cloth, for 40 yards, at 14s. per yard.		3	28	00	00

The *Cash Book* is the most important of the *auxiliary books*. It is so called, because it contains, in *debtor* and *creditor*, all the *cash* that comes in, and goes out of a merchant's stock. The *receipts* on the *debtor's* side; the *persons* of whom it was received, on *what*, and on *whose* account, and in what *specie*: and the *payments* on the *creditor's* side; mentioning also the *specie*, the *reasons* of the *payments*, to *whom*, and for *what* account they are made.

To your *ledger* you must have an alphabet, for the ready finding every account, whether proper, or factorage, domestic or foreign; as men, wares, voyages, profit, and loss, accounts current, &c. the method whereof let be thus, of having a page for, as there is occasion for each letter. Generally it is the letter of a man's surname, and the proper name of the thing, or commodity, that directs its place in the index.

Thus,

	C.		Folio	r
Cash	—	—		1
Charges of merchandise	—	—		4
George Clifford	—	—		2
D.				
Drugs	—	—		2
G.				
Paul Grove	—	—		1
H.				
Peter Higgs	—	—		3
Household Expences	—	—		4
N.				
Norwich Wares	—	—		1
Matthew Noble	—	—		2
P.				
Joseph Price	—	—		2
Profit and Loss	—	—		3

R.				
James Rowland	_____	_____	3	
Raw Silk	_____	_____	3	
S.				
Stock	_____	_____	1	
William Stubb	_____	_____	2	
T.				
Peter Trueman, my account current	_____	_____	4	
V.				
Voyage to Aleppo, consigned to P. Truman			1	

The *debt book*, or *book of payments*, is a *book* wherein is entered the day whereon all sums falls due, whether to be paid or received by bill of exchange, merchandise, or otherwise; to the end, that by comparing receipts and payments, provision may be made in time for a fund for payments, by receiving bills, &c. or taking other precautions. This *book*, like the *ledger*, must be on two opposite pages, money to be received on the left hand, and that to be paid on the right. Thus,

June	1759	To pay	l.	s.	d.
6	To Matthew Sullivan, for money lent Jan. 1.	}	500	00	00
	To Joseph Plumtree, a note under hand of May 2.		200	00	00
8	Remittance of Trueman, of November 30, to Grove	}	1000	00	00
	My own bill of the 30th of September to bearer		800	00	00

June	1759	To receive	l.	s.	d.
10	Remittance of Peter Trueman of the 20th of May	}	1700	00	00
20	Of George Dean for druggs, sold the 30th of January		300	00	00
25	Of Simpson Pickthread for Norwich wares, sold February 3.	}	150	10	03
	Of Paul Grove, for money lent May 12,		225	11	08
	Of Peter Price, for money paid on his account June 6.	}	50	15	00
	Of Jonah Toms for 200 lb. of opium sold Jan. 1.		25	12	00

The *cash-book*, is the *book* wherein are entered all the sums received and paid daily; those received on the left hand, with the person's name of whom received, for what, for whom, and in what specie; those paid on the right, mentioning likewise the specie, the reason why, the person to whom, and for whom the payment is made; and once in a

month, or oftener, sum up your account of cash received and paid, carrying the sum to the account of cash in the *ledger*, which account, without this book, would swell too big, provided you should enter the particulars there. For Example,

## C A S H - B O O K.

June 1759	Cash Debtor.	l.	s.	d.	June 1759	Cash Creditor.	l.	s.	d.
6	Received for 300 <i>l.</i> of scammony, sold <i>George Dean</i> , in guineas	307	10		7	Paid in full, to <i>John Baker</i> , in guineas	150		
8	Received in part, of <i>William Short</i> , in pieces of eight	16			12	Paid in part, for <i>Norwich</i> wares, to <i>Paul Grove</i> , in thirty-six shillings, <i>Portugal</i> pieces	80		
	Received in full for raw silk, of <i>Joseph Grove</i> , in moidores	1337	10		15	Lent <i>Peter Price</i> , in guineas, at interest for three months	500		
	Received in full, of <i>Peter Price</i> , part in moidores and part in guineas	92			20	Paid <i>Lewis Stone</i> , in pieces of eight, by assignation	80		
	Carried to folio 1 in the ledger	1896			25	Paid to <i>ditto Lewis</i> , in guineas and in full,	29	04	
					27	Paid <i>Charles Stanyan</i> , in shillings and crown pieces	140		
					30	Paid <i>Joseph Grove</i> , in part, in pieces of eight	31		
					31	By household expences this month from folio 1.	149	08	6
						By charges on merchandize, this month, as on folio, 1.	92	15	11
						Carried to the ledger, folio 1.	1252	08	05

The *book of ENVOICES*, is to keep an account of goods, shipped, either for your account, or for others in commission, according to the bills of lading; with the whole charges, till on board; every *envoice* following another, according as they happen, *i. e.* entering the goods sent or shipped off to be sold, for your account, with the value, and time when sent, on the left hand *folio*; and entering the same on the right hand *folio*, as you receive advice of their sale: so you may readily see how the account stands in that particular. Thus,

*Envoice of goods shipped on board the America sloop, Burthen 250 tuns, Peter Brown master, bound for Genoa; the following goods, consigned to William Stockwell, for my account, or by order and the account of James Price, and company.*

*Book of account current*, is kept in debtor and creditor, like the *ledger*; and serves for accounts sent to correspondents to be regulated in concert with them, ere they are entered in the *ledger*. This

is properly a duplicate of the accounts current, kept to have recourse to, on occasion.

*Book of Acceptances*, is destined for the registering all bills of exchange, notified by letters of advice from correspondents; to be able to know, on the bills being presented, whether they have orders to accept them, or not. When they chuse to decline accepting a bill against the article thereof, in the *book*, they put *P, i. e. protest*; that on offering the bill the bearer may be told he may protest it: on the contrary, if they accept it, they write against it an *A*, adding the date or day of acceptance. And this, upon being transferred to the *debt book*, is cancelled.

*Book of remittances*, serves to register bills of exchange, as they are remitted by correspondents, to require the payment thereof. If they be protested for want of acceptance, and returned to those who remitted them, mention is made thereof against each article, by adding a *P* in the margin, and the date of the day when they were returned, then cancelled. The *books of acceptances* and *remittances* have so near a relation to each other, that many merchants

merchants make but one of the two, which they keep in debtor and creditor; putting acceptances on the side of debt, and remittances to that of credit.

The *book of expences*, is a detail of the petty

expences, both domestick and mercantile; which at the end of each month are summed up, and make an article for the *cash-book*; and to the profit and loss account in the *ledger*; which is debtor to cash for it. Thus,

*Household Expences, Debtor.*

May	1759		l.	s.	d.
9	To cash paid Paul Grove, for one quarter's Rent of my dwelling-house, due at <i>Midsummer-day</i> last, in full	}	40	10	
5	To cash for my pocket expences		4	0	
10	To cash paid my wife for apparel, &c.		50	14	
20	To cash paid Abigale Pilfer, the house-keeper, for this month	}	50	4	6
25	To cash paid for my children at school		50		
27	To cash paid to my taylor		15		
30	To cash for my pocket expences		4		
Carried to cash-book, Folio 1.			214	8	6

*Book of numero's, or wares*, is kept for the easy knowledge of all the *goods* brought in, lent out, or remaining in a warehouse. On the left hand page are entered the quantity, quality, and number or mark of the *goods* brought in; on the right, the discharge of the *goods* out of the warehouse, against the respective articles of the first. Thus,

N <sup>o</sup> 1.	A bale of white paper, weighs	400 l.
2	A piece of crimson damask, ells	63.

March 1.	Sold to Joseph Grove.
April 2.	Sent to Peter Price.

Besides these *books*, each merchant is to form to himself such other *books* of accounts upon the same principles, as shall best suit his own particular dealings, correspondence and commerce, which are too many and too minute to be inserted in this treatise: therefore it remains only to shew how to close the account, and how to balance our *books*.

To *close* an account, is to make an end, or shut up an account, when you intend to add no more thereto; and is done by ballancing, and drawing a line, &c.

All accounts are closed either with profit and loss, or with ballance, or with profit and loss and ballance, or with stock.

All accounts of goods or wares, where all that was bought is sold, are closed with profit and loss; which, if you gain thereby, is entered on the

debtor side of the account, and on the creditor if you lose; of which the account of *Norwich wares*, *Fol. 1.* is an example.

All accounts of men are closed, with ballance, on the debtor side, if you owe to them; or on the creditor side, if they were indebted to you.

All accounts of wares, where all that are bought are not sold, are closed with profit, and loss, and ballance, *i. e.* with profit and loss on the debtor side, for the sum gained by what is sold; and with ballance on the creditor side, for what the goods remaining unfold cost; as in the accounts of drugs and raw silk.

No accounts are closed with stock, but with profit, and loss, and ballance.

These rules carefully observed, it will not be difficult to ballance, either a single account, or your whole *ledger*, in order to know how much cash, wares, and debts you have; what debts you owe, and what you have gained by trading since your last general ballance.

To ballance any single account, sum up the debtor and creditor sides, and put their total on a piece of waste paper, where take their difference, which is the ballance, and must be entered on the debtor or creditor side, as is taught in closing an account; which done, the sum of the debtor and creditor side shall be equal. But in an account of wares, the said difference is the profit or loss, and must be entered on that side whose sum is least, to make the sums of debtor and creditor sides equal. And to ballance your *ledger*, for the end above-mentioned, take a sheet of paper, and on one side write *ballance debtor*; and on the other side write

*per*

*per contra creditor*, as the sheet lies extended before you.

To ballance all your particular accounts, you must begin with cash, (except stock, and profit, and loss) which being done throughout your *ledger*, begin again, at the account of the cash, and where an account is clos'd with ballance, enter the same on the contrary side of the account of ballance in your paper, as in the account of cash above-mentioned, cash is creditor by ballance 2185*l.* 11*s.* 7*d.* therefore ballance on your paper, must be made debtor to cash 2185*l.* 11*s.* 7*d.*

Likewise, where an account is clos'd with profit and loss, enter the ballance sum on the contrary side of the account of profit and loss; as in the account of *Norwich* wares, which is clos'd debtor to profit and loss 26*l.* 12*s.* Therefore profit and loss must be creditor by *Norwich* wares. And where you meet with an account clos'd both with profit and loss, and ballance, as is that of voyage to *Aleppo*, consigned to *P. Trueman*, because ballance is on creditor side, make ballance on your paper debtor to voyage to *Aleppo*, &c. 150*l.* 12*s.* 6*d.* and because the said account of voyage, &c. is debtor to profit and loss, make the account of profit and loss creditor, for the like sum of 150*l.* 12*s.* 6*d.* And thus having guided you through the several cases that may happen, proceed with the rest of the accounts to the end of your *ledger*, leaving profit and loss unclos'd till you have clos'd and ballanc'd the rest of the accounts, except stock. Then close the account of profit and loss, with debtor to, or creditor by stock, and carry the foot to the contrary side of the account of stock, as in the example of the foregoing account of profit and loss clos'd with debtor to stock 896*l.* 10*s.* 1*d.* Stock must, therefore be made creditor, by profit and loss, 896*l.* 10*s.* 1*d.*

With the difference of debtor and creditor side of ballance, *i. e.* with debtor to, or creditor by stock, close the account of ballance, and carry the foot to the account of stock, as in the foregoing account of ballance, it is so clos'd; creditor by stock 3546*l.* 0*s.* 1*d.* Therefore stock must be debtor to ballance 3546*l.* 0*s.* 1*d.* Then sum up the debtor and creditor sides of the account of stock, and if they ballance, or are alike, your *books* have been kept right, otherwise you have committed some error.

Take this for a general rule for ballance of accounts, that your present stock, and what you owed when you began the account now ballanced, will be always equal to your stock, when you began your accounts, and what you have gained since, to the day the general ballance is made. The reason of this is plain; for your former stock, and what you have gained since, must be your present stock;

as in the example foregoing of stock, your former neat stock (debts deducted) is 2649*l.* 10*s.* 0*d.* and you have gained since, as appears by the account of profit and loss, 896*l.* 10*s.* 1*d.* the sum of which is 3546*l.* 0*s.* 1*d.* = your present stock; but if you add, as you must, your gross stock, when you began trade, to what you have gained since; the same will, consequently, be just so much more than your present neat stock, as was the sum you owed when you began trade; which if you therefore add to your present stock, the sum must be equal to your former gross stock, and the sum gained; which is evident in the example.

For if 2649*l.* 10*s.* — 510*l.* + 896*l.* 10*s.* 1*d.* be = 3546*l.* 0*s.* 1*d.*

It follows,

That 3159*l.* 10*s.* + 896*l.* 10*s.* 1*d.* is = 3546*l.* 0*s.* 1*d.* + 510*l.*

Note, That (—) is less, (+) more, and (=) equal to.

At present the most considerable *shop-keepers*, who commonly deal in a few different species of goods, as *drapers*, *mercers*, &c. usually keep a *ledger* for persons and wares distinct, without any formal connection or reference of the accounts in their several articles; whereby there can no regular ballance be made. In the accounts of persons they use the formality of a debtor and creditor style, which is mere shew, without the real value of a regular account; there being no opposite corresponding debtors and creditors to be found; for their *ledger* of wares, as they call it, contains nothing of this, and is but an imperfect contrivance, which they satisfy themselves with, to know how much remains; but the worst is, that in allotting spaces for the account of wares, they frequently allow no more than they suppose may serve for the retail of the quantity first entered on that space for a new parcel; which, in a quick trade is not only troublesome, but confused, if there be any of the old parcels remaining; unless they carry it to the new account.

For *petty traders*, who deal in some hundreds of trifling wares, and make sale to the value of a farthing or halfpenny, they cannot pretend to keep orderly accounts; the best they can do is, to be careful that servants do not wrong them; for they have no accounts of goods; and if they are asked what of any kind remains with them, they must go look, if their memory fail. These can only have a *cash account*, which they are to charge once a week, with the money received, and discharge for what they give out; it is not convenient that they should touch the *cash-book* or *till*, oftener than

once

once a week, when it is compleated; but if they do, they must keep a separate accompt of what they take out, to know what was received: besides which, they should have a kind of *ledger* for the persons with whom they deal upon credit; in which they give every *debtor* or *creditor* an account, with a debt and credit both on one side, either with a double *money-column*, or constant deductions, as the debts and credit succeed one another. They may also, for the sake of those, have *memorandums*, or *day-books*, wherein all things of this nature are writ down, and then carried into the other.

For *artificers*, *bandicraftsmen*, and the like, they may keep account of the expences of living; but it will also be necessary to make a distinct account of the charges and profit of their business, which may easily be done, by an exact account of all they pay or owe for the materials and instruments of their work, with servants wages, and taxes upon their trade; and of all they receive; of what is due for their work. They may conveniently keep account for the materials of their work, to satisfy them of the disposal thereof, and serve as a check on servants, who have access to those things, and they must keep accounts for the persons they deal with, both in buying and selling.

For gentlemen of landed estate, the books necessary to be kept are, 1. A great *waste-book*, containing a plain narrative of all things, as they occur, as receipts and payments; every thing given and received; and, in short, whatever is done relating to any thing, or person they are concerned with: out of which is to be made up, 2. A *cash-book*, containing in a plain narrative stile, upon the debtor-side, all receipts of money; and upon the creditor-side all payments; and though there be several articles received or paid together, belonging to the same account, which are entered particularly in the waste, yet they may be set down here, in a total sum; for example, there is paid 26 *l.* for divers pieces of household furniture, all particularly mentioned in the *waste-book*, yet in the *cash-book* there needs no more than to say paid for household furniture, &c. 3. A *book of accounts with tenants*, where in distinct places, every one's charger and discharge may be fairly written, without any great formality of stile, and if it have a shew of debtor and creditor-side, it will be the more distinct. 4. A *book of petty accounts with servants*

and workmen, &c. 5. A *book of real accounts*; containing an account of cattle, corn, and other stock or furniture, to know at all Times what you have, and how it is to be disposed of. If a gentleman advances no nearer to the artificial part of accounting, he must keep an account with every person with whom he has dealings; which may be done in the same book with his tenant's accounts, only allotting distinct parts for them; the last will take no great room compared with the other. These books of accounts must have indexes.

For a person in a single state, who has no business but the receiving at certain times in a year, a sum of money, which he lays out again for his private and personal expences, a pocket-book is sufficient.

For one in a married state, whose fortune consists also of money, as he has greater variety of expences, he must be careful to keep an exact account of what cash he receives and pays; and to make this account more distinct and orderly, it will be best to keep the particulars of the payments in a separate book, and to bring them into a *cash-book*, once a week, in totals, digested under such denominations as he thinks fit, as *bread*, *beer*, *flesh*, *coals*, *candles*, &c. Things thus brought into the cash account, may be again drawn into an abstract, shewing the total of each kind of expences for every month, by dividing a page into twelve columns, with the names of the twelve months; and then in so many articles on the margin, setting the names of the several heads of expences, and against each, under the respective month, the sum of that kind of expences, in that month; then will the sum of the money in the columns, under each month, be the total expence of that month, and the aggregate of those sums the year's expences.

For factors, or stewards on land-estates, a general *waste book* is necessary to contain all matters transacted, relating to their master's concerns, under their management; out of which let them make a *cash-book* in the manner above directed; also a book of real accounts, that they may know what real effects, besides money, they have the charge of, and how it is disposed of; particularly the corn rents, which have been delivered by the tenants, and put in the granaries under their charge, to be disposed, and given out according to order.

## Of BOOKSELLERS.

**A** BOOKSELLER is one who trades in *books*, whether he prints them himself, or gives them to be printed by others.

*Booksellers* are in many places ranked among the members of universities, and entitled to the privilege of students, as at *Tubingen*, *Salisbury*, and *Paris*, where they have always been distinguish'd from the vulgar and mechanical traders, and exempted from divers taxes and impositions laid upon other companies.

The traffic of books was antiently very inconsiderable, in so much, that the book-merchants both 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 *Booksellers*, 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 *Booksellers* 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.

In *London* they were incorporated by the charter of PHILIP and MARY, in deed, and the name of FREEMEN of the mystery or art of a STATIONER of the city of LONDON and suburbs thereof.

The preamble to this charter runs in these words. 'WE considering and manifestly perceiving, That several seditious and heretical books both in verse and prose, are daily published, stamped and printed by divers scandalous, schismatical and heretical persons, not only exciting our subjects and liegemen to sedition and disobedience against us, our crown and dignity; but also to the renewal and propagating very great and detestable heresies, against the faith and sound catholic doctrine of the holy mother church; and being willing to provide a proper remedy in this case, DO will, give, grant, &c.'

The reason given in this preamble for incorporating the *Booksellers*, shews that they were designed for a *state-engine*, which in the hands of a *popish* sovereign might assist in the reduction of the nation to the obedience of the papacy.

The privileges granted to the *Stationers* by this charter, were very considerable. No bye-law was to be made without the concurrence of the *commonalty* or body of *freemen*, who are thereby empowered to meet for such purpose without molestation. The *commonalty* are allowed to choose a *master* and *wardens* once a year or oftner, from amongst themselves, i. e. *Freemen*, for ever; and to remove or displace the *master* and *wardens* at their pleasure.

No person to exercise the art of printing for sale, unless he be free of the *Stationers* company of the city of LONDON, except *patentees* authorized by his Majesty's special privilege.

The *masters* and *wardens* are empowered to search for, and to seize, take away, tear, burn, or convert to the use of their society, all prohibited books: to imprison offenders for three months: and to levy a fine of five pounds for every offence against the regulations of this charter.

This charter was exemplified and confirmed by Queen Elizabeth and King Charles II.

It may be proper to observe that this charter neither constitutes a *court of assistants*, nor a *livery*.

The *livery* of this company was granted by the city of *London* not till the 2d of Elizabeth; and then in such a latitude as not to exclude or refuse any *freeman* able and willing to take it up.

As to the *court of assistants*; the first mention thereof is found in the XXth article of that arbitrary charter granted by King Charles II. and repealed by act of parliament in 2d WILLIAM and MARY.

However this power has been obtained in the government of the *Stationers* company; the *liverymen* have always insisted upon a right to be chosen into the *court of assistants* according to their SENIORITY; and in the case of Mr. GILES SUSSEX (*Anno Domini 1691*) the court of lord-mayor and aldermen did not only order him to be admitted one of the *assistants* of the said company; but committed the *master* and *wardens* for refusing to admit him, to the jail of NEWGATE.

This company has been favoured with several other royal grants: particularly K. James I. being informed of the poor state and condition of many *freemen* of this company, granted the corporation sole right to print *primers*, *psalters* and *psalms*; all *almanacks*, *prognostications*, and *books* thereunto tending in the *English* tongue for THEIR help and relief.

How far this bounty of the Sovereign, which is still retained by the Court of Assistants, extends to the *help and relief of the poor freemen*, is worthy of their enquiry, who have power to call for the account of that stock, which has for many years been divided very largiously amongst the Assistants, and their relations and favourites.

Should we now consider the *bookfellers* out of their corporate capacity; and only view them, as individual, each pursuing their private interest, we find them greatly indulged by the laws. They are not under the caprice of a licencer, nor restrained from publishing and selling any subject, that does not alarm the government. But where shall we meet with amongst us, a *Stephens*, a *Bleau*, a *Plantain*, a *Janssen*, or a man of genius and letters, except we must allow a superior merit to this age for the art of *puffing*, striking out title pages, and imitating mountebanks in the art of letting off their stock by deceitful advertisements: so that the art and mystery of bookselling seems at present to be dwindled into a crafty device, to impose upon the credulity of the people.

Most of our *bookfellers* labour under a very great disadvantage, which is, that very few of them have a liberal education; therefore, tho' their *profession* is one of the most genteel and honourable, and very well becoming a gentleman; they, nevertheless, have no other advantage above the meanest trader, than that of dealing in *books*, while others, deal, perhaps, in *old books*, *oysters*, *apples*, &c. which makes me compare them to a blind man, introduced into a place adorned with some of the inimitable pieces of *Titian*, *Michael Angelo*, *Raphael*, *Rubens*, *Le Brun*, *Coepel*, *Holben*, *Vandike*, *Kneller*, &c. For though he be environed with some of the most beautiful pieces of painting, he is nevertheless an utter stranger to it, nor can he judge of their elegance and beauty. Likewise, our *bookfellers* are, perhaps, every day amidst the best *authors* every age has produced, and are, nevertheless, as great strangers to them, as if they were carried all on a sudden to the court of *Prestor John*; though some of them are very much infatuated with a pretended merit, which it is impossible any body else should discover but themselves.

I wish our *bookfellers* would follow the example of those of *Paris*, where there is not one who has not studied, at least, as far as rhetorick, and consequently understand the *Greek* and *Latin* tongues; and therefore can read most of their *authors*, and, if they have any genius, can likewise understand them: but as the reading is the key to it, how can ours pretend to be judges of a *work*, when they cannot so much as read it?

What judgement will our posterity form of the *bookfellers*, when they find that in their times they have published nothing but obscenity and ribaldry? Must they not imagine that their minds were very much vitiated, or that our age produced nothing else but profligates and blockheads, utter strangers to morality and true learning?

It is true, that the *works* of those *authors* are bought very cheap, considering what *bookfellers* gain by it; but those sorts of *works* have but what *bookfellers* themselves call a run, and will never bear reading twice; they are like those *Spanish olla Podridas*, or *Pots Pouris*, which we have a fancy to taste once, but which we should be sorry to see every day served at our tables, as a common food; while, on the contrary, those written for our edification, or instruction, have always their merit, and are always in request: and if the *bookfeller* is longer kept out of his money, he might, however, consider it as an estate he has purchased, not for himself only, but likewise for his posterity, and which is to bring him several times the interest and principal, without the fund being ever exhausted. A depraved taste is never universal, and never reaches the most sensible part of a nation, which has always the majority on its side; and far from being hereditary, it is seldom of a long duration: which consideration must be a very great inducement to a *bookfeller* to buy valuable *copies*.

*Monopoly* is their favourite vice; for tho' we can judge, from several instances, that there is no great *cordiality*, or *friendship* subsisting between them, they nevertheless all reunite in one, (especially those among them, who by their wealth have acquired the greater reputation) to *oppress* those of their brethren they have some pique against, which always proceeds from self-interest; it seems, because they live in *splendor* and *opulence*, as if they were determined others should not live at all. I cannot blame them for *opposing* those, who contrary to all laws and equity, *rob* them of their *property*, on purpose to under-sell it, and thereby frustrate them of the *profit* they could reasonably expect from it; but it is equally unjust in them, to attempt to *engross* the *whole trade* to themselves. What! because they are masters of a *copy*, which has proved beneficial to them, must others be deprived of the same advantages which they suppose they could make of another such *copy*? Must no *author* write, but those who write for them? Or is none capable to write, but those who write for them? Or does the whole merit of a *work* consist in their publishing it? Are there none *good* but those which are published by them? Must every subject be deserted, which has been once treated of for them? must the version

of the scripture by St. Jerome be despis'd because that of the *Septuagint* was the first, and much esteem'd? have the writings of *Tertullian*, *Origen*, and St. *Cyprian*, eclips'd the lustre of those of St. *Augustine*? or those of St. *Augustine* prov'd disadvantageous, or detrimental to those of *Tertullian*, *Origen*, St. *Cyprian*, &c. Must any future poets forbear writing, because Mr. *Pope* has wrote with a general applause? why has Mr. *Chambers* compil'd a dictionary of arts and sciences, since *Corneille* had

done it before him? what, because he has pyrated *Corneille*, and has made a kind of *Dedalus*, which has neither beginning nor end, with a monstrous confusion of unnecessary and inaccurate references, which puzzle the most judicious reader; and because our eminent bookfellers (as they are pleas'd to call themselves) have publish'd that work, must no body be permitted to write something better, and dispose it in a more instructive and clearer order?

## Of B O T A N Y.

**B**O T A N Y (*Greek Boravn, Herb*) is a science treating of the *vegetation, origin, parts, nutrition and increase* of PLANTS: also, of their kinds, virtues, uses, analysis, maladies and death.

Let us begin with the souls of PLANTS or their vegetative life.

*Aristotle* defines the vegetative soul of a plant, *Causa cur res augeantur et aluntur* (lib. 2. de anima, c. 4.) The cause whereby things are increased and nourished. Which cause is a certain spirituous and mobile substance, whereby a body is inwardly agitated, and the nutritive juice distributed throughout all the parts, by means of certain small pipes, and ducts, form'd by nature.

In the schools, the vegetative soul is commonly defin'd, *Aelus primus corporis physici organici, potestate, vitam vegetantem habentis*, i. e. the first act of a physical and organical body, which has potentially a vegetative life.

Those things have a vegetative life, which are nourished, increase, and generate; for by vegetation this triple function is understood, viz. nutrition, increase, and generation: therefore a triple faculty is commonly attributed to the vegetative soul, viz. nourishing, increasing, and generating.

We will begin with the generating faculty, from this commandment, or omnipotent word of God, *Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself upon the earth.*

Plants have their origin from seeds, which being taken from the first plants, have propagated their species, by the Creator's will, as far as our times, and will continue to do so, to the end of the world: which opinion is supported by the above quoted words of the scripture, unless there be a seed which contains already the conformation of the plant, whose parts are unfolded by that fermentation, neither fermentation or motion can give origin to the

plant; therefore, the Lord God made the earth, and the heavens, and every plant of the field, before it was in the earth, and every herb of the field before it grew, Gen. ii. 4, 5. which makes me conclude, that all plants have their origin from the seed, and which I prove thus:

All plants have their origin from what contains them, actually, or potentially; which must be the seed, since the first rudiments of a plant can be discovered no where else, nor by the naked eye, nor even by the help of a microscope; so that the seed contains not only the coarser matter of the plant, with its organical parts, which have the ratio of a body, but a certain spirit likewise, i. e. an active, mobile, and vegetative substance, called soul; which although, in some manner asleep, in the grain, or seed, is nevertheless excited to motion, by the heat of the sun, the warmth of the earth, and with the rain impregnated with particles of volatile salt, whereby it unfolds its parts, and pushes the plant forward. A short scion, or sprig, is a seed; for it being set at a proper time, produces a tree; the smallest seed of that scion is a grain of the same kind, and hitherto visible to us; and though we cannot discover with the eye the seed of that grain, we nevertheless can form conjectures of it; for if there was not some virtue in those principles, several things, which are not sowed, would never grow.

We have all the reason imaginable to believe, that by the fecundity of the sun, and the culture of the earth, seeds are changed into a better kind, as the poet expresses it, *Georgic, lib. I.* in the following verses:

*Semina vidi equidem, multos medicare ferentes  
Et nitro prius, & nigra persundere amurca:  
Grandior ut foetus siliquis fallacibus esset.*

They likewise can degenerate, through the sterility of the soil, or the negligence of the Husbandman,

bandman, as the same poet is pleased to inform us in the same place.

*Vidi lætā diu, & multo spectata labore,  
Degenerare tamen, ni vis humana quotannis  
Maxima quaque manu legeret.*

And *Eclog* 5.

*Grandia sæpe quibus mandavimus hordea fulcis,  
Infelix lolium, & steriles dominantur avenæ.*

It might be objected likewise, that some plants grow, or from a sprig or layer set into the earth, or from a root or scion grafted into another plant; and that therefore all plants do not grow from seed.

The answer to this objection is, that tho' plants grow from a layer, a root, or a scion, that layer, root, or scion had their first origin from seed; and therefore it is certain, that from the creation of the world plants have been propagated, to this time, by a feminal virtue.

This *germ*, according to Dr. *Grew's anatom. plant. c. 1.* has two parts, *viz.* the *radicle*, which is the embryo, or beginning of the root, and the *plumule*, because in the shape of a small bundle of feathers: which in the vegetation forms the stalk or trunk, and the branches of the plant.

There are besides in the body of each seed two lobes or parts, which the bud is wrapped in, and whence it draws its *nutrition*, like a chicken from the yolk of an egg, or an embryo from the *placenta*.

From the softest and more spongy part of the seed, which Dr. *Grew* calls *Parenchyma*, are formed the marrow and skin, and from the most solid and compact part, the ligneous body.

Having thus examined the seed, we will *sow* it, and examine the process of nature in the *vegetation*.

*Vegetation* is a fermentation excited in the earth, by its warmth and humidity, and the heat of the sun, of different saline particles proper to unfold the different parts of the plant, contained in the seed, as is in an embryo; and by their rarefaction and exaltation form the juices, which serve for the *nutrition* and *growth* of the plant.

The first thing, which presents itself to my imagination, is the *sun* and *earth* concerting together, the one by his heat, and the other by her moisture, how to rid the embryo of that hard tough envelope, it is wrapped in, and which is the greatest obstacle to the explosion of its parts; therefore the earth, which is the first agent in this case, and which is to do the office of *incubation*, makes use, first, of its natural moisture, to soften the outward rind or husk, by having it percolated through the pores or

pipes of the said husk, whereby they are so opened and dilated, as to facilitate the introduction of the different salts appointed to operate on the whole substance of the seed, by unfolding the different parts it contains, and disposing them severally towards assuming their respective forms.

The SUN on this occasion excites, by a gentle warmth, the different salts the moisture of the earth is impregnated with, that they may be capable to conquer the stubbornness of the husk, by forcing themselves, first into its almost imperceptible pores, conquering all the obstacles, and razing all the obstructions, which the several substances, to be sent from the womb, for the nutrition and increase of the Fœtus, could meet with, to obstruct their motions.

By this means a free passage being opened, for such a quantity of the moisture of the *Matrix*, as is necessary to make a due separation of the husk from the most essential part of the seed, the salts, employed in that operation, being volatilized, or already fixed on that essential part, leave the husk filled with nothing else but the *Lympha*, which groweth *turgid*, and being deprived of the nourishment it received, when united to the substance of the seed, begins to tend towards its dissolution.

The thicker is the husk, and the closer the parts it is composed of, are coadunated together, the longer time it takes to be impregnated with the vapours and exhalations of the earth, and the longer it adheres to the *pulp*, or *flesh* of the seed. This coadunation of its parts retards, likewise, its laceration, which is of an indispensable necessity, for the entire explosion of the first rudiments of the plants contained in the *germ*; which laceration does not happen till the continuity, which subsisted between the pipes, or pores of the husk, by their being extended, or dilated out of measure, by the *lymph*a they are filled with, is broken. The husk or rind, never breaks till all the parts of the plant are unfolded, and the organical vessels so well formed and disposed, as to be capable to assist each other in their mutual growth; which is evident, being often brought out of the earth adhering yet to the *germ*; as we see a young partridge newly hatched running with the shell of the egg sticking yet on his back.

The formation of the plant being so far conducted by *vegetation*, and its organs disposed for their respective functions, the sun, by his heat, impregnates the nutritive juices, supplied by the earth for the nutrition and increase of the plant, with a principle of life, more perfect still than that it had received in the incubation, by exalting and volatilizing their different salts, whereby they are rendered capable of circulating through all the parts

of the plant, and rid themselves of the terrestrial *faeces*, which could obstruct that circulation.

The plant increasing in bigness, and its bud, or stem, becoming taller, from whitish turns greenish; the lateral roots, also break forth greenish, and pyramidal, from the gaping sheath, which adheres closely to the plant, and the lower root grows longer, and hairy, with many fibres shooting out of the same: though there are hairs hanging all along on all the roots, except on their tips, and these fibres are seen to wind about the saline particles of the soil, little lumps of earth, &c. like ivy; whence they grow curled: about the lateral root there now breaks out two other little ones.

On the fourth, says *Malpighi*, the stem mounting upwards, makes a right angle with the seminal leaf; the last root puts forth more, and the other growing larger, are clothed with more hairs, which streightly embrace the lumps of earth; and where they meet with any vacuity, unite into a kind of net-work. The conglobate, or flower-leaf, is now softer; and when bruised yields a white sweetish juice, like barley cream. By stripping it off, the root and stem of the plant are plainly seen, with the intermediate knot, whose outer part is solid, like a bark, and the inner more soft, and medullary.

The fifth day, in the opinion of our author, the stalk still rising, puts forth a permanent, or stable leaf, which is green and folded; the roots grow longer, and there appears a new tumour of a future root; the outer, the sheath-leaf, is loosened, and the seed leaf begins to fade.

The sixth day the stable leaf being loosened, the plant mounts upwards, the sheath-leaf still cleaving about it like a bark. The seed-leaf is now seen sinuous, or wrinkled, and faded; and this being cut, or freed from the secundine, or husk; the flesh, or *pericarpium*, is found of a different texture, the outer part, whereby the outer part of the seed, or grain, is heaved up, being more solid; but the inside vesicular, and filled with humour, especially that part near the navel-knot. All the leaves being pulled off, the roots torn, and the flower-leaf removed, the trunk appears; wherein, not far from the roots, the navel-knot bunches out, which is solid, and hard to cut: above there is the mark of the sheath-leaf, which was pulled off; and underneath, as in an arm-pit, where the gem is often hid. The hind-part of the plant shews the breaking forth of the roots, likewise the faded *placenta*, &c.

After the eleventh day, the seed-leaf, as yet sticking to the plant, is crumpled, and almost corrupted; within it is hollow, and about the secundine, the mucous, and white substance of the seed, being continued to the navel knot, forms a cavity.

All the roots becoming longer, put forth new branches out of their sides; the seed-leaf withers, and its vessels are emptied; the internodes, or spaces between the knots, grow longer; new germs appear, and the middle root grows several inches long. After a month, the roots and stalk being grown much longer, new buds break out at the first knot and little tumours bunch out, which at length break into roots.

Thus the plant is hurried in this short space of time, by *Malpighi*, through these various changes and mutations, which tho' real, and as sensible as he is pleased to represent them, are not accomplished with such celerity in all sorts of plants, nor even in a grain of wheat, which he takes for example; tho' in some sorts of plants all those variations happen in a shorter time.

The plant carried thus far, wants food for the preservation of its vegetable life, which being deprived of, it cannot subsist; of which the naturalists are so sensible, that their common opinion is, that *water* is the great vegetable food. Which they endeavour to confirm, by often-repeated experiments; especially by that made on a sprig of balm, mint, or the like plant; which being set in a phial of pure water, without any mixture of earth, grow, and put forth roots, leaves, and branches. But this *hypothesis* is rejected by others; who are advocates for the earthen soil, in which we plant or sow; for the following reasons. 1. There is not the least reason to suppose that the humidity, exclusively of all the other substances the earth is composed of, ascends up the vessels of the plant for its nutrition, since the fluid mass has no other power to direct itself to motion, but what it borrows from the saline particles it is impregnated with, of which once entirely divested, by evaporation, it remains an unactive, heavy, and dead mass; till by a new fermentation in the earth, or otherwise, it be impregnated a-new. 2. That it is not likely nature should make use of so heavy a vehicle for to supply the vegetable body with food, while the earth can furnish her with so many others, and so proper for the purpose; as are the oleaginous, sulphurous substances it is composed of, and which are so proper for exaltation, and which once put into a ferment, by its natural warmth, assisted therein by the heat of the sun, can penetrate the most compact pores of the *planets*, and unite themselves to the nutritive juices, between which and them there is so perfect an analogy. 3. That it is very likely that those particles and salts, in their sublimation, can carry along with them a sufficient quantity of the radical humidity, which is absolutely necessary to temperate the too great impetuosity of the juices in their circulation, but it is absurd to think that

the

the whole food of the vegetable body consists in that humidity; else the plant should be always in a cacochimous condition, as is evident from the various accidents of the animal body, wherein the *lympha* superabounds, is subject to. 4. Humidity is so far from being capable of the operations attributed to it, that when once admitted into the plant, it grows still more imbecile, in being divested by the circulation, or continual rotation of the nutritive juices, of the few elastick particles, it had brought into it, and remains at last like a kind of excrement, or *caput mortuum*, which the most volatile particles usher out, as far as the bark, where they leave it: and therefore, 5. It is not true, that the humidity, in its supposed emission from the plant, carries with it many parts of the same nature with those of the plant, through which it passes, since, as can be proved, that humidity has no elasticity; and, if it was even possible it could be emitted from the plant, divested as it must be then, of its saline particles, it could not enter into the composition of our atmosphere, but must fall of itself, as a dead weight. Those parts which Dr. Woodward observes deposited on the surface of the leaves, flowers, and other parts of the plants, which he is pleased to stile the grosser particles of the humidity, impregnated with particles of the same nature, whereof the plants consist, are nothing else but the oleaginous and sulphurous particles, which compose the atmosphere of the plant, and which overburdened with their own weight, as well as with that of the particles of the plant, they have gathered in their ingress and regress through it, rest themselves on the outer parts of the plant; and form our manna's, honey's, and other gummous exudations; which is far more probable than to say, that they consist of humid particles, impregnated with the parts of the plant, since most of those substances are subject to a liquefaction by heat. 6. If a greater quantity of odours is found exhaling from vegetables in humid weather than in any other, it is not because the air is impregnated with the humid particles, which have passed through the plant, but rather, by the sulphurous ones, which chiefly compose the atmosphere of the plants, and which strike more powerfully our organs of smell in humid seasons, than in any others; because then the atmosphere is more condensed and consequently nearer us than in another season.

Water, however, though it cannot be a vehicle to the vegetable matter, is, nevertheless, very beneficial to vegetation; since the aqueous particles, carried along with the vegetable ones into the plant, moderate the too great impetuosity of the nutritive juices, which, otherwise, by their continual motion, would become adust, and outwardly cool the

pores, which, by their friction with the saline particles in their ingress and egress through it, could by the condensation of the most sulphurous and viscous, be obstructed, and thereby the whole vegetable substance be deprived of its food. Therefore water is of the same use in this case, as in the refrigeratory of an alembick, *i. e.* by regulating the percolation of the nutritive juices, which otherwise would flow with too great an impetuosity thro' the organical vessels of the plants, hinder a too copious exaltation of the volatile salts they are impregnated with, which otherwise would cause a too great dissipation of them, and thereby prove very prejudicial to the whole plant.

All *Botanists* are of opinion that there is a certain analogy between plants and animals; since plants like animals are composed of certain parts, moved by a certain vegetative spirit, and are possessed of a greater *apparatus* of organs, for the performance of their vital functions.

Two things are to be carefully considered in plants, *viz.* the sensible and organick body; and the spirit or the subtil and vegetative body, which is the cause of the whole motion, and the principle of all vital functions.

Plants consist of several organical parts, subservient to this motion, *viz.* of a *root*, *trunk*, *branches*, *leaves*, &c.

The *Root* is the lower part of the plant, whereby it adheres to the earth, whence, by the gentle, inward heat of the earth, the vertical motion of the æthereal substance, and the fermentation, it receives its nutritive juices, which are carried upwards, for its preservation. Therefore the *root* must admit, into its composition, a great number of pores and ducts, through which the juices should ascend for the nutrition of the plant, since it cannot subsist without aliment; for though some plants have no branches, as wheat, or no fruits, as jessamin; they all nevertheless have *roots* to supply them with aliments. This aliment taken by the *root*, as by a mouth, is distributed through the open pores and ducts to all the parts of the plants. *Boerhaave* considers the *root* as composed of a number of absorbent vessels, analogous to the lacteal in animals, and *M. Reaumur* takes it to do the office of all the parts in the *abdomen*, which minister to nutrition; as the stomach, intestines, &c.

The marrow, bark, ligneous body, and the *trachea's* are parts in the *root*, which are equally distributed to the trunk, and to the branches; but, it is evident that, the marrow and the bark have the same origin; for in the lower part of the *root*, where the bark is thicker, there is little or no marrow; on the contrary, in its superior part, and

in the trunk, the bark is thinner, and the marrow in a greater abundance.

*Berhaave* observes, that the *root* may have any situation at pleasure, with respect to the body of the plant, nor needs to be either lowest or highest. Accordingly in the aloe, coral, mosses, fungusses, &c. the *root* is frequently uppermost, and its growth downwards,

*Roots* are divided by *Botanists* into *fibrous*, which send out only small strings from the bottom of the plant, distinct from each other. Such are those of most species of grass. Thick and gross, on account of their thick and gross body, either branched out into subdivisions, or else sending out fibres from it all along. These last are either *carnous*, which again are either broad and swelling, or long and slender, which are commonly harder and more woody.

Broad and swelling *roots* are either *bulbous*, which consist but of one globe or head, and send out fibres from the bottom; and are either *squamous* and scaly, as lilies, martagons, &c. *Coated*, which are involved in skins, or coats, as *cepa*, *hyacinthus*, *allium*, &c. *Tuberous*, which are of a carnosous, solid, and continued consistence; and these either, *simple*, with but one globe or head. as *rapa*, *crocus*, &c. *Manifold*; as *asphodelus*, *pæonia*, &c.

Long *roots* are either *sarmentous*, i. e. twiggy or branching, which shoot or creep out transverse, or in breadth; of these some are geniculated, knotty or jointy; as couch grass, mints, &c. *Cauliformes*, i. e. stemmy or stalky, which shoot down deep directly, though often sending out fibres and strings from the great stem; which, also, itself is sometimes divided or branching.

As to the *trunk*, called also, in trees, the *stem*, and which is that part between the ground and the place, where it divides into branches, is considered as the body of the plant, which transfers the humour it receives from the earth, through the *roots* to the superior parts. Outwardly, it is covered with bark, which is a skin to it; inwardly, it has marrow, which, commonly, is called the heart of a tree, except when very soft, and fungous. As in the *elder*. Between the marrow and the bark is placed what we call the *ligneous body*. And when several stems, and of the same equality rise from the same *roots*, they are called *shrubs* or *ferments*.

*Malpighi* in the anatomy of plants, distinguishes a double order of fibres, or parts in the trunk or stem. 1. There are fibres or small pipes collected into bundles, protracted lengthways; then between them in an almost horizontal manner is inserted a certain number of small buds or bunches, which are something like the insertions described by Dr. *Grew* in his anatomy of plants.

Besides these *fibres* and *buds*, *Malpighi* has also found in the trunk or stem, larger vessels disposed in form of *lamellæ*, or turned into a *spire*; but the parts they are composed of are so thin, that they might be depressed or dilated at pleasure; therefore he calls them *trachææ* and *spiral vessels*. For he imagines that plants have need of respiration, and that the air is carried with the juice not only thro' the ligneous fibres, but likewise throughout the spiral and spiratory vessels: and he maintains no corporeal substance can live, nor in the earth, nor in the water, without respiration.

The *vessels* are common, perhaps, to all sort of plants; but each kind has, besides its proper vessels, appropriated to carry some particular juice, or aliment, which are apparent in several, whether they be filled with turpentine, as the terebinth; or with milk, as in the lactiferous; or with rosin, or other liquor, which always seems more elaborate than that juice contained in the ligneous pipes or the buds.

The *marrow* is supposed to be of the same use in plants, as are the heart and brain in animals; and *Malpighi* believes that the transverse dispositions of *buds* are designed for the same use with the marrow itself; for he conjectures that there is a crude juice carried upwards through the ligneous fibres, which gradually falls into the *buds*, and the marrow, where by a longer stay, and the fermentation, it is elaborated and perfected, to be ready at hand for the nutrition of the young *buds* and *leaves* at their eruption.

The *branches* of a tree proceed from the trunk, as the members from the animal body; and are of the same nature with the trunk; for they are likewise covered with bark, have marrow, and a ligneous body. Often the branches, rise without order, and in confusion, from the trunk, as in the *elm*, *oak*, and others; and sometimes in an elegant order, as in the pitch and fir-trees. The branches which grow last, especially when the top is cut off, are called *scions*; and those, which grow from the *roots* of the tallest trees, unprofitable branches.

Lastly, Every body knows that the leaves, flowers, and seeds spring like new plants from the principal or master plant. The leaves themselves have also their caulicoles, in which the ligneous pipes produced from the trunk, and the branches are assembled together with the buds and *trachææ's*, and displayed in all the parts of the leaves to carry the nutritive juice.

From this dissertation we will proceed to the *oeconomy* or *use* of the parts of PLANTS, with respect to their nutrition and increase.

The *Peripatetics* and *Galenists* define the nutritive power, a faculty of the vegetative soul, by which it changes the aliment into its substance for its preservation. Hence its proper function is called nutrition, which is defined by them, a conversion of the aliment into the substance of what is fed.

We suppose that faculty to be nothing else but the vegetative soul, or the active substance, which being excited by the heat of the sun, as well as by that of the earth, causes a fermentation in the nutritive juice, or which, perhaps, being taken by the vertical motion of the æthereal substance, brings up through the pores of the *roots*, appropriated to that use, the vegetable matter into the trunk and branches, and which by a kind of circulation, returns again to the inferior parts. For the *roots* of the plants dispersed in the earth, produce certain filaments, and small tubes, through which the exhalations of the earth, or rather the vegetable substance, is forced, by the ambient atmosphere, into the master *roots*, whence it ascends through the ligneous fibres, as it is imagined, as far as the upper extremity of the plant. Then passes afterwards into the buds, whence after it has been elaborated, and fermented a-new, it is distributed to every part of the plant, for the nutrition and increase of the whole vegetable body; for it is impossible that a crude and undigested juice could nourish the plant; therefore when it ascends upwards, if it happens that some parts are more elaborated than others, they serve for the nutrition of the upper parts of the plant; and those which are superfluous, and more crude, after they have been prepared by a new coction, in the buds of the other parts of the plants, and even in the marrow, they return to the inferior for their nourishment likewise.

Therefore as the blood, in animals, flows thro' the arteries, from the heart to the extremities, and returns through the veins from the extremities to the heart; likewise the nutritive juice in plants ascends from the *roots* to the upper parts, and descends back again, from the top, or upper parts, to the *roots*. Which doctrine is not mere conjecture, since it is confirmed by a vast number of experiments.

Therefore they imagine that the air, as well that inclosed in the *trachæa's*, as that mixed in the ligneous fibres, in the nutritive juice, (whether that air exhaled from the earth ascends into the fibres and *trachæa's*, or is brought in through the pores of the bark, together with the nitrous spirits) while rarified, by the diurnal heat of the sun, accelerate the ascent of the nutritive juice. Whence we are to imagine a certain mechanical structure of the parts, in the ligneous pipes, which can facilitate the ascent of the juice, and render its descent diffi-

cult; whether some small fibres be placed so as to have a communication from the inferior part of the plant to the top; or whether we imagine some other disposition of the parts, which could supply the place of valvules in the veins of animals. Though it is inferred from a branch of a tree, planted upside down, shooting forth other branches, that there are no valvules in the ligneous pipes; but no body questions, at present, either the respiration, or the circulation of the nutritive juices in the plants. Therefore plants have their manner of respiration. Which I prove thus:

Those bodies have their manner of respiration, in which the air has its ingress and regress. That the air has its ingress into the plant, is evident, from what we have said already, that it being dilated by the heat of the sun, and mixed with the nutritive juice, it ascends the ligneous fibres of the plants, which it unfolds; and that being received into the *trachæa's*, it dilates them into a larger volume, that they might press the ligneous fibres, for the easier carrying upward the nutritive juice. Which air is expelled from the plant, by the contraction of the ligneous pipes, and spiral vessels; therefore plant; have their manner of respiration.

Likewise, there is a continual circulation of the nutritive juice through the whole substance of the plant; which is also proved in the following manner:

There is a continual circulation of the nutritive juice, if that juice, lifted up by the vertical motion of the æthereal substance, and by the impulsion of the air, is carried from the inferior parts of the plant to the superior, and brought back, through the buds from the superior to the inferior; which must be a true supposition, since,

1. Such circulation is common to all sorts of living bodies, which want aliment, as well for their nutrition, as to repair their exhausted substance. Since the parts of the living bodies can receive no nourishment till that portion of the aliment, which is well elaborated, be separated from what is crude and indigested, which must undergo another coction; whence the *roots* cannot receive any nourishment from the indigested juice, which they receive immediately from the earth: therefore a juice, far better elaborated, must be brought back to them from the superior part of the plant, for their nourishment.

2. Some trees die when they are divested of their leaves, as it happens to mulberry-trees, whose leaves are often torn off to feed silk-worms; which seems to proceed from the impossibility the nutritive juice is then in of being percolated in the leaves, and of being depurated from the crude particles, that when carried back to the *roots*, it might be a food for them.

3. If

3. If the vine be divested of its leaves during the summer, the grapes are never brought to maturity, because deprived of the juice which should have been elaborated in the leaves, and brought back to them for their aliment.

4. When the laceral plants are tyed in the middle of the stem, it swells above the *ligature*, which could not happen, was not the nutritive juice stopped by the *ligature*, in its descent from the upper parts of the plant to the roots.

5. A curious person selected once two carpine trees from a long row of the same, whose trunks adhered to one another; he took the pains to cut one of them cross-wise, with a saw, very near half a foot under the cohesion, and inserted a very smooth stone between the divided parts to stop all communication between them. The following year he found that small branches had budded between the cohesion and the section, which young branches must have received their aliment from the juice coming back from the upper parts of the tree, since they could be supplied from no where else.

Therefore it is plainly evident that the nutritive juice not only ascends from the roots to the upper parts of the plants, but likewise descends from the upper to the inferior parts; and consequently, that both the *nutritive* and *augmentative* faculties of the plants are contained in that motion. For the *augmentative faculty* is defined, in the schools; a faculty of the vegetative soul, whereby it lives, by taking inwardly the aliment, and by changing it into its substance, acquires its right form and proportions.

Though plants are almost all generated in the same manner, and all composed of the same organick and other parts, have all the same vegetable matter for their subsistence, &c. there is, nevertheless, the same difference between them, as there is between *animals*; since there is among them, as some imagine, a distinction both of *sex* and *species*: and they are not only distinguished with regard to their species, into *terrestrial*, *aquatick*, *amphibious*, *annual*, *bisannual*, and *perennial*; but likewise into *male* and *female*.

All plants, which bear no fruits or seeds and have only the organ of generation, are considered as *males*: and those, which bear fruit, as *females*.

But why should we make a distinction of sexes in the plants, to what end? Have they not the principle of generation within themselves, from that very moment the creator commanded the earth to bring forth grass, the herb yielding seed, and the fruit tree yielding fruit after its kind, whose seed is in itself upon the earth. Gen. i. 11. Is not this

better understood, and more agreeable to reason, than to have recourse to impossibilities for the generation of plants.

From this difficult point we'll proceed to the other distinction we have made of plants: into *terrestrial*, which are those that live only on land, as oak, beech, &c. *Aquatick*, which live either in rivers, as the *water-lily*, *water-plantain*, &c. or in the sea, as the *fucus*, *coral*, *coralline*, &c. *Amphibious*, which live indifferently either in land or water, as the *willow*, *alder*, *mint*, &c. *Annual*, which are those, whose *root* is formed and dies the same year, such are the leguminous plants, *wheat*, *rye*, &c. *Bisannuals*, which only produce flowers and seeds the second, or even third year after their being raised, and then die; such are *funnel*, *mint*, &c. *Perennial*, which never die after they have once born seed. Of those, some are ever-greens, as the *asarabacca*, *violet*, &c. others loose their leaves one part of the year, as *fern*, *coltsfoot*, &c. Note, That this distinction is not made with regard to their species, but only to their age and period.

Plants are also distinguished, with regard to their magnitude, into trees, shrubs, and herbs. *Trees*, are the *oak*, *pine*, *fir*, *elm*, *sycamore*, &c. *Shrubs*, are the *holly*, *box*, *ivy*, *juniper*, &c. And *herbs*, are *mint*, *sage*, *sorrel*, *thyme*, &c.

Mr. Ray distinguishes the trees and shrubs of *English* growth into *nuciferous trees*, which are those, which have their flower disjointed and remote from the fruit, or bear nuts; as the *walnut-tree*, the *hazle-nut-tree*, the *beech*, the *chestnut*, and the common *oak*. *Coniferous*, or such as bear a squamous or scaly fruit, of a conical figure, and a woody or hard substance, in which are many seeds; which, when they are ripe, the cone opens or gapes in all its several cells or partitions, and lets them drop out. Of this kind are the *Scotch firs*, male and female; the *pine* which in our gardens is called the *Scotch fir*, the common *alder-tree* and the *birch-tree*. *Bacciferous*, or such as bear berries, *i. e.* fruit covered with a thin membrane, wherein is contained a pulp, which grows soft, and moist when ripe, and encloses the seed within its substance, which trees Mr. Ray divides into four kinds. 1. Such as bear a caliculate, or naked berry; the flower and calx both falling off together, and leaving the berry bare, as the *sassafras-tree*. 2. Such as have a monopynereous fruit, that is, containing in it only one seed, as the *arbutus*, *terebinthus*, *lentiscus*, &c. 3. Such as have a naked but polypynereous fruit, that is, containing two or more kernels or seeds within it, as the *jasmine*, *ligustrum*, &c. 4. Such as have their fruit composed of many *acini*, or round soft balls

balls set close together like a bunch of grapes, as the *uva marina*, *rubus vulgaris*, *rubusidæus*, and the *rubus minor fructu cæruleo*.

There are also *lanigerous trees*, or such as bear a woolly, downy substance; as the black, white, and trembling poplar, willows, and osiers of all kinds. *Trees* that bear their seeds (having an imperfect flower) in leafy membranes and cases, as the hornbeam, or hardbeam, called in some places the hornbeech. Such as have their fruits and flowers contiguous, which are either with the flower placed on the top of the fruit, or adhering to the base or bottom of the fruit. Of the former kind, some are pomiferous, as apples and pears; and some bacciferous, as the forb, or service-tree, the white, or hawthorn, the wild rose, sweet-briar, currants, the great bilberry-bush, honey-suckle, ivy, &c. The latter kind are either such as have their fruit soft, and moist, when ripe; as, 1. *Pruiferous* ones, whose fruit is pretty large and soft, with a stone in the middle, as the black-thorn, or sloe-tree, the black and white bullace-tree, the common wild cherry, the black cherry, &c. 2. *Bacciferous trees*, as the strawberry-tree in the west of Ireland, mistletoe, water elder, the dwarf or large laurel, the *viburnum*, or way-faring tree, the dog-berry-tree, the sea black-thorn, the berry-bearing elder, the privet, barberry, common bramble, and the spindle-tree, or prick-wood.

Also such as have their fruit dry, when ripe; as the bladder nut tree, the box-tree, the common elm, and ash, the maple, the gale, or sweet-willow, common heath-broom, dyer's weed, furze, or gorse, and lime-tree.

*Shrubs*, are nothing else but little, low dwarf-trees, or woody plants, of a size less than a tree; and which, besides their principal stems and branches, frequently from the same root put forth several other considerable sets, or stems. Such are the privet, phyllirea, holly, box, honey-suckle, &c. *Shrubs* are distinguished, by some, from *sufcutices*, or *under shrubs*, which are low bushes, that do not put forth in autumn, like *trees* and *shrubs*, a kind of buttons, or gems, in the axis of the leaves; such are lavender, rue, sage, &c.

*Botanists* divide, likewise, the vegetable world into *genera* and *species*; though they do not all agree upon, from what consideration the division into *Genera* is best taken. *Tournefort*, one of the latest and best writers, after a long and accurate discussion, has chose, in imitation of *Gesner* and *Columna*, to regulate them by the flowers and fruit considered together; so that all plants, which bear a resemblance in those two respects, are of the same *genus*, (i. e. that they all agree in some one common character, in respect of the structure of cer-

tain parts, whereby they are distinguished from all other plants) after which, the respective differences, as to root, stem, or leaves, make the different species or subdivisions. He pretends, contrary to Mr. *Ray's* opinion, that he has never hitherto met but with fourteen different figures of flowers, which are to regulate entirely the *genus* or class of plants, and which is all that is to be retained in the memory, to be capable to descend to six hundred and seventy three *genera*, which comprehend 8846 species of plants; which is the number of those yet known by land and sea.

Since M. *Tournefort* is of opinion that the different figures of flowers are to regulate entirely the *genera*, or classes of plants; it will not be improper to examine, in this place, and previously to the distinction of plants made by Mr. *Ray*, not only those different figures of flowers, but also inform ourselves, in a more particular manner than we have done yet, of the structure of those flowers, and first of the definition of flowers.

FLOWER, is defined, by *Botanists*, that part of a plant which contains the organs of *generation*, or the parts necessary for the propagation of the kind.

Doctor *Grew* divides the *flower* into three parts, which are the *empalement*, *foliation*, and *attire*.

He calls *empalement*, or *calix*, the outer part of the *flower*, that environs the two others, which is either of a whole piece, or continued; as in pinks and carnations; or divided into several, as in roses. When divided, it resembles small *Leonies*, as it appears in the *flowers* of the quince-tree, or of primroses. The *calix* of *flowers*, is composed of the same essential parts which form the plant, viz. of the skin, or *cortex*, *parenchyma*, and *ligneous* body; as is evident in the *artichoke*, which is but a *flower*, of which, what is vulgarly called the *leaves*, is the *empalement*, or *calix*. It even appears that the skin which covers those *leaves* is all of a piece, from the inner, which are lesser, to the outer *leaves*, which are the greater; so that what we take to be different *leaves*, is only the same *empalement*, or *calix*, which has several *plis*.

The use of the *calix* is, to support and cover the other parts of the flowers; it covers them while they are yet in buds, and thereby defends them against the injuries of an excessive cold, or of an extreme heat; and supports them in such a manner, as to keep them always in the most advantageous situation. It is for this reason that *calices*, are different, or more or less strong, according to the diversity of flowers. There are some flowers, which have no *calix*, as tulips; because their leaves being thick and strong, and each resting on its proper basis, they want no *calix* for their support. On the

contrary, carnations and pinks have a *calix*, which, to be stronger, is all of a piece; otherwise their leaves, whose foot is very long and slim, would part from each other, and deviate from their natural situation, or place. This *calix* is *dentated* a-top, that it may the easier shut and cover the leaves, while yet too tender; and afterwards open, and spread itself a little under the same leaves, to support them, when the flower is entirely blown. Lastly, There are flowers, whose leaves being very long, and very tender, have *calices* compos'd of several pieces, the one placed above the other, almost like the scales of a fish, being thereby more proper to support and preserve those flowers; as is plainly seen in *jacees*, and other like flowers.

The leaves of the flower are also compos'd of the same essential parts with the green leaves; for their membranes, pulps, and fibres, are nothing else but the skin, *parenchyma*, and *ligneous* body, which have spread to form them.

Mr. Ray divides *flowers* into *perfect* and *imperfect*, and subdivides the *perfect* (which, in his opinion, are all those which have the *petala*, though they want the *stamina*) into *simple* and *compound*. The *simple* are those which are not compos'd of other small ones, and, usually, have but one single style; and the *compound* have many *fosculi*, all making but one *flower*.

*Single flowers* are either *monopetalous*, or *polypetalous*. The *monopetalous* have the body of the flower all of an entire leaf, though sometimes cut, or divided a little way, into many seeming *petala's*,\* or *leaves*; as in burrage, bugloss, &c. The *polypetalous* are those which have distinct *petala*, and those falling off singly, and not altogether; as the seeming *petala* of the *monopetalous flowers* always do.

Both these are further divided into *uniform* and *difform flowers*. The *uniform* have their right and left hand parts, and the forward and backward parts, all alike. But the *difform* have no such regularity; as in the *flowers* of sage, dead nettle, &c.

*Monopetalous difform flowers* are, likewise, further divided into *semi-fistular*, *labiate*, and *corniculate flowers*. The *semi fistular flowers* are those whose upper parts resemble a pipe cut off obliquely; as in the *aristolochia*. The *labiate*, those either with one lip only, as in the *acanthium* and *scordium*; or with two lips, as in the far greater part of the *labiate flowers*. And here the upper lip is sometimes turned upwards, and so turns the convex part downward; as in the *chamæcissus*, &c. but most usually the upper lip is convex above, and turns the hol-

low part down to its fellow below, and so represents a kind of helmet, or monk's hood; such are the *flowers* of the *lamium*, and most *verticillate plants*. Sometimes, also, the *labium* is entire; and sometimes jagged and divided. The *corniculate* are those hollow *flowers*, which have on their upper part a kind of spur, or little horn; as in the *linaria*, *Delphinum*, &c. and the *corniculum*, or *calcar*, is always impervious at the tip, or point.

*Compound flowers*, are either *discous*, *planifolious*, or *fistular*. The *discous*, or *discoidal*, are those whose *fosculi* are set together so close, thick, and even, as to make the surface of the *flower* plain and flat; which therefore, because of its round form, will be like a *discus*, which is sometimes radiated, when there is a row of *petala* standing round in the disk, like the points of a star; as in the *matricaria*, *chamæmelum*, &c. and sometimes naked, having no such radiating leaves round the limb of its disk; as in the *tanacetum*. The *planifolious* are those compos'd of plain *flowers*, set together in circular rows round the center, and whose face is usually indented, notched, uneven, and jagged; as the *hierachia*, *sonchi*, &c. The *fistular* are those, which are compos'd of many long hollow, little *flowers*, like pipes, all divided into large jags at the ends.

*Imperfect flowers* are such as want the *petala*, and are called, likewise, *stamineous*, *apetalous*, and *capillaceous flowers*. Tournefort calls *amentacious* those *flowers* which hang pendulously by fine threads, like the *juli*; we call them *cat's-tails*.

The other divisions of *flowers* are into *campaniform*, *cruciform*, *infundibuliform*, *cucurbitaceous*, *stamineous*, *leguminous*, *papilionaceous*, *umbelliform*, and *verticillate flowers*. The *campaniform* are those in shape of a bell. *Cruciform*, those consisting of four *petala*, or *leaves*, the *calix*, also, containing four *leaves*; and the pistil always producing a fruit: such as those of the clove-tree, cabbage tree, &c. *Infundibuliform*, are such as resemble the figure of a funnel, *i. e.* are broad and ample a-top, and contracted into a neck at bottom: such is that of the *auricula*. *Cucurbitaceous* are such as resemble the *flower* of the gourd, or have the same conformation therewith. *Stamineous* are such as have no *petala*, but consist wholly of *stamina* or threads, with *apices* a top. The *leaves* placed round the *stamina*, are not to be esteemed as *petala*, but a *calix*, in regard they afterwards become a *capsula*, or cover, including the seed; which is the office of the *calix* alone. The *leguminous* are those of *leguminous plants*; they bear some resemblance to a flying butterfly;

\* PETALA are the coloured leaves of a flower.

terfly; for which reason they are also called *papilionaceous*, which consist of four or five *leaves*, whereof the uppermost is called  *vexillum*, or standard; and the lowest *carina*, as resembling the bottom, or keel of a boat. Those between the two are called *lateral leaves*, or *alee*; from the bottom of the *calix* arises a pistil, which is encompassed with a sheath, or cover, fringed with *stamina*; this pistil always becomes the fruit, and is usually called the pod, in *Latin siliqua*. *Umbelliform*, are those with several *leaves* double, and disposed in manner of a rose, and whose *calix* essentially becomes a fruit of two *seeds*, joined before they come to maturity; but afterwards easily separated again. They are thus called, because they are usually sustained by a number of threads, which proceeding from the same center, are branched all round like the sticks of an *umbrello*; of this kind are the *flowers* of *fennel*, *angelica*, &c. And the *verticillate* are those ranged, as it were, in stories, rings, or rays, along the stems; such are those of the horehound, clary, &c.

From the *flowers* we'll pass to the *fruits*, which are composed of the same essential parts described already in the other parts of the plants; that is to say, of the *skins*, or membranes; of the *pulps*, or *parenchyma*; and of the *fibres*, or *ligneous body*. The most common, and principal, to which all others might be reduced are *apples*, *pears*, *prunes*, and *blackberries*.

*Apples* are composed of four parts, which are the *skin*, the *pulp*, the *fibres*, and the *capsule*, which contain the *seed*. The *skin* is a continuation of that of the branch extended as far as the *fruit*. The *pulp* is likewise nothing but the *parenchyma* of the tree, which extends itself and swells, which appears manifestly, when we examine an apple, yet very small, and newly formed; and that pulp, hard, and of a coarse juice, at first, becomes, in process of time, tender, delicate, and grateful to the taste, the same as the marrow, which is commonly pretty hard, and of an acerb taste, becomes tender and sweet in some roots, as in parsnips, turnips, carrots, and others.

The *fibres* are but the *ramifications* of the *ligneous body*, which penetrate the *parenchyma*, and whose bigger joins together, as in the *leaves*, by the interwaving of the smaller. There are commonly in apples fifteen large *fibres*, ten of which are distributed throughout the whole substance of the pulp, and at last join together towards the *umbilic*, or the eye of the apple; and the five others pass in a right line through the *pedicle*, as far as the said eye of the apple, where meeting with the first ten, they mix, and unite with them: these last five

have their origin from a single one, which having extended itself all along the center of the *pedicle*, and even in one part of the pulp, is divided, at last, into five branches, to which are tyed the *kernels* of the apple. Therefore though originally those *fibres* cross in a right line the whole pulp of the *fruit*, and penetrate as far as to the *flower*, to which they carry the sap which makes it grow; nevertheless, in process of time, the *fruit*, which grows bigger, drawing to itself all the juice which passes in those *fibres*, the *flower* withers, and falls, and those five *fibres* are no longer of use, but to the *fruit*. Whence it may be concluded, that of the fifteen large *fibres* discernible in the apple, ten serve to carry the sap into the pulp, or *parenchyma*; and five are destined for the nutrition of the *kernels* or *seed*.

The *capsula* proceeds from the marrow; for as soon as the pulp begins to grow big, the juice, finding room enough, enters into it, and quits the marrow, which withers, and thus forms the *capsula*.

*Pears* are composed of five parts, which are the *skin*, or *cortex*, *parenchyma*, ramification, stone, and *acetarium*. The three first are very near like those of *apples*, with this single difference, that the *fibres*, which run in a right line in the *pear*, and serve for the nutrition of the *kernels*, are in greater number; for commonly there are found ten.

The *Stone* observ'd chiefly in choaky pears, is not an essential and vital part like the others, but is only a congeries of stony corpuscles, dispers'd throughout all the whole *parenchyma*, but in the greatest plenty, and closest together, about the center, or *acetarium*. It is form'd of the stony, or calculous parts of the nutritious juice of the *parenchyma* extravasated in masses.

The *Acetarium* is a substance of a tart, acid taste, of a globular figure, inclos'd in an assemblage of several of the stony parts above-mention'd. 'Tis of the same substance with the *parenchyma* and the marrow, though 'tis almost impossible to determine from which of those two parts it proceeds immediately.

As for the origin of the *stone*, the various stony corpuscles 'tis compos'd of are nothing else but several parts of the juice, indurated, and coagulated, by precipitation, like those we see often in the *sediment of urine*, in *wine-casks*, &c.

In the plumb, cherry, &c. there are four parts, *viz.* a coat, *parenchyma*, ramification, and stone, or *nucleus*. The coat, *parenchyma*, and *fibres*, have the same origin, and are form'd in the same manner, as in apples and pears; but the *fibres* have a different disposition. There are in all sorts of plumbs five large *fibres* extended over the surface of

the stone, from the base to the point; four on one side, and one on the other. The same number is found in apricots, with this difference, that the *fibres* which is single on one side, is not extended on the surface of the stone as in plumbs, but penetrate into the stone. On the other side there are likewise found between the four large *fibres* heretofore mention'd, two or three small *fibres*, which, after having, like the others, a little extended themselves on the surface of the stone, penetrate into the pulp, and are dispers'd therein. Lastly, there are in all the parts of *peaches* a very great number of these small *fibres*.

But notwithstanding the different disposition of these *fibres*, observ'd in the *fruits* here mention'd, that which is single is dispos'd in the same manner in all, *i. e.* that it enters the stone, at the base, and after it has extended itself in the very substance of the stone, it enters the middle cavity, through the point, where the *kernel* is suspended by its *envelope*.

The stone is a compos'd body, though at first it appears simple. Its inner part is the thinnest, and is also whiter, denser, and more polish'd than the rest. It derives from the *medulla*, and the manner 'tis form'd is very curious, but not easily observ'd. For as the *fibres* of the *seed* does not penetrate it directly through the base, but only through the point, it carries along with it a considerable part of the *medulla*, which gathers round it, and forms a kind of *parenchyma*; so that penetrating into the cavity of the stone through the point, that *medulla*, or *parenchyma*, which surrounds it, enters likewise, and being there coagulated forms in the whole extent of that cavity a kind, of white lining, hard, and polish'd.

The external part of the stone, which is the thickest, is compos'd of several parts, which are precipitated and coagulated, as in pears; with this difference only, that in plumbs, and other such *fruits*, the precipitated parts are still nearer to one another, and are not only contiguous, but form, likewise, a continu'd stone, and all of a piece. It is so very true that the *stones* are form'd thus, that even in pears the *stone* is the same, especially toward the eye of the pear; and it is also in the same manner that in animals some parts of the *urine*, which are precipitated, form a gravel, and afterwards stones. But we must observe, that as in the stones of pears there is a *parenchyma* mix'd with the stony corpuscles; there is one, likewise, in the stones of plumbs, mix'd with the precipitated and coagulated parts. 'Tis true, that the stone being form'd, those parts are not so easily distinguish'd; but, notwithstanding, the foundation of all stones is nothing else but a perfect *parenchyma*, which by those precipitations

and coagulations, which gather round it, suffers such alteration, as to become dry and hard; so that it is impossible to distinguish it from those parts, which are coagulated.

The *nut*, analogous to which is the *acorn*, consists of a shell, *cortex*, and *medulla*. The Shell consists of a coat and *parenchyma*, deriv'd from the bark and wood of the *tree*. The *cortex* is also a body compos'd of several different substances; its surface is a duplicature of the inner tunick of the shell, which, towards the base, folds itself, and extends on the *cortex*, which it covers almost entirely; of which we are easily convinc'd, when we examine it. For we see then that the base of the *cortex* is continu'd with the *parenchyma* of the coat, from which it is not separated by the skin. Whence it ensues, that the superficial part, which covers almost the whole *cortex*, and which is but a continuation of the skin of the coat, is not found in the base, whereby the *cortex* and coat are join'd. The inner part of the *cortex*, which is the thickest, is not a *parenchyma* semblable to the coat, but mix'd with several precipitated and coagulated parts; as in the stones I have describ'd already, and are even intermixed with several *fibres*, or branches of the *lignous* body; with this difference, that in the *cortex* the *external fibres*, which are not appointed to nourish the *seed* or *kernel*, are in a considerable number, coming from the *parenchyma* of the coat, to enter into the *cortex* through the base, are separated in round like the threads of a puff, and thus extend themselves on the *circumference* of the *cortex*, as far as the point, between the skin and the inner part of that *cortex*, which is nothing else but a coagulated *parenchyma*. As for the *inner fibre*, which serves to nourish the *seed*, 'tis always single, and coming from the *coat* between the two others, it enters through the base of the *cortex*, and is not extended in the body of that *cortex*, as in the body of the stones of plumbs, to go and unite itself to the *kernel* by the point, but passes directly through the *center* of the base, into the *medulla*, which it penetrates and runs throughout its whole length, as far as the point of the *cortex*, to which the skin of the *kernel*, or *seed*, adheres. But whether the *medulla*, or pulp of the *kernel*, arises from the pith of the *tree*, or the cortical part of the *fruit*, is not agreed.

*Berries*, as *Grapes*, &c. are compos'd of three parts, besides grains of a stony nature, *viz.* the coat, *parenchyma*, and *fibres*.

The origin of the coat is the same, as in the other *fruits* heretofore mention'd; but there are found in these, two sorts of *parenchyma*: the first, call'd *external parenchyma*, is adherent to the coat; and as it is of an extreme acidity, 'tis commonly spit

spit out, when those *fruits* are eaten. It derives from the *parenchyma* of the *cortex* of the branch: and the pores of both, as well as of the *medulla*, are visibly dispos'd in the same manner. The other, call'd the *inner parenchyma*, is that which is commonly eaten; its taste is so grateful, and itself so tender and delicate, that it seems but as a thicken'd juice, though it be a true *parenchyma*, whose pores are very large, and full of liquor, like those of oranges and lemons.

There are also in these *fruits*, like in the others, two sorts of *fibres*. The *external* ones are extended in curve lines, between the coat and *external parenchyma*, from the *pedicle* to the base of the flower; and though they be not always in the same number towards the *pedicle*; however, there are ten found towards the base of the flower; five of which serve to the five leaves of the flower, and the five others to the leaves of the *calyx*. As for the inner fibres two are commonly found diametrically opposite to each other, which, towards the base of the flower, are mixed with those already mentioned, and being divided afterwards into several smaller, each of these small *fibres* has a grain tied to it, into whose coat it enters by two filaments, one whereof answers to the base, and the other to the point of the grain. Those *fibres* are all white and big enough for us to see easily; when cut obliquely, they are hollow, and true spermatick vessels, since they have very near the same figure, and the same use as those of animals.

From the *flowers*, and *fruits* of plants, I'll proceed to the distribution of plants by Mr. Ray, into twenty-five *genera*, or classes, under the following denominations (see the PLATE OF BOTANY.)

The first class contains *imperfect* plants, such as appear to want the flower and seed, as *corals*, *sponges*, *truffles*, *moss*. The second produce plants of an imperfect flower, and whose seed is too small to be discerned by the naked eye; such are *fern*, *polypody*, &c. The 3d, those whose flowers want *petala*, as *hops*, *hemp*, *nettles*, *docks*, &c. 4th, Those with a compound flower, and which emit a milky juice, when cut, or broke, as *lettuce*, *dandelion*, *succory*, &c. 5th, Those of a compound

flower of a discous form, and whose seed is winged\* with down, as *coltsfoot*, *sea-bane*, &c. The 6th contains *herbæ capitatae*, or those whose flower is composed of long fistulous flowers gathered into a round head, and covered with a scaly coat, as the *thistle*, *great burdock*, *blue bottle*, &c. 7th, *Corymbiferous* † plants, with a discous flower, but no down, as the *daisy*, *yarrow*, *corn-marygold*, &c. The 8th contains plants with a perfect flower, but only one seed to each flower, as *valerian*, *agrimony*, *brunet*, &c. 9th, *Umbelliferous*, or those of five *petala*, spread out like an *umbrella*, and two seeds to each flower. This is a very large genus of plants, which are distinguished by the same author into seven species, viz. those with a broad flat seed, like a leaf, as wild garden *parsnips*; with a longish and larger seed swelling in the middle, as *cow-weed*, and *wild chervil*; with a shorter seed, as *angelica*; with the tuberous root, as the *earth nut*; with a small strait seed, as *caraways*, *saxifrage*, and *brunet*; with a rough hairy seed, as *parsly* and *wild carrot*; with entire leaves subdivided into *jags*, as *sanicle*, and *thorough-wax*. The 10th contains *stellate* plants, whose leaves grow round the stalks at certain intervals in form of stars, as *mug-weed*, *wild madder*, *cross-wort*, *mollugo*, *asperula*, or *wood-ruff*, *gallium*, or *ladies bed straw*, *aparine*, or *cleavers*, *rubia tinctorum*, or *dyer's madder*; to which may be added, as a-kin to this genus, the *nasturtium indicum*, *indian cress*, or *yellow larkspur*. The 11th, *rough-leav'd* plants, which have their leaves placed alternately, or in no certain order along the stalks, as *hound's-tongue*, *mouse-ear*, &c. 12th, *Suffrutices*, or *verticillate* plants, whose leaves grow by pairs on their stalks, one leaf right against another, the flower being monopetalous, and usually in form of a helmet. The same author makes two species of these *verticillate* plants. 1. The *fruticosa*, of such whose superficies is perennial; these again have either a plain flower, as the *chamaedrys vulgaris*, *thuerium*, and the *marum sylvaticum*, or a flower with a lip, called *labiated flower*; or one something in the form of a helmet, called *galeated*, as the *sacra strachos*, *hyssopus*, *rosmarinus*, *satureia*, *marum vulgare*, *thymum vulgare*, and the *polium montanum*. 2. The *herbaceæ*, or such whose,

\* Winged seed are such as have down or hairs on them, whereby the wind taking hold, blows them to a distance.

† *Corymbus*, among the antient *botanists*, was particularly used to express the bunches, or clusters of ivy-berries. Some also call the top of the stalk of a plant, when so subdivided, and adorned with flowers, or fruits, as to make a round spherical figure, by this name; as the tops of *leeks*, *onions*, and the like; and others confound the word with *umbrella*, which expresses the flowery tops of such plants as have their branches and flowers spread round, into the form of an *umbrella*. But among the modern *botanists*, *corymbus* is chiefly used for a compound discous flower, whose seeds are not pappous, i. e. do not fly away in down, nor blown any where about with the wind.

stalks are not perennial; these are the *mentha*, *verbera*, *dictamnus*, *creticus*, *origanum*, *majorana*, *ocimum*, *herminum galeopsis*, *nepeta*, *betonica*, *prunella*, *stachys*, *clinspodium vulgare*, *lanium*, *molucca*, *hedra terrestris*, *galericulata*, *calamintha*, *melissa*, *mar-rubium commune*, *nigrum*, & *aquaticum*, *chamaepitys*, *scarodonia*, *scordium*, *bugula*, *syderitis*, *cardiaca*.

The 13th contains the *poly spermous* plants, which are those, which have more than four seeds succeeding each flower, without any certain order or number. These are also subdivided into.

1. Such as have a *calyx* or *perianthium*, consisting either, first of three leaves, and the flower *tripetalous*, as *plantana aquatica*, and the *sagittaria*, both water-plants, or the flower *poly petalous*, and the *calyx* falling with it, as the *chelidonium minus*; or remaining after the flower is dropped, as in the *hepat'ca mobilis*. Secondly, Of five leaves, in some deciduous with the flower, as in the *ranunculus*; in others *perennial*, as in the *belleborus niger ferulaceus*; or *annual*, as in the *flos adonis*. Thirdly, of eight leaves, as the *malva* and *alcea*. Fourthly, of ten leaves, as the *caryophylla*, *fragaria*, *pentaphyllum*, *tormentilla*, *argentina*, *althæa*, and *pentaphylloide*.

2. Such as have no *calyx*, or *perianthium*, as the *clematitis*, *filipendula*, *ubnæria*, *anemone-nemorum*, *pulsatilla*, &c.

In the fourteenth, are the *bacciferous* plants, or such as bear berries, as *briony*, *honey-suckle*, *solomon-seal*, *lily of the valley*, *nightshade*, *asparagus*, &c. The 15th contains the *multifiliquous*, or *corniculate* plants, which after each flower, produce several long, slender *siliquæ*, or cases, wherein their seed is contained, as *orpins*, *navel-wort*, *bears-foot*, *columbines*, &c. The 16th, *vasculiferous* plants, with a *monopetalous* flower, and which after each flower have a vessel besides the *calyx*, containing the seed; which is sometimes divided into cells. They have their *monopetalous* flower, either uniform, or difform. The former have all their seeds divided, 1. Into two partitions, as the *hyoscyamus*, *incotiana*, *priapeia*, and the *gentiana*. 2. Into three partitions, as the *convolvulus*, *speculum veneris*, *trachelium*, *repunculus*, or *campanula*, *repunculus corniculatus*, &c. 3. Into four partitions, as the *stramonium*. Those of the latter kind, which have a difform *monopetalous* flower, as the *linaria pinguicula*, *antirrhinum*, *aristolochia*, *serophu'aria*, *digitalis*, *pedicularis*, *matampyræum*, *euphrasia*, &c. Mr. Ray makes three classes of this *vasculiferous* plants, which I have reduced here into one; and therefore proceed to the 20th, which contains the *leguminous* plants, or such as bear pulse, with a *papilionaceous* flower, consisting of four parts, joined at the edges, as *pease*, *beans*, *vetches*, *tars*, *lentil*, *liquorice*, *trefoil*, &c. The 21st, plants with a true *bulbous* root, as

*garlick*, *daffodil*, *hyacinth*, *saffron*, &c. The 22 those whose roots approached nearly to the *bulbous* form, as *flower-de-lis*, *cuckow-pint*, *bastard bellebore*, &c. The 23d, *culmiferous* plants, with a grassy leaf, and an imperfect flower, having a smooth, hollow-jointed stalk, with a long, sharp-pointed leaf at each joint, and the seeds contained in a chaffy husk, as *wheat*, *barley*, *rye*, *oats*, and most kinds of *grass*. The 24th, plants with a grassy leaf, but not *culmiferous*, with an imperfect or staminate flower, as *rushes*, *cats-tail*, &c. And in the 25th are contained plants, whose place of growth is uncertain, chiefly *water-plants*, as the *water-lily*, *milk-wort*, *mouse-tail*, &c.

Before we attempt to enumerate, to make the *analysis*, and discover the virtues of the plants, contained in the several classes, or *genera* above-mentioned, which M. *Tournefort* reduces to fourteen, as less burthensome to the memory, it is proper to define certain *terms*, which are to be used in the sequel, and inform the reader of the rule observed in the discovery of these several things.

By the chemical *analysis* of plants is understood, the separation of their principles, by fire and convenient vessels, to effect which, fresh plants are distilled in alembicks, in *balneo marie*; or else before they are distilled, they are put into fermentation or digestion for some time, according to the nature of the plants, and the designs of the artist. The substances extracted from them are to be divided into portions, of five or six ounces each. That their respective character may be examined separately; by that means are extracted their *flegma*, *spirituous water*, or *ardent spirit* of plants. When the distillation is ended, the grounds left are put into a *cornue*, whence by a graduate fire, are extracted from almost all plants an *urinous spirit*, a *concrete volatile salt*, and a *fetid oil*. From the *caput mortuum* lixiviated, is separated by filtration and evaporation, the salt which was mixed with the earth. Without this operation it would be impossible to discover which sort of salts are contained in plants, and which salt is predominant; which must be necessarily known to discover the virtues of plants, and before they can be employed with any appearance of success in medicine.

To proceed with some order in that discovery, we must previously know what's understood by the different salts found in plants, since they all contain some of those salts, more or less; therefore,

1. By *alkaly* and *acid salt*, are understood those two sorts of salts, to which our modern physicians and chemists have given those names; and which are easier understood than defined.

2. By *essential salt* is understood that formed by the crystallisation of the juice of plants.

3. By

3. By *volatile salt* is understood the salt, which by the distillation through the *cornue*, adheres at the top of the vessel.

4. By the *fixed or fixt salt*, is understood the salt extracted by elixivation, from the ashes of burnt plants, or from the *caput mortuum*, of those which are analysed.

This, 'tis true, informs us of the difference of those several salts; but how shall we know if they are all contained in the plant, or only in part; or which is the predominant? By the following means.

1. The *acid salt* is discovered, by being mixed with salt of *tartar*, or spirit of *sal armoniack*, or like matters, with which acids ferment commonly. The acids are also discovered by the blue paper, which they change red by degrees, from a very pale red to a very high one.

2. The spirit of *nitre*, of salt, of sulphur, of *vitriol*, and other acids, are employed with success, to discover the *salt alkaly*; for those acids ferment with the *alkaly*.

3. As the *sal-armoniack* is easily discovered, by its urinous volatile salt, *Botanists* and chemists make use of the oil of *tartar* to discover if there is any armoniack salt in plants, for then they exhale an urinous spirit; like to that exhaled from urine, or the armoniack salt itself.

4. As the character of *nitre* is discovered by *detonation*, 'tis thought, that the surest expedient to know nitrous substances, is by throwing them upon burning coals.

5. Every body knows that the chief quality of *vitriol* is to turn black the infusion of galls, therefore the matters under examination are to be mixed with that infusion.

6. To know if there is any sulphur in some matter, that matter must be put into digestion, in a very strong spirit of wine. If the same matter burn easily, 'tis a certain sign that they contain abundance of sulphurous particles. The *elaterium*, when dry, burns at the candle, and the *sedum majus vulgare* of *C. B. binus*, does not burn, therefore the former contains a sulphurous matter, not to be met with in the latter oleaginous substances, when mixed, makes a lather when with oil of tartar.

We'll proceed now to the enumeration of the plants, and to the discovery of their several qualities and virtues, in an alphabetical order, contenting ourselves with the description of a few, which are better known, and more useful.

*ALTHEA*, (see the plate,) *Marsh-mallow*. *Morison* and Mr. *Ray* have taken the flower of this plant to be of five leaves, though M. *Tournefort* says, that it is all of a piece. The leaves of *marsh-mallows* are glutinous, insipid, and do not change the blue paper. The roots have the same taste, but

change a little the blue paper. The glutinous juice of this plant appears to be a mixture of a great deal of phlegm, of a considerable portion of earth, acid, and sulphur.

All authors agree that this plant sweetens the blood, and is *emollient*. It not only blunts the corrosive salts, but likewise softens the fibres, when too much strain'd, and restores them to their natural motion, and thereby appeases pain. In diet-drinks, or *ptisans*, they are an excellent remedy for a violent cough; and in the *nephritick* for the retention of urine, attended with inflammation. 'Tis also administer'd, for the same maladies, in syrups, tablettes, or lozenges; in lochoch, in clysters for the inflammations of the abdomen; in *unguentum* for the sciatick and rheumatism; to resolve tumours with inflammation; in poultices with milk, to bring those tumours to suppuration when the matter is dispos'd for it, &c.

*AGRIMONIA*, *Agrimony*, is of a stiptick taste, a little salt, and mix'd with some acrimony, and changes blue paper a little; which makes one believe that it contains a salt which approaches very near the vitriolated tartar, or the salt of coral made with spirit of *verdigrise*. This salt in *agrimony* is mix'd with a great deal of sulphur, and with much earth; therefore 'tis *astringent*, *deterfive*, *vulnerary*, and *aperitive*. *Agrimony* is very good in chronick maladies; for it absorbs and incises the thicken'd *lymph* which occasions them. 'Tis us'd in diet-drinks, decoctions, and in aperitive, cooling, and vulnerary draughts, or juleps. This is of a very great succour in the spitting of blood, in the bloody flux, and in the inflammation of the liver. Apply'd externally, it is vulnerary, and proper to resolve the tumours of the *scrotum*, or purse; and of all other parts where there is inflammation. *Targus* assures us, it is boiled in lees of wine, with bran of wheat, and apply'd on the part.

*ALKEKENGİ*, *Winter cherry*. Its leaves are acerb, and bitter; they do not change the blue paper, but the fruit changes it very much. It appears, at first, sourish, and afterwards bitter; which makes one conjecture, that in the fruit of that plant there is a salt approaching very near the *oxysal angeli salt*, mixed with a small quantity of foetid oil. In the leaves that salt is too well wrapped up in sulphurous and terrestrial particles to be felt. The *alkekengi* is very *aperitive* and *diuretick*. *Dioscorides* used to give it for the *green-sickness*, and retention of urine. *Arnould de Villeneuve*, and *Cesalpinus*, advised the dropical, and those who had a retention of urine, to drink wine wherein had been bruised three or four fruits of this plant. The fruit of *alkekengi* is prepared into *troches*.

*AQUILEGIA sylvestris*, *Celandine*, is *aperitive*, *diuretick*, and *sudorifick*. *Tragus* assures us, that a drachm of the powder of the *root* taken in *wine*, cures the *cholick*. *Camerarius* relates, that in *Spain* they eat every morning, for the *calculus*, a small quantity of that *root*. For the *angina*, and the *ulcers* in the throat, *Pena* and *Lobel* prize gargarisms made with the seeds of this plant. Some use it in the *scurvy*. Some pretend, that taken in *wine* it *accelerates* the birth. *Pauli* us'd to give half a drachm, or a drachm of it, in a glass of water of *fumiterre*, or of *carduus benedictus*, for the small-pox and measles.

*ARTEMESIA, vulgaris*, *Mugwort*, or *Motherwort*, has a small taste of salt, and changes a little the *blue paper*, which indicates that its salt has something of the nature of *sal ammoniac*, but united with a great deal of sulphur and earth. All its principles render the plant very *aperitive*, and proper to regulate and provoke the natural evacuations in women. For the vapours, the *leaves* and *flowers* of *mugwort* are taken, instead of *tea*.

*BETONICA, Betony*. The *leaves* of this plant have the taste of herbs, are a little salt, and a little aromack. The *flowers* change *blue paper* a little, as well as the *roots*; which, besides, are very bitter. The *betony* is full of sulphur, mixed with a small quantity of oily, volatile salt, and some earth. By the analysis are extracted from this plant a great deal of oil, a little earth and fixed salt, no concreted volatile salt, but a small quantity of urinous spirit. *Betony* is *vulnerary*, *aperitive*, *diuretick*, proper for the maladies of the head, and of the abdomen. It is used in lieu of *tea*, for the vapours, sciatica, the gout, head-ach, jaundice, and for the palsy. The diet-drink made of *betony-leaves*, the water it has been macerated in, the conserve of its *flowers* and *leaves*; the juice and extract of its parts, have the same virtues. These *remedies* procure the expectoration of purulent matter; they consolidate the inward ulcers, restore the functions of the *viscera*, promote the urine, and carry off the obstructions of the *viscera*. Of the *leaves* of *betony* is made a plaister, and particularly those of the head. The *roots* have not the same virtues.

*BRYONIA aspera, sive alba, baccis rubris*, *Bryony*, *hip*, *white vine*. The *leaves* of this plant are insipid, glutinous, and do not change the *blue paper*; the *root* changes it much, it is bitter, and of a bad smell; whence it is conjectured that the acid of ammoniac salt, which is predominant in that plant, is more unfolded in the *root* than in the *leaves*, where it is wrapped up in a great deal of sulphur. By the analysis these *roots* give a great deal of acid liquor, and a considerable quantity of concreted volatile salt. The *root*, *tops*, and *seeds*

of *bryony*, are a strong purgative, and carry off the most obstinate obstructions; therefore this plant is of great service in the dropy, gout, epilepsy, asthma; in the vapours, palsy, vertigos, and in the most tedious maladies. The *root* is given in powder, from one scruple to two; the juice is given to drink, from a drachm to half an ounce; and the decoction from half an ounce to an ounce, and an ounce and a half. But in whatever manner this *root* is used, it must be corrected with cream of tartar or vegetal salt.

*BURSA pastoris major, folio sinuato*, the *shepherds-purse*, or *pouch*, tastes a little salt, and is deterfive; the juice of these leaves changes a little the *blue paper*; whence it is conjectured, that in that plant the ammoniac salt, which is in the natural salt of the earth, predominates the other principles. This ammoniac salt is dissolved into a considerable portion of phlegm, and is tempered by much earth and little sulphur. This plant gives no acid by the chemical analysis, and all extracted from it is almost alkaly. Very few plants give so much concreted volatile salt, more lixivial fixed, and more earth. These principles mixed render the *bursa* proper to melt the blood, when too much thickened by the heterogeneous acids, which obstruct the circulation. The juice of its leaves drank from four ounces to six, is of a great help in losses of blood, and even in fluxions, accompanied with inflammation. Its water distilled has little or no virtue, it is only the phlegm separated from the other principles. This plant is found during the whole year, because it sows itself towards the end of the summer.

*CALAMINTHA humilior, folio rotundiori*, *Ground-ivy*. *Cardus* has described this plant under the name of *chamæcluna*. Its *leaves* are very bitter, a little aromack, and scarce change the *blue paper*. By the analysis this plant gives no concrete volatile salt, but a small quantity of urinous spirit; all the rest is acid, alkaly, oil, and earth; and these two last parts are found in it, in a reasonable quantity. The *ground-ivy* is very aperitive, deterfive, and vulnerary. *Camerarius* and *Cesalpinus* esteem it much to provoke the urine, and force the *calculus*. *Lobel* used it, in the gout, by way of prevention.

*CARDUUS STELLATUS, starry thistle*. Its *leaves* are very bitter, and the *root* tastes of *artichoke*. It contains a salt which approaches very near the natural salt of the earth; for its solution is very bitter, and loaded with *sal ammoniac* and *nitre*. The *cardus* is *sebrifuge*, *vulnerary*, and *aperitive*. In an *intermittent fever* five or six ounces of the juice of this plant is given at the beginning of the paroxysm. The same juice carries off the spots in the eyes, and cures the wounds. *M. de Lamignon*,

*moignon*, intendant of *Languedoc* in France, has communicated to the publick a remedy which had cured him of a violent *nephretick*; which remedy is as follows.

28th day of the moon, in every month, the patient must drink early in the morning a large glass full of very good white wine, in which has been macerated a drachm of the first bark of the root of *carduus*, gather'd toward the end of *September*, and dry'd from the sun, and powder'd very fine. This bark is a very small and thin skin, brown outwardly, and white inwardly. The day this remedy has been taken, must be put towards the evening into half a pint of water, a handful of parietary, a drachm of *sassafras*, as much aniseed, and half a drachm of cinnamon, in powder: the whole is boil'd on a clear fire for the space of half a quarter of an hour. The vessel is taken off the fire, and plac'd, closely cover'd, on the hot embers; the next day 'tis put again on a clear fire, that it may boil for another half quarter of an hour; after which, the liquor is pour'd over two ounces of powder'd sugar-candy put into a porringer, or other such vessel; the infusion strain'd through a linnen cloth, with expression of the ground. When the sugar is melted, the patient drinks it as hot as he can, and must take nothing else: for three hours after, no more than when he has taken the first remedy.

*CHAMÆDRIS minor, repens, Germander*; the leaves of the *germander* are bitter and aromattick, and do not change the blue paper; which shews that it contains principles different from those of the *centorie*. Its salt does not differ from the natural salt of the earth, which is a mixture of sea salt, nitre, and *sal ammoniac*. 'Tis acerb, very bitter, and very aperitive. There is an appearance that that found in this plant has lost its acrimony by the mixture of a great deal of essential oil, which renders the *germander* aromattick. 'Tis *febrifuge*, *stomachick*, *aperitive*, and *diaphoretick*. A handful of its leaves are macerated for a whole night, from the fire, in a glass of wine, together with a drachm of vegetable salt, which must be drank fasting, for the green-sickness. A drachm of the extract made with its leaves and flowers, with two drops of oil of cinnamon, is prescrib'd for the same malady. Its leaves are used in infusion, in the manner of those of tea, for the gout and sciatica.

*CHAMÆMELUM, vulgare leachantemum, Camomile*. This plant is bitter, aromattick and changes much the blue paper. It seems that it contains a *sal ammoniac* loaded with a great deal of acid, and wrapp'd up in a great quantity of sulphur and earth. The *camomile* is *aperitive*, *diuretick*, and *febrifuge*. In *Dioscorides's* time, the powder of

*camomile flowers* was used in *intermittent fevers*. *Rivierus* prescribes it on the same occasion. The infusion of the summits, or tops of *camomile*, and of *melilot*, give ease to those troubled with the *nephretick*, and with a retention of urine. It appeases the gripes, which often happen after a delivery. *Pauli* prizes much the wine in which *camomile flowers* have been macerated, for the pleurisy; but there must be applied, at the same time, on the part where the pain is felt, bladders filled with the decoction of the same plant, heating the decoction, from time to time. It is employed likewise in clysters, fomentations, cataplasms, and in the half baths, for the gout, sciatica, and hemorrhoids, or piles. Its oil is very useful on the same occasion. For the rheumatism it is mixed with equal parts of oil of *St. John's-wort*, and of camphorated spirit of wine, for a liniment, covered afterwards with a hot cloth.

*CHELIDONIUM majus, vulgare, Celandine*. The *celandine* is bitter, acerb, and burning, especially the root, which gives more orange-coloured juice than the other parts of the plant. It changes but very little the blue paper, and smells like rotten eggs; which makes me believe that its juice is, as it were, phagenetical, semblable in some manner to the liquor which results from a mixture of solution of corrosive sublimate and of lime-water. The *celandine*, by the analysis, gives enough of that salt fixed, as well as volatile; but it is wrapped up in a great deal of sulphur and earth. This plant taken inwardly, is very *aperitive*; for the dropsy, an ounce of its root, and half an ounce of tincture of *Mars*, are infused, or macerated during four and twenty hours, in a pint of white wine; the infusion is strained through a cloth, two ounces of which are taken twice a day. The following preparation is very good for the vapours, and for the consumption. There must be put in digestion, during eight days, twelve pounds of the whole plant slightly pounded, three dozen of *craw-fishes* cut in pieces, and two pounds of honey; then the alembick must be luted, and the matters contained in it distilled in *balneo marie*. The distilled water is very good for the vapours drank from two ounces to four. It carries off the inflammation of the eyes, and dries up the ulcers of those parts. The herbs pounded cure the wounds of horses.

*COFFEE*, is the fruit of a plant very common in *Arabia Felix*. That of the *Levant* is most esteemed, being greener, heavier, and appearing riper than that from *Mocha*, which is larger, lighter, and whiter.

This is what *Dominicus de Farcy*, doctor in physick of the faculty of *Paris*, says of coffee, in a thesis held in the college of physicians of that metropolis,

tropolis, Anno 1695. ' The volatile salt with which the *coffee* berry abounds, agitates the spirits, whose velocity hinders sleep; besides the adult particles, of which there is a great quantity in the *coffee*. as we may judge by the smell and taste, insinuate themselves first into the blood, then into the texture of the nerves, to which, by the disproportion of their figure, and their continual motion, they add a stimulation; whence the spirits are forwarded in the latent ducts of the brain, in their usual operations. From the abundance of these salts the blood is freed from the viscous humour it is wrapped up in within the substance of the lungs, as well as the bronchia of their sordes. However, a considerable quantity of the blood is resolved into a serosity, which being filtrated through the reins, fall into the bladder.

*Coffee* produces these effects, particularly with people of a pretty corpulent habit; being found hurtful to those who are thin, lean, dry, and of a bilious temperament, as it dries up the nerves, and inclines them to tremors. It is said to be prejudicial, likewise, to those who digest too fast, where the circulation is too quick, or where there is a spitting of blood arising from the mouths of any of the veins and arteries being too open, or the blood too thin and sharp.

The oily matter, which separates from the *coffee*, and appears on its surface when roasted, and its particular smell, which distinguishes it from peas, beans, rye, &c. which some substitute in lieu of *coffee*, are to be the real indications of its effects. If considered with regard to the oil drawn with the retort, this, as well as that, contains volatile principles, as we have already observed, both saline and sulphurous. It is to the dissolution of its salt, and the mixture of its sulphur in the blood, that its chief faculty of promoting watchfulness is to be attributed; hence also its property of promoting digestion, of precipitating foods, of preventing eruptions, and correcting acrimonies of the stomach, when taken after meals. Hence also that fermentation in the blood serviceable to corpulent people; hence also its diuretick virtue. By experience it is found of service to drink a glass of water before *coffee*, to render it laxative; to mix it with milk, or cream, to extinguish its sulphur, embarrass its saline principles, and render it nourishing.

The tree that produces the *coffee* is a kind of *Arabick* jessamine; the berry, when ripe, is as hard as horn.

The preparation of *coffee* consists in roasting, or giving it a just degree of torrefaction, on an earthen

or metalline plate, till it has acquired a brownish hue, equally deep on all sides; it is then ground in a mill, as much as serves the present occasion; a proper quantity of water is next boiled, and the ground *coffee* put into it; after it has just boiled, it is taken from the fire, and the decoction having stood a while to settle and fine, they pour and decant it into dishes, and drink it as hot as possible, with sugar.

CORAL, (See the figures of sea-plants in the copper-plate BOTANY,) is a production of the sea, usually ranked among the number of *marine plants*; though the antients took it, without hesitation, for a stone; most of the moderns hold it a vegetable; of late days one maintains it partly a plant, partly stone; while another curious and able naturalist, who has much studied the production of the sea, almost ranks it in the number of animals; as imagining it the work of certain sea-insects. This opinion is now so well established, that all other sentiments seem almost precluded. Father Kircher supposes entire forests of it at the bottom of the sea; and M. Tournesfort maintains, that it evidently multiplies by seed, though neither its flower nor seed be known. However, the Count De Marsigli has discovered some parts therein, which seem to serve the purpose of seeds and flowers.

*Coral*, then, being established a plant, has, in that quality, roots, wherewith it is fastened to the rock wherein it grows: These roots are covered with a bark beset with starry pores, which traverse them from top to bottom. Above the root is the ligneous, or woody part of the plant, if we may call a substance so, that rather seems to resemble stone than wood. It is divided into branches like other plants, having white streaks therein, which seem to represent a kind of fibres. The extremities of the plant are soft, and rounded with little bowls, ordinarily divided into six cells, filled with a humour somewhat like milk, fatty, sharp, and astringent. Lastly, these bowls are esteemed a kind of pods, or *capsule*, containing the seed of the *coral*; it is even said, that in what place, or on what matter soever this juice be shed, it carries fecundity with it, and produces a plant of *coral*: whence it is, that in the cabinets of the curious we find some of it on dead men's skulls, pieces of earthen ware, and other kinds of solid bodies, which chance, and the working of the sea, have thrown into some of father Kircher's forests.

*Coral*, the Count de Marsigli observes, grows chiefly in grottos, whose mouth or aperture is towards the south, and their vault or concave arch nearly parallel to the surface of the earth. For its growth, it is necessary the sea be as quiet as a pond:

it vegetates the contrary way to all other plants ; its foot adhering to the top of the grotto, and its branches shooting downwards. The foot takes the exact form of the solid it grows to, and even covers it like a plate, to a certain extent ; which Monsieur de *Marfigli* thinks a proof that its substance was originally fluid : And what confirms the thought is, that the same substance shall sometimes line the inside of a shell, which it could never have entered but in form of a fluid.

All its organism, (according to *Marfigli*) with regard to vegetation, consists in its rind ; that the tubules of this rind filtrate a juice which fills the cellules, and runs along the canals as far as the extremities of the branches ; and that this juice being petrified, both in the cells encompassing the *coralline* substance, and in those of the extremities of the branches, whose substance is not yet formed, makes the plant grow, both in height and bulk.

There are properly but three kinds of *coral*, *red*, *white*, and *black* : the white is the rarest and most esteemed ; but the red is ordinarily used in medicine. It must be chosen thick, smooth, and shining, and of a beautiful red, not covered with any tartarous matter. There is a kind of *white coral* pierced full of holes ; and a *black coral*, named *antipates* ; appearing of a different nature from the rest ; but these are of no use. The chymists draw a magisterial tincture from *coral*, and a salt.

The virtues attributed to *coral*, and its preparations, are, that it is cardiack, and therefore of use in diarrhœas, too large fluxes of the *menstrua*, and flooding ; of service in the *fluor albus*, and to prevent miscarriages ; besides its use in common, as a testaceous powder, in children's diseases, &c.

The time for gathering this plant is from *April* to *July* ; the places are the *Persian Gulf*, *Red Sea*, coast of *Africa*, towards the bastion of *France* ; the isles of *Majorca* and *Corfica* ; and the coast of *Provence* and *Catalonia*. The method of gathering *coral*, is nearly the same in all places ; that used at the bastion of *France*, where there is an established fishery, under the direction of a company at *Marfeilles*, is as follows :

Seven or eight men go in a boat, commanded by the patron or proprietor ; the caster throws his net, if we may so call the machine wherewith he uses to tear up the *coral* from the bottom of the sea, and the other six manage the boat. The net is composed of two beams tied a-cross, with a leaden weight, to press them down : to the beam is fastened a great quantity of hemp loosely twisted round, among which they mix some strong nets.

In this condition the machine is let down into the sea ; and when the *coral* is pretty strongly embarrassed, in the hemp, and the net, they draw it out by a rope ; which they unwind according to the depth, and which sometimes requires half a dozen boats to draw ; if the rope happen to break, the fishermen are in great danger of drowning. Before the fishermen go out, they agree on the price of the *coral*, which is ordinarily, at the rate of 4s. 6d. per lb. When the fishery is over, which in a season usually amounts to 25 quintals of *coral*, each boat, it is divided into thirteen parts ; the patron whereof, or master-coralier, has four, the caster two, and each of the six companions one, the thirteenth being reserved for the company, &c.

*CYNOGLOSSUM majus, vulgare, Dog's-tongue.* The leaves of this plant are white and silky ; its flowers are, at first, purple, which become blue afterwards. The bark of its root is a little bitter, salt, stiptick, and glutinous ; it changes the blue paper. It appears that the *sal-ammoniack*, which is in the natural salt of the earth, is predominant in the *cynoglossum*, where it is temporated by much phlegm, earth, and foetid oil. Therefore its root is proper to stop all sorts of fluxions, and sweeten the acrimony of the humours. Its leaves are vulnerary and deterfive.

*DENS LEONIS latiore folio ; Lion's tooth.* The leaves of this plant are very bitter, and change a little the blue paper. The roots change it a great deal more, they are bitter, stiptick, deterfive. The whole plant is aperitive, diuretick, vulnerary, and febrifuge. *Targus* prescribes the water of *dent de lion*, in the internal inflammations. *Barbet* advises to take the juice, it purifies the blood by urine. To appease an excessive cough, and cure a cold, a quarter of a pint of milk is drank at night, with which is mixed, boiling hot, as much of the decoction of *dent de lion*, adding to it a small quantity of sugar candied. The extract of this plant is given from half a drachm to a drachm and a half.

*EUPATORIUM cannabinum, a kind of Agrimony ; in French, Eupatoire.* The juice of the leaves of this plant, or a drachm of its extract, and the diet-drinks prepared of it, drank by glasses, are very proper to carry off the obstructions of the *viscera*, especially those which succeed to intermitting fevers ; the use of its leaves, in infusion, in the manner of tea, relieve the dropicals : it must be prescribed after the puncture, or tapping, and the legs must be fomented with the decoction. For the green-sickness, for the itch, and all other cutaneous distempers, it is mixed with the sumiterre in whey, or diet-drinks. The summities loaded with flowers

are very vulnerary. The roots are both emetick and cathartick.

*FUMARIA officinarum & Dioscoridis, Fumitory.* This plant though very bitter, changes nevertheless the blue paper; therefore, it is conjectured that it contains a salt like the natural salt of the earth; but in which the *sal ammoniac* predominates the nitre and marine salt; besides, the salt of *fumitory* is joined with a great deal of sulphur and earth dissolved in a considerable quantity of phlegm. By the analysis the fumitory gives a great deal of concreted volatile salt, a great deal of fixed salt, very lixivial, and a great deal of a very thick oil. All these principles render this plant laxative, diuretick, proper to purify the blood, and for the despoliation of the parts. It is esteemed a specificck in all cutaneous distempers; in the hypochondriacal melancholy; in the cachexy and dropfy. Its juice is administered from two ounces to six. The infusion in whey from six ounces to ten or twelve. The distilled water from a glass to two. The simple syrup; two or three ounces in a diet-drink; the compound syrup from one ounce to two, if the patient is to be purged. The water of *fumitory* is also deterfive, and proper to dry the ulcers of the mouth.

*GERANIUM, storksbill.* This plant is stiptick, salt, and sowerish: it smells of *bitumen*, and changes the blue paper. There is some appearance that it contains a salt like the alum, mixed with a small quantity of foetid oil, and a very little of *sal-ammoniac*. By the analysis it gives a great deal of acid, very little of oil, no concreted volatile salt, but a small quantity of urinous spirit. The *Geranium* is very astringent, and very vulnerary; the wine, wherein the leaves bruised have macerated for a whole night, stops all sorts of hemorrhages.

*HYOSCYAMUS vulgaris, Henbane.* The leaves of this plant are insipid, and of an ill smell; it tastes of artichoke. It is conjectured that the *sal ammoniac*, which is in it, is wrapped up in a great deal of sulphur and earth; for by the analysis its leaves give a concrete volatile salt, and a great deal of oil. The *henbane* is soporiferous, resolutive, and sweetening; it is seldom used in internal remedies. *Helidæus* valued much its seeds, which he mixed with conserve of roses, for the spitting of blood. *Tragus* assures, that the juice of *henbane*, or the oil made by the infusion of its seeds, cured the pains in the ears, by syringing it into those parts. The *henbane* is employed in anodyne cataplasms, to resolve the tumours. For example; two handfuls of leaves of *henbane*, as much of those of *mandragora*, and an ounce of seeds of *henbane*, and of poppies, are boiled in a certain quantity of

milk; the whole is strained through a cloth. There must be added to it the yolk of an egg, and some saffron. Some content themselves with boiling only the leaves of *henbane* in milk, and apply them on the places where the gout is felt. Others soften the leaves of *henbane* under the hot embers, and apply them on the breasts to expel the milk from them, or to dissipate it when knotted. For chilblains, they are exposed over the smoke of seeds of *henbane*, burned on the coals.

*JUNIPERUS vulgaris, the Juniper-tree.* By the analysis are extracted from this plant several acid liquors, a small quantity of fixed salt, but no volatile. We must observe, that the salt of this plant is wrapped up in a very great quantity of sulphur, and some terrestrial particles. The wood of *Juniper*, besides an æthereal oil, gives a great deal of thick oil, in the consistence of a syrup. The berries give a great deal more, and the summits a little less. All these principles render the *juniper* proper to restore the functions of the stomach, to dissipate the wind, and griping matters, to free the lungs, and disengage them of that thick *lympha*, which often obstructs the respiration. This plant is, also, sudorifick, cephalick, and hysterick. It provokes the *menses*, carries off the obstructions of the *viscera*, restores their springs, and helps the evacuation of urine. Use is made of the wood, summits, and berries. The decoction of the wood volatilizes the blood, and purifies it by the insensible perspiration. A half bath is prepared with this wood, which proves very beneficial to those who have the gout. The wine in which the summits of *juniper* are boiled is very diuretick. *Tragus, Matthiæolus, Hartman, and Simon Pauli*, assure us, that they have cured some dropsical persons with this sort of wine. *Tournefort* says, that he has seen several persons very much eased by the pills made of two parts of aloes, and one of *juniper-berries*. From these berries are extracted an ardent spirit, a tincture, an elixir, and an extract; and of them are prepared a *ratifia*, and a sort of honey. The tincture is made by macerating the berries in their ardent spirit; the infusion of the same berries in their spirit, or in common water evaporated to the consistence of honey, is called elixir, or extract of *juniper*. The honey of *juniper* is nothing else but common honey boiled with *juniper-berries*. It is good in clysters, in the *dy-senteria*, and *tenesma*. The *ratifia* of *juniper* is made by macerating its fruit in brandy, or champagne wine, adding to it some sugar and cinnamon. The pulp of *juniper-berries*, freed from its grains, and mixed with sugar, makes a conserve, which has all the virtues of those preparations

tions heretofore mentioned. Lastly, the fruit is burned to expel the bad air, and macerated in vinegar, in the time of the plague, to wash letters, linnen, and even plates.

**MELILOTUS**, *Melilot*. This plant is acerb, bitter, stiptick, and odoriferous; whence it is conjectured, that its salt is much like the natural salt of the earth, but mixed with much essential oil, and terrestrial particles; for by the analysis, the *melilot*, besides much acid phlegm, gives also a great deal of oil and earth, enough of urinous spirit, of volatile concrete salt, and of very lixivial salt; therefore that plant is diuretick, resolutive, and sweetening. The diet-drink made with its summits, and those of camomile, is excellent in the inflammations of the abdomen, the cholick, and in the retention of urine, in the rheumatism, and generally in all occasions where the course of humours is to be facilitated. The water distilled from the flowers of *melilot* is of a grateful smell. The *melilot* is used in the carminative clysters, and in the resolutive cataplasms. For clysters, the flowers of *melilot*, and those of camomile, are boiled in tripe's broth, and to the decoction, after it has been strained through a cloth, are added some drops of oil of anniseed. For cataplasms, two roots of lillies are boiled with half a handful of flowers of *melilot*, and two handfuls of leaves of henbane; the whole is strained through a sieve, to which are added some drops of fetid oil of tartar. The juice of the flowers of *melilot*, or the infusion of its parts in boiling water, appease the inflammation of the eyes; especially if after it is taken off the fire there be added to it some camphorated spirit of wine; the whole being strained through a cloth, to separate the needless camphire.

**PAPAVER** *Erraticum majus*, *Poppy*, in *French Coquelicoc*. The flower of this plant, which is the principal part employed in medicine, is glutinous, and changes a little the blue paper, like the solution of *opium*; whence it is believed that it has a salt analogous to it. But in the *opium*, that salt, which approaches near the *sal ammoniac*, is mixed with a great deal of fetid oil, whereas in the *poppy* there is a great deal less of oil, and much more viscous phlegm; so that the flowers of this plant are sweetening, and proper to help spitting in the fluxions of the breast, in colds, and in dry coughs. They stop the hemorrhages, and are a little sudorifick. The water distilled from the flowers of *poppies*, is prescribed from three ounces to six; the tincture is taken by glasses, in the fluxions of the breast. The following diet drink is excellent for a dry cough: you must boil three ounces of roots of *bugles*, and as much of those of *gramen*,

or *grafs*, in two pints of water, and pour the boiling decoction upon an ounce of flowers of *poppies*, and upon three heads of *white poppies*, cut small, and tyed up in a little sack. The dried flowers of *poppies* are used like tea. A conserve and a syrup is made of them.

**POLYPODIUM** *vulgare*, *Oke-form*. The root of this plant analyzed gives several acid liquors, a small quantity of urinous spirit, no concrete volatile salt, a great deal of oil, and some earth. The antients believed this root purgative. *Menardus* is the first, among the moderns, who discovered that it purges but slightly; and *Dodoneus* confesses that it does not purge at all, unless it be boiled in the broth made of an old cock, with mallows and leeks. The *oke-form* sweetens the blood, and carries off the obstructions of the *viscera*. It must be used for a dry cough, when the *saliva* is salt; in the asthma, scurvy, and hypocondriacal affections.

**PULEGIUM** *latifolium*, *Penny-royal*. This plant is very bitter, very acerb, of a penetrating smell, and changes much the blue paper; whence it is conjectured that it has an aromattick and oily volatile salt, yet loaded with acid; whereas in the artificial volatile salt this acid is stopped by the salt of tartar; therefore this plant is aperitive, hysteric, proper for the maladies of the stomach, and those of the breast, when 'tis wanting to dissipate those glutinous matters which obstruct the *bronchia*, and *vesicles* of the lungs; especially when boiled with honey and aloes: for then, as *Dioscorides* observes, it purges, and helps the expectoration. *Trogus* says, that the juice of this plant clears the sight, and carries off the rheum. For the distempers of the eyes, *Montanus* prescribed the powder of *penny-royal* mixed with equal parts of vinegar, honey, and water. The conserve of the flowers and leaves of this plant are good for dropical persons, and for those who have the yellow jaundice. Mr. *Ray* assures us, after Mr. *Boyle*, that a spoonful of the juice of *penny-royal* is a good remedy to appease the convulsive cough of children. *Cbesneau* prescribed a glass of the decoction of this plant for hoarseness, and advised to take it at night, going to bed.

**QUINQUEFOLIUM** *majus repens*, *Cinquefoil*. Mr. *Ray* has very well described the fruit of this plant. The taste of its leaves has something glutinous, they change a little the blue paper, but the roots change it more; they have some acidity, and are stiptick, which makes us believe, that amidst a great deal of earth and sulphur, they contain an aluminous salt modified with a small quantity of *sal ammoniac*, which, in the leaves, is very much embarrassed in a viscous phlegm. This plant is vulnerary, and astringent. By the analysis it gives a small quantity of concreted volatile salt. Beside

the extract prepared of the roots, they are also successfully employed in diet-drinks, and in the astringent broths, for the spitting of blood, the hemorrhoidal flux, for the heat of urine, and for all sorts of hemorrhages. The gargarism made with the decoction of this plant, cures the ulcers of the mouth and sore throats. It is assured, that a drachm of the powder of the same root taken in a glass of water, before the paroxysm, carries off intermittent fevers.

*Ruscus Myrtifolius, Butcher's-broom.* The root of this plant is one of the five common aperitive roots, proper to carry off the obstructions of the viscera, and to accelerate the passage of urine. For the dropsy, cachexy, jaundice, calculus, and the retention of urine; it is prescribed in broth, diet drinks, and apozems: for scrophulous tumours half a pint of white wine, in which has been macerated a drachm of the powder of the roots of *ruscus*, with equal quantity of those of *scrophularia*, and *filipendula*, must be drank for several days successively. The conserve of the berries of *ruscus* is very good for the excessive heat of urine. The seeds of *ruscus* are employed in the composition called *benedicta laxativa*.

*SAMBUCUS, fructu in umbella nigro, elder-tree,* The leaves of this plant have at first a salt taste; and, afterwards, they are bitter. The fruit is sweetish.

By the analysis the leaves, besides several acid and alkaline liquors, give a concrete volatile salt, much oil, and much earth. Therefore there is appearance, that this plant operates by a *sal armoniack* more loaded with acidity than common; and mixed with a great deal of foetid oil and earth. The salt, which is in the fruit of *elder*, approaches nearer the *allum* than the *sal-ammoniak*. There is but a very small quantity of urinous spirit extracted from its parts, but much of acidity, oil, and earth. *Bauhin*, and Mr. *Ray* have taken the flower of this plant for a flower of five leaves, though *Tournefort* has found it of a single piece. *Hippocrates* used the *elder* to purge, and to help the evacuation of urine. *Dioscorides* says, that the decoction of its summities purges the serosities, and eases the dropsical, as well as the wine, in which the roots have been boiled. These parts, according to the same author, are good for the bite of vipers, and for the hysterick passion, as well as the fruit drank in wine. *Dioscorides* adds, that the leaves of *elder* appease the inflammation, cure the burnt ulcers, the bite of a mad dog, and the gout. *Tragus* and *Dodonæus* ordered to drink the juice of the middle bark of *elder*, to purge the bile, and the serosities, or had it macerated in wine or milk, after it had been pounded. *Gesner* prescribed the decoction of that bark, for

an excellent sudorifick in the plague. *J. Baubin* ordered the dropsical to drink three times a day, an ounce and a half of the water of the middle bark of *elder*, viz. the first in the morning, the second at noon, and the last at night. The flower of this tree fried with eggs, purge well enough, but they must be fresh gathered, for they lose their virtue in drying. The whey wherein those dry'd flowers have been macerated, is of a great succour to those who have the small-pox and the erisipele. They must drink a glass of it morning and night and have their face washed with two parts of the water of the flowers of *elder*, and a part of good *spirit of wine*. A conserve and a syrup are made of those flowers. They are put in vinegar, and boiled slightly with honey, to be used in clysters. Of *elder-berries* are prepared the rob, extract, spirit, wine, syrup and oil. For the rob a pound of the juice of *elder-berries*, with half a pound of sugar, is thickened on a slow fire. The extract, according to *Quercetan*, is made in the following manner. The fruits of *elder* dried from the sun, must be put into a matras, pouring over it the best *spirit of wine*, which must rise about five fingers breadth above the fruit, adding to it some spirit of sulphur, and leaving the whole in digestion during five or six days; which expired, the tincture must be filtrated, which is very good for the hylterick: the dose is half a spoonful, or a spoonful. To make the extract, the *spirit of wine* is drawn off by distillation, and the extract remains at the bottom of the cucurbit. The dose is a scruple, or even a drachm, for the same distemper, and for the diarrhoea. The ardent spirit of *elder-berries* is a very great sudorifick, as well as the juice of those berries, which is easily preserved, or with oil, or mixing with it one third of the best *spirit of wine*. Of the grains of those berries is extracted an oil, which appeases the gout. For the same malady another sort of oil is used, made by the resolution of the leaves of *elder*, whose ribs are bruised, and afterwards put into an earthen pot, which being very closely luted, with plaister, is buried very low in the ground; at the end of a year is found in the bottom of that pot a sort of oil, very good for the gout. The leaves of *elder* boiled in strong wine are very resolute; they carry off the swelling of the legs of the dropsicals, especially if a vaporous bath be made of them, or frequent fomentations, and the leaves are applied in cataplasms, it is proper to mix with it the leaves and flowers of tansy. *Mathirole* gives the description of an excellent *unguentum* for a burn. He will have a pound of the middle bark of *elder* boiled into two pounds of oil of olive; the oil is strained through a cloth; when the bark is become black, and seems to be done enough, there are added

ded to it two ounces of new wax, and as much of the juice of the tenderest branches of *elder*, which is boiled to the consumption of the juice. This done, the vessel is taken off the fire. Then must be added to it two ounces of *turpentine*, four ounces *olibanum*, and two hard yolks of eggs. The *unguentum* is preserved in an earthen pot for the gout, for the inflammation of the piles, and for burns. It suffices to boil the middle bark of the branches of *elder* in oil of *olives*, or in that of *walnuts*, and to give it the consistence of *unguentum*, with a sufficient quantity of new wax, and yolks of eggs; nothing can ease more those who have been burnt with gunpowder, than to apply immediately on the burnt part the common honey, and afterwards the oil of *walnuts*, with which has been boiled the *elder*.

*SAXIFRAGE rotundifolio*, *Saxifrage*. This plant is esteemed a very grand diuretick. The infusion of its roots in *white wine*, or in *cinnamon-water*, is its usual preparation. *Facchius* assures us that it provokes the *menfes*, and that it purges the lungs of that thick *lympha*, which hinders their motion.

*SCABIOSA pratensis hirsuta quæ officinarum*, *Scabious*. The figure which *Tabernæmontanus* gives of this plant is very good. The *scabious* is bitter, and changes, a little, the blue paper; whence it is conjectured that it contains a salt which approaches near the *sul-armoniack*, mixed with great quantity of fœdid oil and earth; for by the analysis, besides several acid liquors, there are extracted from this plant much sulphur and earth, a small quantity of urinous spirit, and of a concrete volatile salt. The *scabious* is sudorifick, aperitive, deterfive, vulnerary, proper to help the expectoration, when the *branchia*, and the vesicles of the lungs are stuffed with a thick and glutinous phlegm. The juice of this plant is prescribed from three ounces to six, in which is dissolved a drachm of *teriack*, and ten grains of *camphire*, when the patient must be sweated. This remedy is good in malignant fevers, in the small pox, the measles, and the pleurisy, after the use of the antimonial remedies. The water of *scabious*, and that of *cardus benedictus*, are commonly mixed in expectorative and sudorifick juleps. A syrup is made of the juice extracted from the whole plant, which is very proper for all cutaneous distempers. But, mean while, the parts be washed with the decoction of *scabious*; with every pint of that decoction are mixed three spoonfuls of camphorated brandy; the whole is strained through a cloth, to separate the *camphire* chilled on the decoction. Drank by spoonfuls, it is good for vapours. *Tabernæmontanus* says, that the juice of *scabious*, mixed with some *borax* and *camphire*, carries off those spots seen often on the *cornea*.

*SERPILLUM*, *wild betony*; there are different species of this plant, but they all become alike by the culture. *Wild betony* is a little bitter, acerb, stiptick, odoriferous, and changes the blue paper. There is appearance that it abounds with aromatick and oily volatile salt; but this salt retains yet part of the acidity of the *sal ammoniac* of the earth, when as in the artificial oily and aromatick volatile salt, the acid part of the *sal ammoniac*, has been stopt by the salt of tartar, therefore the *wild betony* is cephalick, stomachal, and proper for the vapours. It destroys the explosive matter which causes the convulsive motions. It furnishes the blood with spirituous particles: it restores the natural functions, and carries off the obstructions. The spirit of this plant and the water distilled from it, are very proper for soporous affections, and for the vapours. Its essential oil, and the water extracted from its flowers, macerated in brandy, and distilled afterwards, are esteemed for the epilepsy. For a cold, or an old cough, two large handfuls of *wild betony*, are thrown into a pint of boiling water. Then the pot is taken off the fire, and covered: afterwards two spoonfuls of white honey are dissolved in the infusion; which the patient must drink, very hot, at night in going to bed. The conserve made of the flowers of this plant, is a remedy for the epilepsy.

*TABACUM*, *tobacco*, is a plant that was brought into *Europe* from *America*; and may be cultivated with success in any part of *Europe*.

If *tobacco* be used with judgment and moderation, it may justly claim the predecency of all other remedies; for if thrust whole, or in powder, into the nose, when necessity requires, it pricks the membrane which lines the innermost parts of the nose, and the bones which enter into its composition; that membrane being thereby contracted, presses the *papillæ* and small gland found in its texture, and from them, as from sponges squeezed with the hands, forces out the snout, which being purged, streams of serosities following the same motion, like water running through a cock, are continually flowing from the adjacent vessels and glands. A like thing happens when *tobacco* is chewed or smoked; for the maxillary glands, and salivary ducts, being likewise thereby irritated by a repeated contraction, discharge a considerable quantity of that *saliva*, which causes the fluxions; and by the successive contraction and extension of the membranes, the lungs purged of a viscous *pituita*, are free from asthma, cough, catarrh, and other dangerous affections. *Tobacco* appeases, likewise, by its sulphur, the excruciating pain of the teeth; nay, it has even the excellent qualities of the *Nepenthes*

of *Homer*; for it makes us forget the cares of this life, renders us happy in the most extreme poverty, carries along with it, into our veins, the most flattering hope; eases our mind, and even supplies the want of victuals; for by its means, an abundance of *pituïta* falls into the stomach, which renders hunger supportable, and having stupified the sense of the nerves, appeases the craving stomach. *Tobacco* is not only a remedy to our internal indispositions, but cures, likewise, gnawing ulcers, and by eating the putrid and fungous flesh, cicatrizes those which have rendered abortive the virtues of the best remedies. But as much as *tobacco* is capable to produce all these salutary effects, it is as certain, that it can also be attended with very dangerous consequences, when taken to excess, or without judgment: for as it has a corrosive faculty, whereby it mundifies the most filthy ulcers, and corrodates the swelling and cadaverous processes, to the quick flesh; what dangerous effects will it not produce, by its burning salt, if too often taken in snuff, or smoaked? for then, wounding the tenderest membranes, it renders the nerves of the throat and stomach convulsive, and throws the whole nervous mechanism into disorder. Of what detriment must be the *saliva*, if falling into the stomach, impregnated with that salt, it communicates to the aliments, already changed into chyle, that dangerous acrimony, to have it carried through the whole body by means of the circulation of the blood? &c.

TEA. *M. De Farcy* speak thus of *tea*: This precious leaf, TEA, contains two substances, one fixed, and the other terrestrial, which render its infusion bitter; but the other abounding with volatile salt, communicates a grateful smell to the same infusion, which infusion produces the following good effects: it dissipates soporous affections, and keeps one awake; it cures ebriety, or excessive drinking, and strengthens the stomach; it raises the obstructions of the spleen, or milt, cures the cholick, and cleanses the reins of a viscus *Lympha*; it appeases the excruciating torments of the rheumatism and gout, and perhaps might render the cure perfect.

TORMENTILLA, *sylvestris*, *Tormentille*. The flower of this plant is of four leaves. The root of *tormentille* is styptick, very bitter, and changes a little the blue paper; the leaves change it less; they have a glutinous taste. By the analysis, this plant gives only an urinous spirit, no volatile concrete salt, much acid, oil, and earth; therefore there is appearance that it contains an aluminous salt, wrapped up in a great deal of sulphur, and mixed with very little *sal ammoniac*. This plant is vulnerary, astringent, and detersive.

TUSSILAGO *vulgaris*, *Fole foot*, *colt's-foot*, *horse-foot*. The leaves of this plant are green a-top, lanuginous, and white underneath; they are bitter, glutinous, a little styptick; they taste of artichoke, and change very little the blue paper. It seems as if there was in this plant a salt like that of coral, wrapped up in sulphur, and much viscous phlegm. The leaves, and flowers of *colts foot* are sweating, moderately aperitive, and dedicated (if I may use the expression) to the maladies of the breast, caused by acrimonious and salt ferosities. Asthmatics are ordered to smoak the leaves, instead of *tobacco*. Mr. *Boyle* advises to mix the flowers of brimstone with those of *colt's-foot*, and assures us, that it has cured several Phthisicks. In *Dioscorides's* time, those sort of patients were made to receive, by the mouth, the smoke of the leaves of *colt's-foot*. The leaves and flowers are used in pectoral decoctions, and in the loches proper to facilitate expectoration; a syrup and a conserve are made of those flowers. The following diet-drink is very good for a dry cough: four pints of boiling water are poured over four handfuls of the leaves of *colt's-foot*, and a half a handful of its flowers, half a handful of the summits of hyssop, an ounce of dry'd raisins, and three spoonfuls of the best honey; the whole is left to boil for the space of two minutes, then it must be taken off the fire, and covered, and the diet-drink strained when it is cold.

VALERIANA *silvestris*, *valerian*, or *stewal*. The leaves of this plants have no smell, but they have a taste of salt herb, bitter, and change the blue paper; the roots change it but little; they are bitter, styptick, of an aromattick smell, but penetrating, and which has something unpleasant. This plant has an aromattick and oily volatile salt, loaded with part of the acid of the *sal ammoniac*, whereas in the artificial oily volatile salt that acid has been stopped by the salt of tartar. Therefore the *valerian* is anti-epileptick, sudorifick, hysteric, and proper to provoke the menses. It eases much the asthmatick, and those who are subject to vapours. *Camerarius* esteems it for the jaundice, and *Columna* for the epilepsy. This author pretends to have cured epilepsies in using these roots. He advises, to gather it before it shoots forth the stems, to reduce it into powder, and take half a spoonful of it in wine, water, milk, or other liquor. It may be given to children, and to all those who are subject to convulsions. For the hysteric, and the most violent paroxysms of the asthma, a pint of boiling water must be poured over an ounce of the roots of this plant, and the vessel being taken off the fire, and covered, the infusion is taken by glasses. The extract of these roots is good for the same maladies. The dose is a scruple, with a grain

of laudanum, or the laudanum is mixed with the powder.

*VIOLA martia, purpurea, flore simplici*, the *Violet*. The root of this plant is a little salt, glutinous, and deterfive; it does not change the blue paper, no more than the leaves, which are insipid, and more glutinous. The fresh seeds change it a little, and are saltier than the roots. There is in the *violet* a glutinous sap, which wraps up the other principles, and stops their activity; for by the analysis are extracted from this plant several acid liquors, much oil, a sufficient quantity of concrete volatile salt, enough lixivial fixed salt; but it is not surprizing if it be sweetened by its phlegm, and its oil, and if it is diuretick, and laxative by the mixture of the other principles. The salt of the *violet* participates of the *sal ammoniac*, since it is composed of an urinous part. The infusion of two ounces of the roots of this plant, is both emetick and cathartick; the leaves are emollient and laxative, they are employed every day in clysters, fomentations, and cataplasms; the flowers are loosening. *Poterrius* assures us, that a drachm of their powder purges well enough. Of them are prepared three sorts of syrup; the simple, whose colour is very beautiful, provided it be not boiled; the compound, which is the invention of *Chefve*; and the purgative, of which *Lemery* gives the description. The simple, and the compound, are very proper for the maladies of the breast, caused by acrimonious and salt humours; those syrups are cooling. The purgative syrup is proper for the same distempers, when a purgative is wanted; for the seeds and *calices* of the flowers used in that syrup, purge very well. The roots could very well be added to it. *Etmuller* relates, that *Timæus* used to prepare a very good laxative conserve of the flowers of *violets*, by giving to *manna* the consistence of conserve, with the juice of these flowers; that conserve kept the body open. The dose was from a drachm to half an ounce. A sort of *ratifia* is prepared in the following manner, for those who are colicive: in six pounds of the juice of the flowers of *violets* must be dissolved, on a clear and gentle fire, a pound and a half of *manna*, the whole to be strained through a cloth, adding to it a pint of very good spirit of wine. A spoonful or two of this *ratifia* must be taken, if necessary, morning and night. For the nephritick, and the retention of urine, the following emulsions are prepared: let an ounce, or an ounce and a half of seeds of *violets* be pounded in a stone or marble mortar, adding to it six ounces of the water of *gromen*; strain the emulsion through a cloth, and mix with it an ounce of syrup of *violets*.

*Vegetables*, like animal bodies, are subject to an infinite number of distempers, proceeding from internal or external causes.

Among the exterior causes of the maladies of plants, *blasting* deserves the first place, which, proceeding from a sort of viscid humour, corrupts the substance of the plants, especially the legumns and corns, in which it is found. Hence, *Virgil, lib. I. Georgic*.

*Mox & frumentis labor additus, ut mala culmos, esset rubigo.*

The vines are also subject to this malady.

Next to *blasting* is the *dew*; when by a too great abundance of rain, the flowers of the vines are beat down, as well as young plants, which have not yet shot forth roots strong enough to shelter them from such accidents.

Then follows the *cold blast*, of which *Pliny, lib. 18. Nat. Hist. c. 28.* speaks thus, *Carbunculare*, says he, *vites dicuntur, ut quodam uredinis carbone exustæ*; for plants are imagined burnt, when the phlegm, by the cold nights, is contracted in the bud of the vine; or when, by the excessive heat of the sun, the fibres of the leaves, and of the clusters of grapes, are torrifed, and thereby obstruct the circulation of the nutritious juice. These, and other-like maladies, which proceed from the air, are called *syderation*.

*Vermiculation*, which *Pliny* mentions, *lib. 17. c. 24.* is nothing else than an irruption of worms into trees, by whom they are corroded, especially those which bear the sweetest fruits, as *apples, pears, &c.* for the acerbs, if the oil be excepted, are not so much exposed to this malady.

Plants are subject to several other distempers, proceeding from external causes, *viz.* scabs, ring-worms, and decortication, occasioned by a certain acrimonious humour, intercepted between the bark and the ligneous body, which divests trees of their bark, especially in the *spring*.

Trees can also be wounded, but their wounds are not all mortal; for the *pine*, the *fir-tree*, and the *terebinth*, are eased by their wounds, which procure the evacuation of part of their fat, which otherwise would be very troublesome to them. Others, especially young plants, die, not only by *section* and *terebriation*; but likewise by contusion and convulsion, whereby the texture of the fibres is lacerated: and therefore the circulation of the nutritious juice is intercepted also by the bite of animals, which affects the same nutritious juice. This is called a violent death.

Plants suffer likewise, and sometimes die, thro' too great a heat, or an excessive cold.

There is, almost, but one sole internal cause of the maladies of plants, viz. when trees, worn out with age are deprived of aliment, by their vessels

being contracted, or when they cannot retain it, nor distribute it to the several parts they are composed of, through the imbecillity of their organs: which is an infallible prognostick of their approaching death.

## B R E W I N G.

**I**N the art of *brewing* two principal things are to be considered. *First*, the preparation of the *barley*; of which the *malt* is made, and then the manner of extracting the *liquor* from the *malt*.

*Malt*, is *barley* prepared, to fit it for making a potable liquor called *beer*, or *ale*, by stopping it short at the beginning of vegetation.

In making *malt* from *barley*, the usual method is to steep the grain in a sufficient quantity of water, for two or three days, till it swells, becomes plump, somewhat tender, and tinges the water of a bright brown, or reddish colour. Then this water being drained away, the *barley* is removed from the steeping cistern to the floor, where it is thrown into what is called the wet couch; that is, an even heap, rising to the height of about two feet. In this wet couch, the capital part of the operation is performed; for here the *barley* spontaneously heats, and begins to grow, shooting out first the radicle, and if suffered to continue, then the plume, spire or blade. But the process is to be stopped short at the eruption of the radicle, otherwise the *malt* would be spoiled. In order to stop it, they spread the wet couch thin over a large floor, and keep turning it once in four or five hours, for the space of two days, laying it somewhat thicker each time. After this, it is again thrown into a large heap, and there suffered to grow sensibly hot to the hand, as it usually will in twenty or thirty hours time; then being spread again, and cooled, it is thrown upon the kiln, to be dried crisp without scorching.

This is the general process of *malting*, in which almost every malster has his secret, or particular way of working. But to render the operation perfect, the following cautions must be observed:

1. That the *barley* be newly thrashed, or at least newly winnowed.
2. That it be not mixed, or made up of different sorts.
3. That it be not over steeped in the cistern, or so long as to make it soft.
4. That it be well drained.
5. That it be carefully looked after in the wet couch, so as to stop the first tendency of the blade to shooting.
6. Another caution is, to turn the wet couch inside outmost, if the *barley* comes, and shoots more

in the middle of the heap than on the sides. 7. To keep it duly turning, after it is out of the wet couch. 8. To give it the proper heating in the dry heap. 9. To dry and crisp it thoroughly upon the kiln, but without a fierce fire, so as to be several days in drying a kiln of pale *malt*. And if these directions be carefully observed, the *malt* will always be good.

The method of malting *Indian corn* or *Virginia wheat*, is much less laborious. For, if this corn be buried two or three inches deep in the earth, and covered with the loose mould, dug up to make room for it, in ten or twelve days time the corn will sprout, and appear like a green field; at which time being taken up, and washed or fanned from its dirt, it is immediately committed to the kiln, and by this means it becomes good *malt*. It is observable of this corn, that both its root and blade must shoot to a considerable length, before it will make *malt*; and, perhaps, this is the case in all large bodied grain.

The importation of *malt* from beyond the seas is prohibited: and on its being exported, it is not only freed from paying the excise of 6d. a bushel, but a bounty is allowed by act of parliament.

*Malt-liquors*, from the different methods of preparing the *malt*, are distinguished into *pale* and *brown*; and from the various methods taken in brewing the liquors, they are divided into *ale* and *beer*, strong and small, new and old. The colour of the liquor, and many of its effects, depend on the manner of *drying* the *malt* it is brewed with; that which has the palest tinge, is made with *malt* but *slenderly* dried; whereas that which is high coloured, is made with *malt* that is *high* dried, or roasted, as it were, in comparison of the other; and *amber-ale* is made of a *mixture* of both.

Another difference in the preparations of *malt-liquors* consists in the larger quantity of *bops* in *beer*, and the smaller in *ale*; for *bops* add something of an *alkaline* nature to the liquor, and not only render it more easy of digestion, and secretion in the body, but while it is in the liquor, prevent its running into such cohesions, as would make it rosy, vapid,

vapid, and sour: for this reason Dr. Quincy is of opinion, that for one constitution injured by *beer*, there are numbers spoiled by *ale*, which is apt to stuff the vessels with slime and viscidities, to make the body unweildy and corpulent, and to pave the way for *cachexies*, the *jaundice*, *asthmas*, and the *dropsy*.

The different degrees of *strength* in *malt-liquors*, also make them produce different effects. The stronger they are, the more viscid parts they carry into the blood: they are therefore in general the more wholesome for being small; that is, of such a strength as to carry some degree of warmth into the stomach, but not so as to prevent their being proper diluters of our necessary food. Indeed people of robust constitutions, who labour very hard, may dispense with reasonable quantities of the strongest; especially as their food is frequently poor and slender enough, the deficiencies of which this supplies; and their continual exercise and strength of body, digests and breaks the viscidities of the drink into convenient nourishment: though in persons of another habit, and way of living, they would only produce obstructions and ill humours. As to the age of these liquors, it has somewhat the same effect as hops, for those that are the longest kept, are certainly least viscid: for age, by degrees, breaks their viscid parts, and by rendering them smaller, makes them fitter for secretion.

The spirit of *malt* is thus obtained; make choice of good water. They that regard the strength more than the colour of their liquor, prefer standing waters in a flat ground, if clear and sweet, to spring or pump waters. But Sir John Moor found by experience, that the best *malt liquor* is made with water supplied by a rivulet, or brook undisturbed by navigation, fording, or floods of rain.

All waters that are not greasy, and will bear soap and lather without breaking, are good. But the best *pale malt liquor* is brewed with spring and well waters: and *Thames* water taken up near *London* makes the best beer called *Porter*.

The Brewer to malt and water adds a third ingredient called *hops*.

In the use of *hops* consists chiefly the differences of *malt liquors*; for those *hopped* are called *beer*; and those *unhopped*, *ale*. The difference made by *hop* is best discovered, from the nature and qualities of the *hops* themselves; these are known to be a subtle grateful bitter, in their composition, therefore with this liquor, they add somewhat of an alkaline nature, *i. e.* particles which are active, sublime, and rigid; by which means the ropy, viscid parts of the *malt* are more divided, and subtilized; and are, therefore, not only rendered more easy of digestion and secretion in the body; but also, while

in the liquor, prevent it from running into such coctions, as would make it ropy, vapid and sour. For want of this, in *unhopped drinks*, that clammy sweetness, which they retain after working, soon turns them acid, and unfit for use; which happens sooner or later, in proportion to the strength they receive from the *malt*, and the comminution they have undergone by fermentation.

The proportion of *hops* may be half a pound to an hoghead, of strong ale; one pound to a hoghead, of ordinary strong beer, to be soon drank out; and two pounds to a hoghead of *March*, or *October* beer; and for the after-worts, which are not to be kept long, what comes from the first wort, will serve well enough to boil again with them. If a greater proportion of *hops* be put into the first wort, and boiled all the while the wort boils, they will make it bitter.

Regard is to be paid not only to the materials, but to the season in which we brew, and to the time employed in the mashing tub, in boiling the worts, and in working them in the tun.

As to the season: the best time to brew in is from *Michaelmas* to *Lady-day*; especially *March* and *October*, for *strong beer*, intended to be kept the year round or longer. In hot weather the liquor will frequently grow acid in the mashing tub, which will always be the case, if the liquor be left on the grains till their earthy particles ferment.

The stronger the worts, and the longer they are intended to be kept: the more they require to be boiled.

As for working the worts in the tun or vat, care ought to be had always to barrel them up as soon as the barm at top begins to sink.

Five gallons of drink must be proportioned to every bushel of *malt*, *i. e.* (avoiding fractions) eleven bushels of *malt*, to every hoghead of *ale* or *beer*. But it must be observed, that in so great a disproportion of *malt-drink*, as eight to five, almost a third of the liquor, in the first wort, will be absorbed by the *malt*, never to be returned; and that an allowance is to be made of about a sixth part, to evaporate in boiling: so that if it be expected to clear a hoghead of drink, that is, fifty-four gallons, from the first wort, there must be put into the *mash-tub* near ninety gallons of liquor; but for the second and third wort, the goods being wet before, no more liquor is wanted, but what is intended to make drink, except an allowance of about a tenth part for waste, this not boiling so long as the first wort; and of this second wort may be made a hoghead of good middle *beer* or *ale*, as strong as the common ale-house drink in *London*. The third wort will make one hoghead of good *small beer*. In ordinary brewing, six or seven bushels of *malt* will make one hoghead of good strong, and another of

*small beer*; and in such case, two *moaks* will as well take out the strength of the *malt*, as three in the other.

The necessary *utenfils* for brewers, are a *copper*, *mash-vat*, *receiver*, or *under-back*, *rudder*, *lead*, or *pump*, *hand-jet*, *coolers*, or *cool-backs*; *tubs*, *tuns*, &c.

All these *utenfils* should always be kept very clean, especially the *mash-vat*, *coolers*, *tuns*, *tubs*, &c. and washed well with cold water, which is better than hot; for boiling water drives back into the wood, a certain sour, fulsome quality, which the former wort has left behind; which sourness communicates itself to the next wort, and impregnates it with that sharp quality called *pricks*, which is often the occasion why brewers *ale*, in hot seasons, will not keep above four or five days, or thereabouts; which inconveniency could be easily prevented, by keeping the vessels clean. Those that brew only for their own private family, should have their *mash-vat*, and *coolers*, tinned over; which, in some measure, would prevent the souring or *pricking* of their *ale*, in summer.

For *March*, or *October* beer, it is adviseable to have large vessels bound with *iron hoops*, containing two, three, or four hogheads, according to the quantity intended to be made, putting all into one vessel; that sort of drink digesting, and mellowing best, in the largest quantities. If the vessels were not *iron hooped*, the *March* beer would be in danger to be lost, or spoiled.

Being provided with all the implements necessary for brewing, we will begin the operation by putting our liquor into our *copper*; which done, we will strew a handful or two of bran, or meal, upon it, not so much to strengthen our liquor, as to make it heat quickly; for simple water, alone, is long ere it boils.

Some put their *malt* first in the *mash-vat*, and then pour in their liquor for the first wort; but as we follow Sir *J. Moor*, we will pour in our liquor first, for our first wort; and let our liquor remain in the *mash-vat* till the vapour from it be so far spent that we may see our face in the liquor; and then pour in the *malt* upon it; we have this further advantage, that we can keep our liquor longer hot, and it will sink gradually, distributing its strength to the liquor equally, without matting; and if it does not descend fast enough itself, we will press it down with our hands or *rudder*, with which we use to stir our *moaks*. This must be done by degrees, always remembering that we shake our sacks before we remove them, over the sides of the *mash-vat*, to get out the flower of the *malt* which sticks to them. And after all the *malt* is settled, and the liquor appears above it, we must put into the *mash-vat* as much more hot water out of the *copper*, as

will make in all ninety gallons for one hoghead; then we will stir it, almost without ceasing, till it has been in the *mash-vat* about two hours from the first putting up the *malt*.

After this, we will pull out the *rudder*, and putting a little dry *malt* a-top, we will cover it close, and leave it to stand half an hour undisturbed, that it may run off clear, and the *malt* being sunk to the bottom, the liquor a-top will run through it all again, and bring away the strength of it. After this, we must lift up our *tap-staff*, and let out about a gallon into the long-handle jet, and put it back again, stopping the *tap-hole*: we will do this two or three times, till we find it runs clear, which it will not do at first, though our *tap-hole* is never so well adjusted.

In the *North of England*, where much the best *malt-drink* is made, they are so careful of making their drink fine, that they let their first wort stand in the receivers till it is very clear, all the gross parts being sunk to the bottom; this they continue to do about three hours in summer, and ten or twelve hours in the winter, as occasion requires, which they call *blinking*; after which, leaving the sediment behind, they only lade out the fine into the *copper*; which custom is peculiar to the *North*, and wholly unpractised in other parts.

When all is run out into the receivers, or under-back, we will lade, or pump out our second liquor, ordered so as to be just then ready to boil, on our *moaks*; and putting the first wort into the *copper* again, we will let it boil reasonably fast (which boiling will be accelerated by the *hops* put on it) for about an hour and a half, for *March*, or *October* beer, to be kept long; and an hour for strong *ale* to be drank new. But wort must rather boil reasonably fast, than to stand long to simmer; because common experience shews, it wastes less, and ferments better, after so long boiling, than simmering.

Our first wort being thus boiled, must be pumped, or laded off into one or more *coolers*, or *cool-backs*, in which we'll leave the sillage behind, and let it run off fine; the more *coolers*, and the thinner it stands, and the sooner it cools, (especially in hot weather) the better. We'll let it run from the *cool backs* into the *tun*, very cool, and will not set it there to work, in summer, till it is as cool as water; in winter it must be near blood-warm; at least the bowl, in which we put the yeast, to set the rest on working, must have a mixture of wort hot enough to make it all ferment. When we find that it begins to work up thick to a yeast, we'll mix it again with our *hand-jet*, and when it has worked itself a second time to a yeast, (if we design it for *ale*, and speedy drink, and *hop* it accordingly) we'll beat in the yeast every five hours,

for two days together, in summer, or more, according as the weather is; and for three or four days in winter; covering the *vat* close, that it falls not into the working tun. When the yeast begins to work sad, and upon turning the concave of the bowl downward, sticks fast to the inside, skimming off, then, the yeast first, we must clean the rest into the vessel, leaving all the dregs in the bottom of the tun, and putting only the clean up. After it has a little fermented in the vessel, we'll find it, in a few days fine, and fit to drink; though, according to the quantity of the *hops*, we may proportion it for longer keeping. If we brew in *March*, or *October*, and have *hopped* it for long keeping, we must then, upon its second working to a yeast, (after once beating in) cleanse it into the vessel with the yeast in it, filling it still, as it works over, and leaving, when we stop it up, a good thick head of yeast to keep it.

Some make their first wort in this manner: they make their liquor near boiling hot, as above mentioned, then pour just so much into their *mash-vat* as will wet their *malt*, which they stir, and let stand half an hour, which they pretend prepares the *malt* the better to communicate its strength to the liquor; they afterwards pour the whole quantity of liquor over the *malt*, and let it stand an hour and a half, or two hours, if they want to have their first wort very strong, and the season be not too hot: then they put what quantity of *hops* they think proper into their receivers, and let their wort run to them; and after their *hops* have infused an hour and a half in their wort, they strain it off into the *coolers*, and thus pretend to have perfected their first wort. Then they put upon the *malt* their second liquor, near as hot as the first, rather cooler, if there be any difference, which they let stand on the *malt* no longer than an hour, at most; then take what quantity they please of fresh *hops*, which they put into their receivers as before, and let the second wort run to them; then take both second wort, and *hops* together, and put it into the *copper*, where they let them infuse till the wort is near boiling, and then strain this, also, into the *coolers*.

Others boil a quantity of water, which is left to cool till the height of the steam be over; then pour so much to a quantity of *malt* in the *mashing-tub*, as makes it of a consistence stiff enough to be just well rowed up: after standing thus a quarter of an hour, a second quantity of the water is added, and rowed up, as before. Lastly, the full quantity of water is added, and that in proportion as the liquor is intended to be strong, or weak. This part of the operation they call *mashing*. The whole now stands two or three hours, more or less,

according to the strength of the wort, or the difference of weather, and is then drawn off into a receiver, and the mashing repeated for a second wort, in the same manner as for the first; only the water to be cooler than before, and not to stand above half the time.

They then mix the two worts, add the intended quantity of *hops*, and cover the liquor close, boiling it in a *copper* for the space of an hour, or two; then they let it into the receiver, and the *hops* strain'd from it into the coolers; when cold, they apply the yeast, or barm, and leave it to work, or ferment, till it be fit to tun up.

It is pretended, that *March* is the best month for brewing, and the water, then, better than in *October*; but Sir J. Moor says, that he has always found, that the *October beer*, having so many cold months to digest in, proves the better drink by much; and requires not so much watching, and tending, as the *March beer* does, by being obliged to open and stop the hole on every change of weather. He says, again, that he always broached his at about nine months end; his *March beer* at *Christmas*, and his *October* at *Midsummer*; at which time he supposes it generally the best; and likewise, that it would keep very well in bottles a year or two more.

The vessel, where the *beer* is kept in, must be stopped close with cork, not clay; and there must be made near the bung-hole a little vent-hole, stopped with a spile, which is never to be pulled out till we bottle or draw off a great quantity together; by which means it is kept so close stopped, that it flushes violently out of the cock, for about a quart, and then stops on a sudden, and perles, and smiles in a glass like any bottled *beer*, though in Winter; but if once the vent-peg is pulled out to draw a quantity at once, it will sensibly lose this briskness, and be some time before it recovers it.

For *small beer*, there is a third *mashing*, with the water near cold, and not left to stand above three quarters of an hour, to be *hopped* and *boiled* at discretion.

But the best *small*, or *table beer*, is made by adding a larger proportion of liquor to the *malt*, (according as one would have it) and then mixing the first and second wort equally together.

Sir J. Moor says, that the reason why publick and common brewers seldom or never brew good drink is, that they wet more *malt* at once than it is possible they can have vessels and servants enough to work, and set it cool enough to ferment kindly; and withal brew so often, that they cannot sufficiently, between one brewing and another, cleanse and scald their brewing-vessels and barrels, giving them due time to dry; but that they will retain such

such a rust (as I have observed already) as will always *char* and *four* their liquor. My *brewers*, says he, have been so cautious in this particular, that if any servant's had, by accident, made use of any *long-banded jet, hand-jet, or pail*, washed with cold water, during the *brewing*, they would scald it a-new, and let it dry, before they would use it again.

## Of CANDLE - MAKING.

**C**ANDLES are made of various kinds of materials. A candle consists of an outward and an inward matter. The outward matter is either *wax, sperma-ceti, tallow, or fat* of beasts. The inward matter is either twisted *cotton, tow, or rushes* properly prepared.

As to the form of candles; they are made of various sizes, both as to length and thickness; and their common figure is cylindrical; and they are commonly of an even superficies; but the most genteel are fluted.

WAX is the produce of bees, and the best way to chuse it is by its colour, smell and substance: for the best is that of a *high colour*, an agreeable smell, brittle, and which does not stick to the *teeth* when *chewed*.

This sort of *wax* is *bleached*, or whitened, by reducing it first into little bits, or grains, by melting it, and throwing it, while hot, into cold water; or else by spreading it into very thin leaves, or skins. This *wax*, thus granulated, or flatted, (though it is best to be granulated) is exposed to the air on linen cloths stretched tight on a frame. raised three or four feet above ground, and exposed in an open place, or garden, to the most powerful beams of the sun; the granulated *wax* is spread thin over it, where it rests night and day, having equal need of sun and dew. Then it must be melted, and granulated over again, several times, still laying it out to the air in the intervals between the meltings. When the sun and dew have at length perfectly *blanched* it, we'll melt it for the last time, in a large kettle, out of which we'll cast it with a ladle upon a table, covered over with round cavities, of what bigness we please to form our *wax* into cakes; having first wetted those *moulds* with cold water, that the *wax* may be the easier got out. These cakes must be laid out to the air, for two days, and two nights, more or less, according to their *thickness*, to render it more transparent, and drier.

Our *wax* thus prepared, we'll go to work, beginning with *tapers*. *Tapers* are of a conical figure, still diminishing from the bottom, which has a hole to receive the hook of the candlestick; and are made either with a *ladle*, or with the *hand*.

To make *tapers* with the *ladle*, the *wicks* must be cut of the proper *length*, and a dozen of them tyed by the neck, at equal distances, round an iron circle, suspended directly over a large basin of copper tinned, and full of melted *wax*; then a large *ladle* full of this *wax* is poured gently, by inclination on the tops of the *wicks*, one after another; so that running down, the whole *wick* is thus covered, the surplus returning into the basin; where it must be kept warm, by a pan of coals underneath it. We must thus continue to pour on the *wax* till the *taper* arrives at its destin'd bigness; still observing, that the three first *ladles* be poured on at the top of the *wick*. the 4th at the height of  $\frac{1}{4}$ , the 5th at  $\frac{1}{2}$ , and the 6th at  $\frac{3}{4}$ ; by which means, the *taper* arrives at its pyramidal form: which done, the *tapers* must be taken down hot, and laid a side of each other in a feather-bed folded in two, to preserve their warmth, and keep the *wax* soft; then they are to be taken and rolled one by one, on an even table, usually of walnut-tree, with a long square instrument of box, smooth at the bottom, the roller having been before moistened with water, to hinder the *wax* from sticking to it. The *taper* being thus rolled and smoothed, its biggest end is cut off, and a conical hole made in it with a peg shaped in that form, which must be also moistened with water, and the *taper* rolled all the while the said peg is thrusting into it, to facilitate its introduction. While the *taper* is yet warm, roses, and other figures may be made upon it, with pincers made of box, and may be adorned with gold leaves. This first manner of making *tapers*, has been for a considerable time almost out of use, by reason of its being too tedious, too precarious, and because *tapers* thus made are very fragile, or easily broken, even when exposed to the least heat.

Therefore the most practised method of making *tapers* at present, is, by the *hand*; which is done thus: the *wax* being cut into pieces, and each piece weighed, according to the intended weight of each *taper*; those pieces are put into hot water contained in a brass cauldron tinned, very narrow and deep, to be softened; which is not done by the hot water alone, but the *wax* must be worked with the *hands* several times in the hot water, to reduce it to a due softness, that it may be worked with ease, and

without being brittle: We must observe, likewise, that the water should not be too *hot*; for then it would make the *wax* run, and stick to the *hands*; but it must be of such a moderate heat, as the workman may bear his hands in it to take out the *wax*; which being brought to a competent softness, the workman hangs an end of his *wick* on a hook fixed on some place and at a moderate height; then takes out a piece of the *wax*, which he works for the last time in his *hands*; then having given it the shape of a little channel, fixes it on the *wick* at that end tyed to the hook; then greasing his hands with oil, or lard, but most commonly with oil, disposes his *wax*, by little and little, round the *wick*, beginning with the biggest end, and diminishing gradually, till he arrives down to the lower end, which is to be the neck of the *taper*, and where he cuts its *wick*; and then carries his *taper* to the table to be rolled, and perforated, as those made with the *ladle*. *Tapers* made in this manner are stronger, and burn a great deal longer, and in *hot weather* will rather bow than break.

*Cylindrical wax candles*, are either for the table, or drawn. The first kind are made of several threads of cotton loosely spun, and twisted together, covered with the *ladle*, and rolled, as the conical ones, but not pierced.

*Drawn wax candles*, are so called, because actually drawn, in the manner of wire, by means of two large rollers, or cylinders of wood, turned by a handle; which turning backwards and forwards several times, pass the *wick* through melted *wax* contained in a brass basin, and at the same time through the holes of an instrument like that used for drawing wire, fastened at one side of the basin; so that by little and little the *candle* acquires any bulk at pleasure, according to the different holes of the instrument through which it passes. By this method may four or five hundred ells length be drawn running,

TALLOW is a sort of animal fat melted down, and clarified. There are scarce any animals but a sort of *tallow* may be prepared from; but those which yield the most, and whereof the most use is made, are the horse, bullock, sheep, hog, goat, deer, bear, &c. But the best *tallow* for *candles*, must be half sheep's, and half bullock's; that of hogs making them gutter, gives an ill smell, and a thick black smoke. *Candles* made of dripping or other kitchen-stuff as they call it, are of little or no service; for besides that, they give but a very bad light, they are almost as soon burnt as they are lighted.

The best *tallow* is that which is hard, has a blueish cast, and when handled does not feel greasy. This *tallow* is made by cutting the *fat* of the

animal, *viz.* of bullocks and sheep into pieces, (though *tallow* made wholly of *sheep's fat* be the best, and makes finer *candles*) and throwing it into a pot or boiler, while it is melting it must be skimmed of all its impurities; and when entirely melted, it is strained through a sieve made for that purpose, to free it of the impurities which could have escaped the skimmer; which is a great deal better method than that of throwing water into it to precipitate those impurities; for the water communicates a certain humidity to the *tallow*, which hinders the *candles* from burning well, and is the cause why they so often crackle and spit in the burning. Though it be the common practice here in *England*, where, after the *tallow* is melted, they empty it, thro' a sieve, into a tub, having a top for letting it out as occasion requires; and use it after it has stood three hours.

The liquid *tallow* is drawn off from the tub, which has a tap for letting it out into a vessel called the mould, sink, or abyss, of an angular form, like a prism, except that it is not equilateral; the side on which it opens being only ten inches high, and the others which makes its depth, fifteen. On the angle, formed by the two great sides, it is supported by two feet, and is placed on a kind of bench, in form of a trough, to catch the droppings, as the *candles* are taken out each dip. In *France*, their mould, sink, or abyss, is a stone vessel, glazed within and without, of about two feet long, a foot and a half deep, and four or five inches broad a-top. This they fill up from the copper, or *poile*, as they call it, wherein they keep their *tallow* melted over a very slow fire, to keep it always in a due consistence, that they may be capable to supply the stock in the mould, when it begins to be too much diminished. Before the artist sets his mould for the operation of dipping, he has all his *wicks* singed over a flame, to singe off all the nap, which would be upon them, which is so often the occasion why *candles* run and sear; and after they are thus sing'd, they are rubbed again with a piece of cloth, to make them smooth. Then they are all put upon five or six broaches, more or less, according to their quantity, and each broach immersed once, the *wicks* being all in a heap upon each broach; after which immersion the *wicks* are all parted, one by one, smoothed and straitened with the fingers, and then strung on other broaches, by sixteen, if the *candles* be eight in the pound; by twelve, if of six in the pound, &c. In my opinion, this first dipping contributes much towards making the *candles* strait, as well as facilitating the first immersions, which otherwise would be attended with some difficulty, each *wick* without it being too light to be immerg'd with ease; while,

on the contrary, being render'd heavier by the *tallow* they have gather'd in that first immersion, that weight helps towards their precipitation into the *tallow*, and keeping at a due distance from each other.

The *wicks* being thus disposed upon the *broaches*, they are hung on a rack, and then the workman, sitting at a due distance from his mould, takes two *broaches*, at a time, and holding them equidistant, by means of the second and third fingers of each hand, which he puts between them, he immerses the *wicks* two or three times for their first lay, and holding them sometimes over the top of the vessel, to let them drain, strikes gently the ends of the *candles* against the said top, to make it round, (which striking is repeated every time the *candles* are immerg'd, and till they are quite finish'd, which saves the trouble of passing them, after they are made, over a flat brazen plate, heated to a proper pitch by a fire underneath, to take off their peak'd ends, or bottoms) then he places again the *broach* on the same rack he has took it from, which, for greater conveniency, should be placed on his right hand, beginning at the end next to him, and proceeding thus to the further end, that when he has immerg'd all his *broaches*, he may come back to the first *broach* he had begun with, and so on to the others successively, that each *broach* may have time to dry before 'tis dipp'd again; which dipping is to be repeated as often as the workman judges it proper to bring the *candles* to the thickness propos'd; with the last dip the *candles* are naked, *i. e.* plung'd below that part of the *wick* where the other lays ended. During the whole operation, the *tallow* is to be stirred from time to time.

We'll proceed to the making of *mould candles*; which to perform, we have provided ourselves with brass and tin *moulds*, which are the best, which *moulds* consist of three pieces, the neck, shaft, and foot. The shaft is a hollow cylinder, of the diameter and length of the *candle* propos'd; at the extremity of this is the neck, which is a little cavity, in form of a dome, having a moulding within side, and pierced in the middle with a hole big enough for the *wick* to pass through. At the other extremity is the foot, in form of a little tunnel, through which the liquid *tallow* runs into the *mould*. The neck is soldered to the shaft, but the foot is moveable, being applyed when the *wick* is to be put in, and taken off again when the *candle* is cold. A little beneath the place where the foot is applied to the shaft, is a kind of string of metal, which serves to support that part of the *mould*, and to prevent the shaft from entering too deep in the table, to be mentioned hereafter. Lastly, in the hook of the foot is a leaf of the same metal, sol-

dered within-side, which advancing into the center, serves to keep up the *wick*, which is here hooked on precisely in the middle of the *mould*.

Having thus describ'd the *mould*, we'll proceed to the operation, by introducing, first, by a piece of wire, the *wick* into the *mould*, through the aperture of the hook, till it comes out at the neck, to which it must be tyed, so that in drawing the wire back the *wick* comes along with it, leaving only enough a-top for the neck; the other end is fastened to the hook, which keeps it perpendicular. Then we'll dispose the *moulds* in the table above-mentioned, pierced full of holes, each an inch in diameter: These holes receive the *moulds* inverted as far as the string in the foot. Being thus placed perpendicularly, we'll fill them with melted *tallow*, (prepared as before) by pouring it into the foot with a pot, or ladle. After the *moulds* have stood long enough to cool, for the *tallow* to have arrived at its consistence, the *candle* is taken out, by taking off the foot, which brings the *candle* along with it. This sort of *candles* is more agreeable to the sight, light better, and last longer, than the dipped ones, and cost but a trifle more.

All these candles and tapers are made of *cotton* or *tow*.

The *cotton* is bought in skeins, ready spun, by chandlers. In the countries where that commodity is not easily come at, its want is supplied by *tow*, which being spun and whitened, makes as good wicks as cotton itself. The threads, either of *cotton* or *tow*, are wind'd of three or four together, according to the intended thickness of the *wicks*, into bottoms or clues, whence they are cut out with an instrument, contriv'd for that purpose, into pieces, for the length of the *candle* required. If the threads be made of *tow*, care must be taken, in cutting the *wicks*, to pick out and free it of all the small rushes which could have been left in it, and which otherwise would make the *candle* slear, and run; each *wick*, after it is cut, must be slightly twisted, and rubbed, with a coarse piece of cloth, else it would not keep on twisted. Then they must be put on the sticks or broaches, then hung up to dry, in some place near the fire, or in a stow; for unless the *wick* be thoroughly dry, the *candle* will never give a good light.

The *candles*, whose *wicks* are made of *rushes* are called *rush-lights*, and are generally used by poor people, or to burn steady instead of a lamp in a bed-chamber, where a light is required.

There is another sort of *candles* called *flambeau*.

FLAMBEAUX are made square, usually of four *wicks*, or *branches*, of an inch thick, and about three feet long, made of a coarse hempen yarn

half twisted. They are made with the *ladle*, much the same as *tapers* are, *viz.* by first pouring the melted wax on the tops of the several suspended *wicks*, and letting it run down to the bottom: this is repeated twice. After each *wick* has thus got its several cover of *wax*, they are laid to dry, then rolled on a table, and four of them joined together by being soldered with a red hot iron. When joined, more *wax* is poured on them, till the *flambeau* is brought to the size required, which is usually a pound and a half, or two pounds. Their form, or outside, is finished with a kind of polishing instrument of wood, by running it along all the angles formed by the union of the *branches*.

The *flambeaux* of the antients were made of

wood dry'd in furnaces, or otherwise. They used divers kinds of wood for this purpose; the most usual was pine. *Pliny* says, that in his time they frequently also burnt oak, elm, and hazel. In the 7th book of the *Æneid*, mention is made of a *flambeau* of pine; and *Servius* on that passage remarks, that they also made them of the cornel-tree. *Flambeaux* are sometimes made of *white wax*, and sometimes of *yellow*; but those made of *white wax* are finer, light best, and are of a less offensive smell; though in all *flambeaux*, let them be made of *white*, or *yellow wax*, both sorts of *wax* are always more or less sophisticated. They serve to burn a-nights in the streets, as also at funeral processions, illuminations, &c.

Of CHIRURGERY, or SURGERY.

CHIRURGERY, or SURGERY, is that branch of *medicine*, which teaches the method of *curing* WOUNDS of all kinds, and performing a variety of *manual operations* necessary in *dislocations*, *amputations*, *cutting* for the stone, *fractures*, *phlebotomy*, the *Cæsarean section*, &c.

It is derived from the Greek *χειρ*, a hand, and *εργον*, operation, and it is divided into *speculative* and *practical*, one whereof does that in effect, which the other teaches to do.

All the operations of *Chirurgery* are reduc'd under four kinds; 1. the *synthesis*, 2. *diæresis*, 3. *exæresis*, and 4. *prothesis*.

The *SYNTHESIS* is that, which reunites all the divided parts; as are the *wounds*.

The *DIÆRESIS* is that, which divides and separates the parts, whose union hinders the cure of maladies; as is the *continuity* of the *skin*, and of the *flesh* in abscesses, which must be open'd to procure the evacuation of the *pus* contain'd therein.

The *EXÆRESIS* is that, which extracts from the body all, which could be hurtful to it; as *bullets*, *arrows*, *pus*, &c.

The *PROTHESIS* is that, which supplies, artificially, the want of some parts; as, of *legs*, *arms*, &c. when the natural ones are lost. It adds, besides, some instrument, to help the weak parts; as *peffaries*, to keep the *matrix* in its place, when it falls; *crutches* to help walking, when a person is weak, &c.

The foundation of *Chirurgery* consists in three things, *viz.* in the knowledge of the *human body*; of the *maladies*, which want the *operation of hands*; and of the proper *remedies*.

The knowledge of the *human body* is acquir'd by the study of *Anatomy*, of which we have given an accurate treatise under the letter *A*. That of the *maladies*, I. By reading good books, and the lessons

of the best masters in *Chirurgery*; and, 2. By a constant and assiduous practice.

The *maladies* which fall under the consideration of a *Chirurgicon*, are tumours, impostumes, wounds, ulcers, fractures, dislocations, and generally all maladies, which can be the subjects of operations.

The MEANS and INSTRUMENTS us'd in *Chirurgery*, to cure those *maladies*, are the *hand*, *bandages*, *medicaments*, *iron*, and *fire*.

The INSTRUMENTS are *portative*, and *non-portative*.

The *portative instruments* are those, which a *Chirurgicon* carries in his case, together with his box of *unguentums*, as a good pair of scissars, a razor, a *bistouri*, straight and bow'd, a *spatula*, a great *lancet* for the abscess, smaller ones for bleeding, a *hollow probe*, of silver or steel, several other *probes*, straight, bow'd, &c. of several sizes; a silver *canule*, or pipe, to carry the button, or knob of fire to a distant part without any danger of burning the neighbouring ones; another *canule*, or pipe, for a case for needles, made like a whistle at one end, for the *utures*; a big triangular needle, call'd *carlet*, a *myrtle-leaf*, a *small file*, instruments for tooth-drawing, a lenticular, an *errhina*, &c.

The *instruments non-portativs*, are the *trepan*, to open the bones of the head, or other parts; the *algabus*, or *probes*, for men and women in the stone, and difficulties of urine; large bow'd cutting knives, a saw for amputations, great three-square needles for *setons*, small needles for the ablation of the *cataract*, small plates and buckles.

From the *instruments*, we'll proceed to *compresses*; *bands*, *splinters*, *fanons*, *tents*, and *lint*.

A BAND is a long and large string made of linen, wherein the parts and *apparatus* are wrapp'd up, and contain'd.

A *BANDAGE* is the *band* apply'd on the part. There are as many different sorts of *bandages*, as there are parts to be ty'd; therefore they are either *simple* or *compound*.

The *COMPRESSES* must be made even, soft, and in proportion to the bigness of the part, or of the wound. They must be garnished in uneven places, that the bandages may be the easier rolled over them, and humect'd with some liquor proper to the malady.

The different *MALADIES* which fall under the inspection of a *Chirurgion* are *tumours* in general.

A *TUMOR*, or *tumour*, is a particular rising, or eminence, on any part of the body; otherwise, it is a solution of continuity, arising from some humour collected in a certain part of the body, which disjoins the continuous parts, insinuates itself between them, and destroys their proper form.

This gathering of humours in the parts of the body, is call'd *depositum*, which *depositum* is made either by *fluxion*, or *congestion*.

A *Depositum* by *fluxion* is that, which forms the *tumour* all on a sudden, or in a very short time, by the fluidity of the matter. And a *Depositum* by *congestion* is that, which produces the *tumour* by degrees, and almost insensibly, thro' the slowness and thickness of the matter.

The most dangerous of all *tumours* are those made by *congestion*; because their coarse and thick matter renders their cure very difficult.

The general rules which a *Chirurgion* is indispensibly oblig'd to observe before he undertakes the cure of *tumours*, are these: 1. He must examine the nature of the *tumour*; because that which is natural, is otherwise treated than that which is *ankist*, critical, or malignant. 2. The time of its formation, *i. e.* its beginning, increase, state, and declension; in which different periods there must be apply'd different remedies. And, 3. Its situation, that the *Chirurgion* may avoid, in the opening of the *tumour*, the encounter of a neighbouring artery or tendon.

We must observe, also, that all *tumours* terminate, or are remov'd by *suppuration*, or *resolution*. The safest manner to cure a *tumour*, is by *resolution*, except when the *tumours*, or *abscesses*, are critical and malignant; for, then the *suppuration* is not only the surest way, but must be procur'd even by opening it; without waiting for a perfect maturity. In such opening, the *Chirurgion* must take a great deal of care not to cut the fibres of the muscles, and ought not to procure an entire evacuation of the *pus* at once, especially in great *abscesses*, for fear the patient should faint away; neither is such opening to be made, always, longitudinally, or according to the straitness of the fibres; for when the *tumours* are large, and there is a *cystis*, the incision must be *crucial*, or *radice* or *oblique*.

†

To proceed in the cure of *tumours*, let us begin with the *phlegmon*.

The *PHLEGMON*, from the *Greek* φλεγμων, to burn or inflame, is a *tumour* attended with redness, tension, renitency, pulsation, and great pain; which when occasion'd by an extravasated blood, good and laudable, but only peccant in quantity, is call'd, *true phlegmon*; but if that blood be adulterated with bile, or *pituuta*, it is call'd *bastard phlegmon*.

There are two sorts of remedies proper for the cure of *phlegmons*, the one general, and the other particular. The general remedies, which carry off the antecedent cause, are bleeding, and an exact diet. Purgatives cure sometimes the *phlegmon* in its *antecedent cause*, by diminishing the plenitude, heat, and alteration of the blood. Fomentations, cataplasms and plasters, cure it in its *conjoint cause*, by procuring the resolution, or suppuration; all which different remedies ought to be administr'd in order, and with judgment, *v. g.* Bleeding is to be done in the beginning and augmentation, or increase of the *phlegmon*. The resolutive and anodyne remedies are necessary, such as those prepared with *chervil* boiled in whey, to which is to be added some saffron, to wash the tumour with, which must be wrapt in cloths dipped in the same liquor. The sperm of frogs alone, or lime and soap water mixed together; or else oak and plantain leaves bruised and applied on the part, are also very good remedies for the *phlegmon*; avoiding above all things cold remedies, oil, and grease, which are pernicious in great inflammations. These are the remedies by which we must begin the cure.

But in the augmentation of the *tumour*, and of the pain, it must be softened by resolution; and for that purpose a cataplasm is compos'd with leaves of elder, with mallows, camomile, and melilot, to which is added pounded linseed, boiling the whole in whey, adding to a pound of it the yolk of an egg, twenty grains of saffron, a quarter of a pound of honey, and crumbs of bread, till it has acquired a due consistence for a cataplasm, which must be renewed every twelve hours at least.

When the *phlegmon* is arriv'd at its height, if it could not be brought to a resolution, its suppuration might be procur'd, by adding to the aforesaid cataplasm, garlick, the roots of white lilies broiled under the embers, whey and basilicon: Or else we'll take only a glass of whey, in which we'll melt an ounce of soap, to dip cloth in it, which we'll apply on the tumour, reiterating it often. The plaster *diaphosphuris* is very excellent alone.

When the malignity is conquered, and the *phlegmon* is on its declension, the ulcer must be dried by degrees with the plaster *diaphosphuris*, or the *diachylum*, afterwards we'll use those of *ceruse*.

If, during the inflammation, the gangrene should happen:

happen, there must be dissolved in an ounce of the best vinegar, a drachm of white vitriol, with the same quantity of *sal-ammoniac*, to bathe the tumour with, or else we'll take the tincture of myrrh, and of aloes, with some *Ægyptiac*, and we will make afterwards a digestive with terebinth, yolks of eggs, and honey, mixing with it some spirits of wine, or brandy, if any purulent matter was left behind.

*Bastard pblegmons*, otherwise *pblegmonous tumours*, are *buboes*, *carbuncles*, *furuncles*, *antrax*, *phigeton*, *phyma*, &c.

All these *tumours* are cured with emollient, resolutive, and suppurative cataplasms and plaisters, applied with judgment, and in proportion, as 'tis done to the *pblegmons*.

The same cannot be said of the *gangrene*, which is distinguished into *gangrene* and *sphacelus*, though they be but one and the same thing; the *gangrene* being a mortification begun, while yet the part retains some sense of pain, and a share of natural heat; and the *sphacelus* a thorough mortification, where there is no sense or warmth left.

The *gangrene* is a disease in the flesh of the part, which it corrupts, consumes, and turns black; spreading and seizing itself of the adjoining parts: it proceeds from a stoppage or interception of the circulation of the blood, which by this means fails to furnish the part with the nutritious and spirituous juices, necessary to preserve its warmth and life.

To stop the progress of the *gangrene*, Physicians prescribe, internally, sudorifics and alexipharmicks: Externally, decoctions of quick lime, either simple, or with the addition of *sulphur*, *mercurius dulcis*, and *spirit of wine* camphorated. In a severe stage of the distemper we scarify deep to the very quick; and afterwards apply hot liquors, cataplasms, &c. Some recommend horse-dung boiled in wine, or urine: The *unguent Ægyptiac* also comes into use. *Belloste* prescribes the following as the most efficacious remedy known for *gangrenes*, viz. *quicksilver* dissolved in double the quantity of *spirit of nitre*, or *aqua fortis*; a linen cloth dipped therein, and applied to the *gangrenous* part: this alone, he assures us, is sufficient. If the *gangrene* be occasioned by an intense frost, *snow-water*, or a linen-cloth dipp'd in cold water, and applied to the part affected, *Boerhaave* directs as the best cure. If the *gangrene* proceed to an entire *sphacelation*, and be seated in any of the limbs, or extreme parts, recourse must be had to amputation.

The *panaris*, *panaritium*, or *paronychia*, (from the Greek *παρονυχια*, q. d. an abscess at the root of the nails) is a *tumour* or inflammation arising on the extremities of the fingers or toes, properly called *whitloe*.

An infallible remedy for the *panaris*, is to open it either with a point of a lancet, or with some un-

guent, and then to dip the finger in a *lixivium* made of pine ashes.

*Chilblains* are cured by washing and holding, for some time, the heel or other part affected in hot wine, where have been boiled *allum* and *salt*, of which a cataplasm is made, afterwards, by adding to it *rye-flower*, *honey*, and *sulphur*. The juice of radishes and also of turneps applied hot, with *unguent of roses*, is also a very good remedy.

The *burn* is cured by anointing the part with sweet oil, or with soft soap, or with white ointment, mixed with *unguent of roses*, and of *populeon*, the yolk of an *egg* and quick lime. If the *burn* be in the face, there must be particularly used the *mucilage* of *quince-seeds*, and of *psyllium*, of *sperm of frogs*, equal part of each, and to four ounces thereof must be added twenty grains of *sugar of saturn*. This remedy is spread on the face with a feather, and over it, is applied a piece of grey paper. This remedy is excellent.

If the *burn* has made a crust, 'tis taken off with fresh butter, spread on a cabbage-leaf, applied hot: or opened for the evacuation of the *pus*, which would cause a deep ulcer, if kept long under it, and there must be applied to it the *unguent of quick lime*, with *oil of roses*, and *yolks of eggs*.

The next sort of *tumours*, to be considered are the *erysipelas*, and its dependencies.

*Erysipelas* is an eruption of a fiery or acrid humour, from which no part of the body is exempted, though it chiefly attacks the face.

As to the material cause of an *erysipelas*, it seems to be of a caustic, acrid, and putrifying nature; perhaps corrupted *bile*, which, being conveyed into the mass of blood, indispotes the whole nervous and vascular systems, and excites a fever, till it is at last driven out to the surface of the body. Persons of a sanguine habit, young people, and pregnant women, are most subject to it; and all hot things, violent passions, and whatever occasions other inflammations, likewise give rise to this.

The patient is taken suddenly, whilst he is in the open air, with chillness, a shivering and other symptoms common in a fever: the part affected swells a little with great pain, and intense redness, and is beset with a vast number of small pustules, which, when the inflammation is increased, are converted into small blisters. The malady gradually creeps further and further, spreads itself from place to place, and is attended with a fever.

There is another sort, though it seldom happens, commonly arising from a surfeit, or a debauch of drinking spirituous liquors. A small fever, which precedes it, is followed presently by an eruption of pustules, almost all over the body, which look like the stings of nettles, and sometimes rise up into bladders: presently they go away again, with an itching

itching scarce tolerable; but as often as they are scratched, they appear again.

This distemper has a great affinity with a pestilential fever, as it is attended with most of the symptoms in that case: but this is to be understood of the worst kind of *erysipelas*. On the third and fourth day, the malignant matter is thrown out on the surface of the body, and then the symptoms a little abate. There is often a pain, redness, and *tumour* in the inguinal glands, from whence the matter, of a hot, fiery quality, descends to the feet. If the head is attacked, the parotid glands are affected; if the breast, the axillary. The mammary and axillary glands are not seldom ulcerated, and affect the joints with a virulent corruption; and likewise, as in the plague, there is nothing more dangerous than the expelled matter to return back from the surface of the body to the inward parts.

In some, especially young persons, the matter is not so violent, nor the fever so great: the glands remain unaffected, and the eruption happens on the second day. This is not at all dangerous. In children, the umbilical region generally suffers, with a fatal event. If in a day or two the *tumour* subsides, the heat and pain cease, the rosy colour turns yellow, the cuticle breaks, and falls off in scales, the danger is over. When the *erysipelas* is large, deep, and falls upon a part of exquisite sense, the patient is not very safe; but if the red colour changes into black and blue, it will end in a mortification. If the inflammation cannot be discussed, it will suppurate, and bring on *fistulas* and a *gangrene*: when the patient is *cacochymical*, the leg will sometimes swell three times as big as the natural size, and is cured with great difficulty. Those who die of this disease, die of the fever, which is generally attended with difficulty of breathing, sometimes a delirium, sometimes with sleepiness; and this in seven days time.

Let the patient's diet be water-gruel or barley-broth, with roasted apples. If he drinks any beer, let it be very small, and let him keep out of bed some hours in a day.

The medicinal writers do not agree in their opinions, concerning purging in the cure of the *erysipelas*; but what they deliver upon this subject, is full of doubtings and uncertainties, and that at a point of time when the distemper is most dangerous and threatening: however, it is the general opinion in this case, that it is a right practice, more especially if the head is affected with an *erysipelas*, and there comes upon it a *coma*, a *delirium*, or *convulsions*, wherein the brain is evidently attacked; then purging is the only indication that can afford any hopes of recovering the patient: nor in these difficulties should the matter be delayed till the fever is abated, or the humour subsided. Therefore, the

best practice appears to be that of taking away nine or ten ounces of blood, and the next morning giving the patient the common purging portion.

It will be safest to avoid external applications, unless a powder made of elder-flowers and liquorice sprinkled on the part; or lime-water-mixt with a fourth part of spirit of wine and camphire, dipping a linen cloth in it several times doubled, and applying it hot to the part.

An infusion of scordium, elder-flowers, and fennel-feed, drank in the manner of tea, is useful to expel the morbid matter. If the disease does not yield to the first bleeding, let it be repeated. If that will not do, let it be reiterated twice more, one day being interposed between. On the days free from bleeding, prescribe a clyster of milk, and syrup of violets; also the cooling emulsion and julep.

Turner commends much a mixture of *ol. sambucin.* and *aqua calcis*, with some spirit of wine camphorated. A cataplasm of cow's dung is very good to ease the pain.

In a *symptomatic erysipelas*, the following liniment is good: R *Ol. sambucin.* lixiv. *tenuior.* ana p. æ. m. let them be shaken in a phial till they unite in an ointment.

In a *scorbutic erysipelas*, besides externals, sudorifics are to be given; as *rob. sambucin. spi. samb. ci. bezoar. min. sp. sal. ammon. cochlear.* &c.

From the *erysipelas* we'll pass to the *Oedema*.

The OEDEMA, (from the Greek *οίδημα*, I swell; whence *οίδημα*, a *tumour*;) is a *tumour*, which appears whitish, soft, and lax, without any notable change of colour, heat, pain, or pulsation; and which yields to the pressure of the finger, so as for some time to retain the dent or impression thereof.

Its chief seat is in the legs: In a *leucophlegmatia* the whole body is *oedematous*.

Fomentations, cataplasms, liniments, and plaisters, are very good remedies for the *oedema*. The fomentations are made with *wall-wort*, tied in bundles, covered with hot wine, and put in an oven after the bread has been took out; they are also took out smoaking hot, the bundles are untied, and the part is wrapp'd up within them, covering them over with a hot cloth. This being often reiterated, the humour transpires by sweat. The cataplasms are composed of *camomile*, *melilot*, *St. John's wort*, *sage*, *parietary*, the root of *briony*, *onions*; the whole boiled in *white wine*, with *honey*. Cataplasms are also made with *horse-dung* and *cumin seeds* boiled in strong *vinegar*, mixing with it *barley-flour* to the consistence of pap. The plaisters are prepared with an ounce of *diachylum de gummis*, half an ounce of *martiatum*, a pound of *oil of lilies*, half an ounce of *cumin-seeds* in powder, half a drachm of *sal-ammoniac*, and an ounce

of yellow wax, to bring it to a consistence. If there was a hardness, the plaister made with the gum of *bdellium*, *ammoniac*, and *galbanum*, dissolved in vinegar, must be used.

OEDEMATOUS *aposthumes*, or *tumours*, which partake of the nature of the *Oedema*, are, the *phlyctains*, *empysima*, *batracos*, or *ranuncle*, the *wyne*, the *talpa*, the *broncocel*, the *ganglion*, the *fungus*, the *king's-evil*, and all the species of *dropsies*, general and particular.

All the remedies prescribed for the *oedema* are also employed variously in all these maladies, as are liniments, fomentations, cataplasms, and plaisters. Internal remedies, such as diaphoreticks, sudorifics, and purgatives, supported with an exact diet, are of great service. The decoction, of *briony*, and *marshmallow roots*, with *betony*, *liquorice*, and all other diureticks, which push by urine, give a great deal of ease.

The *SCIRRHUS*, (from the Greek *σκιρθε*, a piece of marble) is a hard indolent *tumour*, formed gradually in the soft glandulous parts of the body; sometimes internal and sometimes external.

The *scirrhus* is cured by softening and resolving it, seldom by bringing it to *suppuration*. 'Tis softened by the application of cataplasms, made of the leaves of *violets*, *mallows*, *marshmallows*, *leeks*, *alder*, *rue*, and *wormwood*; with *camomile flowers*, *horse* and *cow's dung*, and roots of *white lilies*, all this is boiled together in wine, to which are to be added *honey* and *hog's-lard*, to make a cataplasm, with crumbs of bread. 'Tis resolved with plaisters composed of *diachylum*, *melilot*, and *mucilages*, to which are added the *oil of worms* and the *flour of sulphur*. And to render the remedy more efficacious, the *oil of tobacco* and *gum ammoniac* dissolved in vinegar. These topical or external remedies must be accompanied with internal, which serve to prepare the humours to be evacuated, as the decoction of *sarsaparilla*, the use of good wine, and light aliments, of an easy digestion.

The *POLYPUS*, *πολυπους* or *πολυπος*, is a fleshy *tumour* or excrescence, on the inside of the nostrils, prejudicial to respiration, or speech; call'd also, by way of distinction, *polypus narium*.

*Polypus* is also us'd for a morbid excrescence in the heart; consisting of a tough concretion of grumous blood lodg'd therein.

The *polypus* of the nostrils may be cured in its beginning, but when neglected, or ill managed, it degenerates into an incurable cancer. The general remedies are small bleedings, and reiterated purgatives, with an exact diet; of the particular ones, are those which dry up and consume the excrescence; as the decoction of *plantain*, *betony*, and *parietary*, in red wine, which must be drawn up

the nose, or introduced into it with small tents, often renewed, adding to it some tincture of *myrrh*, and *honey*. If the distemper cannot be conquered by remedies, recourse must be had to the extirpation thereof.

The *NACTE*, *longing*, is a *tumour* or excrescence of the flesh, which grows on the face, and every where else; occasioned by the urgent desires of the mother during gestation, for things which she has not enjoyed, as she could wish.

The *CANCER*, is a roundish, hard, ragged immoveable *tumour*, of an ash or livid colour; encompassed round with branched, turgid veins, full of black muddy blood; situate chiefly in the glandulous parts. There have been some found in the gums, belly, neck of the matrix, ureter, lips, nose, cheeks, abdomen, thighs, and even the shoulders.

*Stollerforth* observes, that it has been often cured by mercury and salivation. It is usually cured, while yet a small *tumour* of the bigness of a nut, or at most of a small egg, by *extirpation*: when it seizes the breast, or is burst into an ulcer, *amputation* takes place.

Having thus treated of all the different species of true *tumours*, we'll pass to the *encisted* or *bastard* ones.

*ENCISTED tumours*, are those formed by a *deposited* of mixt and corrupted humours, whose matters are contained in *cystis*, or membranous bags.

The species of those *tumours* are the *steatoma*, *atheroma*, *meliceris*, &c. The *steatoma* is known by its matter, which resembles tallow; the *atheroma* by its softness resembles pap; and that of *meliceris* resembles honey.

These sorts of *tumours*, like the others heretofore mentioned, should be resolved; but however, the surest way is to bring them to *suppuration*, and to extirpate the *cystis*, which is subject to be filled again, after the resolution of the humour. All the remedies used for the *oedemas* and *scirrhus* are very good for these *tumours*. The specificck ones are these: Take *rosemary*, *sage*, *wormwood*, *elder*, *camomile*, *melilot*, *St. John's wort*, put them to boil in white wine, with mercurial honey, add to it the seeds of cummin pounded, and the oil of worms, to compose a cataplasm, which must be renewed twice a day, after which, if the *tumour* cannot be dissipated, you must apply the following plaister, which is excellent: take equal parts of *diachylum* and of *devigo*, four parts of mercurial plaister, melt them together, and mix with them saffron and oil of tobacco, to make a plaister, which you'll spread upon a piece of leather and apply on the *tumour*, without removing it but once in eight days to renew it.

As for the extirpation of the *cystis*, it is made by dividing the *tumour* into four parts, by procuring the

the suppuration, and consuming the *cystis* by degrees.

The SCURVY is a malady common among us. *Wallis* says, that the *scurvy* is not a particular disease, but a legion of diseases, by its attacking the several parts of the body at once.

The most usual symptoms of the *scurvy*, are, sinking ulcers in the mouth, a copious salivation, head-ach, vertigo's, epilepsies, apoplexies, paralyties; the face appears of a pale and dark red, swelled, inflamed, and covered with pustules; the teeth fall, the gums swell, itch, putrify, and ulcerate; they become cancerous, and the jaws are almost immovable; and the ulcers cause sometimes so much disorder, that the jaws are all eaten with it, and the teeth seen. There happens a relaxation of the parts, the patients grow stupid and sleepy, they breathe but with difficulty, have a palpitation of the heart, cough, and faint away; they have frequent reachings, loosenesses, gripes, have red and livid pustules on the belly and natural parts, the whole habit of the body grows dry, &c.

In the beginning of this malady it is easily cured, but when it is rooted, has attacked the *viscera*, or when it is a disease of the country, or the patients are old, the cure is next to impossible. One of the best remedies for this distemper is exercise, and endeavouring to conquer drowsiness, which is one of its most dangerous symptoms.

A very exact diet is held of more effect than the best medicines; bleeding does not avail, strong purgatives are hurtful, so is sugar, and all sweet things. *Mercurius dulcis* used internally, so as not to salivate, but only raise a sweating, is found excellent. *Dolæus* undertakes to cure any *scurvy* in twelve days time, by the use of this alone, only the patient must drink nothing all that time but the decoction of simple antiscorbuticks, such as that of horseradish, sorrel, butterbur, scarzonera, fowthistle, zedoary, polypody, elecampane, guaiacum, sassafras, mustard-seed, *nasturtium aquaticum*, *trifolium paludsum*, &c. oranges, lemons, juniper-berries, &c. are also very good remedies.

*Chsfelden* recommends a continued use of milk. *Etmuller* makes copious vomiting the basis of the cure of the *scurvy*. Strong catharticks, he observes, are prejudicial; but gentle ones good; for the body is to be still kept open. He forbids the use of vinegar, but allows the juices of fruits and vegetables to be wholesome. The use of lemon-juice is much recommended by Dr. *Lister*. The decoction of mustard-seed, to wash the mouth with, is, to the full, as excellent. These remedies, taken internally, are very good for this disease, *viz.* the tincture of flint, from ten grains to thirty; dia-

phoretick antimony, from six to thirty grains; *mercurius dulcis*, from six to sixteen grains; diaphoretick *mars*, from ten grains to twenty; aperitive *crocus martis*, from ten grains to two scruples; the volatile spirit of *sal ammoniac*, from six to twenty drops; the spirit of *guaiacum*, from half a drachm to a drachm and a half; *tartarum vitriolatum*, from ten grains to thirty; tincture of antimony, from four drops to twenty; the volatile salt of tartar, urine, vipers, and hartshorn, from six to fifteen grains of each; spirit of *gum ammoniac*, from eight drops to sixteen; and the mercurial *panacea*, from six grains to two scruples.

Emollient and detergent clysters must be administered to the patient when he goes to bed, keeping his body open with pitifans. He may take afterwards sudorificks, made of decoctions of fumitory, wild succory, dandelion, *scelopendria*, scabious, germander, borage; the roots of *scarzonera*, polypody, parsley, and fennel; the flowers of green broom, alder, marygolds, &c.

The decoctions to wash the mouth with, are made of sage, rosemary, hyssop, the leaves of oak, *cochlearia*, cressies, *nicotiana*, the roots of *aristolochia*, tormentil, iris, and red roses.

To strengthen the gums, gargarisms are made with simple antiscorbuticks; as the spirit of *cochlearia*, two drachms; a scruple of spirit of vitriol, a scruple of common salt, four ounces of rose and plantain-water, two of each. If the gums are rotten, they must be rubbed with honey of roses, and some drops of spirit of salt.

To appease the pains in the limbs, there must be prescribed baths and fomentations externally; and internally the decoction of sassafras, with some drops of *laudanum*.

To appease the gripes, there must be administered clysters made of whey, sugar, syrup of poppies *cochlearia*, camomile, melilot, and oil of worms.

The use of milk hinders vomiting; the looseness is stopped by the spirit of mastic; the fever by the febrifuges and antiscorbuticks; the spots are fomented with the decoctions of aromatick and antiscorbutick herbs, with nitre, and unguent of storax: for the ulcers of the legs, lint covered with a powder made of equal parts of sugar of saturn, *crocus martis*, myrrh, and *mercurius dulcis*, must be applied upon them. The following remedy is very good to sweeten the acidity of the humours: take half an ounce of spirit of *cochlearia*, two drachms of tartarized spirit of *ammoniac*, and one drachm of the tincture of worms; fifteen drops of which liquor are taken thrice a day, in a decoction of parietary.

Against the *tubercles*, take two handfuls of the flowers of camomile and alder, two drachms of the roots

roots of briony, and an handful of crumbs of bread; and have the whole boil'd in whey for cataplasms. To appease the head-ach, must be taken twenty five or thirty drops of the tincture of *fuccinum*, in the antiscorbutick spirits, or waters. To facilitate respiration, must be prescrib'd two spoonfuls, several times in a day, of a medicine made with two drams of antiscorbutick water, two drams of the essence of elecampane, and half a drams of spirit of gum *ammoniack*.

To hinder the putrefaction of the gums, they must be rubb'd often with a liquor made of a dram of the tincture of gum lack, three drachms of spirit of *cochlearia*, and fifteen or twenty drops of oil of tartar *per deliquium*. All the lotions made of waters and decoctions of antiscorbutick simples, are very good for this use. They use at the *Hotel-dieu*, at *Paris*, the unguent of *itorax*, to take off the spots, and resolve the hardness in the legs.

We'll pass now to the *examen* of wounds and ulcers, and to the most easy manner how to cure them.

A **WOUND** is a solution of the continuity of a fleshy part, made by some penetrating body, while it yet remains fresh, bloody, and without putrefaction.

The two first things to be observ'd in the treatment of *wounds*, are their differences, and the instruments they are made by.

In *wounds* where any large artery is quite cut in two, the flux usually proves mortal. A lesser artery, cut transversely, flies back against the solid parts, and will have its mouth stopp'd; if an artery be not quite cut off, there arises a perpetual flux; or if that be stopp'd, an *aneurysma*. A nerve being cut off, flies back, produces a pain and obstruction about the *wound*, and below it a numbness and wasting immobility; the case is much the same in *wounded* tendons, and membranes. *Wounds* of the temporal muscle are rarely cur'd, but generally bring on horrible convulsions.

All *wounds* are reputed more dangerous and difficult of cure in winter than in summer; in autumn, than in spring.

The *cure* of *wounds* consists in helping nature to make the reunion of the parts, which had been divided, after having took off and appeas'd all that could be an obstacle to it; which are all foreign bodies, as bullets, burs, wood, stones, &c. or the accidents they are attended with; as, hæmorrhages, inflammation, mortification, excrescence of flesh, *hypersarcosa*, dislocation, fracture of a bone, splinters, and sometimes a bad air.

The most dangerous symptoms in a *wound*, are the hæmorrhages: therefore it may be stopp'd with the following remedy.

Take two ounces of vinegar; a drachm of colcothar, or red vitriol. two drachms of astringent *crocus martis*, and beat the whole together; in which the lint to be apply'd to the *wound* must be dipp'd.

There is also the *actual* and *potential cautery*, or the ligatures alone. The *actual cautery* is not always safe; a *potential cautery* has always the desired success; such as this: take very near equal parts of *vitriol*, and the powder of what's vulgarly call'd *tead-stool*; and apply it with some lint on the place whence the blood flows, and the blood will be instantly stopp'd, taking care not to touch the nerve or tendon; because vitriol is capable to excite convulsions.

If the *wound* be attended with an inflammation, caused by a *foreign body*, that foreign body must be immediately extracted with a proper instrument. If the inflammation is occasioned by a quantity of *pus*, the *pus* must be evacuated. If it proceeds from excessive pains, those pains must be appeas'd with anodyne cataplasms and liniments; such as those which have been proposed in the cure of the *phlegmon*; or the part must be bath'd with an equal quantity of spirit of wine and water. Sugar of *saturum* in lime-water has the same effect.

Against the mortification of the part, is used a decoction of *wormwood*, *St. John's-wort*, *rosemary*, and *aloes* made with wine; or the tincture of *aloes* and *myrrh*; or camphorated *spirit of wine* alone.

In great *wounds* it is very proper to cover the *ap-paratus* with such a cataplasmi as this: take the leaves and flowers of camomile and melilot, summits of wormwood, mallows, marshmallows, anised and cummin-seed, in powder, which must be boil'd together in wine, adding to it barley-flour, to give it a due consistence. If there was the least appearance of a gangrene, there should be mixed with it saffron, myrrh, aloes, and spirit of wine.

It is not necessary to thrust tents into all sorts of *wounds*; for in the small ones it suffices to make the reunion with the balsams alone; because they are not to be brought to suppuration.

*Lastly*, The whole secret consists in cleaning the *wounds*, whether with cloths, or with injections; of tincture of myrrh and aloes, or with simple decoctions of wormwood, scordium, and bugle, in white wine; prescribing internally the vulnerary decoctions of *alchymilla*, *veronica*, ground-ivy, *St. John's wort*, wormwood, centaury, bugle, cheivil, and others.

The **SUTURES** are often of very great help for the re-union of *wounds*, which cannot be reunited by the bandage; for *sutures* are not to be made but while the *wounds* are recent and bleeding, when there is no contusion, loss of substance, nor great hæmorrhages; when they are not made by bites

of venomous beasts; when there are no great inflammations, and the bones are not discover'd; because they commonly are to be exfoliated. Neither are they made on the breast, because of its motion.

INSTRUMENTS to make *futures* with, are strait and bow'd *needles*, wax'd *thread*, and the *fingers*.

The ancients invented a great variety of *SUTURES*; as, the *INCARNATIVE future*, so called, because by rejoining the edges of a wound, and keeping them together by means of a thread run a-crofs with a needle, they grow together, and incarnate as before.

The *RESTRICTIVE futures* served to stop the flux of blood from large wounds, where any considerable vessels were cut.

It is still in use for wounds in the intestines, and called the *skinners future*; because they use the like in sewing up the holes made by the butchers in fleazing off the skin.

The *INTERTWISTED future* is when the needles are left sticking in the wound, and the thread is wound round them, much after the same manner *tayors* do the threaded needles they keep in their sleeves, &c. This *future* is performed two ways; for either the needles are passed a-crofs the wound, or they are stuck on the side thereof.

All the *futures* hitherto mentioned, are made with needles and thread; besides which, there is another kind called *dry futures*, which are performed with glue, size, or other proper viscous matter.

The *DRY future* is ordinarily made with small pieces of leather, on linen cloth indented like a saw, so that the teeth may fall between each other, and the whole row may be closed. The cloth, before it is cut into this form, is spread with some proper plaister, in order to its firm adhesion. The plaisters, thus prepared, being cut into this form, are applied on the firm flesh, according to the length of the wound, reaching from it to the distance of some inches; and after they are dried, or well fasten'd to the part, the lips of the wound being approach'd, they may conveniently be held together by the *future* in that posture. This kind of *future* is principally used for wounds in the face, to prevent unsightly scars. It is likewise convenient, when the fibres of the muscles are cut a-crofs, and where it is difficult, or impossible to apply a bandage.

In the other kinds of *futures* the stitches ought always to be taken of a depth proportionable to that of the wound; care being had to avoid the nerves as much as possible. In long wounds they are best begun at the ends, but in short ones at the middle. If the wound be angular, they must be begun at the angles. Before the knot be made,

the lips of the wound must be as near, and as even as possible, approached near one another; the knots are begun by that of the middle. A simple one is made first on the side opposite to that where the matter is to be evacuated; a small compress of waxed linen cloth may be put on that knot, on which compresses must be made a running knot, to be untied easily, if some accident should happen. If a plaister is to be placed on the wound after the *future*, a small compress is to be put on the knots, lest they should stick to the plaister. If there happens an inflammation in the wound, the knots must be relaxed; and when the accidents are past, tyed up again: but if the inflammation continues, the threads must be cut, by passing a probe under it. When the re-union of the wound is perfected, the thread must be also cut, by passing likewise a probe under it. To extract the threads, a finger must be applyed on the knot, for fear of re-opening the wound.

Of *WOUNDS* in the *HEAD* two things are to be considered.

That *wound* is called *superficial*, which goes no farther than the skin; and that *deep*, which penetrates as far as the *pericranium*, *cranium*, or the substance of the brain.

If the *wound* be only *superficial*, it may be cured with *Hungary water*, or with balsam, putting over it a plaister of betony. If the wound, or the tearing of the skin be large, it must be sewed up.

If the *wound* be *deep*, and in the *pericranium*, it must be kept open, waiting for the suppuration. If it penetrates as far as the *cranium*, there is either contusion, or fracture; if contusion, the *Chirurgieon* must wait for the suppuration, and the fall of the splinter, by keeping the wound open. If fracture, that fracture is either in the first or second table, or in both. It is known to be in the second table, only, when attended with no accidents; and in both tables, when the signs appear, and by the incision crucial of the flesh, and the discovery of the *fissura*.

The signs of the fracture of both tables of the *cranium*, and of the extravasation of blood, on the membranes of the brain, are the loss of judgment or reason, at the very instant the wound is received, the hæmorrhage through the nose, mouth, and ears, a drowsiness and heaviness of the head, and especially bilious vomiting: whence it is concluded that the operation of the *trepan* is absolutely necessary.

*Wounds* in the *FACE* are to be treated with the greatest care; to avoid, as much as possible, incisions and suppuration; which would cause scars and deformities in the face.

Of the *wounds* of the *BREAST*.

When

When the *Chirurgion* is sure that the wound penetrates into the capacity of the breast, he must examine which part is wounded, by observing the situation of the wound, and its accidents. If the lungs are wounded, there is a frothy spitting of bright blood, with a difficulty of respiration, and a cough. If some of the large vessels be open, the patient feels a weight in the bottom of the breast, has cold sweats, breathes with difficulty, vomits blood, which likewise comes out of the wound. If the diaphragm is cut in its tendinous part, the patient has laughing convulsions. If the heart be wounded in its basis, or in its ventricles, the wounded faints away, and dies: but if the probe cannot penetrate, and none of the accidents above-mentioned appear, it is certain that the wound is not of great consequence.

When the wound penetrates, and there is no part offended, but only an effusion of blood on the diaphragm, recourse must be had to the *empyema*; otherwise the extravasated blood would putrefy, cause inflammation, the gangrene, and consequently death. Which *empyema* is an operation, whereby the matters extravasated on the diaphragm, are evacuated by an aperture made on the *breast*.

From the *breast*, we will descend to the ABDOMEN. The qualities of a wound made in the *Abdomen* are known by probing it, observing its situation, and minding its accidents. By probing it is discovered whether the wound penetrates into the capacity, or not.

In the cure of the wounds of the *Abdomen*, care must be taken not to let the air enter into them; they must be dilated to sew the wounded intestine, and restore it to its place; the *epiploon* or *cæcul*, if it comes out through the wound, must be tied and cut, lest growing putrid, it should infect the neighbouring parts, which must be washed with strong wine, in which have been boiled *camomile-flowers*, *roses*, and *wormwood*; they must be powdered with *aloes*, *myrrh*, and *olibanum*, and the wound sewed to be dressed outwardly; prescribing an exact diet to the patient; and abstaining, on these occasions, from clysters, especially if one of the great guns be wounded, using rather suppositories, and laxative pitans, or diet-drink, to avoid dilatation.

Another kind of *wounds*, which deserve a particular attention and skill, are those made with FIRE-ARMS. Those wounds are always with laceration, loss of substance, fracassment, and breaking in the bones. They are red, black, livid, and with inflammation. They are seldom accompanied with *hemorrhages*: they are commonly round, narrower at the entrance than at the exit, unless they have been made with quartered bullets, &c.

If those wounds penetrate the substance of the brain, the *medullæ spinalis*, the heart, the *pericardium*, the large vessels, and others of the noble parts, it is almost always present *death*: but all the superficial ones, those made in any other parts of the body, are curable.

To do it with judgment, and hope of success, the patient must be put, if possible, in the same situation he was when wounded, the easier to know the direction of the wound by the probe, with which the bullet must be searched, or some other extraneous bodies, as *wood*, *burr*, *linen*, *stuff*, and the like, which must be extracted, through the same aperture they have entered into it, avoiding lacerating the part in extracting them. If the operator has worked in vain for extraneous bodies, he will make a counter opening at the opposite part, on the place where any hardness is felt, without touching the vessels: the incision made, he must extract those bodies with his finger, or some instrument.

If the bullet be so far in the bone, that it cannot be extracted without splitting it, it is better to leave it there. If there is a great fracassment of bones in the legs or arms, they must be amputated. The pain and inflammation are to be appeased by bleeding, anodyne topicks, cooling clysters, and purgatives; if there had been a too great effusion of blood, bleeding is to be avoided.

The purgatives must be very gentle, as are the *castia*, *manna*, *tamarinds*, *syrup of violets*, and that of *damaſk roses*. Anodynes to appease the pain are cataplasms made with crumbs of *bread*, *milk*, *saffron*, and the *yolk of an egg*. *Oil of roses*, alone, made hot, is a very good remedy. To appease the great inflammations, there must be applied on the part *oil of roses*, the *white of an egg*, and *vinegar*, the whole beaten together.

Spirituos remedies are the first, which are to be applied on the wound; lint dipped in camphorated *spirit of wine*, and applied on the part, is excellent; but if the blood was to flow, there should be applied *styptick water*, or other astringent remedies, all which are to be applied hot. To hasten the suppuration of contused wounds, a digestive must be prepared of *oil of roses*, *yolks of eggs*, and *terebintine of Venice*. If the wound was on the nerves, tendons, or other nervous parts, none but spirits or remedies should be used, never unguents, which would only putrefy the parts.

The balsam of *Peru*, the distilled oils of *benzoin*, of *wax*, of *lavender*, of *lays*, and that of *absolopthers*; the balsam of *St. John's wort*, *spirit of wine*, and *gum elemi*, are excellent remedies for the nerves. Take four ounces of unguent of *althea*, a drachm and a half of distilled *oil of bay*, which being mixed together are applied; or, take

an ounce of distilled *oil of terebintine*, a drachm of *spirit of wine*, half an ounce of camphire, mix it together, and let some of it be dropped in the wound; or, take a scruple of *euphorbium*, half an ounce of *terebintine*, and some *wax*; mix them together, to be applied hot to the nervous parts.

If the wounds are deep, injections are to be made with the following vulnerary water; it is very good for all sorts of contusions, for the *gangrene* and *ulcer*. Take small *sage*, *mugwort*, *comfrey*, of each four handfuls; *plantain*, *nicotiana*, *betony*, *St. John's wort*, *wormwood*, of each three handfuls; *fennel*, *centauri*, *bugle*, *scrophulary*, of each three handfuls; three ounces of round *aristoloch*, and two ounces of the long: let the whole be in digesting, during thirty hours, in eight quarts of good white wine, and distilled afterwards in *balneo mariæ*, to the consumption of a third part.

If the *gangrene* happens to the part, we will use the *spirit of matricaria*, made of two drachms of *mastic*, *myrrh*, *olibanum*, *succinum*, and a quart of wine rectified; the whole must be distilled. This is a very good fomentation: take equal parts of camphorated wine, and of water of *quick lime*, with two drachms of *camphire*. This fomentation must applied hot.

From *Wounds* we will pass to *Ulcers*. **ULCER**, *ulcus*, is a solution or discontinuity of texture, or loss of substance in the fleshy parts of the body, proceeding from an internal cause.

*Old ulcers* are rarely cured without the use of internal remedies, which are to be such as destroy and absorb the acidity; sudorificks, especially decoctions of the woods, antimonials, viperines, and volatiles; but above all things vomitories often repeated; in the most obstinate *ulcers*, mercurial salivation is often required. *Old ulcers* are frequently incurable, without making an issue in the opposite part.

The cure of *simple*, *shallow ulcers* is commonly effected by applying a pledget armed with *liniment arcei*, or *basilick flower* to the part; a plaister of *diachyl. simpl.* or *de minio*, being laid over it, and repeating the dressing once a day, or seldomer. If only the *cuticula* be lost, or eaten away, nothing more than a little *unguent. desiccativ. rub.* or *diaphanphol*, &c. spread thin upon linen, need be applied.

If spongy flesh should grow up, in either case, it may be kept down with a little *Roman vitriol*, &c. Evacuations are indispensibly necessary, in the cure of *ulcers* of the compound kind, where the constitution will admit thereof. If the *ulcer* be fistulous, sinuous, cancerous, &c. and the matter fetid, thin, or sanious, it is found proper to join calomel with the purgatives, or to give it in small doses, between the repetitions thereof, so as not to salivate.

Besides the use of evacuating medicines, it will here also be proper to order a course of diet-drink, made with the sudorifick woods, especially where the *ulcer* is suspected to be venereal. In the mean time, proper dressings are to be used.

When the *ulcer* obstinately resists this treatment, a salivation is generally proposed, and seldom fails to promote the cure, though all other remedies should have been tried in vain. If the patient be too weak to undergo the fatigue of a thorough salivation, it may be moderated, and kept up the longer, in proportion to his strength.

External medicines, for *ulcers*, are digestives, cleansers, farcoticks, and epuloticks. Mr. *Bullock* gives us a medicine of singular efficacy in the cure of *ulcers*; and it is no more than a decoction of walnut-tree leaves in water, with a little sugar; in which a linen cloth being dipped, is to be laid on the *ulcer*, and this to be repeated every second or third day. This simple and vulgar medicine, he finds, suppurates, deterges, incarnates, resists putrefraction, &c. more than any other medicine known.

The *Venereal Disease* falls next under our consideration, which we design to examine through its different stages, *viz.* the *clap*, *chordee*, *gonorrhœa*, *shankers*, *bubo's*, and the *grand pox*.

**VENEREAL DISEASE**, called the *French pox*, is a contagious malady, contracted by some impure humour, generally received in *coition*; and discovering itself in ulcers, and pains about the genital, and other parts.

The tradition is, that the *venereal disease* first broke out in the *French* army, when it lay encamped before *Naples*; and that it was owing to some unwholsome food: on which account the *French* call it, the *Neapolitan disease*, and the *Italians* and *English* the *French pox*: but others go much higher, and suppose it to be the *ulcer Job* complains of so grievously.

*Physicians* and *Chirurgeons* divide the *venereal disease* into several stages, of which the *clap* is the first.

Dr. *Cockburn*, and others after him, will have the *clap* to consist in an ulceration of the mouths of the glands, of the *urethra* in men, and of the glandular *lacunæ* in women; and discovers itself by a painful tension in the *penis*, an excruciating pain in making water; by the *urine* appearing whitish, and full of small threads.

If the person be affected with a running of a thin consistence, a yellow or green colour, and in great quantity, and the testicles swelled, it is usually termed a *gonorrhœa virulenta*, and the *clap* supposed to be in its second stage.

A *clap* is often attended with an inflammation and contraction of the *frænum*, and the under part of the *penis* called *chordee*, and which renders erection painful. If the *chordee* be violent, or does not decrease proportionably to the other symptoms in *gonorrhœa's*, an emetick of turbith mineral is usually given with success, it causing a revulsion from the part.

*Clap* is also often called a *virulent Gonorrhœa*, to distinguish it from a simple *Gonorrhœa*, which takes its rise from violent exercises and strainings; the immoderate use of hot foods, and particularly fermented liquors, as beer, wine, cyder, &c. This is cured by indulging rest, nourishing foods, broths, &c.

The cure is effected by emollient cataplasms, and fomentations upon the part, and a half bath. For the other species, more powerful means are to be used. The principal remedies are mercurial purges, an emulsion of green hempseed, cuttlefish bone, turpentine, *saccharum saturni*, &c. we have, likewise, great commendations of green precipitate of mercury, and *mercurius dulcis*. *Bals. saturn. terebinthinatum*, prepared with a gentle fire, of *saccharum saturni*, and oil of turpentine, is much applauded where the heat is great about the reins and genitals; as also camphire. An infusion of cantharides in wine is the *nostrum* of a noted Dutch physician. Resin of the wood *guaiacum* is also recommended; and balsam of *cupaiba* is held a sort of specifick; to which must be added, *antimonium diaphoreticum*, *bezoardium minerale*, water wherein mercury has been boiled; injections of lime-water, *mercurius dulcis*, *saccharum saturni*, &c.

SHANKERS are the next thing in the *venereal disease* worthy attention. They are round ulcers, caved in the middle, which rise on the glans and the prepuce.

To cure *shankers*, they must be touched with the infernal stone, and brought to suppuration, with red precipitate mixed with the unguent of *André de la Croix*. Oil of Mercury, put upon lint is very good to open *shankers*, and to consume the flesh. The patient must be very well purged with calomel and scammony; after which, he must take the mercurial *panacea's*, which is a very good remedy for all but a confirm'd pox.

Next to *shankers* come BUBO's, which are large tumours, or abscesses happening in the groin. *Buboes* must not be left to come to a perfect maturity before they be opened. They must suppurate a long while, and care must be taken to purge the patient with calomel and scammony.

All these abovementioned are but the forerunners,

of the *pox*, which sometimes begins by a virulent *gonorrhœa*.

When the *pox* is but just begun, it is easily cured; but if it be an old confirmed one, and the patient of a bad constitution, has his voice hoarse, and ulcers, *caries* and *exostoses*; the cure is very difficult.

The patient being prepared by proper purgatives must be brought to a salivation by *frictions*, made with unguent of mercury. This unguent is composed of *crude mercury*, mixed with *turpentine* in a mortar; the whole being mixed afterwards with *hog's-lard*; i. e. one part of mercury upon three of *hog's-lard*.

The *frictions* begin at the sole of the foot; from thence they are continued to the legs, and to the inside of the thighs, taking care not to touch the back bone. When the patient is of a tender constitution, sometimes a single friction suffices. He must be rubbed by the fire, after he has took some chicken broth. He must not be rubbed, each time, with more than one or two drachms of mercury without reckoning the grease. He is rubbed with the hand, so that no grease appear on his skin; after which, he must be put to bed. The *Chirurgion* must often look in the mouth of the patient, to see if the mercury operates, which is easily known; because the tongue, gums, and *amigdale* swell, and grow thick; the patient has the head ach, his breath is strong, his face red, he has some difficulty to swallow his spittle, or begins to salivate.

During the *frictions*, the patient must be fed with chicken broth, eggs, &c. which he must take every two hours, at least. He must keep his bed in a warm room, and must not get up, but when the salivation is to be stopped, which commonly lasts 20 or 25 days, or rather till the salivation be fine, i. e. no longer stinking, nor coloured; but clear and fluid.

If a looseness happens during the salivation, it stops; but it must be procured again, by stopping the looseness, with clysters made with milk and yolks of eggs; and if it could not be procured that way, a slight friction must be made; if the salivation was too copious, it must be diminished with some gentle purgatives.

The patient salivates, ordinarily, three or four pounds every day, in a basin made on purpose; which he keeps in his bed near his mouth, into which the *saliva* runs. A small stick, tied round with some linen cloth, must be thrust, from time to time, between the teeth and the jaws, which otherwise would glue together.

If the salivation does not stop of itself, in a due time, to stop it, the patient must be purged. If there are ulcers left in his mouth, they must be dried with gargarisms made of barley-water, honey of roses, or warm'd wine. Warts are cured with being tied, if the ligature be possible; and if not, they must be consumed with causticks. Sometimes they are cut, and left bleeding, and washed afterwards with hot wine.

When the patient is up, he must be changed of linen, bed, and room, and purged, after which, he will recover his strength by being fed with good aliments, and by drinking good wine. If he be too much weakened, he must drink cows milk, with sugar of roses.

From the maladies of the flesh, we will proceed to those of the bones, which are five in number, *viz.* the luxation, fracture, caries, or ulcers, the exostosis, and the nodus.

LUXATION, or dislocation, (from the latin, *luxare*, to loosen) is the slipping of the head of a bone from its proper receptacle into another place, whereby the natural motion of the joint is destroyed.

The cure of a simple luxation, is by a speedy reduction of the dislocated member to its natural place. To this are necessary, 1. *Extension*, *ἀνέξωσις*, that the head of the bone may more directly be introduced into its seat.

This extension is made either by the hands alone, or by ligatures or towels, or by instruments or great machines, when the luxation is difficult and inveterate. 2. After extension follows the intruding of the joint into its natural cavity: which likewise, may, either be effected by the hands only, or by the heel (as when the head of the *os humeri* is fallen into the arm pit) or by means of ladders, doors, pestles, or *Hippocrates's* instrument, called *amb.*

Lastly, It is necessary, yet further, to apply compresses and bandages; by which means the articulation is preserved safe, till the ligaments may acquire their usual strength of elasticity and astringency.

The luxation of the thigh with the hip, is seldom or never reduced. That of the first vertebra is very difficult. That of the inferior jaw-bone, and of the sole of the foot is mortal.

If an inflammation should happen before the member is reduced, nothing ought to be attempted till that inflammation is appeased, but in order to prevent and appease it, the reduced member must be bathed with hot wine, in which have boiled the summits of *St. John's wort*, *camomile*, *rosmarin*,

*stachas*, and the like. The bands must be dipped in the same liquor.

If an *œdematous* tumour rises on the luxated member, after the articulation has been reduced, sudorificks must be administered to the patient, and the member anointed with oil of *St. John's worts*, or of *turpentine*, and covered with a plaister made of *yellow wax*, and *white resin*; the whole being melted, there must be added to it *white succin*, and *guneleni*; of each a sufficient quantity to make a mass, which must be incorporated with the *balsam of Peru*.

When the dislocated bone has not been reduced soon enough, there is formed in the cavity a *coagulum*, which hinders the reduction; this *coagulum* may be melted with the following oils before the reduction of the bone. Take one part of distilled oil of *human bones*, two parts of fetid oil of *tartar*; mix the whole together, and put *quick lime* over it to have it distilled through a retort; the part must be fomented with this oil.

If the luxation has happened through a too great relaxation of the ligaments, they must be strengthened by the part reduced being kept in its place by good bandages, prescribing all remedies, impregnated with an oily volatile salt, as those produced by the *saffras*, *jasparilla*, *sal-ammoniack*, &c.

The most ordinary luxations are of the wrist, of the leg, of the rotula, of the foot, and of the jaw-bones.

The bone being reduced into its natural place, there are bandages used to keep it there, in the following cases. 1. In the luxations proceeding from internal causes; because the ligaments having been relaxed, a bandage must supply their want. 2. In the luxation of the jaw-bone, especially when it happens in gaping; because the ligaments having been weakened, and softened, by some humidity, want help to keep up the jaw bone, whose weight tends towards a new luxation; to which must be added, that the patient can scarce be at rest, and that the continual motions he is obliged to make, either to speak, or eat, could cause a second luxation. 3. In the luxations of the wrist and the foot; because, as we have observed already, they are ordinarily accompanied with starting of the *cubitus* and *radius*, and of the *tibia* and *peroneus*, a bandage must be made, from above downwards, to bring together gently the started bones, and keep them firm; which must be done without a compression on the afflicted part. 4. In the luxations of the clavicle, with the *sternum*, the arm must be kept up, by means of the scarf.

In all other luxations, there wants no bandage, unless there be an inflammation; and the bandage ought to be contentive only, to keep up what's put on the afflicted part. For the thigh, leg, &c.

the

the patient must keep his bed for two or three days, to strengthen the part.

Let us proceed to FRACTURES.

FRACTURE is a solution of continuity in a bone, when it is crushed or broken by some external cause.

In the cure of *fractures*, the *Chirurgion* has two things to attend to; first, to restore the *fractured* bone to its natural situation; and to keep it tight with splinters, and bandages: in which case, nature takes on herself the office of healing, and conglutinating it, by forming a *callus* thereon.

If the *fracture* be transversely, the reduction must be made by extension, and counter-extension; and if lengthwise, *coaptation* suffices. If the *fracture* be complicated with a wound, the cure must begin by the reduction, and the other remedies are administered afterwards, as in the simple *fracture*.

When there are splinters left in the *fracture* after the reduction made, they are not to be pulled out, but the *Chirurgion* must wait patiently their coming out with the pus, or help their coming out with the use of injections made with the tincture of myrrh and aloes, and with proper plaisters, and also with pincers.

There is more or less time required in the cure of a *fracture*, as the *fractured* bones are different in bigness; thus the *callus* of the *fractured* jaw-bone is formed in 20 days; that of the clavicle, or shoulder, in 24; that of the *humerus* in 40; that of the *cubitus* in 30; that of the bones of the *carpus*, and of the fingers, in 20; that of the ribs in 20; that of the *femur*, or thigh, in 50; that of the *tibia*, or leg, in 40; and that of the bones of the *tarfus*, and of the toes, in 20.

To facilitate the formation of the *callus*, the *fractured* part must be rubbed with oil of worms, and hot spirit of wine, mixed together. The *Lapis Abteocolis* is a specific on this occasion.

All the *fractures* of the CRANIUM do not oblige the *Chirurgion* to have recourse to *trepanning*, but only the deep ones; as for the superficial, they are cured by exfoliation, or scaling of the bone.

The deep *fracture* of the *cranium*, which obliges to *trepanning*, is that made of both tables of that part, and which penetrates to the *meninges*, on which there is then an extravasated blood, which must be took off by the operation of the *trepau*.

The accidents or signs of the *fracture* of the *cranium*, are, dimness of the eyes, and loss of judgment, both which happen at the very instant of the blow, or fall, with a bilious vomiting, which follows soon after. These signs are called *univocal*; there are others called *equivocal*, which are for a confirmation of the first: as the loss of blood thro' the nose, eyes, and ears; redness of the eyes, hea-

vinefs of the head, swelling of the face, and afterwards drowsiness, shivering of the whole body, fever, convulsions, &c. but it is not necessary that all those signs should appear, to judge of the necessity of *trepanning*, since it suffices to have the *equivocal* ones to make the crucial incision in the place of the wound, and discover the bone to find the *fracture*. See the practice of *trepanning* hereafter.

The wounds with *fracture* must absolutely be *trepanned*; in which operation, oil of turpentine must be used to distil on the membrane of the brain; or spirit of wine mixed with oil of almonds; and the *Chirurgion* must by all means bring it to a copious suppuration. The patient, besides, must be let blood before and after the operation, especially if there be a fever, or plenitude; taking care to facilitate the natural evacuations by means of clysters, at least every other day, prescribing an exact diet, free of all agitations of the body and mind, abstaining even from eating till the fourteenth day; and from coition, which is mortal at that time, for forty days from that of the operation; as it is, likewise, in all considerable wounds.

The method to be observed in the wounds of the head, and the *fractures* of the *cranium*, is as follows:

In the *simple wounds* of the *head*, none but balsams are to be used, applying a plaister of *diachylum* over it. When there is *contusion*, either in the *pericranium*, or *cranium*, the wound ought to be kept open till after the suppuration, or exfoliation. When there is only a *bump*, without wound, or accidents, it must be resolved with verjuice, vinegar, or spirit of wine mixed with oil of St. John's wort, in which compresses are dipped, and applied to the part.

The third *malady* of the BONES, is the *caries*; which is the putrefaction of the substance of the bone, or an ulcer, and the gangrene in that part.

The *CARIES* has either an internal or external cause.

When the *caries* is known to proceed from an external cause, the best remedy is the powder of *Iris*, which suffices, when the *caries* is superficial; but the oil of *guaiacum* must be employed on lint, which is applied on the ulcer, when it is deep; or brandy, in which have been macerated iris-root, cinnamon, and cloves. Lastly, the *aëtual cautery* must be applied.

When the *caries* arises from an internal cause, the flesh must be opened, to give vent to the *sanies*, which runs from the ulcerated bone, the better to procure its exfoliation; and if the ulcer has not yet opened the bone outwardly, the *trepau* must be applied to it, treating the ulcer afterwards as above directed.

The EXOSTOSIS, (which is the *fourth* malady of the BONES) is a tumour, which rises on the superficies of the bone; occasioned by the *depositem* of an unfiltrated humour in its own substance. This tumour is commonly accompanied with violent pains; because in growing and rising insensibly, it pushes, raises, and lacerates the *periosteum*.

There are several kinds of these tumours, and they are treated differently, *viz.* *Exostoses* of those afflicted with the pox, are cured by a good salivation; and when they come to rot, the hand and fire must be joined to remedies, to melt what is carious. *Abscesses* of the articulations, can't be conquered but by the amputation of the part; it is true, that some are cured without amputation, but it is with a great deal of care, and it takes a long time; but when the whole bone is *exostosed*, it must be cut off. The *exostoses*, or *nodus*, which rise on the bones of the head, are more difficult to cure than others; as also the *caries* of that part.

There are other *maladies* of the BONES; as the softness of the bones, their brittleness, bowing, or *rachitis*, vulgarly called *ricketts*; and cracking.

The SOFTNESS of the bones proceeds from the nutritious juice of the bone being too little impregnated with saline and acrimonious particles, and their marrow too abundant; since that watery juice produces the same effect in the bones it does in trees, and in horn. One thing is to be observed, that there is never a *softness* in the bones but where there has been left some leaven of the *rachitis*. The best remedies for this malady, are sudorificks, diureticks, and absorbents.

The RACHITIS, or *ricketts*, is a disorder affecting the bones of children, and causing a considerable protuberance, incurvation, or distortion thereof. It arises most commonly from the neglect of a dirty, lazy nurse, who does not keep the child clean, nor give him proper exercise. Or it may be occasioned by some fault in the digestion, occasioning the aliment to be unequally applied to the body, by which some parts of the bones increase in bulk more than the rest.

When the disorder is taken early, it may be remedied by proper bolsters and bandages, suited to the parts affected; but when the bones are grown rigid and inflexible, other mechanical contrivances, as puddings, strait boots, and several sorts of machines or engines made of pasteboard, whalebone, tin, &c. are made use of, to restore the distorted bones to their natural straitness.

*Mercurius dulcis*, syrup of chicory and of roses, manna, and scammony, are accounted very good purgatives in the *ricketts*; together with diuretick

and diaphoretick ptisans made of *china*, *sarsaparilla*, &c. absorbent powder, which corrects the acidity of humours, the infusion of *millepedes*, or wood-lice, and dry frictions made over the whole body with a warm linen cloth before the fire, especially on the parts affected, are found of service. A liniment of rum and palm oil, or a plaister *de minio*, and *oxyroceum*, applied along the back, to cover the whole spine, are much esteemed; also the oil of snails is very famous for the same intention; being what drains from them after bruising and suspending them in a flannel bag; with this the limbs and spinal bones are anointed.

Certain bones have been seen several times to break easily. A man coming out of the pox, and walking in his room broke at once both his thighs.

What causes the fragility of the bones is, that their parts being disunited, and touching but slightly each other, they are separated by the least violence made to them.

The CRACKING, or *cliquetis* of the bones, which is heard sometimes in the motion of the members, depends on the acidity or driness of the articulations, occasioned by the liquor they are moistened with being exhausted; as it happens in certain persons afflicted with the gout, who hear a noise in their knees while they walk. This noise may be caused by the extension of the ligaments and tendons, which surround the articulation, and striking strongly against the air, cause that noise.

Let us now proceed to *Chirurgical operations*. This is the nicest point of the whole art. For this purpose it will be necessary to take a view of those instruments used in the common operations; such as are necessary to make a *cautery*, a *seton*, and for *bleeding*, *cupping*, and *blisters*.

A CAUTERY, *Cauterium*, (from the Greek *καυρω*, or *καυρωσις*, formed from *καω*, I burn) is a medicine to burn, eat through, or corrode some solid part of the body. *Cauteries* are of two kinds, *actual* and *potential*.

*Actual CAUTERIES*, are those which produce an instantaneous effect; as fire, or a red-hot iron, which are applied in the *fistula lachrymalis*, after extirpation of cancers, amputations of legs or arms, &c. in order to stop the hæmorrhages, and produce a laudable suppuration. They are also sometimes applied to carious bones, abscesses, and malignant ulcers, in order to open a passage for the discharge of the peccant humours. The irons us'd on these occasions, are sometimes crooked at the extremity, and that variously, according to the various occasions; whence some are called *cultelary*,

*lary*, others *punctual*, others *olivary*, &c.

The *actual cautery* of hot iron is frequently applied for the making of issues in parts where cutting is difficult, or inconvenient: It makes a little round hole, which is to be filled up with a pea, or ivy-berry, to keep it open for the humour to pass through.

*Potential CAUTERIES*, are compositions of caustick medicines, usually of quick-lime, black sope, and chimney-foot.

In the operation the *actual cauteries* are the surest; but in hæmorrhages *potential cauteries* are the surest.

*Cauteries*, otherwise called *Issues*, are applied wherever there is to be attraction, to correct the *intemperies*, or stop the course of humours, by making a scar to the part; however, the places they are commonly affixed to, are the *fontanella* on the head, the back, between the first and second *vertebra*, at the exterior part of the arm, in a small hollow which is between the muscle *deltoides*, and the *biceps*; between the muscle *psoas*, and *vastus internus* in the inside of the knee, above the *flexores* of the leg; observing, that the *issue* be placed every where near the great vessels, that it may draw, and purge more abundantly.

There is an easy way of making an *issue*, which succeeds best in children; it is done after this manner: having applied a small piece of blistering plaister, about the bigness of a small pea, to the part where you would have an *issue*, and letting it lie on for a few hours, it will cause a blister; the skin being raised, apply a pea as usual, and compress it tight with a bandage, till by degrees it sinks in, and forms an *issue*.

The *Seton*, *Setaceum*, is a wound made in the skin of the hind-part of the neck, or elsewhere, which is kept suppurating by means of a little skein of silk or cotton passed through it, and which has very near the same effect, as a cautery. The skein of silk ought to be dipped in oil of roses, and one of its ends should be longer than the other, to procure the evacuation of the humours. It often happens, that a *Chirurgion* is obliged to use it in wounds made with a small sword, or with a musket, which run thro' and thro', then the skein is soaked in proper medicaments, and every time the *apparatus* is rais'd, that part drenched with pus must be cut off, which is then drawn from the ulcer.

*CUPPING*, is an operation for the discharge of blood and other humours, by the skin. It is performed by collecting the humours into a tumour under the *cutis*, and letting them out thence by scarification.

*Cupping* is performed either *dry* or *wet*. *Dry*

*cupping* is when it is done without opening the skin; and the *humid*, or *wet*, when made with scarifications. The operation is performed thus: The vessel is heated with candles, tow, a torch, lamp, or the like; but in my opinion tow is best, and less troublesome. A ball of it is made slightly between both hands, and thrust into the *cucurbitulæ*, which is afterwards held over a candle; the flame of the candle catches the tow, which immediately appears all in flames; in which state the vessel must quickly be applied close to the part, which is no sooner done but the flame is extinguished, and the tumour begins to rise; for the air in the cavity of the vessel being, by this means, rarefied, and brought near to the condition of a *vacuum*; that part of the body covered by its becoming less pressed by the air than the rest, its juices are forced up with the *cutis*, and raise a bunch in the cavity of the vessel; to which the scarificator being applied, and ten or twelve incisions made at the same time, a plentiful evacuation is effected.

*BLEEDING*, more properly called *PHLEBOTOMY*, (from the *Greek* φλεψ, vein, and τερμειν, to cut) is a species of evacuation of the utmost importance in medicine, performed by the *Chirurgion* by the artificial incision of a vein or artery.

The vessels opened in *phlebotomy*, are the *preparate vein*, in the forehead; the *ranulæ*, under the tongue; the *jugular veins* and *arteries* in the neck; the *temporal arteries* in the temples; the *basilica*, *cephalica*, and *mediana*, in the arms; the *sabatella* between the *annularis* and little finger; the *saphena* on the internal *malleolus*, or ankle; and the *ischiatrica* on the external.

The conditions requisite to *bleed* well, are, to chuse well the vessel, to not prick at a venture, to not *bleed* without necessity, or the advice of a physician, who must know the proper times for it, as that of the intermission in intermitting fevers, the cool of the morning in summer, and towards noon in winter; and how to make different orifices; for in summer they ought to be smaller, and greater in winter.

To avoid pricking the *artery* in *bleeding*, you must know that the *artery* is placed in the arm under the *basilica*, and that you must feel it before you make the ligature, and observe well if it be profound, or superficial; for if it be superficial, it may be easily avoided, by pricking the vein higher or lower; but however, when an *artery* has been opened, if it be well opened, the blood must be let to flow, till the person falls into a *syncope*, or faints away, and through that means it is easier to stop the blood afterwards; which will be done by making a good bandage with several compresses.

pieces, putting in the first a piece of chewed paper with graduated compresses over it.

That in the *bleeding* of the foot, there are very few or no accidents to be feared, because the veins of the muscles are accompanied with no arteries, nor tendons. Therefore it is said that the arm must be given to a master *Chirurgion*, and the foot can be given to a prentice.

The first operation made on the head, and the most considerable one, is, that of *TREPANNING*, to relieve cuts, contusions, caries's, and fractures in the skull, by means of an instrument called the *trepanum*, or *trepan*.

Before we begin this operation, it will be necessary to observe, 1. That there is no *trepanning* on the superciliary *sinus*'s, because of their cavity, nor on the *futures*, because of the vessels which pass there; nor on the temporal bones, without an urging necessity, especially on that part which joins with the parietal, because the extremity of that bone would part, being only applied on the parietal; nor on the middle of the coronal, and occipital, because of an interior eminence to which the *dura mater* adheres; nor on the lateral *sinus*'s which are situated on the side of the occipital. 2. That if the fracture be very narrow, the *trepan* may be applied upon it; but it is better to *trepan* on the side of the fracture, on the inferior part; that the *trepan* is never applied on hollownesses; and that if the bones part, there ought to be no other *trepanning* than to raise them with the *elevator*.

Notwithstanding these cautions, if a violent fracture should happen in or near these parts, you should *trepan* as near them as possible; and if the fracture has passed across the *futures*, you must *trepan* within a finger's breadth of the *future* on each side. Sometimes it is impossible to discover the particular part of the *cranium* which is injured, the patient in the mean time being affected with the most dangerous and urgent symptoms. In these cases it will be necessary to *trepan* first on the right side, then on the left, afterwards upon the fore-

head, and lastly upon the occiput, and so round till you meet with the seat of the disorder.

After having pitched upon the part to be *trepanned*, your next business is to shave the *scalp*, and make an incision through the integuments to lay bare the *cranium*, except it be done already by the wound. The incision of the integuments may be made in the form of a cross, or of the letters X, V, or T, large enough to admit the crown of the *trepan* upon the bone. The wound may be enlarged, and the hæmorrhage stopped, after the integuments and *periosteum* are separated and elevated from the *cranium*, by inserting a large quantity of scraped lint. Next a compress dipped in warm camphorated spirit of wine must be applied and retained by the kerchief bandage. Then the patient is to be left, if the disorder will permit, for a few hours, that the blood may be stopped before the *trepan* is applied.

Among the apparatus, or instruments and dressings, which must be provided, before the operation is entered upon, the first and principal is the *trepan* with its crown, (*see* the plate, *fig. 1.*) made in the shape of a common gimblet. with a handle turning round. The crown of this instrument, marked A, is joined to the lower part of the handle, B, by a screw, so that it may be taken off and put on at pleasure, or else that a crown of another size may be screwed in its place.

The *trepan* is distinguished into male and female; in the first of which the crown is furnished with a sharp point E, but when the said point, or pyramid, *fig. 2.* is taken out by the winch, *fig. 3.* the *trepan* is then termed female.

You must also be provided with a *scalpel* of a particular make, with a round and flat head, as represented in *fig. 4.* which is denominated the *lenticular scalpel*; to which is added another instrument for gradually depressing the *dura mater*, of the shape represented in *fig. 5.* There must be also a perforating instrument provided, *fig. 6.* which must be screwed into the cavity B of the handle, *fig. 1.* also a hair-brush and an *elevator*. \*

\* *ELEVATORY*, *elevatorium*, is an instrument for raising depressed or fractured parts of the skull, to be applied after the integuments and *periosteum* are removed. If there is any hole, the instrument must be fastened to it; but if there is none, the *screw-end* of the instrument must be applied. *See* plate, No. 1.

But as these *elevatories* are so contrived, that, where the neighbouring bones are fractured or depressed, they cannot be applied without greatly increasing the pain, *Surgeons* have invented another kind which might be applied with more safety, called *tripes*, from the number of its feet. It is near twice as big as the figure we have given of it; (*ibid. Fig. 2.*) and the feet A A A stand nearer or farther from each other, as there is occasion. The manner of applying it is this: the feet are to be applied to the sound parts of the head, and the screw B C, by frequently turning its handle DD, will presently lay hold of the depressed part of the *cranium*, especially if a small hole has been made in it with the point of a sharp awl. Then upon turning the screw, E E, the *trepan* is raised by degrees, and with it the depressed part of the *cranium*. But if any opening shall appear between the fractured parts, it will be proper to take off the pointed end of the instrument B, and in its room fix the *elevator* G, by the screw H, about the part F of the figure No. 2. by the assistance of which it will be easy to raise the depressed part. *See* the manner of applying this instrument represented *ibid.* No. 3.

The apparatus of dressing and bandage, to be applied after the operation, consists of a dossil of lint, of an orbicular figure, which must be tied round the middle with a piece of thread about a span long; there must be pledgins of lint for covering the other dressings, and filling up the cavity of the *cranium*, &c.

The apparatus being thus provided, in order to perform the operation with greater readiness and exactness, the patient must be disposed in such a convenient posture that the *Chirurgion* and assistants may have free access to perform each their part.

The dressings being removed the wound is to be cleansed; after which, the head being placed in a convenient manner upon a pillow, the *Chirurgion* takes the perforating *trepán*, *Fig. 6.* and adapting it to the handle B, *Fig. 1.* instead of the crown A, so that by turning round the handle D, he makes a full entrance, or aperture, with his instrument, and then applies the male *trepán*, with a crown A, *Fig. 1.* Upon the top of the handle CC the *Chirurgion* fixes his left hand, upon which he places his chin or forehead, while with his right he slowly and carefully turns round the handle till the crown of the *trepán* with its spindle have made a circular entrance deep enough in the *cranium*, and then he removes the spindle, and continues his work with the crown of the *trepán* only as long as he sees convenient; all the saw dust being first brushed off from the *cranium*, and the teeth of his instrument, with the brushes. He now continues to use the *trepán* till the saw-dust becomes bloody, which denotes that he has penetrated the *diploë*: however, he may not always meet with this sign, because in some skulls the *diploë* may be wanting in the part trepanned; but when the saw-dust becomes bloody, the instrument is to be laid aside: and after washing away the blood with a sponge dipt in spirit of wine, he then screws the *elevator*, by two or three turns into the small aperture in the middle of the *trepanned* piece of the bone, and takes it out again, making two or three more turns with the crown of his *trepán*: then he examines with a probe, whether the plates of the *cranium* are sufficiently sawed through, which cannot be better known than by attending to the colour of the circular groove; for when that appears blue or grey, it is a sign that you have penetrated thro' the lower plate of the bone, so far as to render the *dura mater* almost conspicuous thro' it; but if the bony plate appears livid in one part of the circular groove, and white in another, it is a sign that the *trepán* has not cut equally through, and therefore it must be inclined and pressed a little harder upon the whitest parts, moving round the handle till the saw-teeth of the crown have cut deep enough to make the round

piece of the bone loose or moveable. In that case it will not be convenient to cut totally through the bone with the saw-teeth of the *trepán*.

Having thus extracted the round piece of the *cranium*, the blood usually follows it: which being wiped off, the *Chirurgion* is to examine whether there be any fragments remaining to be extracted and loosened; for then you must smooth the rough parts about the lower margin of the aperture, by applying the *scalpel*, *Fig. 4.* to prevent the *dura mater* from being pricked and injured by any of the sharp splinters.

This done, the blood will more readily discharge itself, but to promote its exit you may gently incline the patient's head to one side, and another tenderly pressing the *dura mater* itself, either by the hand of the *scalpel* or the *depressor*, *Fig. 5.* by which means the patient is no sooner relieved from the pressure of the extravasated blood on his brain, but he instantly begins to recover his senses: the *Chirurgion* should then direct him to fetch a deep breath, or hold it with a strain, like one that has a hard stool.

The dressings and deligation are to be made with a round pledgit of dry lint laid next the *dura mater*, with a thread fastened to it, and hanging out of the aperture, that it may be placed under, and drawn out from beneath, the *cranium*; upon which pledgit is afterwards poured some honey of roses diluted with a little spirit of wine: you then impose a like pledgit of lint, furnished with a string with other dossils, till the cavity is replete: and in the next place, the *cranium* and wound itself, is to be dressed with lint, spread with some digestive ointment, upon which add a square compress dipt in warm spirit of wine, and then secure the whole, without a plaister by the head bandage. In the subsequent dressings, which must be repeated once or twice every day, you must avoid fat and oily applications.

The wound being constantly attended, you will have an exfoliation of a thin plate from the *trepanned* margin of the bones, usually within forty or fifty days, which ought not to be pulled away by force. The exfoliation being obtained, there will appear new flesh and *callus* shooting up from the clean bone and *dura mater*, so as at length to fill up the whole cavity.

That instrument called the *exfoliating-trepán*, is sometimes used to pare away a carious part in a bone. It is represented in *Fig. 7.* and when used is to be screwed into the handle B of *Fig. 1.* in order to be turned round: A is its point: B B the wings, which scrape the bone while the instrument is turning about.

From the *cranium* we'll descend to the eyes, and make the operation of the *fistula lachrymalis*, and the *ablation of the cataract*.

The operation of the *fistula lachrymalis* is made when there is a fistulous ulcer at the great angle of the eye, at the place of the *glandula lachrymalis*.

For the operation of the *fistula lachrymalis*, the patient is put in a commodious situation, his sound eye is covered, to hinder him from seeing the instruments; the bad eye must be kept steady with a spoon; an incision, in form of a half moon, is made on the tumour with a *lancet*, avoiding cutting the eye-lid, or the small cartilage which serves as a pully to the great *obliquus*; and if the bone was carious, a small *actual cautery* should be thrust into it; for this, a small funnel is made use of, through which is introduced the *cautery* on the bone.

The *apparatus* and bandage of this operation, is made by filling up the wound with small dry tents of lint covered likewise with lint, a plaister over it, and a compress over the plaister. The *bandage* is made with a handkerchief folded triangular, whose ends are tied behind the head. If the flesh grows too much, it must be consumed with the *infernal stone*; and if it be necessary to dilate the wound to facilitate the exfoliation, small pieces of sponge, prepared with wax, must be thrust into it; afterwards the callosities must be consumed with *causticks* mixed with oily remedies, to weaken the action, taking care that they should not incommode the eye. If the bone was carious, *euphorbion* must be applied to it, or small tents of lint dipped in tincture of myrrh and aloes. The ulcer must be treated afterwards as all other ulcers.

The CATARACT is a suffusion of sight arising from a little film, or pellicle, which swimming in the aqueous humour of the eye, and getting before the pupil, intercepts the rays of light. The operation is made to blue, green, pearl-colour, &c. *cataracls*. To know if the *cataracl* be in a condition to be couched, the patient is ordered to rub his eye; if the *cataracl* remains immoveable, it must be couched; but if it changes place, the operation must be deferred till it has grown solid. The spring and autumn are the most proper seasons for this operation, which must be effected in the following manner:

The patient is made to sit down, the eyes turned towards the light; after the sound eye shall have been covered, the *Chirurgion* must sit on a seat higher than that of the patient, a servant must hold the patient's head, who must be ordered to turn the eye towards the nose; the globe of the eye must be kept steady, with the *speculum oculi*, which is a small machine in form of a spoon, pierced in

the middle; through which the eye is made to pass. The *Chirurgion* takes a round, or flat steel needle, which he judges best; with which he pierces the *adnata*, by the edge of the *cornea*, on the side of the little *canthus*, or small angle of the eye, pushing boldly his needle till he comes to the middle of the *cataracl*. He pushes the *cataracl* upwards, to loosen it, and then downwards, keeping it sometimes, with the point of his needle beneath the pupil; if it re-ascends after he has quitted his hold, it must be brought down again. The operation is ended, when the *cataracl* remains where he has lodged it, in the bottom of the eye. In pulling out the needle, he must close the eye lids, and press them a little upon the eye.

The *apparatus* and *bandage* of this operation is to close both the eyes of the patient, and put a band over them. He must keep his bed for seven or eight days, and some defensive is put upon the eye, to hinder the inflammation.

There are other operations made on the eyes.

1. There is, sometimes, *pus* under the *cornea*; to extract which the eye is kept steady by means of the *speculum oculi*; a small incision is made with a fine lancet, and the eye a little pressed, to procure the evacuation of the *pus*. If it was too thick it must be extracted, by sucking it softly through a small pipe, in the middle thereof there must be a small phial, into which the *pus* falls, while sucked.
2. A small tumour grows often in the eye. That tumour must be tied by the root with a running knot, to tie the tumour faster, from time to time, to make the tumour fall. If the tumour was on the hole of the pupil, this operation must not be attempted, because it would hinder the passage of the light.
3. Sometimes there is a pretty hard membrane, called *unguis*, formed at the great *canthus*, or angle of the eye. If that tumour was not adherent to the great angle, it should be cut at its root, by tying it; this is performed with a blunt needle, with a thread which must be run under the membrane, and then tied.
4. If the eye-lids were glued together, the operator must take a bowed needle, blunted and threaded, which he must run under the eye-lids, drawing afterwards the ends of the thread to raise the eye-lids; and then they are to be separated with a lancet.
5. If the *cils* or hairs prick the eye, they must be pulled out one by one, with a pair of pinchers.
6. If there were small, hard, and transparent tumours on the eye-lids, they must be opened, for to evacuate the *pus*.

The operation of the POLYPUS is made when there are excrescences of flesh in the nostrils. If the *polypus*, or excrescences of the flesh were livid, stinking, hard, painful, and very adherent, they ought

ought not to be touched, they are cancers, and not *polypus*; but if they are whitish, red, hanging, and without pain, the extirpation must be made with pinchers. The *polypus* is seized as near its root as possible; the *forceps* is moved from one side to the other, to loosen the *polypus*. If the *polypus* descends into the throat, it must be extracted through the mouth with bowed pinchers. If after the operation there happens an hæmorrhage, it is stopped by introducing, into the nostrils, tents dipped in some styptick liquor; or the liquor shall be syringed into the part.

From the nose we'll descend to the mouth, and make the operation of the *Hare-lip*. This operation is made when the *lip is split*.

To make this operation; if the lip was adherent to the gum, it must be loosen'd with a *bistoury*, without touching the gum. The edges of the lip must be a little pared with the scissars, to help the reunion; which to perform with the more ease, the edges of the lip should be laid hold of with pincers. The servant who supports the head of the patient, must press his cheeks forward, to approach the edges of the lip; then a needle threaded with a waxed thread must be run through both the edges of the wound, from outwards, inwards, at one line distance from the edges; the operator must take care that the two edges of the lip should be very well adjusted together, and very equal; the thread is turned round the needle, by crossing over.

For the *apparatus* and *bandage*, the lips of the wound must be washed with hot wine; the points of the needles are cut, and small compresses applied to their ends. Lint with some good balsam is applied on the wound, and a piece of linen cloth dipped in some desiccative liquor placed between the lips and the gum, to hinder them from gluing together, if they must have been separated. Over all is put an agglutinative plaister, which must be sustained with an uniting bandage, which is a small band pierced in the middle. 'Tis passed behind the head, and brought before; one of its ends is passed through the hole, which is applied on the wound, and both ends of the band passed where it is tied. A number of needles must be put in proportion to the length of the wound, which wound must be dressed three days afterwards. For the first time no other thread but that of the middle needle, if there be three, is to be put round it; to effect which, a servant must push the cheeks forward. The eighth day the middle needle, if it be a young child, must be taken off, though the needles are not to be taken off till the edges of the wound appear to be joined; neither are they to be left too long, because the holes they have made could not be closed without some difficulty.

Our next operation is in the THROAT and called the *bronchotomy*.

This operation is to cut into the wind-pipe to prevent suffocation in a squinancy. It is performed thus; the body of the patient being prepared, an incision is made between the third and fourth *annu i*, or in the *trachæa*. In separating the muscles *sternohioides*, care must be taken not to cut the recurrent nerves, because the patient would lose his voice; nor the glands *tyroides*. The skin and integuments divided, and the muscles removed, a silver tube is applied, short and flat, a little bow'd, and not thrust too far, for fear it should cause a cough. This tube must have two small rings, to fix two ribbands on them, which must be tied round the neck. 'Tis left in the wound till the accidents are over, after which it is took out, and the lips of the wound approached near one another with the uniting bandage above described, and the wound dressed.

Leaving the *throat*, we'll lean on the BREAST, to make the operation of the *cancer*.

It must be done in the following manner.

The patient being laid on a bed, the arm on the side of the *cancer* must be raised upwards, and backwards, to give a greater relief to the tumour.

Take a *forceps*, turned at both ends, in form of a half moon; so that both ends of the two half-moons pass over one another, when the *forceps* are shut: and the breast is taken and drawn with the *forceps*, and cut, at one blow, with a flat and very sharp knife. The operator begins to cut at the inferior part, that the mammary vessels should be cut last; for fear of being incommoded by the hæmorrhage.

If the tumour was not yet ulcerated, a crucial incision is made to the skin, without penetrating into the glandulous body; the fore-pieces of skin are separated from the glands, the cancerous tumour is embraced with the pincers, and cut. If there are swelled vessels, they must be tied before the extirpation of the tumour. If the tumour was adherent to the ribs, it ought not to be touched.

From the out-side of the *breast* we'll penetrate into its in-side, to make the operation of the *Empyema*.

The EMPYEMA, from the *Greek* *em*, in, and *pus*, pus, is a collection of pus, or purulent matter, in the cavity of the breast; discharged thither upon the bursting of some abscess, or ulcer, in the lungs, or membranes that inclose the breast.

The cure is difficult, from the difficulty of absorbing, or evacuating such extravasated matter: if nature shews any endeavour to throw it off by vomiting, urine, or the like, she must be seconded and assisted therein. Thus if the urine be purulent,

administer diureticks; if the stools, laxatives; if the spitting, expectorants; but never emeticks. Otherwise recourse must be had to the operation, which must be performed as follows:

If the tumour appears outwardly, the abscess must be opened between the ribs; but if there are no exterior signs, the operator must chuse the most commodious place to make his aperture. The patient set up in his bed, supported by somebody, the aperture is made between the fourth and fifth, or the fifth and sixth ribs, reckoning from the lowest, at four fingers breadth distance from the *spina*. To make it, the skin is pinched transversly, to cut it lengthwise, the operator holds it on one side, and a servant on the other; the incision is made with a strait *hisloury*, and must have three or four fingers breadth in length; the fibres of the great *dorsalis* are cut transversly, that they may not stop the aperture; the index of the left hand is thrust into the incision, to put aside the fibres; the *intercostales* muscles are to be cut, and the point of the *hisloury* guided with the finger, to pierce the *pleura*, for fear of wounding the lungs, which are often adherent to it. The aperture being made, if the pus runs out well, it must be left running; if not, the index must be put into the wound, to break the adherences whereby the lungs are tied to the *pleura*; which is done by turning the finger round between the *pleura* and the lungs.

To facilitate the evacuation of the pus, the patient is made to lean, shut his mouth, stop his nose, and to push, as if he would blow; if blood is contained in the part, more of it must be evacuated than if it was pus; because the evacuation of pus weakens more than that of blood.

In making the incision, the *intercostales* muscles must be cut transversly, not to discover the edges of the ribs; thus the wound will not become so soon fistulous.

If it be judged that there is pus on both sides the breast, both sides must be opened; because the breast is divided into two by the *mediastinum*; in that case both apertures must not be left open, for fear of suffocating the patient.

The APPARATUS, and *bandage*, is made with a tent covered with balsam; it must be soft, and blunted at the end, and must enter no further than between the ribs, for fear it should wound the lungs. If the tent was made of lint, it would be a great deal better than one made of linen; a thread must be tied to it, otherwise it would chance to fall into the breast. *Pledgets*, or lint, must be put upon the wound, a plaister, and a good compress, over all. This *apparatus* is supported with a napkin pinned round the breast, which napkin is also supported with a scapulary, which is a band six

fingers broad, pierced in the middle to pass the head through, one of the ends falling behind, and the other before, both to be pinned to the napkin. This done, the patient is put into his bed half sitting, if the lungs were to hinder the evacuation of the pus, the operator must have recourse to a *canula*.

We must continue our progress, and fall from the breast to the *abdomen*, for the operation of the *paracentesis*.

PARACENTESIS, from the Greek *παρα*, with, and *κένωσις*, to prick, is an operation, which consists in the opening a little hole in the lower venter, or belly, to let out waters collected in the cavity thereof, or between the teguments, in an *ascites*, or water dropy.

This operation is made with a kind of stilet, or bodkin. The patient is supported in his bed, that the waters may descend the easier. A servant must press the belly with both hands, to make it form a tumour. The operation is usually performed two or three fingers breadth on one side the navel, sometimes a little lower, but always so as to avoid the *linea alba*. Before the puncture, it would be very proper to raise the skin a little; the bodkin is accompanied with its *cannula*, which remains in the belly after the *puncture*; the bodkin is took out, to let the water flow as long as the patient's strength will allow; the best operators draw all the water at once. When a new *puncture* is wanted, it must be made under the first.

The APPARATUS and *bandage* are made with a large compress four times double, supported with a napkin folded into three or four, and this napkin supported with the scapulary.

There are several operations made in the *abdomen*, as the *gastrography*, that of the *exomphalus*, of the *bubonocoele*, and *compleat hernia*, of the *castration*, of the *stone*, of the *puncture* of the *pireneum*, and of the *fistula in ano*.

The operation of the GASTROGRAPHY is made, when there is a wound in the belly big enough to let the intestines or guts come out. If there be a wound in the intestine or gut, it must be sewed up with the skinner's *future*. If the *epiploon* or *caecum* was mortified, what's mortified must be cut off; for this, a needle threaded with waxed thread, is run through the sound part of the *epiploon*, without pricking the vessels; the *epiploon* is tied on both sides with each of those threads, which have been run double through it, and cut off an inch beneath the ligature. The threads must come out at the wound, to be took off after the suppuration. Then the guts must be thrust again, alternately, with the ends of the fingers, into the belly. If they cannot be reduced with ease, they must be fomented

fomented with spirituous fomentations, made of a handful of flowers of *camomile* and *melilot*, an ounce of *anniseed*, with as much *fennel* and *cuminseed*, half an ounce of *cloves* and *nutmegs*; the whole must be boiled in milk, adding to it an ounce of camphorated *spirit of wine*, two drams of *saccharum of saturn*, with two scruples of *oil of anniseed*, which fomentation must be used hot.

Before the operator makes the *scutures* of the intestines, or guts, he must have them fomented with camphorated spirit of wine; but if the intestines were mortified, they must not be sewed up, but only fomented with spirituous liquors. Clysters are not to be administered to the patient, lest they should swell up the intestines, but suppositories, or laxative ptisans must be used, if natural evacuations be necessary. The patient ought to be very sober while the cure lasts, and take no other aliments but good broth and gellies.

If the *intestines* cannot be reduced, the wound must be dilated, as far as possible from the *linea alba*, rather towards the inferior part of the belly than towards the superior, if the wound be in the superior. To dilate it, the intestines are placed on one side of the wound, and a compress dipped in hot wine, is put over them, which must be held by somebody; a proper probe is introduced into the belly, taking care not to engage the gut between the probe and the *peritonæum*; to avoid which, rise gut must be a little drawn up: the probe is held with the left hand, to run a bowed *bistoury* into its *canalure*, and the teguments are equally cut, outwards and inwards, and the intestines thrust alternately into the wound with the index fingers.

The *future* must be interwisted; it is made with two bowed or crooked needles, threaded at each end with the same thread; the index of the left hand is introduced into the belly to keep up the *peritonæum*, the muscles, and the skin, on the edge of the wound; the needle is ran with the other hand into the belly, conducting the point of the needle with the index, and piercing pretty deep. The other needle is ran into the other lip of the wound, inside of the belly, observing the same thing as in the first, if several stitches were to be made, the process is the same. A servant must approach the edges of the wound, and make the knots. The wound is to be dressed, and the *apparatus* supported with the napkin, and scapulary. The patient must lie on his belly, for the first days, to cicatrise the wound of the belly, or of the guts.

If the intestine was entirely cut, it should be sewed all around the wound so as to remain always open: if the patient should live, he would render his excrements that way.

The operation of the *EXOMPHALUS*, is made when the intestines have formed a *hernia* in the umbilick. The patient is laid on his back, and an incision made on the tumour as far as the fat, in pinching the skin, if possible; otherwise it must be made on the tumour as far as the fat, without pinching it. Afterwards the membranes are tore with nails, to discover the *peritonæum*, for fear of cutting the intestine. When the operator perceives the *peritonæum*, he draws it upwards with his nails, to make a small aperture to it: he introduces the index of the left hand into the belly, to guide the point of the scissars, with which the incision is to be dilated. He thrusts again the gut into the belly, and if the *epiploon* was adherent to the *tumour*, he would loosen it from it; but if the intestines were adherent to the *epiploon*, they must be separated by cutting part of the *epiploon*, rather than touch the intestine. The intestine being reduced, a servant must press the belly on the edges of the wound. If there was a mass of flesh at the *epiploon*, formed by the adherence of the *epiploon* with the muscles, and the *peritonæum*, that must be loosened, and then a ligature made to carry it off with the *epiploon*, as we have done in the *gastrostomy*, dressing the wound afterwards. The same precautions mentioned in the *gastrostomy*, must be used in this; and the *apparatus* supported with the napkin and scapulary.

The operation of the *BUBONOCÈLE* is made when the intestinal parts are fallen into the *groins*, or the *scrotum*. For this the patient is laid on his back, the buttocks a little risen, the skin is pinched transversely on the tumour; the operator holds the skin by one side, and the servant by the other, and makes an incision in following the split of the *groin*; when he has discovered the fat, he must tear with an instrument, or with his nails, every thing he meets with till he comes to the intestine, which he must take out, a little, if it does not adhere to the *annuli* of the muscles, and handle it softly, to dissolve the excrements. This done, the intestinal parts are reduced alternately with the indices into the belly, if possible; if not, the wound must be dilated upwards, by introducing a probe into the belly, to run the scissars through its *canalure*. If the probe cannot enter, the intestine must be drawn out a little, in putting the finger upon it near the *annulus*, and a small scarification shall be made to the *annulus* with a *strait bistoury*, which must be conducted with the finger to introduce the probe, upon which shall be run a bowed or crooked *bistoury* to cut the *annulus* or ring, *i. e.* to dilate the wound within side. The operator must not go too far, for fear he should cut a branch of arteries; afterwards the parts are reduced into the belly. If

the *epiploon* had caused the *hernia*, it must be tied, and what's altered cut. The *annulus* must be scarified within, in order to make a good *citatrice* or seam.

The APPARATUS and *bandage* must be made with a very soft and blunted tent, big and long enough to hinder that the impulsion of the intestines should make them re-enter between the *annuli*; and that tent must be tied to a thread, to be extracted at pleasure. The wound must be filled with lint, covered with a good digestive, made with turpentine, and the yolk of eggs; a plaister, and a comprefs of a triangular figure, and *bandage Spica*.

The operation of the *complete HERNIA* is made when the intestinal parts fall into the *scrotum* in men, and in women to the bottom of the lips of the *matrix*. For this operation the patient is laid on his back, as in the *bubonocèle*, and the incision is made in the same manner; this is made as far as into the *scrotum*, and the membranes are lacerated as far as the intestine. The operator examines if the parts be adherent to the testicle; if it be the *epiploon*, it must be loosened, and a piece of it left to the testicle; but if it was the intestine, and it could not be separated without offending the one or the other, it is better to offend the testicle than the intestine. If the *epiploon* was altered, it must be cut as far as into its found part; the wound is filled with lint; and for *bandage*, the *spica*, as in the *bubonocèle*.

The operation of the *CASTRATION* is occasioned by the mortification or *sarocèle* of the testicles. In this operation the patient is made to lie on his back, his backside higher than his head, to open his legs, which are held by servants; then the operator pinches the skin of the *scrotum*, giving one end to hold to a servant, while he holds the other, to which he makes a longitudinal incision from top to bottom. The carnelosity of the *dartos*, which wraps in the testicle, is separated. The vessels are tied between the *annuli* and the tumour, and cut a finger's breadth under the ligature. The spermatick vessels are not to be ty'd too hard, for fear of a convulsion; one end of the thread must be left to come out of the wound. If the excrescence of the flesh was adherent to the testicle, and is felt moveable, it must be separated dextrously, leaving a small piece of that flesh to the testicle. If some considerable vessels were to appear on the tumour, they should be tied, before it is cut.

The APPARATUS and *bandage* are made by filling the *scrotum* with lint. The *bandage* must be the suspensor of the *scrotum*, called *pauche*; it is a *bandage* with four chiefs, the superior serving for a girt, and the inferior pass between the thighs,

and are tied behind to the girt. There is another *bandage* of the *scrotum* with four chiefs, the superior serve for a girt; it is split at the bottom, is without seam; the inferior chiefs cross over one another, to pass between the thighs, and be tied to the girt; both are pierced through for the passage of the *penis*.

The next operation, which falls under our consideration, is a very great one, called the operation of the *STONE*.

Mr. *Sharp* lays down the following method of searching for the stone. The patient being laid on a horizontal table with his thighs elevated, and a little extended, pass the found, or catheter, with the concave part towards you, till it meets with some resistance in the *perinæum*, a little above the *anus*; then turning it without much force, push it gently on into the bladder, and if it meets with an obstruction at the neck, raise its extremity upwards, by inclining the handle of it towards you; and if it does not then slip in, withdraw it a quarter of an inch, and introducing your fore-finger into the *rectum*, lift it up, and it will seldom fail to enter.

Though, upon searching, the *Chirurgion* may be assured of a stone in the bladder, yet he is not without farther enquiry to operate immediately; since there are some obstacles that forbid the operation, either absolutely, or only for a certain time. Among these, that of the greatest consequence is the gravel or stone in the kidneys, which is known by the pain in the loins, vomiting, retraction of the testicles, numbness of the thighs, and often by matter, which the inflammation produces in the kidneys. Difference of age make an extreme difference in danger; infants and young people almost always recovering; but still the operation is adviseable in those advanced in years, though it is not attended with near the same success.

Before the operation is performed, it is proper to prepare the patient with a gentle purge the preceding day, and a clyster early in the morning, which will be of great service in cooling the body and making the operation less dangerous, where the *rectum* is liable to be wounded, when full.

The most convenient time for the operation of *lithotomy* is spring or autumn, though when the patient is in exquisite torment, or his life in danger, the present opportunity should be embraced.

*Lithotomy* is of two kinds: that made into the bladder is termed *cystotomy*; but when the stone is in the kidneys, which very rarely happens, the operation is termed *nephrotomy*.

With respect to the several methods of performing *lithotomy* for the stone in the bladder, they, according to *Heister*, are four: the first, and most antient, is the *apparatus minor*, called likewise the

*cellian*

*cessian* or *guidonian* method: the second, the *apparatus magnus*, or *Marianus's method*; the latter being termed the new, and the former the old method: the third is the *apparatus altus*, or *lypograftic* section; wherein the incision is made at the lower part of the *abdomen* in the *anterior* side of the bladder, immediately above the *os pubis*; whereas in the rest it is made in the *perinæum*, between the *anus* and the *scrotum*: the fourth, and most modern method, was invented towards the end of the last century, and is termed the lateral operation.

The first method is now entirely laid aside; though *Heister* thinks it practicable on boys under fourteen: the wound of the bladder in this operation, says *Sharp*, is made in the same place as is now practised in the lateral method; but its being impracticable on some subjects, and uncertain in all others, has made it to be universally exploded.

In performing *lithotomy* by the *apparatus major*, Mr. *Sharp's* directions for the situation of the patient are thus. Having laid the patient on a square horizontal table, three feet four inches high, with a pillow under his head, let his legs and thighs be bent, and his heels made to approach his buttocks by tying his hands to the soles of his feet with a couple of strong ligatures; and to secure him more effectually from struggling, pass a double ligature under one of his hams, and carry the four strings round his neck to the other ham: then passing the loop underneath, make a knot by threading one of the single ends through the loop; and thus the thighs are to be widened from each other, and firmly supported by proper persons.

The patient thus situated, *Heister*, directs the operation as follows: the operator, dipping the beak of a sizeable and grooved steel catheter A, (see the plate fig. I,) in oil, he conveys it through the *urethra* into the bladder, and being assured there is a stone, turns the crooked part of the *catheter* in the bladder and *urethra* towards the left side of the *perinæum*, but the handle and *penis*, which contains it, towards the right *inguen*, then delivers it to the assistant, who holds up the *scrotum* in the other hand; for the crooked convex part of the *catheter*, thus elevated in the *perinæum*, renders that part of the *urethra*, which is to be divided, sufficiently perceptible both to the sight and touch. He next lays hold of the integuments of the *perinæum* with the fingers of his left hand, holding in his right the incision-knife, B, wrapped in linen, as he would do a pen for writing: with this he makes a longitudinal incision downwards, about the middle of the left side of the *perinæum* near the *future*, through the fat; then he again feels for the *catheter*, and afterwards divides the *urethra* in a direct line

downwards, so that the end of the knife may pass into the groove of the *catheter*.

After a proper incision, the surgeon parts with his knife, inserting in the groove of the *catheter*, if an assistant holds it, the nail of his finger or thumb: then he takes a male *conductor*, C, dips it in warm oil, and having passed it through the groove of the *catheter* and neck of the bladder into the bladder itself, extracts the *catheter*. The male *conductor* being thus passed, a female *conductor*, D, is introduced upon it, in such a manner as the latter receives the prominent back of the former in its groove, and conveys it safely into the bladder through its neck.

After this the two *conductors* are gently separated by their handles, and then a straight *forceps*, E, dipt in oil and shut very close, is carefully conveyed into the bladder between the *conductors*. The *forceps*, after it is introduced, and the *conductors* withdrawn, must be opened several times to dilate the wound, and then shut to search for the stone: when the stone is found, they must be opened with both hands, in such a manner that one jaw, if possible, may lay hold under the stone, and the other above it. When the stone is thus intercepted, the *forceps*, by a gentle motion from side to side, must be brought towards the *rectum*, and the stone extracted downwards; because the parts dilate and yield more easily that way, while upwards they meet with a resistance from the *os pubis*: but if it lies concealed in any part of the bladder, and cannot be laid hold of by the *forceps*, the operator must pass the two first fingers of his left hand into the *anus*, elevate the stone, and force it into them. If it is situated in the upper part of the bladder, behind the *os pubis*, the inferior part of the *abdomen* must be pressed downwards by the hand, that it may commodiously be taken hold of, and drawn out by the straight or a crooked *forceps*; and if it is lodged on either side, the crooked instrument F is most convenient.

When the stone is too large to be extracted whole, it must be broken by a *forceps*, G, with teeth, and the fragments to be drawn out one after another. Lastly, if the stone is too large and too hard to be either extracted or broken, a prudent surgeon will desist, and heal the wound, or leave a fistula for the discharge of the urine.

The stone being thus extracted, and the bladder cleared, the wound is cleansed with a sponge, the ligatures untied, the patient put to bed, and the wound now dressed with dossils of scraped lint: if the hæmorrhage be too profuse, it may be stopped by pledgits of lint dipt in a proper styptic, and the arteries compressed with the fingers till it stops. These must be covered with a linen-holster, and a large square compress without a plaister, securing the

the whole with the T bandage, or that with four heads; and if they are ineffectual, the artery must be tied up with a crooked needle and thread.

After dressing, the patient must be supplied with plenty of pūsan, barley-water, or a strengthening and composing emulsion; his diet should be the same as for people in fevers, or after great wounds.

The *apparatus altus*, or *high operation*, is performed as follows. The patient being duly prepared, and laid in a proper situation, a hollow silver *catheter*, with a flexible leathern tube H. (*ibid*) at the end of it, is to be introduced into the bladder: to the tube must be fitted a large syringe, for the injecting of such warm water, barley-water, or milk, as the patient can bear. When this is done, the *catheter* is extracted: then while an assistant introduces his two fore-fingers into the *anus* to elevate the stone and bladder, the operator makes an incision in a right line through the skin, fat, and abdominal muscles, immediately above the *ossa pubis*. The external wound should be three fingers-breadth long in children, and four in adults; then introducing the left *index*, the Surgeon feels for the liquor that distends the bladder, and then makes an incision into the bladder immediately above the juncture of the *ossa pubis*: after which he passes a small knife into the body of the bladder, so as to make a small wound with the point only; through this aperture he passes a crooked or straight knife, armed with a button, whereby he enlarges the wound upwards the breadth of one or two fingers. He then introduces his left *index* to draw the upper part of the bladder towards the navel, and then enlarges the wound downwards. Immediately after, he introduces the fore-finger of the other hand, and examines the size and situation of the stone, and accordingly he enlarges the wound either upwards or downwards, in order to extract it. And when the stone is extracted, and nothing left, the wound is dressed, and the patient treated much in the same manner, as in the former case.

The fourth method, which is called the *lateral operation*, is performed thus: every thing being properly prepared, introduce a *catheter*, and afterwards make an incision of a proper length, beginning where they end in the *apparatus major*, and continuing it downwards between the *accelerator urinae*, and *erector penis*. on the left side of the *intestinum rectum*; and directing the knife to the posterior part of the *catheter*, through the inferior and lateral part of the bladder, behind the prostate gland, and above the seminal vesicles, then continue it forwards through the sphincter of the bladder, and left side of the prostate glands into the membranous part of the *urethra* even to its bulb,

which preserves the *rectum* better than the *lateral* method.

Among *Chefelden's* emendations, Doctor *John Douglas* enumerates these. 1. If he finds the patient's pulse low after the operation, he applies blisters to the arms, which effectually raise his spirits. 2. If the wound grows callous, he lays on a piece of blister-plaister to erode it, by which new flesh pullulates, and the wound unites. 3. If the wound be putrid, he mixes a little verdigrease with some digestive ointment.

Women are less subject to the stone in the bladder than men, and their urinary passages are more short and lax, so that in general the stone being but small, discharges itself with the urine, and when it happens to increase in the bladder, we have instances of its coming away spontaneously. Doctor *Douglas* proposes to extract a small stone in a woman, by dilating the *urethra* with a tent of gentian-root, or prepared sponge; but when the stone is large, he approves of the *high operation*, distending the bladder with warm water, and compressing the *urethra* by an assistant's finger in the *vagina*, and then making an incision into the bladder immediately above the *os pubis*. This, *Heister* says, is a very proper method, when the stone is very large, and the patient young and healthy; but *Morand*, when the stone is small, prefers the *apparatus major*.

Upon the whole, *lithotomy* appears to be a dangerous and precarious operation, nor can one method alone be depended on; but the *Chirurgian* must be determined in the choice, by the particular circumstances of the case.

NEPHROTOMY, the *second species* of *lithotomy*, is by most writers on the subject thought impracticable, who therefore absolutely reject it; though we have many instances of persons, who have been cured of wounds of the back penetrating to the kidneys. *Heister* mentions one cure of this kind performed by himself. Wounds, therefore of the kidneys, especially those inflicted on the back, without penetrating into the cavity of the *abdomen*, he says, are often curable. And though *Hippocrates* prohibits his pupils from practising *lithotomy*, yet in treating of disorders in the kidneys, in his work *de Intern. Affect.* he directs to make an incision near the kidney, when it is tumefied and elevated, and after extracting the *pus*, to discharge the gravel by diuretics; for this opening may preserve the patient, who must otherwise die: and again, he says, when the kidney, being suppurated, tumefies near the spine, a deep incision should be made upon the tumour near the kidney, or into the kidney itself. *Rouset*, *Riolanus*, and others, think

*nephrotomy,*

*nephrotomy* may be practised with success, if the opening is made where the stone is perceptible, and neither the emulgent artery, vein, nor ureter wounded, nor the cavity of the *abdomen* penetrated. But beyond all dispute it must be reasonable, when nature points out the place by a tumour or abscess in the loins, proceeding from a stone in the kidneys.

The inferior parts are subject to another dangerous disorder or malady, which requires a most severe operation. It is the *FISTULA IN ANO*.

This is a deep winding, callous, cavernous ulcer, yielding a virulent matter in the *anus* or fundament.

The ancients reckoned four kinds of *Fistulas in ano*; but the best writers of late reduce them to two. The *first* are those arising from a *phyma*; these are very painful, and difficult to cure, as entering deep among the interstices of the muscles, and forming various *cuniculi*, or *sinus's*; which the more remote they are from the *Anus*, the worse they are, by reason they do not allow of being cut. The *second* owe their origin to an internal hæmorrhage, or extravasation between the coats of the *rectum*; and have a small perforation near the circumference of the *anus*, whence they yield a thin *fæces*, or ichor, without pain; they in time bring on itchings and excoriations, and the orifices at length become callous, and are sometimes closed, and sometimes open again.

The fresh, simple *fistula*, may be cured without danger, by *cutting*, where that may be done without damage to the muscle of the *anus*, in the following manner:

If the *fistula* be open outwards, the patient must lie on his belly at the edge of the bed, his legs asunder; the operator must make a small incision with a bistoury, at the orifice of the *fistula*, to run into it a small, thin, and bowed or crooked bistoury; at the end thereof there must be put a small pointed stilet, with a small silver tongue to it, to recover it, that it may enter without causing any pain; this bistoury must be introduced into the *fistula*, having the index of the left hand in the *anus*, and its tongue must be drawn out; the handle of the bistoury must be held with one hand, and the stilet, which pierces the *anus*, with the other. The instrument is drawn out to cut the *fistula* all at once.

If the *fistula* opens in the intestine, an incision must be made outwards, at the bottom of the *fistula*, to open it in the place where ordinarily appears a small tumour, or inflammation; or where the patient feels some pain when the part is touched. If the tumour was far from the *anus*, it might be

opened with the potential cautery to avoid causing pain. When the bottom of the sack is opened, the bistoury, with its stilet and tongue, is introduced into it. The end of the stilet is extracted through the *anus*, and the flesh cut all at once. If the *fistula* was too far in the *anus*, the sphincter of the *anus* should not be entirely cut, for afterwards the patient could not be able to retain his excrements.

After the *fistula* has been opened, all the sinuosities found in it must be cut, likewise, with scissars; the wound is filled with tents made of lint, dipped in some anodyne *pledgets*, a plaister, a triangular compress, and the whole supported with the bandage called T.

From the *trunk* of the *body* we'll descend to the extremities, and make the *amputation* of the *LEG*.

For the *amputation of the leg*, the patient is made to sit on the edge of his bed, or in a chair; he must be supported by two servants, one to hold the leg at the bottom, and the other to draw the skin upwards above the knee, that the flesh may cover the bone after the operation. A pretty thick compress is placed within-side the knee, on which are made two ligatures; the first above the knee, to stop the blood, to be straitened with the *grife*; the second under the knee, to straiten the flesh for the knife. Before the first ligature be straitened, a piece of card must be put under it, for fear of pinching the skin. The leg being made very steady, the operator plac'd to the inside of the limb, makes the incision with a bow'd knife, turning circularly to the bone, keeping one of his hands on the back of the knife, and endeavouring to separate the flesh from the bone with a stroke or two; then divides also, the *periosteum* from the bone with the back of the knife, or a bistoury, and cutting the flesh and vessels which are between the two bones. The flesh being cut, a splitted band must be put upon it, whose chief must be crossed, to draw the flesh upwards, that the bones may be cut further, and covered by it after the amputation, and also to facilitate the passage of the saw. The *Chirurgion* must then take the leg with his left hand, and the saw with the right, which he must apply on the two bones, to cut them both at the same time, beginning by the *peronæum*, and ending by the *tibia*. He must incline the saw, and go softly, at first, to make the way; after which, he must go swifter, and with as few strokes as possible.

The ligature of the vessels is done by laying hold of their mouths with a forceps with springs; which forceps is given to a servant to hold; a needle, threaded with a wax thread, is run thro' the flesh under the vessel, and run again, and then

gature is made with the two ends of the thread to the vessel. The gripe, is taken off with the band, the patient is ordered to bow a little, the stump and the flesh is brought down to cover the bone.

The APPARATUS and *bandage* are made by putting small compresses on the vessels, and dry pledgets on the tow bones, and several other pledgets covered with astringent powders; over it another great pledget of cotton or tow covered with astringent powders, the whole being wrapped up with a plaister, and a compress in form of a cross of *Malta*, with three or four longitudinal compresses, and a circular one. The cross of *Malta*, and the compresses, are placed within-side of the knee, whose chiefs, or ends, are crossed over the stump; they must be held by the servant who supports the part; the other chiefs are crossed, likewise; the two longitudinal compresses crossing one another; are placed at the center of the stump, and a third longitudinal is made to run round the stump, to stop the two first; they must be three fingers in breadth, and long enough to pass on the stump.

This done, the bandage is made with a band four ells long, and three fingers broad, rolled to a globe, with which are made three circularies on the edge of the part cut, rising upwards by *doloirs*, and passing obliquely the band under the knee, and descending again over the first turns; continuing thus to descend and rise till the whole stump be covered; the band must be stopped above the knee. In three or four days the dressing may be removed,

and proper digestives, mixed with astringents, applied; having an actual cautery, or some powerful styptick, in readiness, in case of a violent hæmorrhage at the first opening. M. *Sabourin*, *Chirurgien* of *Geneva*, is recorded in the history of the *Royal Academy of Sciences*, *Anno* 1702, for an improvement in the method of *amputation*, proposed to the academy. The whole secret consists in saving a piece of flesh, and skin, a little lower than the place where the section is to be made; wherewith the stump is to be afterwards covered. The advantages whereof are, that in less than two days time this flesh unites with the extremes of the divided vessels, and so saves the necessity either of binding the ends of those vessels with thread, or of applying causticks, or astringents; which are methods very dangerous, or at least very incommodious. Besides the bone, thus covered up, does not exfoliate.

From these examples (compared with our treatise on ANATOMY) the curious enquirer into SURGERY may form a judgment, not only of the use of this art; but also of the manner of executing many cures and operations, not particularly mentioned in this treatise.

As for the practice of MIDWIFERY, which is acknowledged amongst *chirurgical operations*; the subject is of that consequence, that it deserves a treatise by itself; and therefore shall refer the reader to the the letter M, in the course of this work.

## Of C H R O N O L O G Y.

**C**HRONOLOGY is the regulation of times, in regard to *civil* and *ecclesiastical* history; shewing by remarkable signs and tokens, notes and characters, the exact time when every memorable action has happened since the Creation: whence it has it name from *χρόνος*, *time*, and *λόγος* a *discourse*.

Its business is to ascertain and adjust the various epochas and other periods mentioned in history, so that the establishment and revolutions of empires and kingdoms, and other remarkable events may be truly stated.

Mr. *Locke* writes, that history owes its use and beauty to *Chronology*; and that, without its aid, history would be a jumble of facts confusedly heaped together, not capable of giving either pleasure or instruction,

This science begins with some preliminary definitions. For before chronological facts can be ascertained, it is necessary to agree upon the definition and division of TIME.

*First*, TIME is the measure of *motion*, which motion has always been calculated, or computed by the motion of the *sun* and *moon*; as the most regular and constant.

*Secondly*, Upon this doctrine, *time* has been usually divided into *solar* and *lunar* revolutions, called *years* and *months*.

The *solar year* is the space of *time* the *sun* takes to pass through the twelve signs of the *zodiack*, consisting of 365 days, 5 hours, and 49 minutes. This is known by the name of the *natural* or *astronomical year*. But there are other *annual* divisions of *time* devised by the church and state, called *artificial* or *civil*, and *ecclesiastical years*.

Hence arose the variety of computations, which so much perplex our histories.

The *civil year* is that form of year, which each nation has contrived to compute *time* by; or it is the *tropical year* considered as only consisting of a certain number of whole days, *viz.* 365 days, without

without any regard to the surplus of hours and minutes ; which every fourth year being added together make one whole day, and then the civil year contains 366 days, which is called *bissextile* or *leap-year* ; the invention of *Julius Cæsar*, to make the *civil year* keep pace, with the *tropical* or *astronomical*. Of which more particularly hereafter.

In the year 1582, it being observed that the vernal equinox, was by this calculation brought back from the 20th to the 10th of *March*, Pope Gregory XIII. cast out ten days at once in the computation, by ordering the first of *October* to be held for the *eleventh*, &c. And to prevent the like excess for the time to come, in the *Italian* computation, he ordained, that at the end of every century, the *bissextile* or *intercalary* day should be omitted, except the fourth century, when it is to be retained ; because the *eleven* minutes, that the *Italian* exceeds the *natural year*, do not amount to a day in less than 131 years. — This is what was called the *NEW-STYLE* in contra-distinction to the *Italian* computation, which was continued by several nations for a long time, where the Pope's power was not acknowledged. But in 1752, the parliament of *Great Britain* enacted, that the 3d of *September* in that year should be held for the *fourteenth* ; and that for the future this nation should compute *time* by the *New-style*, and to begin the year on the first day of *January*, which before did not commence till the 25th of *March*.

The *lunar year* corresponds with the moon's revolution only. For, as the moon takes up 29 days, 12 hours, 44 minutes and 3 seconds in passing through the 12 signs ; twelve of these monthly revolutions make one *lunar year*, consisting of 354 days, 8 hours, 48 minutes and 38 seconds. So that the difference between the common *lunar year* and the *astronomical solar year* is 11 days, 5 hours and 49 minutes.

The first division of *time* by *years* appears to have been made by *Romulus* : but it was very far from being exact : for it consisted only of 304 days divided into ten unequal months of 30 and 31 days alternately. The inconvenience that arose from this calculation was somewhat removed by the addition of as many days yearly, as he found would make the state of the heavens correspond to the first month, which additional days remained without any distinct appellation till the reign of *Numa Pompilius*, who divided them into two months by the name of *January* and *February* : yet the *astronomical* observations of his successors finding that the entire revolution of the sun could not be accomplished in this number of days, *Julius Cæsar* added 11 days and 6 hours more ; which brought it to that exactness, which has been ever since the

basis of our computations, though Pope Gregory, as mentioned above, has established it upon a more nice calculation.

*Julius Cæsar* observing that time had lost 67 days by the fault of the *pontifices*, who had the charge of regulating its motion at *Rome*, since the days of *Numa*, invited *Sofigenes*, the eminent mathematician from *Egypt*, to assist him in the formation of a more regular annual computation ; who, resolving to fix the beginning of the year to the *winter solstice*, was obliged to make that year consist of 445 days, divided into 15 months, which is there called *annus confusionis*, the *year of confusion*,

The *Egyptians* computed *time* by a year of 365 days, divided into 12 months of 30 days each ; besides 5 intercalary days added to the last month. This is called *Nabonasser's year* ; and, as it looses one whole day of the *Julian year* in every four years ; so its beginning in the course of 460 runs through every part of the *Julian year* till they meet again. However, as this year is used by *Ptolemy* ; it is useful in comparing the ancient *astronomical* observations with the modern.

*Nabonasser's year* after the battle of *Ætium*, was obliged in some measure, with the *Egyptian* liberty, to give way to the regulations of the *Roman* conquerors : and this year thus reformed is filed, *annus Ætiacus*. The *Egyptian year* was the same, only differing as to the names of the months.

The *Greeks* originally computed *time* by a *lunar year*, consisting of 12 months, each of 30 days ; but were changed into months of 30 and 29 days alternately computed from the first appearance of the *new moon*, with the addition of an intercalary month of 30 days, every 3d, 5th, 8th, 11th, 14th, 16th and 19th year of a cycle of 19 years, in order to keep the *new* and *full moons* to the same term of seasons : always commencing at the *full moon* next after the *summer solstice*.

The *Macedonian year* differed from the *Attic* originally, only in the names, and order of the months. But the modern *Macedonian year* is *solar*, and perfectly agrees with the *Julian year*.

The ancient *Jewish year* was also *lunar*, consisting of 11 months, which alternately contained 29 and 30 days : and was made to agree with the *solar year* by 11 and sometimes by 12 days at the end of the year, or by an intercalary month. The *modern Jews* compute also by a *lunar year*, but they reckon 12 months in common, and in a cycle of 19 years, they add an intercalary month to the 3d, 6th, 8th, 11th, 14th, 17th, and 19th year.

The *Syrian* is a *solar year*, and begins with *October* in the *Julian* account of *time*.

The *Persian year* is also *solar*, consisting of 365 days, divided into 12 months, with 5 days added to the last. This was called the *Yezdegerdick year*, to distinguish it from the *Galilean* or fixed *solar year*, introduced in *Persia* in the year of 1079, which was formed by an intercalation made six or seven times in four years, and then once every fifth year: the former was *Nabmasser's year*; the latter is accounted the best and justest for keeping the solstices and equinoxes, and for answering accurately to the *solar* motions.

The *Arabs* and *Turks* differ from the *Syrian year*, only in placing the intercalary month, which they add every 2d, 5th, 7th, 10th, 13th, 15th, 18th, 21st, 24th, 26th and 29th year in a cycle of 29 years.

The *Jews*, and most other nations in the east had a *civil year*, which arbitrarily began with the *new moon* in *September*: and an *ecclesiastical year*, which commenced from the *new moon* in *March*.

The *civil*, or *legal year* has varied much in divers nations. In *France*, during the reigns of the *Merovingians*, it began on the first day of *March*. Under the *Carolingians*, on *Christmas-day*. Under the *Capetians*, the present race, on *Easter-day*; which is still the commencement of the *ecclesiastical year* in the *Gallie church*: but *Charles IX.* in 1564, ordained that the *civil year* should thence forward commence on the first day of *January*.

In *England* the legal commencement of the *year*, till the year 1753, was upon the 25th of *March*; according to which beginning of the *year*, our forefathers were obliged to date all their civil affairs. But we now by act of parliament begin our *year* the first day of *January*: the church of *England*, however, as to her liturgical forms begins the *ecclesiastical year* on the first *Sunday* in *Advent*.

The *Mahometans* begin their *year* the minute the *sun* enters *Aries*: the *Persians* in the month that answers our *June*: the *Chinese* and most of the *Indian* nations begin the year with the first moon in *March*: the *Brachmans* do not begin their year till the new moon in *April*. The *Mexicans* begin the year on the 23d of *February*; being directed by the first appearances of the spring, or the leaves of trees putting forth about that time: and they divide their year into 18 months of 20 days each, making in all 360 days, at the end of which they

spend 5 days entirely in mirth. The *Abyssines*, who begin their year on the 26th of *August*, divide their time in the like manner, and finish the year with five days mirth, which they called *pagomen*. The *Greeks* begin their year from the first day of *September*.

In course of time the annual calculations by astronomical observations were formed into cycles, olympiads, lustrums, indictions, centuries, ages, periods, epochas, or æras.

A CYCLE is a certain period or series of years, which regularly proceed from the first to the last, and then return again to the first, and circulate perpetually.

The most considerable cycles are those of the *sun*, of the *moon*, and of the *Roman indiction*.

The cycle of the *sun* consists of twenty eight years, which contain all the possible combinations of the dominical letters, in respect to their successive order, as pointing out the common years and leap-years; so that, after the expiration of the cycle, the days of the month return in the same order to the same days of the week, throughout the next cycle; except that upon every centesimal year, which is not a leap year, the letters must always be removed one place forward, to make them answer to the years of the cycle; for instance, if the year 1800 were a leap-year, as every centesimal year is in the *Julian* account, the dominical letter would be E D, and C would be the dominical letter of the next year: but as it is a common year in the *Gregorian* account, D is the dominical letter of 1801, which answers to the eighteenth of the cycle, C to the nineteenth, &c. until the next centesimal year.

To find the year of this cycle for any year of the christian æra, add 9 to the current year of CHRIST, because the cycle commenced nine years before the christian æra, and divide the sum by 28, the quotient will shew the number of cycles which revolved since the beginning of that in which the christian æra commenced: and the remainder, if any, shews the current year of the cycle: but if there be no remainder, it shews that it is the last; or twentieth year of the cycle.

The dominical letter of each year in this cycle, until the year 1800, appears by the following table.

1	D	C	5	F	E	9	A	G	13	C	A	17	E	D	21	G	F	25	B	A
2	B		6	D		10	F		14	B		18	C		22	E		26	G	
3	A		7	C		11	E		15	G		19	B		23	D		27	F	
4	G		8	B		12	D		16	F		20	A		24	C		28	E	

*Cycle of the moon, or lunar cycle,* called also the *golden number*, is a period of *nineteen years*, after which the *new and full moons* return on the same days of the months, only one hour twenty-eight minutes sooner: so that, on whatever days the *new and full moon* fall this year, they will happen nineteen years hence, on the same days of the months, except when a *centesimal common year* falls within the *cycle*, which will move the *new and full moons* a day later in the calendar than otherwise they would have fallen, inasmuch that a *new moon* which fell before the *centesimal year*, suppose on *March 10*, will fall nineteen years afterwards, on *March 11*. The number of years elapsed in this *cycle* is called the *prime*, from its use in pointing out the day of the *new moon*, *primum lunæ*, and the *golden number*, as deserving to be writ in letters of gold.

The *golden numbers* are those placed in the *first* column of the calendar, betwixt *March 21* and *April 18*, both inclusive, to denote the days upon which those *full moons* fall, which happen upon, or next, after *March 21*, in those years, of which they are respectively the *golden numbers*.

For finding the *golden number*, add one to the current year of our *LORD*, because one year of this *cycle* was elapsed before the *Christian æra* began, and divide by *19*, the remainder is the current year of this *cycle*, or *golden number*; but if nothing remains, it shews that it is the last year of the *cycle*, and consequently the *golden number* is *19*.

*Cycle of the Roman indiction*, is a period of *fifteen years*, in use among the *Romans*, commencing from the *third year before CHRIST*. This *cycle* has no connection with the *celestial motions*; but was instituted, according to *Baronius*, by *Constantine*; who having reduced the time which the *Romans* were obliged to serve; to *fifteen years*, he was consequently obliged, every *fifteen years*, to *impose*, or *indicare*, according to the *Latin* expression, an extraordinary tax for the payment of those, who were discharged; and hence arose this *cycle*.

To find the *cycle of indiction* for any given year, add *3* to the given year, and divide the sum by *15*, the remainder is the current year of the *cycle of indiction*; if there be no remainder, it is the *fifteenth* or last year of the *indiction*.

These three *cycles* multiplied into one another, that is,  $28 \times 19 \times 15$ , amount to *7980*, which is called the *Julian period*, after which the three foregoing *cycles* will begin again together. This *period* had its imaginary beginning *710* years before the creation, according to the common opinion among *chronologers* concerning the age of the world, and is not yet complete. It is much used in chronological tables.

The *OLYMPIAD* is a space of *four years* invented by the *Greeks*, and named by them from *Olympia* in *Peloponnesus*, where they worshipped *Jupiter* with great ceremony and games. This institution in *Chronology* is dated in the *776th* year before *CHRIST*, or *24* years before the building of *Rome*. Some have been led to compute the *Olympiad* a term of *five years*, because it is written that the *Olympic games* used to be celebrated every *fifth* year. But the late archbishop *Potter* in his *Grecian antiquities* discovers a fallacy in that expression, and shews that the *games were celebrated every fifth lunar month*: that this being the *second month* after the expiration of *four lunar years*, might be called the *fifth year*: but that if the intercalation be duly considered, an *Olympiad* will answer pretty exactly to four solar years and no more.

The *LISTRUM* was the space of *five years*. It was an institution by the *Romans*, and particularly regarded the time of paying their taxes and subsidies.

The *INDICATION* is also of *Roman* extraction, and related only to affairs of state. It consists of three *lustra* or *fifteen years*.

Other states have made use of the like mensuration of time. The *papacy* ever since the days of *Charlemain*, has used this term in the date of *bulls*, beginning from the *1st* of *January*. We also find an *indication* at *Constantinople*, which commenceth on the *first* of *September*, and another in the empire, called the *imperial* or *Cæsarian* indiction, which takes its date from the *14th* of *September*.

A *CENTURY* is the space of *one hundred solar years*, by which *Chronologers* generally divide the age or duration of the world.

*AGE* is a computation, which divides time into three parts; *viz.* The *age of nature*; which comprehends the whole time from *Adam* to the publication of the law by *Moses*. The *age of the Jewish law*; which takes in all the time from *Moses* to *JESUS CHRIST*: and the *age of grace*, which are the years elapsed from the incarnation of the *Son of GOD*.

By another computation used in antient authors, the duration of the world is also divided into *ages* thus: The *first*, from the *creation* to the *deluge* in *Greece* in the reign of *Ogyges*, called the *obscure*, or *uncertain age*. The *second*, follows to the commencement of the *Olympiads*: and there, the *third*, or the *historical age* commenceth.

The *poets* divide the duration of the world into *four ages*, *viz.* the *golden age*; the *silver*; the *brazen*; and the *iron age*.

The definitions of *period*, *epocha*, and *æra* are for nearly alike, that they are generally used as synonymous terms to signify the first point, or certain time.

time remarkable for some event, from which the ancients number the years that followed.

The *creation* of the world is the grand *period*, or *epocha* for the beginning of the account of time; in all nations. But there is great variety amongst *Chronologists* in regard to the number of years, the world has existed.

However, it will be necessary to produce the *principles* upon which *Chronology* in its present state depends. Which is, *First*, the *testimony* of *writers* or *authors*: *Secondly*, *Astronomical* observations, especially *eclipses* of the *Sun* and *moon*: and *Thirdly*, such *epochs*, as are allowed to be certain in history.

Of all writers or authors the *testimony* of the *BIBLE* deserves the greatest credit. The historical fables of the *Chaldeans* or *Babylonians*, pretended to be grounded on astronomical observations, carry the foundation of their empire back to so many myriads of years, and relate such obvious falsities, that *Aristotle* could not refrain numbering them amongst the incredible and false writers.

The *Egyptian* account of 34201 years, which they assign to the government of their nation by the *gods* and *semi-gods*, before ever a man ruled their empire, brought upon the historians of that nation this disadvantageous reflexion by *Plato*, That they were miserably ignorant of antiquity; and should discredit every particular asserted upon so bad a computation.

The *Chinese* are not more to be regarded. They date their histories many ages before the creation, and they are stuffed with such unaccountable stories, and contradictions, that there can be no expectation of arriving at an exact computation of time by their books.

I don't deny that some objections lie against the *Chronology* of the *Bible* also: but those objections are quite of a different sort. They are not supported by proofs of falsities and self-contradiction; but arise from a *variation* in the accounts of ages of men and periods of events, delivered in the *Hebrew* and *Greek* copies of that sacred book. They both agree in the *facts*, but differ in the *duration* of time, and that at the most but 1500 years, which the *Septuagint* carries the world higher than the vulgar account: whereas the *Chaldeans* pretend that the world is *forty-thousand years* older. See the scripture account defended in *Hearne's Ductor historicus*, vol. I. p. 18, &c. and *Card. Pezron's Antiquité de Tems*.

If we look into the histories of all nations, their origin is attended with great obscurity. No people, but the *Jews*, were blessed with an inspired writer of their first transactions. And I might add that no other nation can produce the first writer of its

settlement. So that there are now extant no materials for compiling a *Chronology* of the first ages, but the *Holy Scriptures*.

Another difficulty in *Chronology* arises from the different *Æras* and years in divers nations. The *Grecians* computed from the beginning of the *Olympiads*: the *Romans* from the *building* of their city: the commencement of the *Assyrian* monarchy, being doubtful, makes that *Æra* doubtful also: the same is remarked of the *Nabonassarcan Epocha* used by the *Egyptians*. Some nations have used no *epocha* at all: and the *Christians* did not begin to compute from the *birth* of *CHRIST* till 532 years after he was born.

The beginning of the year both in several nations, and in the different *epochs* is so various, that it also creates much perplexity in the account of time. Before the law was given by *Moses* the *creation* is dated from the *autumnal equinox*: but at the institution of the *passover* *GOD* commanded *Nisan* at the *vernal equinox* to be the first month. The *Grecians* began the year with the *olympiad* at the full moon after the summer solstice. Some reckoned the beginning of the *Roman* year from the 21st of *April*; others dated it from the 1st of *January*. And thus of others, as above observed, in the account of the years.

It ought also to be remarked, that the *poets*, who have taken the liberty to forge people and tenets that never existed, or brought stories from different ages so near together, as to destroy their credibility, have greatly contributed to perplex *Chronology*; and they ought to be carefully avoided.

Hence it appears that the *testimony* of authors (the *scripture* only excepted) is very precarious.

By *scripture* we may gather a certain succession of time for 3500 years, after which *Herodotus* and other credible authors, who write the histories of their own times, will enable us to proceed.

In the mean time let us examine the *second principle* in *Chronology*; this is the *book of nature*, wherein the *motions* and *aspects* of the *sun* and *moon*, and other *planets*, give us a certain guide in this study.

An *ECLIPSE* of the *sun*, or of the *moon* is such an identical mark of a year, that it is easy to distinguish it, at any distance of time from an infinite number of other years. Nothing therefore can so well ascertain the year of a battle, the foundation of a city, the death of a Prince, &c. as an *eclipse* that happens on or near the same day: because by *astronomical tables* it is discovered, that an *eclipse* seen upon such and such a day, ought necessarily to have happened in such and such a year. Thus by an *eclipse* of the *sun* mentioned by *Justin* to have happened

happened at the time the tyrant *Agathocles* crossed the seas from *Sicily* to invade the *Carthaginians*, it is found by *astronomical* calculation to have been done in the year of the world 3634, and 316 years before the vulgar *Æra* of *CHRIST*, on the 15th of *August*.

Again, as it is observed that the great conjunction of *Saturn* and *Jupiter* happens at the end of every 800 years in the same degree of the *Zodiack*; this phenomenon might also be adapted to distinguish and characterize the times. There have been eight of these great conjunctions since the creation: one of which, according to *Archbishop Usher*, was in 3998, two years before the birth of *CHRIST*, and the last of them happened in *December 1603*.

The same use might be made of the aspects of all those planets, which happen but seldom. See this principle largely treated of in *CALVISIUS*, and in the *Reverend Mr. BEDFORD's scripture Chronology*.

The most general principle observed by historians in the account of time, is to observe certain constant epochs agreed upon by all writers.

These EPOCHAS are divided into *sacred* and *civil*.

The most eminent *sacred epochs* are reduced to thirteen, viz.

1. The Creation.
2. The Flood, A. M. 1656.
3. The calling of *Abraham*; before C. 1921.
4. The deliverance and departure of the *Jews* from *Egypt*, before C. 1491.
5. The building of *Solomon's temple*, before C. 1012.
6. The restoration of the *Jews* by *Cyrus*, and foundation of the second temple, before C. 536.
7. The finishing of the second temple in the 6th of *Darius Hystaspes*, whom the scripture names *Abasuerus*. before C. 515.
8. The birth of our SAVIOUR, *JESUS CHRIST*.
9. The martyrdom of *St. Peter* and *St. Paul*, after C. 67.
10. The destruction of the temple and dispersion of the *Jews*, after C. 70.
11. The *Æra* of *DIOCLESIAN*, or the martyrs, 302.
12. Peace given to the church by *CONSTANTINE the Great*, 312.
13. The first general council at *Nice*, 324.

The *civil epochs* of most note are,

1. The taking of *Troy*, A. M. 2766.
2. The first *olympiad*, A. M. 3174.
3. The building of *Rome* A. M. 3197 or 8.
4. The *Æra* of *Seleucides*, A. M. 3637.

5. The first *Julian* year in which *Cæsar* reformed the calendar. Before C. 45.

6. The building of *Constantinople*, A. D. 330.

7. The *Hegeira* or flight of *Mahomet* from *Mecca*; July 16, A. D. 622, instituted by *Sultan OMAR III*.

8. *CHARLEMAIN*, or *CHARLES the Great*, establishes the new empire. A. D. 800.

9. *Constantinople* taken by *Mahomet II*. A. D. 1453.

Besides these *universals*, each nation have their peculiar *epochs* of memorable events, as in *ENGLAND*. 1. The invasion of *BRITAIN* by *CÆSAR*. 2. The establishment of the *Saxon heptarchy*. 3. The expulsion of the *Saxons* by the *Danes*. 4. *Norman conquest*. 5. The union of the houses of *York* and *Lancaster*. 6. The reformation in religion and expulsion of *popery*. 7. The accession of the house of *Stuart* to the throne. 8. The beheading of King *Charles I*. 9. The usurpation of the throne by *Oliver Cromwell*. 10. The restoration of King *Charles II*. 11. *The Revolution*. 12. The union with *Scotland*. 13. The accession of the house of *HANOVER* to the crown of *GREAT BRITAIN*.

Therefore we will run through the most material parts of the *Chronology* of every nation that is come to our knowledge; beginning with

The CHRONOLOGY of the ancient PATRIARCHS.

This part begins with *ADAM*, recounting his children and their descendants as far as the death of the patriarch *ISAAC*.

*JACOB* is the first amongst the names in the *Chronology* of the *Hebrew judges*: which epocha ends with *Samuel*, who gave his nation a King.

Within this space of time the *Assyrian* empire was established, A. M. 1774 by *Nimrod*, whom prophane history names *Belus* the first King in the world. This monarchy continued upwards of 1300 years, when it was destroyed by the *Medes*.

In the mean time *SAUL* was anointed King over the *Hebrews*, divided into the kingdoms of *Israel* and *Judah*: and notwithstanding the powerful opposition this little state met with frequently from the neighbouring nations, and the destruction brought upon their liberty by the powerful enemies of their God and religion; the *Jews* kept up the succession of their Kings, till the death of *Agrippa* the son of *Herod Agrippa*, about 70 years after *CHRIST*.

The *Medes* began to reign at *Ninveh* under *Arbazes*, at the expulsion of *Sardanapalus* the *Assyrian* monarch; and they maintained their conquest

of the *Assyrian* empire about 325 years, when the *Assyrian* line was restored in the person of PHUL, who was lineally succeeded by *Tiglathpileser*, *Salmannassar*, *Sennacherib*, and *Assarhaddon*, in whom the *Assyrian* monarchy expired for ever. For after him there is no mention made of kings of *Assyria*, but of *Babylon* only: the first of whom was *Merodach Baladan*, and the last the prophane *Belshazzar* or *Baltassar*, who was killed, in the midst of his debaucheries by *Cyrus*, who, on the entire ruin of the *Babylonish* empire or kingdom, the conqueror founded the *Persian* monarchy.

With *Cyrus* we begin the *Chronology* of the *Persian* empire: which with his other conquests, was divided at the death of *Alexander the Great*, about 260 years after, amongst his captains.

Upon the death of *Alexander the Great*, his conquests and dominions were erected into four monarchies; viz. *Macedon*, *Egypt*, *Syria*, and *Asia*.

*Macedon* was possessed by *Philip Arideus*, and continued till the death of *Perses*, when after a succession of 145 years this kingdom became extinct.

*Egypt* fell to the lot of *Ptolomy*, natural brother to *Alexander*, and his memory was so revered by his male successors on the throne of this kingdom, that they all took the name of *Ptolomy*, at their accession. This kingdom, at the death of *Queen Cleopatra*, became a *Roman* province; 288 years from its first foundation by the *Ptolomies*.

*SYRIA* was seized by the mighty warrior SELEUCUS NICANOR, i.e.  *victorious*. This is he, who extended his dominion over *Syria*, *Persia*, *Media*, and *Babylon*; and who gives name to the *era* of the *Seleucides*, by which the *Maccabees* begin to reckon the kingdom of the *Greeks* and *Seleucides*. Here we find a succession of nineteen kings, besides the founder, within the compass of 263 years, when it was reduced by the *Romans* and became a province to them.

The *Romans*, whose power at this time overawed the whole world, were first established in the form of a monarchy by ROMULUS; but authors differ very much about the date of *Rome's* foundation: *Torniel* fixes this *epocha* in A. M. 3300, *Capel* in 3247, *Genebrard* in 3403, *Clavissius* in 3198, *Salian* in 3302, *Varro* in 3197, *Cato* in 3198.

In this state it was governed by six kings for the space of 220 years according to *Livy*, and *Halicarnassus*.

At the expulsion of TARQUIN the proud, it degenerated into a republic under the government of a senate and consuls, who were two, chosen annually, for the term of 462 years; when JULIUS CÆSAR

usurped the sovereign power, and laid the foundation of the *Roman* empire in his own person.

During the republic, the *Roman* history records several alterations in the form of government, for though the consuls maintained their dignity, their power was somewhat controuled by introducing a new magistrate by the name and title of *tribune of the people*, chosen out of the commonalty to protect them from the oppression of the great, and to defend the liberties of the people against the incroachments of the senate and consuls. This magistrate was first erected in the 211st, year U. C.

In the year 303 U. C. the consuls for the time being gave such a general disgust by their iniquitous practices, that the government was lodged in the hands of a new magistracy of ten men, called *decemviri*, with power to draw up and make laws for the people. But this sovereign power so intoxicated the heads of the new magistrates, that in less than three years they found it necessary to put an end to it, and the consular power was again restored.

In 311 U. C. the senate and people agreed to chuse six military tribunes; three by the general of the army, and three by the people in the *comitia*, who were invested with consular honours and authority; in order to prevent any excess of power in the administrators of the republic.

Besides these officers, we also meet with a supreme temporary magistrate, created by the name of *dictator* by the senate or the people on some extraordinary occasion, to command with sovereign authority in all affairs, whether military or civil. The first officer of this kind was *T. Lurgus* created in 253 U. C.

The military history of this nation contains several remarkable *epochas*: as the taking of *Rome* by the *Gauls* in the year 365 U. C. The *Roman* war with *K. Pyrrhus* in 473 U. C. The first *Punic* war, and the first appearance of the *Romans* upon the sea, in 489 U. C. The second *Punic* war, in 537 U. C. The *Macedonian* war begun with *K. Philip* in 554 U. C. The end of the *Asiatic* war, in 564 U. C. The beginning of the third *Punic* war in 602 U. C. The *Numantian* war, in 620 U. C. The *Jugurthine* war in 643 U. C.

The conquests made by the *Romans* were not able to defend their liberty against the ambition of those entrusted with their armies.

JULIUS CÆSAR turned their own strength against the constitution of his country, and changed the republic into a monarchy. From his usurpation the *Roman* empire takes it *epocha*, about 48 years before the birth of CHRIST.

This monarchy, continued down to the year 454 after CHRIST, when *Valentinian* the third was

murdered by the intrigues of his general *Maximus*

*Maximus* supported his tyranny only 77 days, and his successors down to *MANILIUS* or *AUGUSTULUS*, so little deserve the name and dignity of emperors, being raised to the government by factions and murders, that though *ODOACER* did not put an end to the *Roman* empire till the year 475, yet we can scarce admit any of the successors of *Valentinian III.* to have a place amongst the emperors.

The *Roman* empire, as established by *JULIUS CÆSAR*, was intended by him to be *hereditary*: and accordingly we find that it passed either by heirship, adoption, or by the will of the emperors in succession, till the cruelties of *NERO* provoked the army to place *GALBA* upon the throne at his death, by their own election. And, though many examples shew that the children and nephews frequently succeeded afterwards to their relatives, it is certain that the army never gave up this power, and exercised it sometimes so licentiously, that different parts of the army would set up divers emperors at a time.

The senate also claimed a right to name an emperor; as may be seen in the exaltation of *PAPIENUS*, *BALBINUS*, and *GORDIAN* the *first* and *second*, whom they successively placed in the imperial seat in opposition to *Maximinus*, that monster of cruelty and intemperance, who is recorded to eat 64 pounds of meat, and drink 24 quarts of wine in one day. But the military faction having the power in their own hands soon convinced the senate, by putting their emperors to death, that they had lost their authority and liberty, by permitting the army to swell above the capacity of the civil power.

From the time of *CONSTANTINE the Great*, the first *Christian* emperor, and founder of the city of *Constantinople* (which he honoured with a senate, and the citizens with the rights and privileges of the city of *Rome*) the succession was regulated in a much better manner, and the empire for some generations descended in a right line, till the weakness and vices of *Valentinian III.* favoured the ambition of *Maximus*, who, after killing his sovereign, usurped his throne, and married his widow *EUDOXIA* by compulsion.

Here we must date the foundation of the republic of *Venice* A. D. 452, by the same *VALENTINIAN*, who flying before the arms of *ATTILA* king of the *Huns*, who had invaded *Italy*, retired in the 27th year of his reign into those islands of the *Adriatic* sea, where *Venice* now stands.

Here also we fix the *Epocha* of the eruption of the *VANDALS* with the *Roman* empire; who invited by the disgusted *EUDOXIA*, to take vengeance

on *MAXIMUS*, landed in *Italy* under the command of *Genferick* their general, unexpected, and entered *Rome* without opposition. The *Vandals* plundered the city, and having burnt such parts thereof as they thought proper, they retired with their booty back to the coast of *Africa*.

After *Maximus*, the army in *Gaul* set up one *AVITUS*, who abdicated the throne after ten months, and made way for a new election by the senate and army together, who raised *Majorian* to the purple. He was murdered by the perfidy of his generalissimo *RACIMER*: who first placed *SEVERUS LIBIUS* in his seat, and afterwards caused him to be poisoned, to make way for *ANTHEMIUS*. But this creature of the generalissimo falling also under his displeasure, was killed by his procurement, to enable him to give the imperial dignity to one *OLIBRIUS*.

Thus the *Roman* empire was obliged to receive four emperors, and their lives sported away at the will and pleasure of a man, who had been raised to the chief command of their armies from the condition of a common centinel.

*RACIMER* died soon after the advancement of *OLIBRIUS*: and the distracted state of the empire encouraged the *GOTHS*, to attempt its reduction. They accordingly invade *Rome*, kill *OLIBRIUS*, and place *GLYCERIUS* upon the throne, who was deposed by *JULIUS NEPOS*; as he himself was, after fifteen months by *ORESTES* general of his army, to make way for his own son *MANILIUS*, nicknamed *AUGUSTULUS*, who was obliged to submit to *ODOACER* king of the *Erules* or *Heruli*, a people from the *Euxine* sea who assumed the name of king of *Italy*, on 23d *August*, 476.

Thus ended the *Roman* empire in the *West*. But, as *Constantine the Great* had laid the foundation of another empire, or succession of emperors at *Constantinople* in the *East*, it must be remarked, that this establishment did not follow the fate of *Rome*.

The *Eastern* empire, which began in the year of *CHRIST* 306, flourished till the death of *ALEXIS V.* in the year 1204 (except we should allow it to continue in the succession of *LASCARIS* at *Nice*, as below).

Upon his death the *Eastern* throne was filled by *THEODORE LASCARIS*. But the factions and destructions of its state were so great, that the *French* were encouraged to dispossess him: and they accordingly drove him from *CONSTANTINOPLE*; and their general *BAUDOIN*, earl of *Flanders*, was saluted emperor by his army. In which state *Constantinople* continued from 16th of *May*, in the year 1204, for 58 years.

*LASCARIS* on his expulsion from the imperial seat of *Constantinople* in 1204, retired to *Nice* in

*Asia*, where he resumed the title of emperor, and collected and protected the scattered parts of his empire. By this means the *Eastern empire* may be said to descend so low as the conquest of *Constantinople* by *Mahomet II.* in the year 1453. By which computation the empire founded in the East by *CONSTANTINE the Great*, lasted 1147 years.

After the extirpation of the *Western* branch of the *Roman* empire, founded by *Julius Cæsar*, we find another erected under the same name by *CHARLEMAIN*, who was crowned emperor of the *West* or of *Germany*, on the 25th of *December* 800, in whose house the succession continued for the space of 112 years, whose defeat by the *Hungarians* and death made way for *CONRADE I.* duke of *Franconia* and *Hesse*.

*CONRADE* was the first *German* that governed that empire. He began his reign in the year of *CHRIST* 912. He was succeeded by *Henry I.* son of *Otho* duke of *Saxony*, whether by election or otherwise does not appear. But it is certain, that the imperial dignity continued in his family for five generations. To the fourth of whom, *Otho III.* authors generally attribute the institution of the *electoral* college.

From this family the electors transferred their choice to *CONRADE II.* a son of *HERMANDUS*, duke of *Wormes* and *Franconia*. In which the purple was worn for four generations.

By this elective power we find also that the families of *Suabia*, *Habsbourg*, *Nassau*, *Luxembourg*, *Bavaria* and *Austria* have enjoyed the sovereignty of the empire of *Germany*: and in particular that the *Austrian* faction in the electoral college has prevailed, and always given it to one of that family ever since the 30th of *May*, 1438, when *ALBERT, II.* archduke of *Austria*, was elected emperor of *Germany*: except *CHARLES ALBERT* duke and elector of *Bavaria*, who was introduced by the intrigues of *France* in the year 1741.

Upon the ruins of the ancient *Roman* empire, we are to view the erection of several powerful kingdoms, besides the partitions already mentioned. As,

The kingdom of the *VISIGOTHS* erected in the year of *CHRIST* 409, or, according to others, in 412, by *Atolf*, who tore *Spain* from the dominion of the *Romans*.

This kingdom flourished, and its kings not only drove the *Romans* entirely out of *Spain*, where they had kept a footing almost 700 years, viz. to the year of *CHRIST* 485, but greatly extended their dominion. But at last, in 713, the *Visigoths* were themselves overpowered, and an end was put to their kingdom by the *Moors*, called in by a discontented nobleman to revenge the dishonour done by king *Roderic*, who had deflowered his daughter.

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The kingdom of the *Franks* or *French*, erected by *PHARAMOND* in the year 420 or 421, was another remnant of the *Roman* empire.

*PHARAMOND* was succeeded by his son *CLODION*; whose success against the *Romans* and their allies in *Gaul*, enabled him to remove the place of his residence from the castle of *Inspruck*, situate between the towns of *Wesel* and *Dusseldorf*, (the very spot lately occupied by the allied army under prince *FERDINAND* of *Brunswick*) to the city of *Cambray*.

The acquisitions obtained by his arms put his family upon a most respectable footing.

He was succeeded in his power and dignity by *MEROVEE*, a younger son of *Clodion*, elected by the *French* at *Amiens* for his good qualities, in preference to his brethren: and from this stock the *French* derive the genealogy of their kings, by the name of the *Merovingian* race.

*MEROVEE* therefore is accounted the founder of the *French* monarchy: whose reign began in 448. He changed the name of *Gaul* into that of *France*, and placed the seat of his residence near *Strasbourg*.

This race of kings became extinct in *CHILDERIC III.* who was dethroned for his stupidity in the year 751, by *Pepin*, one of his great officers, who, favoured by the clergy, was crowned king in his stead, in the same year; and his race held the *French* sceptre till *LOUIS the idle* resigned his breath and his kingdom in 987, to *Hugh Capet* the most powerful amongst the nobility, and the father of the *CAPETIAN*, or third race of *French* kings, which in his present majesty amount to the number thirty one.

In *BRITAIN*, the kingdom of *Scotland* was established by *EUGENE* in the year 427, which continued under its own sovereigns alone till the year 1603, when *James VI.* of *Scotland* ascended the *English* throne. From that time *Scotland* fell under the dominion of the *Kings of England*; and by the *Union* in 1706, *Scotland* is united there to *England* by the name of *GREAT BRITAIN*.

The *CHRONOLGY* of the kings of *England* begins properly at the *Epocha*, when *EGBERT* the first monarch united the *Heptarchy* under one dominion and name of *England*. He defeated the *Danes*, who had invaded three times, successively, his dominions, in the year 830. He died, in the year 836, after he had reigned 37 years.

*ETHELWULF* succeeded his father *Egbert*, in the year 836; he was very wise, and very brave. He died in the year 857, after he had reigned 21 years.

*ETHELBALD*, his son, succeeded him, in the year 857; he had once already endeavoured to have himself acknowledged king, during his father's absence,

absence, who was gone to *Rome*; but he was frustrated in his attempt. He died, after he had reigned two years.

ETHELBERT succeeded him, in the year 860; he was gentle, prudent, and brave. He died in the year 866, after he had reigned five years.

ETHELRED succeeded him, in the year 866; he was brave and just. Under his reign the *Danes* ravaged *England*, against whom he fought nine battles in one year. In one, fought near *Reading*, he gained a compleat victory over them: but in another, near *Basing*, he received a mortal wound, of which he died in 871, after he had reigned six years.

ALFRED, an accomplished prince succeeded him, in the year 871; he obliged the *Danes* either to quit his dominions, or to be baptised. He founded the university of *Oxford*, the second, for antiquity, in all *Europe*, and died in 900, after he had reigned 29 years.

EDWARD I. succeeded him; he rendered himself famous for his prudence, piety, and the good laws he made; he signalized, likewise, his valour, against the *Danes* and the *Britons*. He died in the year 925; after he had reigned 24 years.

ADELSTAN succeeded him, in the year 925; he had a vast deal of wit and courage, was a great admirer of learning, and of the learned, gained several great victories, was pious, and liberal to churches. He died, after 16 or 17 years reign.

EDMUND I. succeeded him in the year 941; he was just, pious, and brave. He gained several victories over the *Danes*, and died in the year 946, after he had reigned 6 years.

EDRED was crowned king at the demise of *Edmund*, his brother, in the year 946; he protected the good, and chastised with severity the profligate. He maintained his authority against the revolt of those of *Northumberland*, and defeated them in a battle. He took special care to promote religion and piety, and died, with the reputation of a saint, in the year 955.

EDWIN, his nephew succeeded him in the year 955; he was impious, incestuous, and cruel; and hated of his subjects, who revolted against him. He died in the year 959, after he had reigned 4 years.

EDGAR succeeded him in the year 959; he was religious, just, prudent, and pacifick; and though of a low stature, very great in courage and valour. He ordered *Ludwal*, prince of *Wales*, to deliver every year 300 wolves, instead of a tribute which king *Adelstan* had imposed upon him, to free his dominions from those wild and voracious

creatures. He died in the year 975, after he had reigned 16 years.

EDWARD II. succeeded him, in the year 975; he was meek, pious, just, prudent, and brave. He was killed by the perfidy of his mother-in-law *Elfrida*, who wanted to place her son *Ethelred* on the throne, in the year 979, after he had reigned three years.

ETHELRED II. came thus to the throne, by the crime of his mother, in the year 979, and that crime brought upon *England* an infinite number of calamities: for the *Danes* invaded the kingdom, where they committed great ravages. *Ethelred* was a negligent, proud, and avaricious prince. The day of his coronation there was seen, all over *England*, a cloud, one half like blood, and the other half like fire. He gave secret orders, throughout all his dominions, that on the 30th of *November*, all the *Danes* found among them should be massacred; which orders were executed in the year 1002. He died in the year 1016, after he had reigned 27 years.

EDMUND II. began to reign in 1016; he was good, just, prudent, brave, and gained great victories. He divided his kingdom with *Canute*, and died some time afterwards, in 1017.

CANUTE I. who succeeded him in 1017, is celebrated for his piety, courage, prudence, and conquests. He died in the year 1036, after he had reigned 20 years.

HAROLD succeeded him in the year 1036; he was a vicious prince, abandoned to all sorts of crimes. He died in the year 1039, after he had reigned four years.

HARDICANUTE succeeded him, in the year 1039; he was cruel and avaricious. He had the body of his brother dug up, and thrown into the *Thames*. He died at table at *Lambeth*, of the fumes of a debauch, in the year 1041, after he had reigned two years.

ST. EDWARD III. called the *confessor*, succeeded him in the year 1041; he was prudent, brave, good, just, grateful, and very religious. He died in the year 1065, after he had reigned 23 years.

Under *Edward the confessor's* reign there fell so great a quantity of snow, that a vast number of animals died of hunger. The year following happened a violent earthquake, accompanied with lightning, which burnt the corn in the fields, and caused a great famine.

WILLIAM THE CONQUEROR, Duke of *Normandy*, came into *England* in the year 1066, and having defeated *Harold*, elected king by the *English*, ascended the throne. The defeat of *Harold's* army was so great, that 60000 of his men were slain in the field of battle. *William* abolished

the *English* laws, and established those of *Normandy*; after which, he returned into *France*, took and plundered *Mantes*, and died at *Rouen*, in 1087, after he had reigned 21 years; during which happened a frightful earthquake, contagious maladies, inundations, and incredible conflagrations.

WILLIAM II. called *Rufus*, succeeded his father, in the year 1087; he was brave, liberal, inconsistent, in his enterprises had but little judgment, and persecuted the bishops. While he was hunting in *New Forest*, *Tirel*, one of his servants, wounded him unawares with an arrow, of which wound he died in 1100.

Under *Rufus's* reign happened an earthquake, in which the sea overflowed its limits, and in that inundation the estate of the earl of *Godwin* in *Kent*, was entirely swallowed up; the same which we call at present the *Coodwin-sands*; and near *Abingdon* a source sprung up, which run fifteen days, and caused the plague and the famine.

HENRY I. seized on the treasures of his father, by which means he was preferred to *Robert*, his eldest brother, then absent in the *Holy land*, where he helped to take the city of *Jerusalem*. *Robert*, at his return into *England*, was maltreated by *Henry*, who caused his eyes to be put out: *Henry* died in 1135, after he had reigned 35 years.

Under *Henry I.* a lady, called *Juga*, left a law, a year, for every husband and wife, who should have passed a year and a day in the conjugal state, without having repented and violated the laws of marriage, of which they were to take an oath at *Dunmow* in *Essex*.

STEPHEN OF BLOIS succeeded him in the year 1135; his reign was accompanied with continual troubles, and he had several very great differences with the empress *Matilda*, who had been declared heiress of *Henry I.* her father: He died in the year 1154, after he had reigned 19 years.

HENRY II. son of *Matilda*, succeeded him in the year 1154; he was a prince adorned with several very great and excellent qualities; he conquered *Ireland*, and had very great differences with *Thomas Becket*, archbishop of *Canterbury*. *Henry* had the displeasure to see his own children revolt against him: He died in the year 1189, and reigned 34 years.

Under *Henry II's* reign there fell in the *Isle of Wight*, a rain of blood, which lasted two hours. Fishermen took up in their nets, on the coast of *Suffolk*, a monster, covered all over with hairs, who had a human form, and who escaped from them, and re-plunged into the sea.

RICHARD I. succeeded him in the year 1189; he was brave, and signalized his zeal for the faith, by carrying his arms into the *Holy Land*, where

he waged war against the enemies of the christian name. He died in the year 1199, after he had reigned 10 years.

JOHN I. succeeded him in the year 1199: he was an unfortunate prince, and lost *Normandy*, which was re-united to the crown of *France*: he was hated by his subjects, who revolted against him; the extreme sorrow he conceived for it caused his death, which happened the 19th of *October*, in the year 1216, after he had reigned 15 years.

HENRY III. succeeded him in the year 1216; he died the 16th, or 20th of *November* 1272, and reigned 65 years.

EDWARD I. succeed him in the year 1272; he was vigilant, brave, just, and very fortunate in his enterprises: he defeated at *Berwick* the *Scotch*, in a pitched battle, where 70,000 of them were killed in the field: he died in 1307, after 34 years, 7 months, and 21 days reign.

EDWARD II. succeeded him, in the year 1307; he proved unfortunate in his war against the *Scotch*, who, with 30,000 men, defeated 100,000 *English* in a pitched battle near *Bannocksborough*: he was inhumanly treated by his own son, and died of a violent death, the 29th of *January* 1327, after 20 years of a reign continually disturbed by domestic divisions.

EDWARD III. succeeded him in the year 1327; he gained the famous battle of *Cressy*, where the *French* lost 30,000 men, and 1500 persons of note. The next day the *English* cut again 7000 *French* to pieces. In that battle fought in the year 1346, there was no quarter given. *David*, king of *Scotland*, having entered *England* at the head of an army of 60,000 men, was beaten, and himself taken prisoner. In 1356 prince *Edward*, son of *Edward III.* gained the famous battle of *Poitiers*, where *John*, king of *France*, was taken prisoner. *Edward III.* died the 21st of *June* 1377, after he had reigned 51 years.

RICHARD II. succeeded him in the year 1377; he was brave and loved glory: he died in the year 1399, after he had reigned 22 years.

HENRY IV. ascended the throne by a regicide, having caused his own king to be killed, in the year 1399; his reign was a texture of perpetual revolutions, which filled *England* with blood and miseries: he died the 20th of *March*, 1413, after he had reigned 13 years and an half.

HENRY V. succeeded him in the year 1415; he gained over the *French*, in 1415, the glorious victory of *Agincourt* in *Picardy*: he died in 1422, after he had reigned 9 years.

HENRY VI. ascended the throne in the year 1422; his reign proved unfortunate, and was disturbed

disturbed with civil wars: he died the 21st of *May*, 1461, after he had reigned 39 years.

EDWARD IV. succeeded in the year 1461; he was a very fine prince, brave, and liberal: he defeated in a battle *Henry VI.* who retreated into *Scotland*, and was afterwards killed in the *Tower of London* by *Edward's* order, after a life mixed with prosperity and adversity. *Edward* died the 9th of *April* of the year 1483, after he had reigned 22 years.

RICHARD III. duke of *Gloucester*, having killed the young *Edward*, son of *Edward IV.* and published that *Edward IV.* was a bastard, usurped the throne in 1483: he was a hypocrite, impious, cruel, and plunged in all sorts of vices: he was vanquished and killed by *Henry* earl of *Richmond* in the year 1485.

HENRY VII. gained the throne by the defeat of *Richard III.* in the year 1485; he was very pious, loved learning, and the learned. He died the 21st of *April*, 1509, after he had reigned 24 years.

HENRY VIII. his son, succeeded him, in the year 1509; he had a vast deal of wit and capacity, but was turbulent and inconstant. He made a divorce with the church of *Rome*; declaring himself head of the church of *England*. He dyed the 28th of *January* 1547, after he had reigned 39 years, and 9 months.

EDWARD VI. his son, succeeded him in the year 1547. Under his reign the mass was abolished. He died in the year 1553, after he had reigned six years.

MARY succeeded him, in the year 1553. She married *Philip II.* king of *Spain*, and restored the exercise of the *Popish* religion. She died of the dropsy, in the year 1558, after she had reigned five years.

ELIZABETH, her sister, succeeded her, according to their father *Henry VIII's* testament, in the year 1558. She had a vast knowledge, spoke five or six languages, was a great politician, and had several other excellent qualities; but she caused *Mary Stuart*, queen of *Scotland*, whom she had detained prisoner for several years, to be beheaded. *Elizabeth* died the 4th of *April* 1603, after she had reigned 40 years, and in the 70th year of her age.

JAMES I. succeeded her, in the year 1603; he was prudent, learned, and a lover of the learned. He died in the year 1625, after he had reigned 22 years.

CHARLES I. succeeded him, in the year 1625; he was an extraordinary good prince, very much inclined to clemency, and brave; but he wanted one of the most essential qualities of a great prince,

which is firmness; and his weakness made him sacrifice his first minister, the earl of *Strafford*, to the fury and rage of the declared enemies of monarchy; which unpolitical step gave so violent a shake to his crown, that it made it fall with his head. This his unhappy catastrophe happened the 30th of *January*, 1648-9, after he had reigned 24 years.

*Oliver Cromwell*, about four years after took the reigns of the government, under the title of *Lord Protector of the Commonwealth of England*; and, in some measure, obliged the greatest powers of *Europe* to acknowledge him as such; though, in fact, they could not consider him otherwise than as an usurper, who had dyed his sacrilegious hands in the innocent blood of his legitimate sovereign. *Cromwell* had certainly all the qualities capable to adorn a throne, had he been born for it; for he was brave, prudent, grateful, wise, a great politician, and liberal without prodigality: but his extravagant ambition, hypocrisy and cruelty, which made him sacrifice to his security the lives of so many of his fellow-subjects, on which he had not the least right, and which was the same thing as murdering them in cool blood, eclipsed all his virtues, and must render his memory infamous throughout all ages. He died the 3d of *September* 1658.

CHARLES II. succeeded his father the 30th of *January* 1648 9, but was kept from his dominions by his revolted subjects till 1660; when he was restored to his throne by the prudent conduct of *Monk*, general of the army of the mock-commonwealth in *Scotland*. *Charles II.* died the 16th of *February* 1685, after he had reigned 36 years, and 7 days.

JAMES II. his brother, succeeded him the 16th of *February* 1685; he was a brave and learned prince, but so attached to *Popery*, as made him unfortunate. He abdicated the throne and his family was excluded by act of parliament. He retired into *France*, where he died at *Germain en Laye*, the 13th of *February* 1701.

WILLIAM and MARY, after king *James's* retreat into *France*, were proclaimed king and queen of *England* in 1689. *William III.* was certainly one of the greatest heroes of his time, but often beaten by the *French*. His wisdom was as great as his magnanimity, and both contributed much to the keeping him on the throne, notwithstanding all the efforts of his enemies, and, perhaps, of some of his former friends, who can never like long the same face, let it be ever so beautiful. Queen *Mary* died in 1695, and king *William* died the 8th of *March*, 1702.

ANNE, queen of *Great Britain*, succeeded him, the 8th of *March* 1702. She has been one of the greatest

greatest ornaments of the *British* throne. She entered into that grand alliance formed by all the other powers of *Europe* against *France* alone, and her forces had a very great share in those several victories gained by the grand allies. Queen *Anne* united *England* to *Scotland*, a project which some of her predecessors had formed, but had found very difficult in the execution. She died the 1st of *August* of the year 1714, after she had reigned 12 years, 4 months, and 23 days.

GEORGE I. of the most illustrious house of *Hanover*, succeeded her, the 1st of *August* 1714. He was one of the most excellent princes of his time; for he was extremely good, very much inclined to clemency; very brave, wise, judicious, prudent, and a great politician. He died on his journey to *Hanover*, the 11th of *June* 1727, after he had reigned 12 years, 10 months, and 10 days.

GEORGE II. his son, succeeded him, the 11th of *June* 1727: he governs his subjects with moderation and prudence.

The kingdom of *DENMARK* is of a later date: for *Harold* I. is the reputed founder thereof, about the year of *CHRIST* 930. The kingdom of *Norway* was united to it by the marriage of *Aquinus* king of that country with *Margaret*, who succeed her father *Valdemare* III. on the throne of *Denmark*, in year 1376, though it does not appear to have been hereditary in any family till the states complimented *FREDERICK the third* with power to leave the crown to his family. This *epocha* happened in the year 1669.

Though *Norway* was united to *Denmark* till the year 1376, yet the first notice, that we have of this kingdom inform us, that it was subject to *Suenon* or *Sucin*, king of *Norway* in 998. This kingdom had kings of its own from that *epocha* down to its union with *Denmark*, as above related. But some will bring its independency so low as to the year 1439, when *CHRISTOPHER the third* confirmed their union, which has always continued ever since.

The kingdom of *SWEDEN* is of a later date. *COMUT* the first king began to reign in the year of *CHRIST* 1182. It has been sometimes hereditary, and at other times elective. No king could rule more arbitrarily than *CHARLES XII.* and yet the present king is so circumscribed in his power and authority by the senate, that he is obliged to look and see his subjects oppressed, and even to sign what his conscience, and the publick interest tells him is ruinous to his country.

The empire of *MUSCOVY* or *RUSSIA*, which, in these days, makes such a figure on the theatre of *Europe*, was known as early as the year 988, by the name of a dukedom: when duke *Wolodimine*

embraced the *Christian* faith, and took the name of *Bazil* in his baptism. As for its history previous to this *epocha*, there is no dependence upon it.

Their wars with the *Tartars* after this kept them always employed; and sometimes in subjection. In the year 1477, *John Bisilides* or *the Great* ascending the throne, he shook off their yoke, and put his country in a more respectable condition. But the present flourishing state of this country and people, is entirely to be ascribed to the prudence, wisdom and courage of *PETER* I. who assumed the title of *CZAR*, or *CÆSAR*, i. e. emperor of all the *Russias*, and died in the year 1725.

The kingdom of *POLAND* was erected by *POLES-LAS* I. who, in the year 999, obtained the title of king from the emperor *OTHO*. This kingdom has a particular form of government. It is under a king, as supreme governor; but in itself it is a republic. The nobles elect the king, and his majesty can do no act but what his electors authorize him to do.

Besides these temporal empires and kingdoms, there is a spiritual or ecclesiastical state in *Europe*, called the *patrimony* of *St. PETER*, and governed by a prince named *PAPA* or *POPE*, that at present, and for the most part has kept his residence in the city of *Rome*; originally nominated by the *western* emperor; but for several centuries elected by a set of ecclesiastical creatures named *Cardinals*, promoted to that dignity by the pope himself.

The chronology of the *Popedom* is very unsettled. The advocates for the *papal supremacy* and *infallibility* seek for its *epocha* in the person of *St. PETER*, who they affirm was the first *POPE* of *Rome*. Others with greater plausibility distinguish between the ecclesiastical and political state of the *Popedom*; and allowing the succession of bishops in the church to rise from *St. PETER*, deny the existence of the *POPE's* power, as a temporal prince before the pontificate of *SILVESTER* I. whom *CONSTANTINE the Great* favoured with some temporal exemptions, immunities and power for the better regulation of the *christian* church. And they who have entirely thrown off all communion with the *Pope*, not only laugh at the succession from *St. PETER*; but with strong vouchers undertake to shew that the rise and progress of the *papal* power has been a work of time, obtained first from the weakness, inadvertency, and bounty of princes and emperors, or procured by frauds, violence and rebellion, which in the pontificate of *Gregory VII.* who was chosen *Pope* on the 22d of *April* 1073, most daringly usurped a right to absolve subjects from their natural allegiance, and depose kings and emperors; and claimed a supreme right over the conscience of all men, and to impose what interpretation they pleased

pleased upon the sacred text of the New and Old Testaments.

I shall subjoin the empire of the TURKS. This is a collective power, composed of several branches lopped off from the limbs of the old Roman empire, by *Osman*, or *Ottoman I.* in the year of CHRIST 1300. He made himself master of several provinces in lower *Asia*; which conquests were extended by his son *ORCHAN*, who succeeded him in 1326.

*SOLIMAN I.* who succeeded him in 1358, carried his arms towards *Europe*, and made himself master of *Adrianople*. In which undertaking he was seconded by his brother *AMURATH I.* He pushed his conquest towards *Europe* by the help of the *Genoese*; and ravaged the coasts of *Macedonia*, crossed the streights of *Gallipoli*, and defeated the prince of the *Bulgarians*.

*BAJAZET*, who succeeded him in 1392, ravaged *Macedonia*, over-ran *Albania*, plundered *Theffaly*, and bid fair for universal monarchy, had not *Tamerlane* emperor of the *Moguls*, stopt his career, and taken him prisoner.

*MAHOMET I.* who ascended the throne in 1413, subdued *Pontus* and *Cappadocia*: and *MAHOMET II.* totally destroyed the empire of the *East* by the conquest of *Constantinople* in 1453, and bringing twelve more kingdoms under his subjection; and was preparing to enter *Italy* with a victorious army, when death cut him off near *Nicomedia*.

*BAJAZET II.* added *Lepante* and *Modon* in the *Morea* to the *Ottoman* empire. And *Selim I.* who began to reign in 1512, reduced many places in *Persia*; took *Grand Cairo* in *Egypt*, and put an end to the empire of the *Mamelus*.

*SOLOMAN the magnificent*, in 1521, took *Belgrade*; *Rhodes* in 1522, entered *Ruda* in 1526, and penetrated to the walls of *Vienna*. And *SELIM II.* reduced *Cyprus* in 1570.

Such was the rapid increase of the *Ottoman* empire; which now seems resolved to remain content with its present extent; and sufficiently employed to keep its different and distant countries in due obedience.

## Of C H Y M I S T R Y.

**C**HYMISTRY (*Greek* χυμος, juice, and χυω, to melt) is the art of separating the several substances, whereof mixed bodies are composed, by the means of fire, or other such powerful agent; and of composing new bodies in the same way, by the mixture of several substances, or ingredients.

By mixed bodies, we understand those things that naturally grow and increase, as *minerals*, *vegetables*, and *animals*. Under the name of *minerals* are included the several metals, minerals, stones and earth: under *vegetables*, all manner of plants, gums, rosins, fruits, fungus's, seeds, juices, flowers, mosses, and all their productions: and under *animals*, all sorts of animals, their parts, excrements, and what ever belongs to them.

CHYMISTRY, like other arts has its particular object: and therefore, it will be necessary to consider those natural bodies called *mixts*, which are its proper objects, by some called the *principles of chymistry*.

These principles are three active, viz. *spirit*, *oil* and *salt*: and two passive, viz. *water* and *earth*. Because the three first by their great motion cause all manner of action; and the two last serve to stop the quick motion of the actives.

The *spirit*, which is called *mercury*, is the first of the active principles that appears to us, when

we make the anatomy of a mixt body. It is a subtile, piercing, light substance, that is more in motion, than any of the others. It is this which causes all bodies to grow in more or less time, according as it abounds in them more or less. But it happens that the bodies wherein it abounds are more liable to corruption, by reason of its too great motion, and this is observed in animals and vegetables. On the contrary, the greatest part of minerals, as containing but a very small quantity of it, do seem to be incorruptible. It cannot be drawn pure. But either it is involved in a little *oil*, that it carries along with it, and then may be called a *volatile spirit*, such as the spirit of wine, of roses, of rosemary, of juniper; or else is detained by some *salts*, which check its volatility, and then may be called a *fixt spirit*, as the acid spirit of vitriol, alum, salt, &c.

The *oil*, which is called *sulphur*, by reason of its inflammability, is a sweet, subtile, unctuous substance that rises after the *spirit*. This is said to cause the diversity of colours and smells, according to its disposition in bodies: this gives them their beauty and deformity, uniting together the other principles: this also sweetens the acrimony of salts, and by shutting up the pores of a mixt, hinders it from corrupting, either through too much moisture or cold. Wherefore many trees and plants that have

have a great deal of *oil*, are wont to last green much longer than others, and can resist the extremity of ill weathers. It is always drawn impure, for either it is mixt with spirits, as the *oils* of rosemary, of lavender, which swim above the water; or else it is filled with salts, that it draws along with it in the distillation, as the *oil* of box, *guaiacum*, cloves, which do precipitate to the bottom of the water by reason of their weight.

*Salt* is the last of the *active principles*, which remains disguised in the earth, after the other *principles* are extracted. It is a fixt, incombustible substance, that gives bodies their consistence, and preserves them from corruption. This causes the diversity of tastes, according as it is diversly mixed.

There are three different *salts*, as the *fixt*, *volatile*, and *essential*. The *fixt salt* is that which remains after calcination: which is drawn thus, The calcined matter is set to boil in much water for dissolving the *salt*, then the dissolution is filtrated: and when all the moisture is evaporated, the *salt* is found dry at the bottom of the vessel. The *salt* of plants drawn after this manner, is called *lixivious salt*: The *volatile* is that which easily riseth, as the *salt* of animals: and *essential salt* is that which is obtained from the juice of plants by crystallization. This last is betwixt the *fixt* and *volatile*.

*Water*, which is called *phlegm*, is the first of the *passive principles*: it comes in distillation before the *spirits* when they are *fixt*, or after them when they are *volatile*. It is never drawn pure, but always receives some impression from the *active principles*. And this causes it to have a more deterfive virtue in it than common *water*. It serves to separate the *active principles*, and to bridle their motion.

The *carb*, which is called *caput mortuum*, is the last of the *passive principles*, and can no more be separated pure than the rest, but will still retain some *spirits* in it; and if after you have deprived it of them as much as you are able, you leave it a good while exposed to the air, it will recover new *spirits* again.

Yet, the word *principle* in *Chymistry* must not be understood in too nice a sense: for the substances which are so called, are only *principles* in respect of us, and as we can advance no farther, in the division of bodies; but we well know that they may be still divided into abundance of other parts, which may more justly claim, in propriety of speech, the name of *principles*: wherefore such substances are to be understood by *chymical principles* as are separated and divided, so far as we are capable of doing it by our weak imperfect powers. And because *Chymistry* is an art that *demonstrates* what it does,

it receives for fundamental only such things as are palpable and demonstrable.

Observe also, that under the general idea of *spirit* are comprehended liquors of quite opposite natures; some being acid, and others alkaline; which last are such enemies to the former, that as soon as they are put together they raise a violent effervescence, and grow hot: and to these may be added a third sort, called vinous or inflammable spirits; which though very subtle and penetrating, are not manifestly either acid or alkaline.

All these sorts of spirits Mr. Boyle shews to be producible: and, 1. The *vinous*, which nature scarce ever produces of herself, are the creatures of vinous fermentation, or are actually produced, though not separated, in that operation.

2. The *alkaline* or *volatile spirits*, called also the *urinous*, by reason of their affinity in many quantities with spirit of urine, are manifestly not simple but compound bodies; consisting of the *volatile salt* of the respective concretes dissolved in the phlegm, and for the moist part accompanied with a little oil: so that these may be referred to the class of volatile salts.

3. *Acid spirits* appear to be producible; because those drawn from common salt and nitre are very different in respect of taste, &c. from the bodies they are procured from, which are not properly acid: so that it does not appear that these spirits pre-existed in that state of those bodies.

What farther confirms this doctrine of spirits is, that the same body, merely by different ways of ordering it, may be brought to afford either *acid*, *vinous*, or *urinous* spirits; add, that whereas salt is accounted the principle of all taste, it follows that spirits, being sapid, must contain salt; since it is taste that characterizes and distinguishes it from phlegm, and denominates it *acid*, *vinous*, or *urinous* spirit.

*Spirits* distilled from fermented liquors, consist of very different ingredients, viz. a pure spirit or alcohol, phlegm, a certain acetous fermented acid, and a small quantity of ill-scented oil; so that it becomes necessary, in order to obtain the spirit perfectly pure, to re-distil it several times. By reducing spirit therefore, to the utmost degree of purity, an *alcohol* is obtained; which, as Doctor Shaw expresses it, is a liquor *sui generis*, and possessed of many peculiar qualities; as, 1. When absolutely purified, it is an uniform and *homogeneous* liquor, capable of no farther separation, without loss or destruction of some of its *homogeneous* parts. 2. It is totally inflammable, leaving no foot, nor any moisture behind. 3. It has no peculiar taste or flavour, any more than pure water, except what

is owing to its nature as alcohol, or perfectly pure spirit. 4. It is an unctuous and crispy fluid, running veiny in the distillation, and its drops rolling on the surface of any other fluid, like peas upon a table, before they unite. 5. It appears to be the essential oil of the body it is obtained from, broken very fine, and intimately and strongly mixed with an aqueous fluid, which is assimilated, or changed in its nature, in the operation. 6. And lastly, it seems to be a kind of universal fluid, producible with the same properties from every vegetable subject; but to produce it thus, requires some care in the operation.

On these principles is founded the opinion, that all spirits may be reduced to a perfect similarity or sameness, from whatever subject they are produced, and on this depends their convertibility into one another; for when once they are brought to this standard of simplicity, there needs nothing more than to add the oil of such of the finer spirits as is required to convert the spirit into that particular kind. By this means the same tasteless spirit, whether obtained from *malt*, *sugar*, or *grapes*, may be made into either *malt spirit*, *brandy*, or *rum*, by adding the essential oil of the *grape*, *sugar*, or *malt*; and thus what was once malt spirit, shall become brandy, or whatever else the operator pleases.

Many methods have been attempted to obtain the first point, that is, the reducing the spirit to perfect and pure *alcohol*: the most practicable means seem to be long digestion, and the repeated distillation from water into water, where the essential oil will at once be left upon two surfaces, and the acid imbibed: the shorter ways, are those by rectifying from neutral absorbent salts and earths; such are *sugar*, *chalk*, and the like; and, lastly, the use of fixed alkalies may be tried, for these very forcibly keep down both the phlegm and oil; inasmuch that this last method promises to be the shortest of all, if the art were known of utterly abolishing the alkaline flavour, which the *alcohol* is apt to acquire.

For, as *vinous spirits* arise with a less degree of heat than watery liquors, if due regard be had to this circumstance, very weak spirits may, by one or two wary distillations, in a degree of heat less than that in which water boils, be tolerably well freed of their aqueous phlegm: and in order to free it from its foul oil, add to every gallon of it a pound or two of pure, dry, and fixed alkaline salt, which being digested together for some time, the alkali, from its own property of attracting water and oils, will imbibe the remaining phlegm, and such part of the disagreeable unctuous matter as may be still left in the spirit, and sink with them to the bottom of the vessel. If the spirit be now again

gently drawn over, it will arise entirely free from its phlegm and nauseous flavour; but as some particles of the alkaline salt are apt to be carried up with it, and give it an urinous relish, a small proportion of any fixed acid liquor, or rather of an acid salt, as vitriol or alum, should be added to it.

The spirit obtained by this process is called *alcohol*, and is extremely pure, limpid, perfectly flavourless, and fit for the finest purposes: it may be reduced to the strength commonly understood by proof-spirit, by mixing twenty ounces of it (by weight) with seventeen ounces of water. The distilled cordials made with these spirits, are much more elegant and agreeable than when the common rectified or proof spirits of the shops are made use of.

There are many occasions in which *Chymists*, and other artificers, stand in need of the true and purest *alcohol*, the least remainder of water rendering the operation unsuccessful: hence it is absolutely necessary we should have some marks, by which to distinguish whether our *alcohol* be pure or not. The principal of these are, 1. If the supposed *alcohol* contains any oil dissolved in it, and so equably distributed through it, that it is no ways perceptible, then upon pouring of water into it, the mixture will grow white, and the oil separate from the *alcohol*. 2. If any thing of an acid lies concealed in the *alcohol*, a little of it mixed with the alkaline spirit of *sal ammoniac* will discover the acid by an effervescence excited by the effusion of the acid; for otherwise there would be only a simple coagulation. 3. If there be any thing of an alkali intermixed, it will appear by the effervescence excited by the effusion of an acid. 4. But it is a matter of great difficulty to discover whether there be any water intermixed with it.

The best method of doing this is the following: take a *chymical* vessel with a long narrow neck, the bulb of which will hold four or six ounces of *alcohol*. Fill this two thirds full with the *alcohol* you intend to examine, into which throw a dram of the purest and driest salt of tartar, coming very hot out of the fire; then mix them by shaking them together, and set them over the fire till the *alcohol* is just ready to boil. Being thus shaken, and heated, if the salt of tartar remains perfectly dry, without the least sign of moisture, we are sure that there is no water in the *alcohol*. The learned *Boerhaave* tells us, that by this method he discovered water in *alcohol* which had been looked upon as pure, having undergone every other method of trial.

*Animal oils* are their *fats*, which are originally vegetable oils: all animal substances yield them, together with their volatile salts, in *distillation*.

*Vegetable oils* are obtained by *expression*, *infusion*, and *distillation*.

The *oils* by *expression* are obtained from the seed, leaves, fruit, and bark of plants; thus, the seed of mustard, and of the sun-flower, almonds, nuts, beech-mast, &c. afford a copious oil by expression; and the leaves of rosemary, mint, rue, wormwood, thyme, sage, &c. the berries of juniper, olives, Indian cloves, nutmeg, mace, &c. the barks of cinnamon, saffraſas, and clove, yield a considerable proportion of essential oil by distillation.

The method of procuring *oils* by *expression* is very simple: thus, if either sweet or bitter almonds, that are fresh, be pounded in a mortar, the oil may be forced out with a press, not heated; and in the same manner should the oil be pressed from linseed and mustard. The avoiding the use of heat in preparing these oils, intended for internal medicinal use, is of great importance, as heat gives them a very prejudicial rancidness.

This method holds of all those vegetable matters that contain a copious oil in a loose manner, or in certain cavities or receptacles; the sides whereof being broken, or squeezed, makes them let go the oil they contain: and thus the zest or oil of lemon-peel, orange-peel, citron-peel, &c. may be readily obtained by pressure, without the use of fire. But how far this method of obtaining oils may be applied to advantage, seems not hitherto considered. It has been commonly applied to olives, almonds, linseed, rape-seed, beech-masts, ben-nuts, walnuts, bay-berries, mace, nutmeg, &c. but not that we know of to juniper-berries, cashew-nuts, indian cloves, pine-apples, and many other substances that might be enumerated, both of foreign and domestic growth. It has, however, been of late successfully applied to mustard-seed, so as to extract a curious gold coloured oil, leaving a cake behind, fit for making the common table mustard.

Certain dry matters, as well as moist ones, may be made to afford *oils* by expression, by grinding them into a meal, which being suspended to receive the vapour of boiling water, will thus be moistened so as to afford an oil, in the same manner as almonds; and thus an oil may be procured from linseed, hemp-seed, lettuce-seed, white poppy-seed, &c.

As to the treatment of oils, obtained by expression, they should be suffered to deurate themselves by standing in a moderately cool place, to separate from their water, and deposit their fæces; from both which they ought to be carefully freed. And if they are not thus rendered sufficiently pure, they may be washed well with fresh water, then thoroughly separated from it again, by the sepa-

rating-glass, whereby they will be rendered bright and clear.

The next class of *oils* are those made by *infusion* or *decotion*, wherein the virtues of some herb or flower are drawn out in the oil; as the oils of rose, camomile, hypericum, elder, &c. However, these require to be differently treated: thus, for the scented flowers, particularly roses, insolation does best; because much boiling would exhale their more fragrant parts: but oils impregnated with green herbs, as those of camomile and elder, require long boiling, before they receive the green colour desired. And, in general, no oils will bear to be boiled any longer than there remains some aqueous humidity, without turning black.

There are many compound oils prepared in the same manner, *viz.* by boiling and insolation, and then straining off the oil for use.

The same contrivance has likewise its use in making essences for the service of the *perfumer*; not only where essential oils cannot be well obtained in sufficient quantities, but also where they are too dear. The essential oil of jessamine-flowers, honey-suckles, sweet-briar, damask-roses, lilies of the valley, &c. are either extremely dear, or scarce obtainable by distillation; and in some of them, the odorous matter is so subtle, as almost to be lost in the operation. But if these flowers be barely infused in fine oil of nuts, or oil of ben, drawn without heat, and kept in a cool place, their subtle odorous matter will thus pass into the oil, and richly impregnate it with their flavour. And these essences may be rendered still more perfect by straining off the oil at first put on, and letting it stand again, without heat, upon fresh flowers; repeating the operation twice or thrice.

Oils, or fats, may likewise be obtained, by boiling and expression, from certain animal substances; for the membranes which contain the fat, being chopped small, and set in a pan over the fire, become fit for the canvas-bag, and, by pressure, afford a large quantity of fat; as we see in the art of *Chandlery*, which thus extracting the oily matter, leaves a cake behind, commonly called *graves*.

As to the essential oils of vegetables, they are obtained by distillation, with an alembic and a large refrigeratory. Water must be added to the materials, in sufficient quantity, to prevent their burning; and they should be macerated or digested in that water, a little time before distillation. The oil comes over with the water, and either swims on the top, or sinks to the bottom, according as it is specifically heavier or lighter than water.

This process is applicable to the distilling of the essential oils from flowers, leaves, barks, roots, woods, gums, and balsams, with a slight alteration of circumstances, as by longer digestion, brisker distillation, &c. according to the tenacity and hardness of the subject, the ponderosity of the oil, &c.

*Essential oils* may be divided into two classes, according to their different specific gravities; some floating upon water, and others readily sinking to the bottom. Thus, the *essential oils* of cloves, cinnamon, and saffras, readily sink; whereas those of lavender, marjoram, mint, &c. swim in water; the lightest of these essential oils, is, perhaps, that of citron-peel, which even floats in spirit of wine; and the heaviest seems to be oil of saffras.

For obtaining the full quantity of the more ponderous *oils* from cinnamon, cloves, saffras, &c. it is proper to reduce the subjects to powder; to digest this powder for some days in a warm place, with thrice its quantity of soft river-water, made very saline by the addition of sea-salt, or sharp with oil of vitriol; to use the strained decoction, or liquor left behind in the still, instead of common water, for fresh digestion; to use for the same purpose the water of the second running, after being cleared of its oil; not to distil too large a quantity of these subjects at once; to leave a considerable part of the still, or about one fourth empty; to use a brisk fire, or a strong boiling heat, at the first, but to slacken it afterwards; to have a low still-head, with a proper internal ledge and current leading to the nose of the worm; and, finally, to cohobate the water, or pour back the liquor of the second running upon the matter in the still, repeating this once or twice.

As to the *salts*; it is to be remarked that we don't know the precise figure of each sort; but we must judge of them by their effects, acid salts should seem to be pointed, and those points tipped with sulphureous matter: whereas the urinous and lixivious salts seem to be like a sponge, containing a part of the acid, and a little fetid oil.

*Acid salts* are ranged, by *Homburg*, under three classes, viz. such as contain an animal or *vegetable sulphur*; as all the acids distilled from plants, fruits, woods, &c. and spirit of nitre; such as contain a *bituminous sulphur*, to which belong the acids of vitriol, *common sulphur*, and alum: and such as contain a *more fixed mineral sulphur*; as the acids drawn from the sea-salt, and sal gem.

Those of the first class act more swiftly than those of the others, and those of the second are the least nimble. *Acid salts*, joined with *lixivious ones*, compose *mixed* or intermediate salts: thus, spirit of nitre, with salt of tartar, produce a true salt-petre; spirit of salt, with salt of tartar, produce true com-

mon salt; and spirit of vitriol, with salt of tartar, produce true vitriol; which are all mixed or intermediate salts, *i. e.* partly fixed and partly volatile, the ingredients still retaining their original natures. *Acids*, joined with *urinous salts*, compose another salt called *ammoniac salts*, which are always volatile.

In all *native salts*, both *fossile*, *vegetable*, and *animal*, after the violence of the fire has separated all the volatile parts, there still remains a fixed salt, to be drawn from the *faeces* by lotion, or lixiviation; hence called a *lixivious salt*, which is no other but the reliicks of the acid salts, that the fire was not able to separate from the earth of the mixed body, but may be separated by dissolving them in common water. The taste of these *lixivious salts* is very different, according to the quantity of the acids still remaining after calcination; part of which is still capable of being volatilized by a more intense heat, or by dissolution, digestion, filtration, and evaporation frequently repeated; or, by adding some urinous salt, to absorb the same.

We have three sorts of *urinous salts*, viz. that of plants or animals, which is the same; the second is *fossile*; and the third of an intermediate kind, partaking both of the *fossile* and *vegetable* nature: the first is volatile, and the two latter fixed.

By *urinous salts*, we mean all such as partake of the taste or smell of urine; their effect in volatilizing fixed salts is well known; for being added to common salt, there arises, by fire, a volatile salt, called *sal ammoniac*. However, for volatilizing the fixed salts of plants, the urinous salts of plants are not so proper as the urinous salts of the intermediate class, such as alum; and for the fixed salts of fossils, the urinous salt is fittest, viz. borax.

All the sorts of salts, then, appear evidently compound and unelementary; and that they are producible *de novo*, and convertible into one another, is strenuously argued by Mr. *Boyle*. The two chief qualities wherein they all agree, he observes, are to be easily dissoluble in water, and to affect the palate, so as to cause a sense of taste. Now that a disposition to be dissoluble in a liquor, may be acquired by mixture, and a new texture of parts appears from many instances; and as for the taste, it is some question, how far the necessity thereof may consist with another principle; for the purest oils are sapid, yet will not dissolve in water; so that there does not appear any strict connection between being sapid and soluble in that fluid.

For *acid salts*, we may instance in nitre; which, though it have no acid taste, may be made to afford by distillation, above three quarters of its weight, of a highly acid liquor: yet it does not appear,

that such a great proportion of acid particles, or possibly any proportion at all, is employed by nature in the composition of nitre.

For *urinous salts*, we have an instance of their production, in the salt obtained by distillation from soot: for though the wood, we burn in our chimneys, seems to have nothing of the taste or smell of urine, nor have the dissolutions of the saline parts of such wood been observed to have any affinity, in taste or odour, thereto; yet when wood is burnt in the fire, and the soot afforded by it distilled, we get a white volatile urinous salt, like what is obtained from blood, urine, or the like.

For *lixivious*, or the *fixed salts* of calcined bodies, the *Chymists* themselves are not entirely agreed; for however the prevailing opinion may be, that those fixed alkalies pre-exist in mixed bodies, *Helmont* very ingeniously proposes another origin, and holds them, as to their alkaline form, productions of the fire, by whose violent action a part of the salt, which in the concrete is all naturally volatile, laying hold of some parts of the sulphur of the same body, both become melted together, and thus fixed into an *alkali*.

In order to lessen the trouble and expence of procuring the *volatile salt* of *animal subjects*, they should be first purged of their oil and unctuous parts, by boiling in water; after which, they will afford volatile *salts* and *spirits*, as pure, or purer, than those obtained from unboiled hartshorn.

Observe farther, that the unrectified volatile salts of vegetable and animal substances, are true *sales volatiles oleosi*; and according to the difference of the oil wherein they abound, they are properly distinguished into salt of hartshorn, of ox-bone, of human blood, of silk, &c. But that when these oils are totally separated from them, they become one and the same undistinguishable volatile salt; for that it is the admixture of oil that gives the colour to volatile salts, they being permanently white when the oil is separated.

These *volatile salts* are obtainable from all kinds of land-animals, the amphibious and subterraneous tribe, birds, fishes, and reptiles; also from alkaline vegetables without putrefaction, and from other vegetables after putrefaction; from soot, horns, hoofs, and all refuse animal and vegetable matters, as urine, the blood of slaughter-houses, &c. and this as pure and perfect as from hartshorn; whence volatile alkalies, and sal ammoniac, might be afforded very cheap.

The volatile animal, and fixed vegetable salts, differ chiefly with regard to their volatility, and fixedness, and the effects thereon depending; but agree in other respects: thus they both make an effervescence, and turn neutral, when saturated

with acids; they are both corrosive, hot, fiery, &c.

The nature and uses of *water*, will best appear from the following *experiments*. 1. That water is contained in many solid bodies, and to appearance in dry bodies, was proved thus: a piece of the hardest and driest bone being procured, and distilled in an earthen retort, with degrees of fire, a very large proportion of water, along with much oil and volatile salt, was obtained: whence it appears, that animal matters are resolvable into the four *chymical principles*, water, oil, salt and earth.

This experiment holds true even of the oldest hartshorn, the driest and hardest woods, earths and pulverized stones. Whence it also appears, that water may be concealed in solid bodies, and make a constituent part thereof: for it is not meant that water insinuates itself into the superficial pores of bodies, such as wood, skins, &c. so as to swell them in moist weather, and leave them shrunk in dry; but that it remains permanently intermixed as an essential ingredient, or as a part of solid bodies.

2. That water may be collected from the driest air, or in the hottest climate, was proved by the following experiment. Half a pint of common water was put into a cylindrical glass wiped perfectly dry on the outside; then was added to the water two ounces and three quarters of pulverized and dry sal ammoniac; these were stirred briskly together; whereupon the water floating in the external air was, by the coldness thus produced, condensed on the outside of the glass as the salt dissolved within, and trickled down in small veins, into the shallow basin set underneath to receive it. This experiment holds in all climates and places of different heights where it has been tried; whence by the law of induction we may make it universal, till any contradictory instance appears. Thus, therefore, it may hold in the most parching countries, and hottest seasons, so as to afford an agreeable method of cooling potable liquors, and rendering them more refreshing. For if the containing glass of the salt and water be set in any liquor, the liquor will be cooled thereby; and if any considerable improvement could be made in the contrivance, it is observed, that it might in some measure serve to supply the thirsty traveller in parched deserts, and the sailors with fresh water at sea.

3. To determine the proportion of water contained in an assigned portion of the atmosphere, we are directed by the following experiment. Having by means of the *air-pump*, and an exact pair of *scales*, found the weight of a certain quantity of air contained in a large glass-vessel, there was included therein a certain known weight of well dried potential cautery, whose property it is powerfully

to attract the moisture of the air. This vessel was kept close stopp'd for several hours; during which time, the potential cauterium was grown wet, in which state being weighed again, it was found considerably to increase; which must be either owing to the water attracted out of the air in the glass, or to a condensation of the air itself, into an aqueous fluid; for such a fluid might now by distillation be obtained from the matter thus run per deliquium.

It is observed that there is room to suspect, that if this experiment were made in perfection, a weight of water almost equal to that of the air included in the vessel, might be thus obtained, which might prove a very extraordinary discovery, and shew what some have endeavoured to prove, that the matter of common air, is little more than water.

4. That an earthy substance is naturally contained in water, was proved as follows. Three several glasses were filled with pure rain water, spring water, and *Thames* water, and suffered to stand, close covered, for some days before they were exhibited. There was an earthy sediment then deposited in all the three, but most in the *Thames* water, the sediment whereof was not only larger, but also more foul and muddy than in the rain water; though here, also, it was dirty, perhaps, because not carefully collected; whereas, in the pump water, it was white, scaly, flaky, and shining, like fine spangles of talc. This experiment is also universal, so far as it has been tried with care, and holds true of the waters of all species, and all countries, particularly in those called mineral waters, from which an earthy substance may usually be precipitated by art, in a considerable proportion.

Certain experiments carefully made, and repeated, shew that the terrestrial matter naturally contained in water, has a principal share in the growth and increase of vegetables; all the plants that thrive in water appearing to enlarge their bulk in proportion to the earthy matter they draw from the water. Whence *pure elementary water* seems but a kind of vehicle to convey this nutrimental or substantial part, and deposite it in the vessels through which the water moves, in order to its general exit at the surface of vegetables. But we are not here to exclude the instrumental efficacy of the two other elements, fire and air.

And this appearing to be the general office of water in the whole animal and vegetable kingdoms, viz. the conveyance or distribution of the alimentary matter to all their parts, it may be proper to consider its physical properties, which would wonderfully fit it for this office.

The figure of its component parts appears to be smooth and spherical, like those of quicksilver; whence it becomes extremely moving and penetrating. Thus it readily enters the pores of wood, leather, skins, chords, musical strings, &c. thus likewise it becomes capable of moving and agitating particles of matter less active than itself, and so proves the more immediate physical agent of fermentation, putrefaction, solution, &c. and thus it also conveys earthy and saline matters through our filters of paper, stone, &c. and even raises some proportion of them in distillations. Its particles likewise appear to be extremely minute, and so have a large share of surface. Hence *water* is admirably fitted for a solvent, or for readily entering the pores of salts, and coming into full contact with all their particles; and thus it will pass where air cannot, on account of its moisture, or lubricating power, whereby it fastens mucilaginous matters, and will therefore soak through the close pores of a bladder.

From the experiments of Doctor *Shaw*, made upon water, he deduces the following axioms and canons. *First*, we have seen, That *water* is naturally contained in some of the driest and hardest bodies, and in the driest air. 2. That itself naturally contains an earthy substance. 3. That it is the proper menstruum of salts, dissolving more of one, and less of another. 4. That one good sign of its purity and wholesomeness is levity. 5. That the ingredients of a mineral water may be discovered by chemical expedients: and, 6. That mineral waters are imitable by art from such discovery.

*Secondly*, That *water* is of infinite use in all the works both of nature and art, as without it there could be no generation, nutrition, or accretion performed in any of the animal, vegetable, mineral, marine, or atmospherical regions. The blood could not flow in the veins, the sap in the vessels of vegetables, nor the particles of minerals concrete and grow together, without water. It is this that makes the largest part of our blood, our drink, and other aliments. There could be no corruption, fermentation, or dissolution carried on without it, no brewing, no distilling, no wines, no vinegar, no spirits, made without it.

*Thirdly*, That we meet with *water* under an infinite variety of forms, and in an infinite variety of bodies, as that of air, vapour, clouds, snow, hail, ice, sap, wines, blood, flesh, bone, horn, stone, &c. through all which it seems to pass unaltered, as an agent or instrument that suffers no alteration by re-action, but remains capable of resuming the form of water again upon occasion.

*Fourthly*, That *water* in its own common state appears to be a combination of all the elements together,

together, as containing a quantity of fire, which keeps it fluid, a quantity of air, and a quantity of earth; whence it can be no wonder that water alone, as it appears to the senses, should suffice for vegetation in some cases, where little earth is wanted, or for supporting animal and mineral life, where no great degree of nutriment is required; and hence it proves a gluten, or cement to some bodies, and a solvent to others; thus it consolidates brick, plaister of *Paris*, stone, bone, &c. but dissolves salts, and subtile earths approaching to salts, and becomes the instrumental cause of their action.

*Fifthly*, That *water* conveys nourishment, or a more fixed and solid matter to the parts of vegetables, where having deposited it, the finer fluid perspires into the atmosphere, which gives us the physical cause of the dampness and unwholesomeness of woody countries, as they remarkably find in *America*. For all large vegetables act after the manner of forcing pumps, and continually draw in large quantities of water at their roots, and discharge it at their leaves, which intimates a method of collecting water in dry countries, and likewise of making salt-water fresh.

*Sixthly*, That the *water* in passing thro' plants, after having deposited its more terrestrial part, does not always go off pure, but impregnated with the finer effluvia, or more subtile particles of the vegetable; thus making an atmosphere round every plant, according to its nature odoriferous or otherwise, which supplies us with a rule for procuring the odoriferous waters of vegetables by distillation.

*Seventhly*, That the particles, not fine enough to go off thus along with the *water*, are left behind upon the surface of the leaves and flowers of plants, being now thickened or strained from their moiister parts, and remaining in the form of honey, manna, gums, balsams, &c. according to the nature of the vegetable. And hence appears the physical cause of plants proving more odoriferous and sweet when the weather is both warm and moist, as immediately after a summer's shower.

*Eighthly*, That the *chymical* operator should form to himself an *hygrometer* for the service of his laboratory to determine the *proportion of water* at all times contained in the air, which continually mixes with his preparations, differently augments their weight, and promotes or hinders many of his operations.

*Ninthly*, That *pure water* makes the largest part of *mineral waters*, where it is impregnated as a menstruum, with several ingredients that it dissolves or drinks up in its passage through the earth.

*Earth* in weight exceeds *water*, *salts*, and the *spirits* of animals and vegetables. When pure, or

perfectly separated from other bodies, it is consistent, hard, and fine, though brittle with regard to our senses, and easily reducible by trituration into a certain powder, in which respect it differs from the true metals and gems; though still more in this, that it remains fixed and unchanged in the most violent fire, even so far as not to flow therein.

*Boerhaave* says, he never could obtain *elementary earth* from *metals*, but it may be obtained from *water*, from calcined *vegetables*, from *smoak* and *soot*, from putrified *animals*, from distilled *animal fluids*, from *fossile salts*, and from fluid and solid *sulphurs*. Whence he concludes, that the same simple elementary earth contributes as a constituent principle to form the particular corporeal fabric of animals, vegetables, and some fossils of a less permanent and less simple nature, and in them all serves as a firm basis to their form, whilst it unites the other principles to itself, and to one another, so as to constitute one determinate individual. Hence also, says he, the property of assimilating other substances into the nature of every body that receives nutriment, and consequently the seminal property of producing their like, is principally owing to the efficacy of this earth; for their properties no longer remain after the particular texture depending principally upon the earth is destroyed, or wanting in any body.

Before the *Chymist* can pretend to work upon these elements, he must be well instructed not only in the different *terms* of art; but how to prepare and manage the *fires*, and chuse *vessels* proper for the work.

The *TERMS* used in *Chymistry* are thus explained.

*Æthiops Mineral* is a preparation of *mercury* and *sulphur*; which name has been given to it, to express a mineral matter as black as an *Æthiopian*.

*Al*, is an *Arabian* particle, signifying *the*: but it is commonly used at the beginning of a word, to express somewhat excellent; because it also signifies *God* in *Hebrew*.

*Alchymy*, from *al* and *χμω*, *fundō*, to melt, is that part of *Chymistry* which teaches the transmutation of metals. See our Treatise on *ALCHYMY*.

*Alembick*, from the *Arabick* particle *al* and *المبيك*, *vasis species*, a particular kind of vessel.

*Alkabeft*, is composed of two *German* words *al* *geist*, that is to say, all spirit: or an universal dissolvent. See our Treatise on *ALCHYMY*.

*Akali*, is composed of the *Arabian* particle *al* and of *kali*; as if one should say, the *kali*, (which is the standard of an alkaline salt.)

To *alcoholize*, or reduce into *alcohol*, signifies to subtilize, as when a mixt is beaten into an impalpable

gale powder. This word is also used to express a very pure spirit; thus the spirit of wine well rectified, is called the *alcohol* of wine.

*Amalgamate* is, to mix *mercury* with some melted metal; this operation serves to render the metal fit to be extended on some works, as gold; or else to reduce it into a very suitable powder, which is done by putting the *amalgam* into a crucible over the fire: for the *mercury* subliming into the air leaves the metal in an impalpable powder; neither iron nor copper can by any means be *amalgamated*.

*Aqua Stygia* is *aqua regalis*, thus called for its corrosive quality, in comparison with the water of a river imagined by the poets to be in hell, called *Styx*.

*Aqua Regalis*, so called; because it distils gold, the king of metals.

*Aqua secunda*, is *aqua fortis*, watered by the silver which it had dissolved.

*Aquila Alba*, is a sweet sublimate: this name seems to have been given to it, as it expresses a white matter, that in its sublimation resembles the flight of an eagle: but since for the same resemblance this matter might be given to other white sublimations, it is probable that this term has been in particular given to the sweet sublimate, which is a medicine used inwardly, in order to distinguish it from the corrosive sublimate which is a rank poison, and to take away the name of sublimate as that was obnoxious to the people.

*Athanasior*, or *Athanasior*, is derived from *tanuaron*, which signifies a furnace. This is very commodious to make such chymical preparations which demand only a moderate fire, such as for digestions; some call it the philosophical furnace; others, the furnace for *Areana*.

*Cement* is a manner of purifying gold. It is done by stratification with a hard paste made of one part of *sal armoniack*, two of common salt, and four of potters earth, or bricks powdered, the whole having been moistened with a sufficient quantity of urine: this composition is called *royal cement*.

*Chrysolca*, from *χρυσος*, *aurum*, gold. This name is given to the *aqua regalis*; because it dissolves gold.

*Circulation* is a motion given to liquors contained in a double vessel, excited by fire, and causing the vapours to ascend and descend to and fro. This operation tends either to subtilize the liquors, or to open some hard body that is mixed with them.

*Coagulate*, is to give a consistence to liquids, by evaporating some part of them over the fire, or else by mixing liquors together that are of a different nature.

*Cobobate*, signifies to repeat the distillation of the same liquor, having poured it again upon the matter that remains in the vessel. This operation is used to open bodies, or to volatilize the spirits.

*Concretion*, is a thickening coagulation or induration of any fluid; as salts dissolved again shoot into figures and chrystalize.

*Congeeal*, is to let some matter that is melted fix, or grow into a consistence, as when we let a metal cool, after it has been melted in a crucible; or else it is when wax, fat, butter, or the like, are taken from the fire, and set to cool.

*Depart*, is a separation of one metal from another, with which it was intimately mixed; for example, when we pour *aqua fortis* upon a mixture of gold and silver, the silver is taken up, but the gold being not penetrated by this dissolvent, subsides at the bottom of the vessels.

*Detonation*, is a noise that is made when the volatile parts of any mixture do rush forth with impetuosity; it is also called *fulmination*.

*Digestion*, is when some body is put to steep, or infuse in a convenient *menstruum*, over a very gentle heat.

*Dissolve*, is to turn some hard matter out of a hard into a liquid form, by means of a certain liquor.

To distil *per ascensum*, is when fire is put under the vessel that contains the matter which is to be heated.

To distil *per descensum*, is when fire is placed over the matter that is to be heated; for then the moist parts being rarified, and the vapour which rises from them not being able to arise away upwards, as it would do if it not hindered, it precipitates and distils at the bottom of the vessel.

*Edulcorate*, is to sweeten some matter that is impregnated with salts, by means of common water.

*Effervescency*, is the ebullition of a liquor without the separation of its parts; as when new milk, or any other liquor's set a boiling on the fire; for after the ebullition is over, it continues of the same nature as before.

*Evapora'e*, is to waste a liquor by the fire or sun.

*Expression*, is to press any matter hard to get out its juice, or any other liquor with which it is charged.

*Extract*, is to separate the purer part from the grosser.

*Fermentation*, is an ebullition raised by the spirits that endeavour to get out of a body; for meeting with gross earthy parts that oppose their passage, they swell and rarify the liquor until they find their

way!

way out; now in this separation of parts, the spirits do divide, subtilize and separate the principles so, as to make the matter be of another nature than it was before.

Though there be some difference between *effervescency* and *fermentation*, as has been shewn, yet generally these two sorts of ebullitions are confounded, and no body scruples to use the one for the other.

*Filtrate*, is to purify a liquor by passing it thro' a coffin of brown paper.

*Fumigate*, is to make one body receive the fume of another.

*Granulate*, is to pour a melted metal drop by drop into cold water, that it may congeal into grains.

*Levigate*, is to reduce a hard body into an impalpable powder upon a marble.

*Magistry*, is a name which the ancient *Chymists* gave to certain white and very light precipitates; and by it they understood a separation very subtle and exquisite.

*Matter Alkaline*, (*the same as alkali*) is any earthen or saltish matter, penetrable by acids, and receptive of their influences.

A *Menstruum* signifies in *Chymistry* a *dissolvent*, which is so called, because that *Alchymists* thought the perfect dissolution of a mixt body was completed in one of their philosophical months, which consists of forty days.

*Mortify*, is to change the outward form of a mixt, as is done in *mercury*. Also spirits are said to be *mortified*, when they are mixed with others that hinder and destroy their strength.

*Piger Horricus*, is the athanor furnace, thus called; because it may be managed by any idle person without much care and pains.

*Precipitate*, is to separate a matter that is dissolved: so as to make it fall or settle at the bottom.

*Projection*, is when any matter to be calcined is put into a crucible, spoonful after spoonful.

*Rectify*, is to distil spirits, for the separation of what heterogeneous parts might have been drawn along with them.

*Reverberate*, is to cause the flame of the wood or coals that is lighted in the furnace, to beat back upon the vessel, by means of a dome placed over it.

*Revive*, is to restore a mixt to its former condition that lies disguised by salts or sulphurs. Thus cinnabar, and the other preparations of *mercury*, are revived into quick silver.

*Scories*, is the scum of metals or minerals.

*Salt acid*, is a salt having very close or small pores, which doth not ordinarily ferment with acid, and from whence is extracted by distillation an acid spirit, as of salt-petre, vitriol, and allum.

*Salt Alkali*, is properly the salt of *kali*, but commonly all salt is so called which ferments with acids, as salt of tartar, of wormwood, &c.

*Salt Essential*, is an acid salt, extracted from plants by crystallization.

*Salt fixed*, is that which will suffer the fire without considerable diminution.

*Salt Fluid*, is an acid salt which remains fluid, and which condensates not without the interposition of some earthy matter that gives a body to it; such are the acid spirits of salt-petre, common salt, and distilled vinegar. And this is called the principle of salt.

*Salt salum*, is an alkaline salt, filled with an acid, as the sal gem and sea salt.

*Salt Volatile*, is a salt which rises with the least heat, such is that of vipers, hartshorn, &c.

*Stratify*, is to lay different matters bed upon bed. This operation is performed when we would calcine a mineral or metal with a salt, or some other matter.

*Sublime*, is to raise by fire any volatile matter to the top of the cucurbit, or into its head.

*Transmutation*, is changing the nature of one body into that of another more perfect, as if one would make gold of silver, or copper of iron.

The FIRES and their several degrees used in *Chymistry*, may be thus explained. (See the *Furnaces*, &c. in the COPPER PLATE.)

CHYMISTS, in their operations, make use of heats with sand, file-dust, and ashes; of the reverberatory fire, of a fire for fusion, of the lamp, the *balneum marie*, the *balneum vaporis*, and the heat of suppression. They also make use of insolation, the warmth of dung, and of quick-lime.

The fires or heats of sand, file-dust, and of ashes, are used when the vessel, containing the matter to be heated, can be placed in them, and gradually warmed.

The *reverberatory* fire is made in a furnace covered with a dome, to the end that the flame or heat, which always tends upwards, may reverberate upon the vessel, which is to be placed on two iron bars.

What is properly called a *naked fire*, or putting a vessel into a furnace of bare fire, is, when nothing is set between, so that the distilling vessel touches the fire, and immediately receives the heat.

The fire for *fusion* is, by putting hot coals round a crucible, or another vessel that contains the matter to be put into fusion.

The *lamp* is made use of, when the matter contained in the vessel is warmed by that heat only, and which must be always equal. It is also used to heat the necks of some vessels, so as they may be hermetically sealed. The lamp or candle is like  
wife

wife employed to heat a small matrafs or back of any glass-head, where one would have it broke by the application of a cold wet rag immediately to that part.

The oil employed for lamps must be very clear and fit to burn; for if it be foul, it will frequently clog the match, so as to damp the light and heat. To prevent which inconueniency, the oil may be purified and prepared in the manner following. Take six pound of oil, mix it with a pound of vitriol dried to a whiteness and powdered; let the mixture boil upon a small fire, to the end the vitriol may absorb or dry up the watry humidity of the oil: the vitriol will remain undissolved, and the oil may be poured off for use.

The match, most commodious for a lamp, ought to be of the *alumen plumosum*; because it will not consume in the fire; but it is inconvenient, upon its aptness to go out, when the operation is interrupted in the time of kindling the same; the best match is therefore of cotton.

The *balneum marie* is, when the alembick, which contains the matter to be heated, is placed in a vessel filled with water, under which fire is put, to the end the heated water may also heat the matter in the alembick.

The *balneum vaporis* is made when a vessel, which contains the matter, is heated by the vapour of hot water.

The fire of suppression is made, when to distil *per descensum*, fire is put above the matter, so that the humidity which is forced thence by the heat is constrained to subside in the bottom of the vessel.

*Insolation* is, by exposing to the rays of the sun any matter to be put into fermentation, or to be digested.

The *dung-heat*, also called the horse's belly, is, when a vessel containing some matter to be digested or distilled, is placed in a great heap of hot dung.

The heat of quick-lime moistened or wetted, may serve in some distillations; for in a mixture with *sal ammoniac*, it will occasion a subtle spirit to distil from thence without any other fire.

To make a fire of the first degree, two or three coals lighted will suffice to raise a most gentle heat. For a fire of the second degree, three or four coals will serve, to give such a heat as is able sensibly to warm a vessel, but so as a hand may be able to bear it some time. For a fire of the third degree, must be a good coal fire. For the fourth degree, use coals and wood together, so as to excite a violent heat.

The fires, or heats of sand, file-dust, and of ashes, have ordinarily their degrees from the first to the third; but the file-dust yields more heat than the other, because it more easily receives the heat,

and grows red hot. The ash heat is most gentle, because they retain less heat than the other substances.

The *reverberatory* fire has its degrees from the first to the fourth; but is ordinarily raised to the greatest violence.

The fire for *fusion* is always violent without degree, because it serves only for calcinations, and meltings, where only vessels of earth are used, and which easily resist the greatest fires.

It is impossible to make a vessel receive different degrees of heat from a lighted lamp, by putting it more or less near; but when the vessel is once heated, it will be continued always equal, because the match of the lamp burns equally alike in the same furnace where it is placed.

The *balneum marie* and *vaporis*, have also their degrees; for according as the water is more or less warmed, the distillation is more or less forwarded. The heat therefore of the *marie* or *vaporis* may be said to be in the first degree when it is but lukewarm, which they must necessarily be in to digest any matter committed to their influence. The heat of the second degree is, when the water or vapour is too hot for one's hand, which they must be in order but to a soft distillation. The heat of the third degree is, when the water boils, in order to hasten the distillation.

The fire of suppression has its degrees; hot ashes are only sometimes used to excite a gentle heat: and this is the first degree; at others they are mixed with a few embers, and that is the second degree; and sometimes with light coals, and that is the third degree.

*Insolation* hath also its degree, according to the force of the sun to which the matter is exposed. The best time for this is in *July* or *August*; because then the sun has the most vigour.

The *dung-heat* has its degrees, according to the bigness of the heap, and according to the place where the same is; for a greater heap will yield a greater heat than a small one; and if it be in a stable, or any other hot and covered place, it will be the warmer, and will consequently be more effectual for digestion or distillation, than any other that is exposed to the air.

The heat of quick-lime hath also its degrees: as we order it to be greater or less: it is more or less exposed to the air in powder to make it weaker: but if we would have all its heat, it must be used all quick.

The fire is often raised to so high a degree as will melt glass retorts in a reverberatory furnace; wherefore it will be convenient to coat them over with such a lute, as, when dry, is able to preserve and contain the matter that is put into them to be distilled.

distilled. This lute may be made after the manner which follows.

Take sand, the dross of iron, potters earth in powder, of each five pounds, horse dung cut small a pound, glass beaten into powder, and sea-salt, of each four ounces; mix them all, and with a sufficient quantity of water make a paste or lute, with which you must coat the retort all round to half its neck, and so set it a drying. This same lute will serve to stop close the junctures of the retort with the recipient; but because when it dries, it grows exceeding hard, and it proves difficult to unlute it, it is needful to wet it with wet clothes, when you would take the retort asunder from the receiver.

The lute, says Lemery, that I commonly use for such occasions, is compounded only of two parts of sand, and one of clay, tempered together with water.

If you would have a lute to separate easily when the operation is done, you must temper fine and well powdered ashes in water, and make a paste of it: but this lute is much more porous than the former, and it may serve as often as you please, only by tempering it over again with water.

As for the conjunction of lembicks, ordinary glue upon paper will serve the turn: but when something very spirituous is distilled, such as the spirit of wine, use a wet bladder, which carries a glue along with it, that sticks very well. But if the bladder happens to be eaten or corroded by the spirits, have recourse to the following glue.

Take flower, and lime slack, of each an ounce, potters earth in powder half an ounce, mix them, and make a moist paste with a sufficient quantity of the whites of eggs well beaten before hand with a little water. This paste may likewise serve to stop the cracks that happen in glass vessels: there must be three lays of the paste bound on with paper.

To seal hermetically, is to stop the mouth or neck of a glass vessel with a pair of pincers heated red hot. To do this, the neck is heated by little and little with burning coals, and the fire is increased and continued, until the glass is ready to melt. This way of sealing a vessel is used, when you have put some matter within it that is easy to be exalted, and you have a mind to make it circulate.

The furnace which is most in use among Chymists is that which is called the Reverberatory; it must be large enough to hold a great retort, for the distillation of acid spirits, and other things. This furnace must be fixed, and made of brick, joined together with a lute compounded of one part of potters earth, so much horse-hung, and twice as much sand, the whole kneaded together in water; let it be two bricks breadth, that the furnace being

the thicker, the heat may be retained the longer: let the ash-hole be a foot high, and the door contrived, if possible, on the side that the air comes, that when you have a mind to open it, the fire may be lighted or increased the more easily: the fire-room need not be quite so high; you must lay across it two iron bars of the bigness of your thumb, which will serve you to set your retort upon; and the furnace must be still raised near about a foot higher, to cover the retort; fit to it a dome, or cover, that may have a hole in the middle with its stopple, and a small chimney a foot high, for to place upon this hole, when the stopple is taken out, and when you would raise a great heat; for the flame preserving itself by means of this little chimney, it reverberates the more strongly upon the retort. This cover may be made of the same paste, that I shall presently describe, speaking of portable furnaces.

It will be necessary to have several furnaces of this same fashion; but they must be of different sizes, to work conveniently, according to the bigness of the vessel you would place in it. For that the fire may act more vehemently upon the retort, there must be left but only the space of a finger's breadth all round between the furnace and the retort. These furnaces may also serve for distilling by the refrigeratory, in the sea bath, the vaporous and the sand bath; for you may place the copper body upon the iron bars, when you would distil by the refrigeratory. It is easy to do the same with the balneum mariæ. As for the sand bath, lay an iron or earthen pan on the bars, and put sand enough into it to cover the bottom and sides of the vessel you desire to heat.

There ought also to be a furnace for many retorts, which one and the same fire may act on at once: this furnace must be made as the former, but only so much larger, that the retorts may be placed conveniently upon it, and that the fire, in the fire-room, which hath only one door, may act equally upon all the vessels.

If you would make this furnace large enough to contain six or twelve retorts, it must be built longways, and the door must be at one of the ends. I have observed, that in these great furnaces there is no need of an iron grate or ash-room, in order to distillations, because they generally put in much wood, which burns sufficiently to heat the retorts, if at the other end there be a hole towards the dome, big enough for one's fist, to let in the air to the fire, or to let out the smoke of the wood. A furnace without a grate wastes less wood and charcoal than that which has one; so that by this means there is much less expence, especially in distillations which continue three or four days.

The fire-place must be large, and above it there ought to be placed strong bars of iron for supporting the retorts, both on the one side and the other.

If the *furnace* be made for twelve retorts, it will require six bars of iron across, but three will serve, if it be only for six. The hole or passage to the fire place must have a door of iron made proper to shut and open, as there is occasion, for managing the fire. It is convenient also to make a border or ledge about the *furnace*, on which the receivers may be set, as you may see in the figure. The ordinary retorts are not so proper for this *furnace*. The receivers must be made so, that they may not take up too much room.

The dome of this *furnace* must be made of the same matter with the others, and divided into two or three pieces which may join easily: for if they be too great, they will be in hazard of breaking: but I have found it most convenient to make a particular dome of tiles at every distillation, which I place over the retorts, and plaister with a *lute* made of common ashes, sifted and moistened with water, which *lute* may be kept, after the distillation, to serve at another time, by diluting or tempering it with new water.

As for *fusions*, you must build a *furnace* of the same matter and form as those spoken of before; only you must forbear laying the two iron bars in it, that you did in the others, for support of the vessel.

*Moveable furnaces* are made of a paste that consists of three parts of broken pots in powder, and two parts of clay tempered together with water. Their structure is just like that of the *reverberatory furnace*. You may also leave holes through which the iron bars may pass, which support the retort, that they may be easily taken out, when you have a mind to use this *furnace* for *fusions*. A *furnace* of this form, whether fixt or moveable, may be called *polychrest*, (or general) because such a one may be used for all sorts of operations.

It is likewise convenient for *fusions*, to have a moveable *furnace* of the same matter as the others; it must be round, and may be set upon a stool: it is to have only one grate, and six registers, or holes on the sides, to let in the air to the fire. The dome may be made of the same matter, for to cover it, and a small earthen chimney for to place upon the hole of the dome, that the fire may keep the stronger.

You must be sure to put sand, or broken pots, or such like things, into the paste that you use for the building *furnaces*, either fixt or moveable, to hinder them from cracks, when they come to dry; for

these matters rendering the clay more porous, the wet breathes out much more easily.

A small iron *furnace* with its iron pot, and a cover to it, is convenient for performing many operations; this pot may serve for a *balneum marie*, and for a vaporous bath, when there is no other. It may be likewise used to distil by an *alembick* in a bath of sand, ashes, or of filings of iron.

A great iron *furnace* should likewise be had, whereon to place a copper *balneum marie*, for to distil with four bodies at once. In the middle of this bath there should be a pipe raised, the top of which must be made like a funnel, into which you are to pour hot water, in place of that which consumes away in vapour.

It is necessary to have a common iron *furnace* with three feet for warming and boiling many things upon occasion; it ought to be plaistered with a *lute*, and some pieces of brick or tile, to make the heat more durable.

It is convenient to have a small *furnace* of tin for many operations, to be managed with a lamp; *viz* digestions, where the fire ought always to be equal. This *furnace* must be round, about two foot high, and one foot diameter; and it must have a hearth, or bottom, where the lamp is to be placed. This hearth is to be a foot and half high, and pierced with five or six holes, at small distances from one another, to give air to the lamp, and continue its burning; the whole must contain a sort of basin, a little more than half a foot high, and flat at bottom; which is to hold the sand, and the vessel that sustains the matter to be digested; and it is to be covered with a dome of the same metal, a foot and half high. The lamp must have three holes, through which three cotton matches are to be put, and these soaked and supplied by the oil in the lamp. The lamp must be of sufficient length, to be taken from time to time from the hearth, and to re-kindle the matches in case they go out, and also to clean away the soot that will gather from them, and damp their heat.

THE VESSELS (see the copper plate) and other utensils necessary in this-work, are,

*Alembicks, retorts, pelicans, serpentine, recipients, or receivers, matrasses, crucibles, moulds* of several sorts, *lingotierres, bells, mortars, and funnels* of glass, &c.

ALEMBICK, from the *Arabick* particle *al*, and the *Greek* αμβίξ, is a *chymical* vessel consisting of a matras, fitted with a roundish head, terminating in a sloping tube, for the condensed vapours to pass through in the distillation. *Alembick* is properly understood of the whole instrument of distillation, with all its *apparatus*; but in the proper sense of

the word, it is only a part thereof, *viz.* a vessel, usually of copper, whereto a concave, globular, metalline head is closely luted, so as to stop the rising vapours, and direct them into its *rostrum*, or beak. The heat of the fire raising the volatile parts of the subject exposed in the bottom of the vessel, they are received into its head, where they are condensed, either by the coldness of the ambient air, or by water externally applied; and becomes a liquor, which runs out at the beak into another vessel, called the *recipient*. The head, or capital, of the *alembick*, is sometimes encompassed with a vessel full of cold water, by way of a refrigeratory; though this intention is now more commonly answered by a *serpentine*.

There are divers kinds of *alembicks*; an *open alembick*, where the head and cucurbite are two separate parts; a *blind alembick*, or blind head, where the capital is sealed hermetically upon the *cucurbite*, which *cucurbite* is an earthen or glass vessel, of the figure of a gourd, or a pear, wherein are put the matters to be distilled. It is also, sometimes made of tin, and sometimes of brass tinned.

RETORT, is a kind of crooked matras, or a round bellied vessel, either of earth, or glass, with a slender crooked beak, or nose, to which the *recipient* is to be fastened. When the *retort* is of glass, it is usually lined with a *lute* of paste an inch thick, to enable it to bear the fire the better. The *retort* serves to draw spirits and oils from woods, gums, minerals, earths, and other matters which require a strong fire.

The *retort* is a kind of *compendium*, or improvement of the *cucurbite* and *holtbead*, answering all the purposes of both, without the assistance of a capital, or head, which the other frequently requires.

PELLICAN, is a kind of double vessel, ordinarily of glass, used in distilling liquors by *circulation*.

SERPENTINE, or *worm*, is a pipe of copper, or pewter, twisted into a spiral, and ascending from the bottom of the *alembick* to the capital, and serving as a *refrigeratory* in the distillation of liquors.

RECIPIENT, or *receiver*, is an appendage of an *alembick*, *retort*, &c. being a vessel luted to the beak thereof, to receive the liquor raised in distillation, &c.

MATRASS, is a glass vessel used in distillation, and other operations. The *matrass* is made in form of a bottle, somewhat bellied in the middle, with a long narrow neck. It is luted with earth, when it is to be placed on a very hot fire; when it is required it should be stopped very close, we seal it hermetically.

CRUCIBLE, from the *French*, *creuset*, which signifies the same, is a little vessel, ordinarily of earth, sometimes iron, without any handle; wherein *Chymists*, coiners, goldsmiths, glaziers, and other artificers use to melt and calcine gold, silver, or other metals, whereon they work. Earthen *crucibles* are made of potters clay, with stone potsherds pounded and sifted. They are of various sizes, but generally of the same form, which resembles that of an inverted cone, or pyramid. Iron *crucibles* are in form of little buckets, without handles, made of iron well forged and hammered. The best, and strongest earthen *crucibles*, are those made in *Germany*.

COPPEL, *copel*, or *coupelle*, is a vessel used to try, and purify metals. The *coppel of may*, is a little flat vessel, made of vine ashes and bones of sheep's feet calcined, and lixiviated, to separate the salts, which would otherwise make it crackle. At the bottom of the vessel is a little cavity filled with a kind of white varnish, composed of hartshorn, or pike-bones, calcined, and diluted in water. The use of this liquor is, that the gold or silver to be essayed may be more conveniently lodged, and that the button of the essay may be separated the more easily.

LINGOTIERRE, or *ingotierre*, is a mould, or cavity, wherein we cast our melted metals, or *regulus* of antimony.

#### OF MINERALS.

Being thus furnished with necessaries for performing any experiment, let us begin with MINERALS. And,

*First*, let us begin with *gold*, that chief of metals. *Gold* cannot be dissolved radically, so as to separate from it salt and sulphur. But though it receives no change for health; yet the preparations made from *gold* with *spirits* are highly valued; for it is these *spirits* that give certain determinations to *gold* according to their nature, and makes it operate, as it is frequently known to do. For example,

The *aurum fulminans*, is *gold* impregnated with some spirits, which disperse its particles with violence when put in the fire. The operation is made in the following manner.

Take what quantity you please of *gold* reduced into filings, put it into a vial, or matras, pour over it three or four times its weight of *aqua regalis*; place the matras over a very moderate sand-heat, and leave it there 'till the *aqua regalis* has dissolved as much *gold* as it can contain, which you'll know by the ebullitions being over; pour by inclination the liquor into a glass; and if any of the *gold* be left in the matras, have it dissolved, as before, with some

*aqua*

*aqua regalis*. You must mix your dissolutions, and afterwards pour over the mixture slowly, some volatile spirit of sal-ammoniac, or oil of tartar *per deliquium*. There will happen an effervescence with heat, and you'll see the *gold* precipitated at the bottom of the glass in a yellow powder. Leave it to settle a long while; and to lose none of the *gold*, pour over it as much common water; then having poured by inclination all the liquor, you'll wash your powder with warm water 'till it is grown insipid; after which it must be dried on a paper, at a very slow heat, because fire catches it easily, and the powder flies off with much noise. If you have employed a dram of *gold*, you'll extract four scruples of *gold fulminans*, very dry; some call it *chalk of gold*.

This preparation of *gold* is prescribed to provoke sweat, and expel the malignant humours by perspiration; it is administered in the small pox, from two to six grains, in lozenges, or in an electuary. It stops vomiting, and is likewise very proper to moderate the too violent action of mercury.

SILVER, the second in dignity among *metals*, is the finest, the purest, most ductile, and most precious of them, except *gold*. 'Tis called *Moon*, because of its colour, and the influences which astrologers imagine it receives from the moon.

*Silver* can be administered like *gold*, in maladies caused by having taken a too great quantity of mercury; for it amalgamates very well with it, and hinders its motion.

The *chymical* preparations of *silver*, which we shall exemplify, are called *crystals of silver*, or *vitriol of the moon*.

This operation is *silver* penetrated and reduced in form of salt, by the acid points of spirits of nitre; which to perform, we cause two ounces of *silver of coppel* to be dissolved in two or three times as much spirit of nitre, pouring this dissolution into a small *cucurbit* of glass, and causing a fourth part of the humidity to be evaporated at a very slow sand heat; and what remains being left to cool without moving it, crystals will be formed upon it, which must be separated from the humidity; and having been dried, they are to be kept in a vial very well corked. Then we'll have half of the liquor remaining evaporated, and crystallized, as before; which evaporations and crystallizations must be reiterated, till all the *silver* be extracted in crystals.

These crystals are used outwardly for causticks, and administered inwardly, from one grain to three, for the dropsy, in some waters appropriated to the distemper. It purges the serosities of the abdomen.

Another *chymical* preparation of *silver*, is, the *lapis infernalis*, or the perpetual caustick, which

is *silver*, rendered caustick by the salts of spirit of nitre, in the following manner:

We'll take as much as we please of refined *silver*, which we'll put to be dissolved in a vial, with twice or three times as much of spirit of nitre; and put afterwards our vial, thus filled, to a sand-heat, to have two thirds of the humidity evaporated, throwing what remains into a good *German* crucible, and a pretty big one, because of the embullitions which will happen. This crucible must be put into a small fire, and left there till the matter being much rarefied, falls down to the bottom of the crucible; then the fire must be increased, and the matter will become like oil; at which time it must be thrown into a *lingotierre*. or mould, where it will coagulate. This *lapis infernalis* is to be kept in a vial well corked, and will be a perpetual caustick, provided it is not left exposed to the air. If we have employed an ounce of *silver*, we shall have an ounce and five drachms of *lapis infernalis*.

The next metal in order and dignity is *Tin*; which, not being of a malleable nature, cannot be reduced into a powder after the usual ways of powdering. Therefore I'll give you a method how to do it easily enough.

Melt in a crucible what quantity of *tin* you think fit, and cast it into a round wooden box, that has been rubbed within on all sides with a piece of chalk, enough to whiten it, cover this box, and presently shake it about, until your *tin* is become cold, and so you'll find it converted into a gray powder.

*Lead* may be *pulverized* after the same manner. The wooden box must be round, because that figure is the most proper to shake a thing in; and the clefts of the box must be joined together as close as may be; and but little of the *tin* must be put into the box at a time, that the parts may be the better able to separate and fall into a powder, by means of the motion or agitation. Indeed the thing may be done without rubbing the box with chalk, but by this means the melted *tin* is hindered from burning the box, as it otherwise would.

LEAD, called also *Saturn*, is a coarse, heavy, impure *metal*, of all others the softest and most fusible, when purified.

*Lead* contains a little mercury, some sulphur, and a great deal of bituminous earth.

There are five *chymical* preparations to be made of *lead*, *viz.* calcination of *lead*, salt of *saturn*, magisterium of *saturn*, balsam or oil of *saturn*, and distillation of the salt of *saturn*.

We'll begin by the *calcination of lead*. For the *calcination of lead*, we must have it melted in an earthen pan, which is not glazed, and is not to be stirred with a spatula, 'till it be reduced into powder.

der. If we increase the fire, and calcine the matter for an hour or two longer, the *lead* will be more open, and more proper to be penetrated by acids. If we calcine that powder at a reverberatory fire, during three or four hours, it will turn red, and it is what we call *minium*.

*Lead* is also prepared into *ceruse*, by exposing it to the vapour of vinegar, for then it changes into a white rust, which is gathered and formed into small cakes. To make what we call *plumbum ustum*, or burnt *lead*, we must melt two parts of *lead* in a pot, or in a crucible, and add to it one part of sulphur or brimstone, to which we must set fire, and when the brimstone is burnt, the matter is found in a black powder, which is the *plumbum ustum*.

All these preparations of *lead* are desiccative, they are mixed in unguents and plaisters, and unite themselves in boiling with oils and grease, and give them a consistence.

To make the *salt of saturn*, which is a *lead* penetrated, and reduced in form of salt by the acid of vinegar, we'll reduce the ceruse into powder, which we'll put into a large glass or stone vessel; we'll pour upon it distilled vinegar to the height of four fingers, there will happen an effervescence of a sensible heat. The whole is to be put in digestion at a sand-heat for three or four days, stirring the matter from time to time, then leaving it to settle, and pouring out the liquor afterwards by inclination; which done, new distilled vinegar must be poured on the ceruse left in the vessel, proceeding as before, continuing to pour on distilled vinegar, and to pour out the liquor by inclination, 'till very near half the matter be dissolved. Then we'll mix all our impregnations together, and having poured them into a stone or glass vessel, we'll have evaporated, at a very slow sand heat, about two thirds of the humidity, or 'till a small pellicle be formed over it; then we'll take the vessel softly off the fire, and leave it to cool without stirring it: there will be formed crystals upon it, which we must take off, and cause the liquor to be evaporated as before, and put it to cool, continuing the evaporations and crystallisations 'till we have extracted all our salt, which must be dried in the sun, and kept in a glass vessel. If we desire to have our salt whiter, we'll have it melted in an equal quantity of distilled vinegar and common water, then filtrated and crystallized as before.

*Salt of saturn* is commonly employed in pomatums for ringworms and inflammations; we also use the impregnation of *Saturn*, made with distilled vinegar for all cutaneous distempers; when mixed with a great deal of water, it makes a white liquor, called *lac virginale*.

*Salt of saturn* taken inwardly is esteemed very good for the squancy, to stop the immoderate flux of menses, of piles, and the dysenteria. The dose is from two to forty grains in plantain-water, or mixed in gargarisms.

*Magisterium of saturn*, is *lead* dissolved and precipitated in the following manner: we must dissolve two or three ounces of *salt of saturn*, purified as above, in a sufficient quantity of water and distilled vinegar; we'll filtrate the dissolution, and drop upon it oil of tartar *per deliquium*, which forms at first a sort of milk, then a *coagulum*, which precipitates in a white powder to the bottom of the vessel; the whole must be mixed again together, and poured into a funnel lined with grey paper: the liquor will run thro' clear as water, and the powder remain, which is to be washed several times, by pouring water upon it, to carry off the impression of the vinegar; afterwards it must be dried, and we shall have a very white *magisterium*, employed for beautifying the face; it is also mixed in *pomatium* for ringworms.

*Balsam*, or *oil of saturn*, is a dissolution of the salt of *saturn* in oil of turpentine; done in this manner: eight ounces of salt of *saturn*, in powder, is put in a matras, and spirit of turpentine pour'd upon it, that it may swim over to the height of four fingers; the matras must be placed at a slow fire of sand, in digestion during a whole day; then we shall have a red tincture: we'll pour out the liquor by inclination, and pour more spirit of turpentine on the matter left in the matras; we'll leave it in digestion, as before, pouring out, likewise, by inclination, the liquor, which will have some colour: then we'll put our dissolutions into a glass retort, which we'll place at a sand-heat, and having adapted a recipient to it, we'll distil, with a moderate fire, very near two thirds of the liquor, which will be the spirit of turpentine: we'll put out the fire, and the retort being cold, we'll pour what it contains into a vial, to keep it. This *balsam of saturn* is excellent to cleanse and cicatrize ulcers. The most malignant shankers are touched with it, because they resist putrefaction.

The *distillation of the salt of saturn*, is a separation of the substances contained in that salt; which ought to be effected thus: two thirds of a stone or glass retort must be filled with salt of *saturn*, which retort is to be placed in a furnace, and a pretty large recipient adapted to it, luting exactly the joints, and giving under the retort a slow fire at first, then increasing it by degrees, and towards the end pushing it with that violence as to make the retort red-hot, then leaving the vessels to grow cold; after which, they must be unluted: what

is contained in the recipient, must be poured into an alembick of glass, and rectified by distilling at a slow sand-heat, very near half the liquor; which done, we shall have a spirit of *saturn*, as inflammable as brandy, and of an acerb taste.

This spirit is very good to resist the putrefaction of the humours. It is given to hypochondriack melancholicks, from 8 to 16 drops, in broth, or other liquors appropriated to the distemper; and it must be used 15 mornings successively.

The other half of the liquor left in the alembick, is improperly called *oil of saturn*; it is good to cleanse the eyes of horses.

Having done operating upon *lead*, we'll pass to **COPPER**, which is a hard, dry, heavy, and of all metals the most ductile and malleable, after gold and silver, and abounds much in vitriol and sulphur.

Astrologers call it *Venus*; and by the analysis it appears composed of a sulphur ill digested, a yellowish mercury, and a red salt.

The calcination of *copper* is a separation made of its most volatile oily particles, by means of common sulphur and fire, to render it more compact; which to perform, must be stratified in a large crucible, *laminæ of copper*, with brimstone in powder; the crucible is to be covered with a tile, or some thing else which has a hole in the middle for the evacuation of the smoak. The crucible is placed in a wind furnace, and a great fire made round it, till no more smoak appears; when the *laminæ* must be taken out quite hot, and separated. This is the *æstum*, or burnt *copper*, employed in external remedies as a detersive. It may be reduced into powder in a mortar.

**IRON**, is a hard, fusible, and malleable metal, very porous, composed of vitriolick salt and sulphur, very ill mixed and digested together; therefore the dissolution of its parts is easily made. *Iron* is also called *Mars*, contains a vitriolick acid, it is nevertheless an alkali; because it ferments with the acids, which will not at all appear surprizing, when we consider that there is a great deal more of earth, than salt, in that metal; and that this earth keeping the salt embarrassed, it has enough pores left to receive the points of the acids poured over it, and to do the office of an alkali.

The *Mars* is almost always astringent through the abdomen, because of its terrestrial particles; and aperitive by urine, not only because of its salt, which is penetrating; but, likewise, because the abdomen contracting itself, the humidities are filtrated by urine.

There are eleven chymical preparations made of *iron*, viz. three sorts of *aperitive crocus martis*, *astringent crocus martis*, two sorts of *salt*, or *vitriol of mars*, *spirit of mars*, *tincture of mars with tar-*

*tar*, *extract of mars aperitive*, *extract of mars astringent*, and *diaphoretick of mars*. Some of which follow.

The *aperitive crocus martis*, is but the rust of *iron*, made by *laminæ of iron*; which washed are exposed to the dew for a considerable time, where they will grow rusty. This *crocus* is the best of all the preparations of *iron* called *crocus*. It is excellent for the obstructions of the liver, the pancreas, and the mesentery. It is used with success for the retention of the *menfes*, the dropsy, and other maladies proceeding from opilations. The dose is from ten grains to two scruples, in lozenges, or pills.

We'll prepare next the *salt*, or *vitriol of mars*, which is *iron* penetrated, and reduced in the form of salt, by an acid liquor, thus: we'll take an *iron* pan, very clean, and pour into it an equal weight of spirit of wine, and oil of vitriol extracted from *English* vitriol; we'll expose the pan, for some time, to the sun, and leave it afterwards in a dark place, without stirring it; when we shall see the liquor incorporating itself with the *mars*, and forming a salt, which must be left to dry, or harden: then it must be separated from the pan, and kept in a bottle well corked.

This *salt* is an excellent remedy for all maladies proceeding from obstructions. The dose is from six grains to a scruple, in broth, or some other liquor appropriated to the distemper.

The preparations of *Quicksilver* are worthy of particular attention.

We won't dispute whether this be a *metal* or *femimetal*: our business is to make it useful to the human body. Which may be done best by chymical preparations.

It is called *mercury* in the shops, which have fourteen preparations of it, viz. the *Æthiops mineral*, the *black mercurial panacea*, the *corrosive sublimate*, the *sublimate mercury*, called *aquila alba*, the *mercurial panacea*, the *white precipitate*, another *white precipitate*, the *red precipitate*, the *red precipitate without addition*, the *green precipitate*, the *turbith mineral*, or *yellow precipitate*, the *oil* or *liquor of mercury*, another *oil of mercury*, and another *precipitate of mercury*.

The *Æthiops mineral*, is a mixture of *mercury* and sulphur, made by putting in fusion, on the fire, what quantity we please of sulphur in an earthen pot, without glazing, and which will bear the fire, and mixing with it, by degrees, with an iron spatula, an equal quantity of *quicksilver*; we'll set fire to the mixture, and the sulphur being burnt, it will remain a black mass, friable and ponderous, which must be left to cool, and afterwards separated from the pot, and kept.

This preparation is good for the asthma, epilepsy, rheumatism, venereal disease, and for scrophulous, and the king's evil. It operates chiefly by perspiration, and seldom by salivation. The dose is from eight grains to two scruples, in a bolus.

The *black mercurial panacea*, which is our second operation on mercury, is mercury penetrated, and impregnated with some portions of sulphur and *sal ammoniac*, thus: we put in fusion in an earthen pot without glazing, four ounces of sulphur, or brimstone; we take it off the fire, and mix with it, by degrees, three ounces of *sal ammoniac*, in powder; it then raises a smoak, proceeding from the phlegm of the *sal ammoniac*; we separate the matter from the pot before it is quite hardened, and find twelve ounces and six drachms of it; which, when cold, we pulverize, and put into a matrafs, to fill but one third of it; we place the matrafs in a sand-heat, and give but a small fire, at first, to heat the vessel; then we increase it gradually to the third degree, and continue it during five hours, or till no more vapours come out through the neck of the matrafs; then we leave the vessel to cool, and break it afterwards: we find at the top some white flowers, which we throw away as useless, and at the bottom a matter disposed by beds of different colours; the first yellow, the second white, the third grey, and the fourth black. We pound this matter, and put it into a matrafs, pushing it, as before, by a graduated fire, during seven hours; then leaving it to cool, and breaking the vessel, we find the matter disposed by beds of different colours, as in the first calculation; which we reduce again into powder, and put into a new matrafs, pushing it, for the third time, as before, by a graduated fire, during seven hours; then breaking the matrafs, we take out the matter, reduce it again into powder, put it in another matrafs and push it, for the fourth time, by a graduated fire, as before, but increasing it towards the end to make the bottom of the vessel red-hot; then we break it, and find the matter separated into two beds of different colours; that a-top is yellow and light; and that underneath is commonly black; sometimes, also, purple, and ponderous. We take this last portion, which is the *black panacea*.

This preparation is sudorifick, proper for the rheumatism, venereal disease, asthma, epilepsy, *scrophulæ*, worms, and to raise the obstructions. The dose is from twelve grains to half a drachm in a bolus. The yellow matter a-top is a mixture of sulphur and *sal ammoniac* impregnated with some portion of mercury. It must be reduced into powder, and kept. It may be employed externally for the itch, mixing two drachms of it in an ounce of *pomatium*.

Our third preparation, is that of *corrosive sublimate*, which is mercury penetrated by acids, and exalted by the fire, to the top of the vessel. The *sublimated mercury* is prepared by putting sixteen ounces of mercury into a matrafs, and pouring upon it eighteen ounces of spirit of nitre. The matrafs is placed at a small sand-heat, and left there till the dissolution be made; which dissolution is poured into a glass vessel, or a stone pan, to evaporate slowly, at a sand heat, all the humidity, till it remains but a white mass; which must be pounded in a glass mortar, and mixed with sixteen ounces of vitriol calcined white, and as much *decrepitated salt*: this mixture is put into a matrafs, two thirds whereof are left empty, its neck having been cut in the middle of its height: this matrafs is placed on the sand, and the artist begins to give a small fire, which he continues during three hours, and then increases it; when there will be formed a *sublimate* at the top of the matrafs: the operation must be ended in seven or eight hours. The matrafs is left to cool, and then broke, the artist avoiding a light powder, which flies into the air when the matter is stirred. The red dross left at the bottom of the vessel, is thrown away as useless.

The *corrosive sublimate* is a violent escharotick, and eats away proud flesh. Half a drachm of it, dissolved in a pound of lime water, turns it yellow, which is then called *phaged-nick water*. It is used to wash ulcers, and tetters eruptions.

*Mercurius dulcis*, our fourth operation on mercury, is the corrosive sublimate divested of its acid strength, in the following manner: six ounces of corrosive sublimate are reduced into powder, in a glass or stone mortar, and twelve ounces of *quicksilver* mixed with it; the mixture is stirred with a wooden pestle, till the *quicksilver* be imperceptible; that mixture, which will be grey, is put into several vials, or into a matrafs, two thirds whereof ought to be empty: the vessel is put in the sand, and a small fire given to it, at first, which is increased afterwards to the third degree, and continued in that condition during five hours, to sublimate, and sweeten the matter; then the vessels are left to cool, and afterwards broke, wherein are found three different sorts of matter, *viz.* a small quantity of a light earth at the bottom, which must be rejected as useless; another matter adhering to the neck of the vials, or of the matrafs, which may be kept to mix with unguents for the itch; and a white one in the middle, which must be gathered carefully, pounded, and put into vials to be sublimated a second and a third time, proceeding in these two last sublimations as has been done in the first. The matter found in the middle, after the last sublimation, will be very well dulcified.

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This *mercurius dulcis* purges gently by stool; it is used in all sorts of venereal diseases; it is disobstructive, and kills worms. The dose is from six to thirty grains, in pills. If it be sublimated twice more, it loses its purgative virtue, and is more disposed to work by perspiration and salivation. If, on the contrary, it be sublimated but twice, its purgative virtue will be greater.

The *mercurial panacea*, is a sublimate of *mercury* dulcified by several sublimations, and spirits of wine, thus: We'll take what quantity we please of the *sublimate mercury* last mentioned, which having reduced into powder in a stone or glass mortar, we'll put into a matras, three parts whereof are to be left empty, and its neck cut at the middle of its height; which matras must be placed in a furnace, at a sand-bath, and a small fire made under it, during an hour, to heat slowly the matter; after which, the fire is to be increased to the third degree, and continued in that condition about five hours, during which time, the matter will sublimate. The vessel being left to cool, and afterwards broke, a small quantity of red and light earth, found at the bottom, must be thrown away as useless, and all the *sublimate* separated from the glass reduced again into powder, and sublimated as before; which sublimations are to be repeated seven times more, changing the matras each time, and each time rejecting the red earth found at the bottom: this done, the *sublimate* is to be reduced into an impalpable powder on the porphyry, and put into a glass cucurbit, pouring upon it alcoholized spirit of wine, to the height of six fingers breadth; then the cucurbit must be covered with its capital, and the matter left in infusion during fifteen days, stirring it from time to time with a wooden spatula: at the end of the fifteen days, the cucurbit must be placed at the *balneum marie*, or *vaporous bath*, adapting a recipient to it: and having luted exactly the junctures with a wet bladder, all the spirits of wine must be distilled by a moderate fire, which accomplished, the vessel is left to cool, and being unluted afterwards, we shall find our *panacea* at the bottom of the cucurbit, which if not dry enough, must be dried at a small sand heat, by stirring it with a wooden spatula in the same cucurbit, till it grows into powder, which must be kept in a glass vessel.

This *panacea* is a very good remedy for all the venereal diseases, inveterate rheumatisms, obstructions, scurvy, king's evil, itch, scald heads, worms, *ascarides*, and old ulcers. The dose is from six grains to two scruples, in a bolus, or pills.

The *white precipitate of mercury*, is a *mercury* dissolved in spirit of nitre, and precipitated by salt into a white powder, in this manner: sixteen oun-

ces of crude *mercury* are dissolved in a glass cucurbit with eighteen ounces of spirit of nitre: the dissolution made, we'll pour upon it filtrated salt-water, made of ten ounces of sea salt, melted in two pints of water, adding to the whole about an ounce of volatile spirit of sal ammoniac: then there will be made a very *white precipitate*, which is to be left to settle, pouring out, afterwards, the water by inclination, and washing the *precipitate*, several times, with spring-water, and drying it in the sun.

This *precipitate* is used to excite a salivation; it is somewhat vomitive. The dose is from four to fifteen grains, in pills. It is also mixed in *pomatam* for cutaneous distempers, from half a drachm to a drachm, for an ounce of *pomatam*.

The other sort of *white precipitate* is the *corrosive sublimate*, dissolved with sal ammoniac melted in water, and precipitated by oil of tartar, thus: Four ounces of sal ammoniac are melted in sixteen ounces of water, the liquor is filtrated through a grey paper, and four ounces of *corrosive sublimate*, in powder added to it, which will melt soon; then oil of tartar *per deliquium* is poured gently on the dissolution, whence an ebullition will ensue, and afterwards a *white precipitate*: the artist continues pouring the oil of tartar till he sees that nothing more is precipitated, then pours a great quantity of water into the vessel, and leaves the matter to settle, till the liquor grows clear; then he pours out the matter by inclination, washing several times its *precipitate*, and having it dried, afterwards, from the sun, it commonly turns a little yellow. This *precipitate* has the same virtues as the other, and the dose is the same.

The *red precipitate* is a *mercury* wrapped in spirit of nitre, and calcined by fire, in this manner: The artist takes eight ounces of crude *mercury*, which he causes to be dissolved in eight or nine ounces of spirit of nitre. He pours the dissolution into a vial, or matras, with a short neck, which he places on the sand, and makes under it a moderate fire to evaporate the humidity till it remains nothing but a white mass: then he pushes slowly the fire to the third degree, and keeps it in that condition till the mass is turned red, then takes it off the fire, and having left the vessel to cool, he breaks it to take out the *precipitate*.

This *precipitate* is an excellent escharotick, it eats proud flesh, it is used, mixed with burnt allum, *Ægyptiack*, and suppurative, to open sinners.

The *green precipitate* is a mixture of *quick-silver*, *copper*, and acid spirits, made in the following manner. We will put four ounces of *quick-silver* into a matras, and one ounce of *copper*, cut into small pieces, into another. We will pour upon the

*quick-silver* four ounces of spirit of nitre, or of good *aqua fortis*, and on *copper* one ounce and a half of the same dissolvent: we will place our matrasses on a sand-heat, and leave them there till the *metals* be dissolved; we will mix our dissolutions in a stone porringer, and cause the humidity to be evaporated at a sand-heat, till they be reduced into a mass: we will increase the fire under the porringer to calcine the mass for about one hour and a half; we will put the fire out afterwards, and leave the mass to cool; then we will take out the mass, and reduce it into powder in a stone mortar; which done, we will pour upon it distilled vinegar to the height of six inches, or thereabouts; we will stir the mixture very well together, and place the matras in digestion at a sand-heat, where we will leave it twenty-four hours, stirring it from time to time: we will afterwards increase the fire to make the liquor boil for about an hour, or 'till the vinegar has took a green colour, inclining to blue, leaving it to cool, and afterwards pouring it out by inclination. We will pour other vinegar upon what remains in the matras, and proceed, as before, to extract the tincture, mixing our dissolutions together, and having the humidity hercof evaporated, in a stone or glass vessel, at a sand-heat, 'till the matter appears in the consistence of a thick honey; then we will take it off the fire, it will harden in cooling. We will reduce it into powder and keep it.

The *green precipitate* is a specificck for virulent gonorrhœa's; it is administered when they run, and to stop them after they have ran; it may be used in the pox for the phimosi and shankers, given inwardly, and applied outwardly. The dose is from two grains to six, in pills, or in a bolus; it purges upwards and downwards. There will remain in the matras a matter which has not been dissolved by the vinegar, it resembles much the *turbith mineralis*; it must be washed and dried, and can be used in pomatums for the itch, a drachm to an ounce of pomatum.

The *turbith mineralis*, or *yellow precipitate*, is *mercury* impregnated with the acid particles of the oil of vitriol: thus, the artist puts four ounces of *quick-silver* into a glass retort, and pours upon it six ounces of oil of vitriol; he places his retort on the sand, and when the *mercury* is dissolved, he makes a fire under it, and distils the humidity: then pushes the fire towards the end to force out one part of the last spirits: he breaks afterwards his retort and reduces into powder, in a glass mortar, a white mass he has found in the retort; then pours warm water upon it, which water changes the powder yellow, which he mundifies with several repeated lotions, and afterwards dries it in the sun.

This *turbith mineralis* purges violently upwards and downwards; it is prescribed in the venereal diseases. The dose is from two grains to six in pills.

The *oil or liquor of mercury* is prepared by putting into a stone-pan the lotions of the white mass, of which the *turbith mineralis* has been made, and causing all the humidity to be evaporated, at a sand-heat 'till a matter remains at the bottom in form of salt; then the pan is to be carried to the cave, where it must be left 'till almost all the matter be resolved into a liquor, which is used to open the venereal shankers, and to eat the proud flesh, by applying it upon them on pledgets.

There is another *oil of mercury*, which is but the corrosive sublimate dissolved in spirit of wine; thus: One ounce of corrosive sublimate is reduced into a very subtile powder, and put into a matras; four ounces of very well rectified spirit of wine are poured over it, the matras well stopped, and the matter left to macerate, in the cold, during seven or eight hours, when the sublimate will be dissolved; but if something was left at the bottom, the liquor must be poured out by inclination, and a small quantity of other spirit of wine poured upon the matter left, leaving it to macerate as before, to perfect the dissolution: these dissolutions are mixed and kept in a bottle well corked.

This *oil of mercury* is softer than the first, and proper for the venereal shankers, especially when we fear the gangrene; it may be used on pledgets, as the other.

There are three other sorts of *precipitate of mercury* besides those heretofore-mentioned, which are nothing else but the corrosive sublimate precipitated into powders of different colours. Those three *precipitates* are prepared in the following manner.

Four or five ounces of corrosive sublimate are stirred in a glass mortar, with eight or nine ounces of warm water, during one hour; then the liquor is left to settle, and afterwards poured out by inclination, filtrated, and divided into three parts, in three vials.

Then throwing into one of those vials some drops of oil of tartar *per deliquium*, there will be made immediately a *red precipitate*. Pouring into another vial some volatile spirit of sal-ammoniac, there will be made a *white precipitate*. And mixing in the last vial five or six ounces of lime-water, there will be made a yellow water, called *phagedenic*, or *ulcerary*, because it is a detesive, and proper to cure ulcers. If the water is left to settle, there will be made a *yellow precipitate*.

To take out those three sorts of *precipitates*, the water must be poured out by inclination; they must be washed, dried, and kept.

The *red precipitate* is used like the other heretofore described, but it is not so strong, it is the true *red precipitate*, which is very much esteemed for the pox. The dose is four grains. The *white precipitate* has the same virtues as the other *white precipitate*. The *yellow precipitate* is employed in pomatums for the itch, mixing half a drachm, or a drachm of it with an ounce of pomatum.

*Note*, All the preparations of *mercury* heretofore-mentioned are but disguisements of that *metal*, made by acids or alkali spirits, which having ceased it in a different manner, make it produce different effects.

I shall conclude the preparations of mineral subjects with some operations in *antimony*, which assumes as many different forms, as *mercury*. We will begin with the *STOMACHIC OF POTERIUS*, or *poter*. This is a *martial regulus of antimony* fixed, and mixed with gold, thus: We reduce into powder four ounce of *martial regulus of antimony*, and twelve ounces of salt petre, which we mix exactly with half an ounce of fine gold; and having made a crucible red-hot, between coals, in a furnace, we throw into it a spoonful of our mixture; there happens a small detonation, which being over, we throw another spoonful, and continue thus till the whole mixture be in the crucible; which having left to calcine for about an hour, we throw it, afterwards, into a large quantity of warm water, and leave it there some hours to steep, for the dissolution of the salt-petre: we pour out the water by inclination, and having washed several times the powder left at the bottom, we put it to dry, then calcine it again in another crucible for the space of an hour, stirring it with an iron spatula; then the operation is ended.

This *antimonial* preparation is esteemed proper to strengthen the stomach and the heart, to repair a decayed constitution, to excite the perspiration of humours, to purify the blood, to resist venom, to stop hæmorrhages, for the palsy, and for maladies caused by *mercury*.—The dose is from 10 grains to 30.

*GLASS OF ANTIMONY*, is a *regulus of antimony* vitrified by a long fusion, in this manner: we calcine, at a slow fire, one pound of *antimony*, in powder, in an earthen pan without glazing, stirring continually the matter with an iron spatula, till it has done smoaking, and is changed into a grey powder, which powder must be put into a good crucible covered with a tile, and placed in a wind furnace, where we will make a very violent fire round the crucible, that the matter be put in fusion; about an hour afterwards, we will uncover the crucible, and introduce into it an iron rod, where-

by we shall discover in taking it out, if the matter adhering to it be very diaphane; and if it be so, we will throw it upon a hot porphyry, where it will congeal, and we shall have a very fine *glass of antimony*, which we will leave to grow cold.

This *glass* is excellent in agues, but one of the most violent emetics made of *antimony*; the emetic wine is a preparation of it: by having it steeped in white wine. It is given in substance from two grains to six.

The *DIAPHORETIC ANTIMONY*, is the sulphur of that mineral fixed by salt-petre, which hinders it from acting otherwise than by sweat.

To make this preparation, we pulverize, and mix exactly, one part of *antimony* with three parts of refined salt-petre; and having made a crucible red hot, between the coals, we throw into it a spoonful of our mixture: there happens a detonation, which being over, we throw in another spoonful, and continue thus till the whole mixture is in the crucible, leaving a very violent fire round it during two hours, that the matter may liquify, or be in a sort of fusion: then we throw that matter which is white into an earthen pan almost full of spring-water, and leave it to steep during ten or twelve hours, for the dissolution of the fixed salt-petre; afterwards we pour out the liquor by inclination, and wash the powder left at bottom five or six times, with warm water and dry it. This is what we call *diaphoretic antimony*, or *chalk of antimony*.

This *diaphoretic antimony* is supposed to resist venom, and consequently very good for malignant fevers, the pox, plague, and for all other contagious maladies: it is astrigent. The dose is from six to thirty grains.

*FLOWERS OF ANTIMONY*, are the most volatile parts of *antimony* exalted by fire, thus: We place in a furnace a very good earthen pot, without glazing which can bear fire, which has a hole in the middle of its height, with a cork to it; and adapt over it three other pots of the same earth, without bottoms to them, and on the superior pot a capital, with a small vial for a recipient: we lute exactly the joints, and take care, by means of some bricks and lutes, that the fire in the furnace does not transpire thro' some hole or other, but only heat the bottom of the inferior pot: then we give a graduate fire, that the pot may heat by degrees, and grow red-hot at last. When red-hot, we throw into it, thro' the hole, a small spoonful of *antimony*, in powder, and spread, at the same time, with a bowed iron spatula, the matter on the bottom of the pot: we take out the spatula, and stop the hole, that the flowers may ascend, and stick against the upper pots; we continue a great fire to keep always the pot red-hot, and when we

See that nothing more sublimes, we throw the same quantity of *antimony*, observing the same rules prescribed before, and continue to throw thus into the pot, till we have flowers enough; then putting out the fire, when the vessels are cold we unlute them, and find round the three superior pots, and the capital, the flowers, which we gather, and keep in a vial.

These *flowers of antimony* are a strong emetick; they are given for the quartan ague, intermitting fevers, and even for the epilepsy. The dose is from two grains to six, in lozenges, or broth.

BALSAM OF SULPHUR is a dissolution of the oily particles of *common sulphur*, in oil of turpentine. The operation is conducted thus: An ounce and a half of *flowers of sulphur* is put into a matras, and eight ounces of oil of turpentine poured upon it: the matras is placed on the sand, and a small fire of digestion given to it, during one hour, which fire is a little increased afterwards, and continued thus for half an hour longer, and then the oil takes a red colour; and when the vessel is cold, the clear *balsam* is separated from the *sulphur*, which could not be dissolved.

This *balsam* is an excellent remedy for the ulcers of the lungs, and of the breast, and for the asthma. The dose is from one drop to six in some liquor appropriated to the distemper. Applied outwardly it resolves the hæmorrhoides or piles.

If the *balsam of sulphur* be prepared with oil of anniseed, instead of that of turpentine, it will be more agreeable, and not so acrimonious.

Under the head of SUBJECTABLES, the *Chymist* has a vast variety of subjects to exercise his skill, for the health and other uses of life. The description of this part of the creation has been already made in the treatise of *Botany*. What remains to be considered by the *Chymist*, is the analysis of those subjects, and by means of chymical operations, which I propose to exemplify by such principles as are best known, and of most use in medicine.

EXTRACT OF RHUBARB, is a separation of its purest part from the terrestrial, made in the following manner: We bruise six or eight ounces of good *rhubarb*, which we put to steep warm, for twelve hours, in a sufficient quantity of water of chicory, so that the water swims four fingers above the *rhubarb*; making, afterwards, the infusion to boil, for about a minute; then we strain the liquor through a flannel, pouring again the same quantity, as before, of water of chicory, on the *rhubarb*, and leaving it to steep for the same space of time; after which, we strain it through the same flannel; we mix our impregnations, or tinctures, and after we have left them to settle, we filtrate them, and cause the hu-

midity to be evaporated at a slow sand-heat, till the matter be reduced to the consistence of thick honey. It is what we call *extract of rhubarb*, which we keep in a pot.

This *extract of rhubarb* purges gently, in binding and strengthening; it is proper for the diarrhæa, pain in the stomach, and to excite the appetite. It is particularly esteemed for the maladies of the liver. The dose is from ten grains to two scruples.

The *chymical* preparation of CINNAMON is that of its *oil*, or *essence*, of its *ætherical water*, and its tincture is extracted thus: Four pounds of the best *cinnamon* are bruised, and put to steep in six quarts or twelve pounds of common water; the whole is left in digestion in an earthen vessel, well corked, for nine or ten hours; and the infusion poured afterwards into a larger copper alembick, to which is adapted a large recipient, and the joints thereof are exactly luted with wet bladders; then three or four pounds of the liquor are distilled at a great fire, and the alembick being unluted afterwards, the distilled water in the recipient is decanted into the alembick, and the oil found at the bottom of the recipient put into a vial, which must be very well corked; the liquor is distilled as before, and the oil found at the bottom of the recipient mixed with that in the vial: those cohobations are reiterated till no more oil ascends, then the fire is put out, and the water in the recipient rectified in the same manner we rectify the spirit of wine.

The *oil of cinnamon* is an excellent corroborative; it strengthens the stomach, and helps nature in its evacuations; it is given to accelerate the birth to women in labour, and to promote the menses; it also excites the seed.

The *spirituous water of cinnamon* has the same virtues. The dose of the water is two or three drachms; and that of the oil from six to 15 drops.

The *tincture of cinnamon* is an exaltation of the most oily particles of *cinnamon* in spirit of wine, prepared in the following manner.

We put what quantity we please of bruised *cinnamon* into a matras, and pour upon it spirit of wine till it rises a finger's breadth above the *cinnamon*. We stop well the matras, and put it, in digestion, in a dunghill, during four or five days: by that time the spirit of wine will have took a tincture of *cinnamon*; we separate that tincture from the *cinnamon*, filtrate it, and keep it in a vial well corked.

This tincture is an excellent cardiack, it strengthens the stomach, and rejoices all the vital parts: the dose is less than that of *cinnamon water*.

Our next operations are to be on *Quinquina*, or *Quinaquina*, called also *China china*, and *Kin kina*.

QUIN-

QUINQUINA is a medicinal bark, brought from the *West Indies*, called also by way of eminence, the *bark*; and *Cortex Peruvianus*, the *Peruvian bark*, from the country whence it is brought; and particularly the *Jesuit's bark*, because at its first introduction it was chiefly sold and administered by the Jesuits.

The TINCTURE OF QUINQUINA, is an extraction of its most oleaginous and loose particles in spirit of wine, made in the following manner: we put into a matras four ounces of good *quinquina*, coarsely pulverised, and when we have poured upon it enough spirit of wine to raise it four fingers breadth above the matter, we stop the matras with another, to make of it a circulatory vessel, which we lute exactly, and place in dung to the vaporous bath for four days, shaking the vessel from time to time; the four days elapsed, we unlute the vessels, and filtrate the tincture, which is red, through a grey paper, and keep it in a bottle, well corked.

This tincture is a febrifuge for intermitting fevers, which must be taken three or four times every day, at some distance from the paroxysm, and the use continued for fifteen days successively. The dose is from ten drops to a drachm, in water of centaury, or of juniper-berries, or wormwood, or in red wine.

If we steep some coriander, or cinnamon, in wine, or water, dissolve some sugar in the colature, and mix it with the tincture of *quinquina*, we shall have a sort of febrifuge ratafia, which may be easily given to children.

The EXTRACT OF QUINQUINA, is a separation of the most substantial particles of the *quinquina*, made thus: Eight ounces of *quinquina* are put to steep, warm, in a sufficient quantity of distilled water of walnuts for twenty-four hours, which being expired, the infusion is made to boil gently, and after it has been percolated with a strong expression, the *quinquina* left is put to steep again in other water of walnuts, and the infusion made to boil, and percolated, as before; which done, the colatures are mixed together, and left to settle: when settled, the clear liquor a-top is decanted and the humidity left made to evaporate, in a glass or stone vessel, at a slow sand heat, to the consistence of thick honey.

This extract is a febrifuge like the preceding ones. The dose is from twelve grains to half a drachm, in pills, or dissolved in wine.

The distillation of a plant which is not odoriferous, such as *CARDUUS BENEDICTUS*, is conducted in this manner: we pound in a mortar a good quantity of *Carduus benedictus*, while in its greatest strength, and having filled the third part of an *alembick* with it, we draw by expression a sufficient quantity of the juice of other *Carduus benedictus*, which we pour into the *alembick*, that

the herbs swimming in the juice may not be in danger of sticking to the bottom of the *cucurbit* during the distillation: we adapt a capital, with its recipient, to the *cucurbit*, and having luted exactly the joints, we cause to be distilled, at a fire of the second degree, about half the liquor.

The water of *Carduus benedictus* is sudorifick, it is used in the small pox, plague, and malignant fevers.

We express through a linen cloth what remains in the *alembick*, and after we have left the juice to settle, and filtrated it, we cause two thirds of the humidity to be evaporated in a glass or stone vessel, at a slow fire, and carry the vessel to a cool place, where we leave it for eight or ten days, during which time, there are crystals formed round the vessel, which we separate, and keep in a vial, well corked. These crystals are called *essential salt*, which is sudorifick. The dose is from six to sixteen grains, in its own water.

Chicory, fumitory, scabious, and all other plants, which are not odoriferous, and have a deal great of juice, are to be distilled like the *Carduus benedictus*; and this method will serve to extract the salt of any plant.

When we want but the *salt fixed* of some plants, we do it by only drying the plant, burning it, to reduce it into ashes, and throwing those ashes into boiling water, leave them there to steep; we afterwards filtrate the infusion, and causing the humidity to be evaporated in an earthen pan, we find left in the vessel a brownish salt, which we calcine afterwards in a crucible till it grows white; which done, we have it melted in water, filtrate the dissolution, and have all the humidity evaporated in an earthen pan: there remains a very pure and white salt, which we keep in a bottle, well corked. The best method to extract salts is, while in the country, in fair weather, and when there is a great quantity of herbs to be burnt, to dig a hole in the earth, to put the plant, well dried, into it, to set fire to it, and to cover the whole with stones, or other earth, leaving no other aperture than what is necessary for the admission of air, to keep the fire: the plant will be burnt gently, and calcined. The operation is ended when the earth a-top is quite cold; then the whole is uncovered gently, and the ashes are found in it, adhering to one another by lumps, which is a mark of a good calcination, and of the reasonable quantity of salt they contain. The best method to burn plants in a laboratory, is, to have a *furnace of fusion*, and placing that *furnace* under the chimney, to fill it up with the plant, well dried; and having set fire to it, to cover the *furnace* with its dome, and little chimney. The plant burns slowly: when it is half consumed, the *furnace* is filled up with

another quantity of it, continuing thus to put in the plant till it is all gone, or the *furnace* is full of ashes; then they are left to calcine, for if the plant has been crowded into the *furnace* every time it was put into it, the ashes will remain lighted for ten or twelve hours after they have done smoaking: they are gathered when quite cold.

We'll make two *chymical* preparations of *Roses*, viz. the *water of roses*, and the *spirit of roses*.

**WATER OF ROSES**, is a separation of the most aqueous and odoriferous part of the *roses*, by distillation, conducted thus: ten or twelve pounds of *roses*, the most odoriferous, gathered some time before sun rising, in dry weather, and separated from their pedicle, are pounded in a mortar till they are reduced to the consistence of paste; and being put afterwards into a large copper *cucurbite*, the juice of other *roses*, newly extracted is poured upon them, till they are sufficiently humected; then a bolt head, with its *refrigeratory*, and a *recipient*, are adapted to the *cucurbite*, and the joints exactly luted: the *cucurbite* thus prepared, is placed in a *furnace* on a moderate fire, and the water in the *refrigeratory* changed as often as it grows hot: when about half the liquor is distilled, the fire is put out, for fear the matter should stick to the bottom; the vessels are separated, and what remains in the *cucurbite* strained through a cloth with expression; the liquor, or juice extracted from it, is put into a *cucurbite*, and two thirds of its humidity distilled at a slow fire: this second distillation is mixed with the first, and afterwards put in bottles, which are left, uncorked, exposed to the sun, for several days, to excite the fragrancy of it; and the bottles are afterwards corked.

When it is wanted to draw the water of flowers which have but little humidity, as flowers of *lavender*, *betony*, *sage*, *rosemary*, &c. they must be humected with white wine, and having been left two days in maceration, they are distilled in *balneo marie*, or at the vaporous bath.

The **SPIRIT OF ROSES**, is an exaltation of the most oily, subtile, and essential part of the *roses*, into a liquor made in the following manner: Fourteen or fifteen pounds of *damask roses*, with their pedicle, are pounded, and put into a large stone pot, one third whereof, at least, is left empty; six pounds of juice of other *roses*, but of the same kind, which has been heated, and eight or ten ounces of beer yeast, mixed with it, are poured upon it: the mixture is well stirred with a stick, and the pot, being well stopp'd, is put in digestion, in a dunghill for three or four days, which being expired, the matter is put in distillation to the vaporous bath; and when about four pounds of the liquor is distilled, the fire is put out, the *recipient*

taken off, and what it contains rectified in a matrafs.

The *spirit of roses* fortifies the heart and stomach, either taken inwardly, or applied outwardly: it is administered to men for synopes, and the palpitations of the heart; but is not proper for women, because it excites the vapours. The dose is from half a dram to two drams, in *rose-water*.

We'll make but one single *chymical* preparation of *sugar*, which is its *spirit*; which *spirit* is a mixture of the acid of the *sugar* with flowers of sal ammoniac; made thus: We pulverize and mix eight ounces of *sugar candy* with four ounces of sal ammoniac, and fill a third part of a stone or glass *cucurbite* with the mixture; we adapt a capital to it, and a recipient, lute exactly the joints, and place it in a *furnace* on sand, making a small fire in the *furnace* for an hour, to heat the vessel, then increasing it to the second degree, a liquor will drop into the recipient, and towards the end of the operation white vapours rise to the capital, which when we perceive, we increase the fire till nothing comes out of the *cucurbite*; which we unlute, when cold, and find in the recipient four ounces of a brown liquor of a bad smell, and a small quantity of black oil sticking to its sides. We pour the whole into a glass *cucurbite*, and having adapted a capital and a recipient to it, and luted exactly the joints, we distil, at a sand heat, three ounces and a dram of a very acid spirit, clear, agreeable to the taste, and without any smell.

This *spirit of sugar* is a very good aperitive against the gravel and dropsy; it is proper to stop diarrhæas and dysenterias; some believe it good for the diseases of the breast. The dose is from ten drops to an agreeable acidity. in some liquor appropriated to the distemper. What remains at the bottom of the *cucurbite* may be used to clean old ulcers.

**SPIRIT OF WINE**, is the oleaginous part of the *wine*, rarefied by acid salts, thus: We fill a large matrafs, with a long neck, half full of brandy, and having adapted a capital and a recipient to it, and luted exactly the junctures, we place it on a pot half full of water, to distil, at the vaporous bath, the spirit, which will be separated of its phlegm, and ascend pure; we continue that degree of fire till it has done distilling, and we have a *spirit of wine* divested of its phlegm, in the first distillation.

*Spirit of wine* serves as a dissolvent to several things in *Chymistry*; half a spoonful of it is given in the apoplexy and lethargy, to make the patient come to himself. It is a very good remedy for burns, if applied as soon as it is made; it is also very good for the palsy, contusions and other maladies where the pores are to be opened.

**SPIRIT OF WINE WITH TARTAR**, is a preparation of the spirit of *wine*, which has exalted a small portion of salt of tartar, in its separation from its phlegm. This preparation is made in the following manner:

A pound of tartar is put in a glass *cucurbite*, and four pounds of spirit of *wine* poured upon it; the vessel is placed in a *furnace*, on the sand, and covered with a capital, and a recipient adapted to it, the junctures having been exactly luted with a wet bladder; a graduate fire is made under it, and continued till about three parts of the *spirit of wine* are distilled; then the fire is put out, and the *spirit* kept in a bottle, well corked.

This *spirit* is more subtle than the common *spirit of wine*, but has the same virtues. The dose is from half a dram to two drams, in some liquor appropriated to the distemper.

**TARTAR**, *tartarus*, or *tartarum*, is a kind of salt which rises from wine, and sticking to the top and sides of the casks, forms a crust, which hardens to the consistence of a stone. *Tartar*, says an ingenious author, has the juice of the grape for its father, fermentation for its mother, and the cask for its matrix.

**CRYSTAL, OR CREAM OF TARTAR** is but the *tartar* purified of its most terrestrial particles, thus: we boil what quantity we please of *tartar* in water 'till it is melted, and strain the liquor hot, through a flannel, into an earthen vessel; and having caused about half the humidity to be evaporated on the fire, we carry the vessel to a cool place for two or three days; during that time little crystals are formed at the sides of the vessels, which we take out; and have again half of what is left of the humidity evaporated, carrying afterwards the vessel to a cool place, where will be formed crystals as before; we continue thus 'till we have extracted all our *tartar*, which we dry in the sun and keep for use.

The *cream*, or *crystal of tartar* is purgative and aperitive, proper for the dropfy, asthma, tertian and quartan ague. The dose is from half a dram to three drams, in broth, or some other liquor.

When the *crystal of tartar* is taken in a liquor, it must be boiled in that liquor, and the liquor drunk very hot, otherwise the *crystal of tartar* would precipitate to the bottom of the porringer.

The **FIXED SALT OF TARTAR**, and its liquor, called *oil per deliquium*, are prepared in the following manner: We break the retort which has served for the distillation of *tartar*, and take out the black mass found in it, which we calcine between the coals, 'till it be white: when white, we throw it into a great deal of water, and make a lixivium of it, which having filtrated into a glass or stone vessel, we cause afterwards all the humidity to be

evaporated at a sand-heat. There remains at the bottom of the vessel a white salt, which is called *alkali salt of tartar*.

This *salt* is aperitive, it is used to extract the tincture of vegetables, and given for obstructions. The dose is from ten grains to thirty, in broth, or in laxative infusions.

If this *salt* be exposed for some days in a flat glass or stone vessel, in the cellar, or some other damp place, it will resolve into a liquor, improperly called *oil of tartar per deliquium*.

This *oil of tartar* is used for the ring-worms, and to resolve tumours; ladies mix it with water of white lilies to wash their face and their hands.

The *extract of opium*, called **LAUDANUM**, is the only *chymical* preparation made of it. This preparation is the purest part of the *opium*, extracted by rain water and spirit of wine; and sometimes reduced in consistence of extract; thus: we slice four ounces of good *opium*, and put it into a matras: we pour upon it a quart of rain-water very well filtrated, and stop well the matras, which having placed on sand, we make a little fire under it at first, which we increase afterwards by degrees, to make the liquor boil for two hours: we percolate that liquor while hot, and pour it into a bottle. We take the *opium* left indissoluble in the rain-water, have it dried in a pan on a little fire, and put it afterwards in a matras, pouring upon it spirit of wine to the height of four fingers breadth: we stop the matras, and put the matter in digestion on hot embers for twelve hours, and percolate the liquor afterwards. We cause our two dissolutions of *opium*, viz. That with rain-water, and the other with spirit of wine, to be evaporated separately, in stone or glass vessels, at a sand-heat, to the consistence of honey: then mix them together, and have that mixture dried at a slow fire, to give it the consistence of pills.

There is no other difference between this solid *laudanum* and the liquid; but that in the liquid there is humidity enough left to render it fluid, that it may be kept in a bottle. Which is effected by mixing both impregnations together, without evaporation of the humidity.

The virtue of *opium* is, by calming the too great impetuosity of the spirits, to promote &c. p.

**EXTRACT OF ALICES**, is *aloes* depurated of the dross it contains, in the following manner: we melt eight ounces of *scorvine aloes* on the fire, in a sufficient quantity of juice of roses, or in a strong decoction of flowers of violet; we leave the dissolution to settle, for the space of six hours, and then decant it, filtrate it, and make the humidity evaporate gently, till the matter has acquired a consistence of extract, which we keep in a pot.

This

This is a very good remedy to purge the stomach, in fortifying it. The dose is from fifteen grains to a dram, in pills.

They seldom purge before the day following. They excite the piles, and the menses; because *aloes* rarefy the blood, by its fermentative salt, and pushes it, with impetuosity, out of the veins.

To prepare the OIL OF TOBACCO, we *Chymists* put eight ounces of good *tobacco* hach'd, into a glass *cucurbite*, and pour upon it about the same weight of phlegm of vitriol; we cover the *cucurbite* with its capital, and leave the matter in digestion, on a sand heat, for a whole day; then adapting a recipient to the vessel, we distil, by a slow fire, about five ounces of the liquor, which we keep in a vial.

This oil is a strong vomitive; it is very good for ringworms, and the itch, by anointing, gently the parts with it.

A drop or two of the *chymical* oil of tobacco, being put on the tongue of a cat, produces violent convulsions, and death itself, in the space of a minute; yet the same oil used on lint, and applied to the teeth, has been of service in the tooth-ach; though it must be to those who have been used to the taking of tobacco, otherwise great sickness, reachings, vomitings, &c. happen; and even in no case is the internal use of it warranted by ordinary practice.

The FINECTURE OF MYRRH, is a dissolution of the oily parts of the *myrrh* in spirit of wine, thus: we put what quantity we please of fine *myrrh*, pulverized, into a matras, and pour upon it spirit of wine, to the height of four fingers breadth; we stir well the matter, and put it in digestion, on a sand heat, for two or three days, or till the spirit of wine be loaded with the *tincture* of the *myrrh*: we pour then the liquor by inclination, and keep it in a vial, well corked.

*Tincture of myrrh* can be used to hasten delivery, promote the menses, for the palsy, apoplexy, lethargy, and all other maladies proceeding from the corruption of humours. It is sudorifick, and aperitive. The dose is from six drops to fifteen in some liquor appropriated to the distemper.

Let us now proceed to the *animal kingdom*, and shew what the *chymical art* can do with those principles for the health and uses of life. In these operations we will begin with the *Viper*, famed for its great use in medicine.

The first preparation made of the VIPER is the powder, which to make, *vipers* must be taken, while they are in their greatest vigour; the females full of eggs, or with young, are not so good as the others; having been skinned, gutted, and their heads cut off, they are put to dry from the sun, and

afterwards pulverized in a mortar: but as this powder is not easily kept, because worms get into it, a paste is made of it, with a sufficient quantity of gum tragacanth and troches, and small balls made of it, which must be pulverized, when wanted.

This powder is administered in the small pox, malignant fevers, and all maladies, where it is necessary to resist venom, and to purify the humours by transpiration. The dose is from eight grains to thirty in broth, or some other liquor appropriated to the distemper.

The heart and the liver are dried in the sun, pulverized together, and have the same virtues as the body of the *viper*; but the dose is a little less. This preparation is called *bezoar mineral*.

The gall of the *viper* is sudorifick. The dose is from one to two drops, in water of *carduus benedictus*.

The fat found in the entrails of the *viper*, is melted, then strained, to separate it from its membranes: it is clear as oil, and used in several countries for the small pox, and fevers. The dose is from one drop to six, in broth. It enters, likewise, in plaisters, and resolute unguents.

But we should prefer the DISTILLATION OF THE VIPER, which is a separation of the principles of the *viper*, viz. of its phlegm, volatile salt, and oil, from its terrestricity; which to perform, we put six dozen of *vipers*, dried from the sun, as above, into a stone or glass retort, which we lute, and place in a reverberatory furnace; we adapt a large recipient to it, and having luted exactly the junctures, begin the *distillation* by a little fire, to heat gently the retort, and to bring out a phlematick water: When we perceive that it has done dropping, we increase the fire by degrees, to bring out white clouds, the spirits which fill the recipient, and afterwards a black oil, and the volatile salt which sticks to the inside of the recipient: we continue the fire till nothing more comes out, after which, we leave the vessels to grow cold, and then unlute them; we shake, a little, the recipient, to loosen the volatile salt which sticks to the side, and pour all into a matras with a long neck, to which we adapt a capital, and a little recipient, luting exactly the junctures: we place our matras on the sand, and make under it a small fire, to sublimate the volatile salt, which will stick to the capital, and to the superior part of the matras; which salt we loosen, and keep in a vial well corked.

The volatile salt of *vipers* is one of the best remedies we have in medicine: It is good for malignant and intermitting fevers, the small pox, apoplexy, epilepsy, palsy, hysteric distempers, and for the bite of venomous beasts. The dose is from

six

fix to sixteen grains, in some liquor appropriated to the distemper.

We pour what remains in the matras into a funnel lined with gray paper; the spirit and the phlegm run through, but the stinking oil remains on the paper; which oil may be given to smell to women attacked with the hystericks, and serves also to anoint the parts in the palsy.

We pour the spirit and the phlegm, mixed confusedly together, into an alembick, and distill, at a vaporous bath, about half the liquor, which is the *spirit of viper*, and has the same virtues as the *salt*. The dose is from ten to thirty drops.

In the same manner may be extracted the *volatile salt of toads, hartshorn, ivory, blood, the cranium, hair,* and other parts of *animals*.

## C L O C K - M A K I N G .

**A** C L O C K is a machine composed of wheels, weights or springs, pendulums or ballances, for an equal horary division of time: which in some countries is measured by a graduation of twenty-four hours; but most commonly, as in *Britain*, by twelve hours.

This machine when it is wrought up into such a volume, as to be fit to carry in the pocket, changes its name, and is called a *WATCH*.

To both these are added several peculiarities both as to use and ornament.

The *Clock* has a bell, on which the number of the hour is struck by a hammer regulated by a particular part of the machine; and on which also the alarum is rung in small clocks, and the chimes in church and musical clocks. — But there is a kind of *clocks*, made for the use of coffee-houses and other public places of entertainment and conversation, called *Dials*, which give the hour and the minutes by proper indexes, but have no bell.

The *watch* is made exactly upon the same principle, as the *clock*. But a bell is no essential part of its composition, and is seldom used in watches for the pocket. Our fore-fathers made a watch with a bell that inclosed the works of the machine, which was thence called a *Cocket-clock*: but this kind was chiefly used by ladies at their sides; and has since been improved into those curious *striking and repeating watches* now so much esteemed by the fair-sex and gentlemen of fortune.

It must be allowed that the ancients had a machine which somewhat resembled a *clock*; as there is mention of such a one invented by *Boetius*, about the year of *CHRIST* 510. But that art was so far lost, that the *Germans* about 225 years ago, who revived it, claimed the honour of its invention. Nor was it till the last century that the use of pendulums was found out: an invention disputed between *Galileo* and *Huygens*.

The first *pendulum clock* made in *England* was in the year 1622, by *M. Fromental*, a *Dutchman*, according to *M. Huygen's* method, which prevailed

for several years; 'till afterwards *Mr. Clement* invented a new method, whereby the pendulum was to go with less, and to vibrate but a small compass, which is now the universal method of the royal pendulums: But *Dr. Hook* denies *Mr. Clement* to have invented this, and says that it was his invention, and that he caused a piece of this nature to be made, which he shewed before the Royal Society soon after the fire of *London*.

There is also a dispute between the partisans of *M. Huygens* and those of *Dr. Hook* for the invention of *pocket-watches*.

*Mr. Derham*, in his artificial *Clock-maker*, says roundly, that *Dr. Hook* was the inventor, and that he contrived various ways of regulation; one way was with a load-stone, another with a tender sprait spring, one end whereof played backward and forward with the ballance, so that the ballance was to spring as the bob of a pendulum, and the little spring as the rod thereof. A third method was with two ballances, of which there were divers sorts, some have a spiral spring to the ballance for a regulator, and others without. But the way that prevailed, and which continues in mode, was with one ballance, and one spring running round the upper part of the verge thereof. Though this has a disadvantage, which those with two springs were free from, in that a sudden jerk or confused shake will alter its vibrations, and put it in an unusual hurry.

The time of these inventions was about the year 1658, as appears, among other evidences, from an inscription on one of the double ballance watches presented to King *Charles II. viz. Rob. Hook, invent. 1658. T. Tompion, fecit, 1675*. The invention presently got reputation both at home and abroad; and two of them were sent for by the Dauphin of *France*.

After this *M. Huygens's* watch, with a spiral spring, got abroad, and made a great noise in *England*, as if the longitude could be found by it. One of these the Lord *Bruncker* sent for out of *France*, where *M. Huygens* had a patent for them. This

watch of *M. Huygens* agrees with that of *Dr. Hook*, in the application of the spring to the balance: Only *M. Huygens* had a longer spiral spring, and the pulses or beats were much slower. That wherein it differs is, 1. the verge has a pinion instead of pallets; and a contrate wheel runs therein, and drives it round more than one turn. 2. The pallets are on the arbor of the contrate-wheel. 3. Then follows the crown-wheel, &c. 4. The balance instead of turning scarce quite round, (as *Dr. Hook's*) does turn several rounds every vibration.

*Mr. Derham* says, that this watch of *M. Huygens's* is a very pretty and ingenious contrivance, but subject to some defects, *viz.* That when it stands still it will not vibrate, until it is set on vibrating: which though it be no defect in a pendulum clock, may be one in a pocket-watch, which is exposed to continual jogs. That it also somewhat varies in its vibrations, making sometimes longer, sometimes shorter turns, and so some slower, some quicker vibrations.

The repetition of watches was the invention of *Mr. Barlow*, a *Romish priest*, and first put in practice by him in large movements or *clocks*, about the year 1676. The contrivance immediately set the other artists to work, who soon contrived divers ways of effecting the same: but its application to pocket-watches was not known before King *James II's* reign, when the ingenious inventor above-mentioned, having directed *Mr. Tompion* to make a repeating watch, endeavoured with the Lord Chief Justice *Allebone*, and some others, to get a patent for it. The talk of a patent engaged *Mr. Quare* to resume the thought of a like contrivance which he had had in view some years before: He now effected it, and being pressed to endeavour to prevent *Mr. Barlow's* patent, a watch of each kind was produced before the King and council; upon trial of which the preference was given to *Mr. Quare's*. The difference between them was, that *Barlow's* was made to repeat by pushing in two pieces on each side the watch-box; one of which repeated the hour, and the other the quarter: whereas *Quare's* was made to repeat by a pin that stuck out near the pendant; which being thrust in (as now it is done by thrusting the pendant itself) repeated both the hour and quarter with the same thrust.

At present the variety of works introduced into clocks and watches, shews that this art is capable of great improvements for demonstration in the sciences, and for delightful recreations. For which we need only view the *Cometarium*, the *Microcosms*, and *Musical-clocks*, which fill every spectator with admiration, and every ear with pleasure.

The machine disposed, either in a large or narrow compass, is called *movement*. This *movement* is often divided into two parts, *viz.* the *watch-work*, which measures the time; and the *clock-work*, which strikes it.

There is no other difference between the watch-work of the movement of a *clock*, and that of the movement of a *pocket-watch*, but in the volume of the different members they are both equally composed of; and the rules to make both movements are the same, though not the materials; for the movement of a *clock* is made of iron, and that of a *watch* is made part of iron, and part of brass, *i. e.* that all the wheels are made of brass, and the spindles, or arbors of the wheels, the springs, &c. made of iron, and steel. There is also this difference between them, that the *movement* of a *clock* is placed within a frame, composed of several iron bars, disposed square-wise; and that of a *watch*, in a case, composed of two round brass plates, supported, and joined together, by four brass pillars.

In these machines the force required for action is by a *spring* or *weight*, and must be such as shall overcome the *vis inertiae* and friction of all the parts in motion: which in *watches* is very inconsiderable, but in *clocks* is much greater, and that in proportion as they are more compounded.

The manner that a *weight* acts upon the cylinder, about which the line or cord (to which it hangs) is wound, is easy to be understood by all: but the action of the spring coiled up within the cylindric barrel, or box of a *clock* or *watch*, is somewhat more nice and mysterious; and the manner how it acts upon the fusee always with an equal force, by means of the *chain*; and the proper figure of the *fusee*, for that purpose, is therefore, to be explained.

The *chain* being fixed at one end of the *fusee*, and at the other to the *barrel*; when the machine is winding up, the *fusee* is turned round, and of course the *barrel*; on the inside of which is fixed one end of the spring, the other end being fixed to an immoveable axis in the center. As the *barrel* moves round, it coils the spring several times about the axis, thereby increasing its elastic force to a proper degree: all this while the chain is drawn off the barrel upon the *fusee*, and then when the instrument is wound up, the *spring*, by its elastic force endeavouring constantly to unbend itself, acts upon the *barrel*, by carrying it round, by which the chain is drawn off from the *fusee*; and thus turns the *fusee*, and consequently the whole machinery.

Now, as the *spring* unbends itself by degrees, its elastic force, by which it affects the *fusee*, will gradually decrease; and therefore, unless there were

were some mechanical contrivance in the figure of the superficies of the *fusée*, to cause, that as the *spring* grows weak, the *chain* shall be removed farther from the center of the *fusée*, so that what is lost in the *spring's* elasticity, is gained in the length of the *lever*: were it not for this contrivance, the *spring's* force would always be unequal upon the *fusée*, and thus would turn the *fusée*, and consequently the whole machinery unequally. All which is remedied by the conical figure of the *fusée*. The *fusée* being acted upon, or put in motion, by an uniform force, the *great wheel*, which is fixed to it, is put into motion, and that drives the *pinion* of the *center-wheel*, which *center-wheel* drives the *pinion* of the *third wheel*, and this drives the *pinion* of the *contrate wheel*, and this the *pinion* of the *ballance-wheel*, which plies the two *pallets* on the axis of the *ballance*, and keeps the *ballance* in motion.

The *ballance* in a *watch* is instead of the *pendulum* in a *clock*, both serving to govern the motion of the whole machinery. To this *ballance* is fixed a small steel *spiral spring*, which regulates the motion thereof, and makes it equable: whence it has its name of *regulator*.

When the *watch* is wound up, the *chain* from the *spring* exerts a force upon the *fusée*, which gives motion to all the parts of the machine, in the following manner; as will be easy to understand, when the number of *teeth* in each *wheel*, and *leaves* in the *pinions*, which they drive, are specified, and these in modern *thirty-hour watches* are as follows:

	Teeth.	Leaves.
Great wheel	48	12
Center-wheel	54	6
Third wheel	48	6
Contrate wheel	48	6
Ballance-wheel	15	2 pallets.

Hence it is easy to conceive how often any one wheel moves round in the time of one revolution of that which drives it.

Thus the *great wheel* on the *fusée*, having *forty-eight teeth*, and driving the *center-wheel* by a *pinion* of *twelve*, must cause the *center-wheel* to move round four times in *one* turn of the *fusée*, and so for all the rest, as follows.

$$\begin{array}{l}
 12)48(4=\text{turns of the center} \\
 6)54(9=\text{turns of the third} \\
 6)48(8=\text{turns of the contrate} \\
 6)48(8=\text{turns of the ballance}
 \end{array}
 \left. \vphantom{\begin{array}{l} 12)48 \\ 6)54 \\ 6)48 \\ 6)48 \end{array}} \right\} \text{wheel}$$

Whence it follows, that the turns of each of these *wheels* respectively, in one turn of the *fusée*, will be had by multiplying those several quotients together successively as follows,

$$\begin{array}{r}
 1 \\
 4 \times 1 = 4 \\
 9 \times 4 \times 1 = 36 \\
 8 \times 9 \times 4 \times 1 = 288 \\
 8 \times 8 \times 9 \times 4 \times 1 = 2304
 \end{array}
 \left. \vphantom{\begin{array}{l} 1 \\ 4 \\ 36 \\ 288 \\ 2304 \end{array}} \right\} \text{Turns of the} \left. \vphantom{\begin{array}{l} 1 \\ 4 \\ 36 \\ 288 \\ 2304 \end{array}} \right\} \begin{array}{l} \text{fusée wheel.} \\ \text{center-wheel.} \\ \text{third wheel.} \\ \text{contrate wheel.} \\ \text{ballance wheel.} \end{array}$$

The several members of the watch part are,  
 1. The *ballance*, consisting of the rim, which is its circular part; and the verge, which is its spindle, to which belong the two pallets or levers that play in the teeth of the crown-wheel. 2. The *potence*, or *pottance*, which is the strong stud in pocket watches, whereon the lower pivot of the verge plays, and in the middle of which one pivot of the ballance-wheel plays; the bottom of the potence is called the *foot*, the middle part the *nose*, and the upper part the *shoulder*. 3. The *cock*, which is the piece covering the ballance. 4. The *regulator* or *pendulum spring*, which is the small spring in the new pocket watches, underneath the ballance. 5. The *pendulum*, whose parts are the *verge*, *pallets*, *cocks*, and the *bob*. 6. The *wheels*, which are the *crown-wheel* in pocket-pieces, and *swing-wheel* in *pendulums*, serving to drive the *ballance* or *pendulum*. 7. The *contrate-wheel*, which is that next the *crown-wheel*, &c. and whose teeth and hoop lie contrary to those of other wheels; whence the name. 8. The *great* or *first wheel*, which is that the *fusée*, &c. immediately drives: after which are the *second wheel*, *third wheel*, &c. 9. Lastly, between the frame and dial-plate, is the *pinion of report*, which is that fixed on the arbor of the *great wheel*, and serves to drive the *dial-wheel*, as that serves to carry the hand.

*Spring* or *pendulum* WATCHES, are pretty much upon the same principle with *pendulum-clocks*: whence their denomination. If a pendulum describing little arches of a circle makes vibrations of unequal lengths, in equal times, it is because it describes the greater with a greater velocity. For the same reason a spring put in motion, and making greater or less vibrations, as it is more or less stiff, and as it has a greater or less degree of motion given it, performs them nearly in equal times. Hence, as the vibrations of the pendulum had been applied to large *clocks* to rectify the inequality of their motions; so to correct the unequal motions of the ballance of *watches*, a spring is added, by the isochronism of whose vibrations the correction is to be effected.

The spring is usually wound into a spiral, that, in the little compass allotted it, it may be as long as possible, and may have strength enough not to be mastered and dragged about by the inequalities of the ballance it is to regulate. The vibrations of the two parts, *viz.* the spring and ballance, should

be of some length; only so adjusted, as that the spring, being more regular in the length of its vibrations than the ballance, may on occasion communicate its regularity thereto.

The *Astronomical WATCH* was invented by that great artist and philosopher, Mr. NEALE of LONDON, for solving several *Astronomical* problems. It has two glasses; that in the front covers a dial-plate, as in common watches; the other, on the back-side, covers a plate forming a segment of a globe, on which are drawn twenty-four meridian lines, with the names of so many countries, at  $15^\circ$  difference of longitude from each other (See *ibid.*) This plate makes an entire revolution in twenty-four hours; and, consequently, every country thereon passes by the sun, represented by A; round this plate, is a circle divided into 24 hours, also at rest; by means of which, when the moveable plate is made to correspond to the true time shewn by the hands on the common side, the time of day or night, at the several countries specified, is shewn by the hour-circle. Round the moveable plate, and between it and the circle of hours above described, moves a narrow circle, on which is engraved the moon's age; and over  $29\frac{1}{2}$  is placed an ivory ball, B, representing the moon: and at the right angles each way, are placed two pins, C and D, one eastward, and the other westward; by means of which, the time of the moon's rising, southing and setting, at those different places, is shewn in a very entertaining manner.

To find the *beats* of the *ballance* in all *watches* going, or in one turn of any wheel. Having found the number of *turns* which the *crown-wheel* makes in one turn of the wheel you seek for, those turns of the *crown-wheel* multiplied by its notches, give half of the number of beats in that one turn of the wheel. For, the *ballance* or *swing* has two strokes to every tooth of the *crown-wheel*, inasmuch as each of the two *pallets* hath its blow against each *tooth* of the *crown-wheel*; whence it is that a *pendulum*, that beats seconds, has in its *crown-wheel* only *thirty teeth*.

To explain this, suppose the numbers of a sixteen-hour *watch*, in which the pinion of report is 4, the dial-wheel 32, the great wheel 55, the pinion of the second wheel 5, &c. The number of the notches in the *crown-wheel* 17 being multiplied into 6336 (the product arising from the continual multiplication of the quotients 8, 9, 11, 8) gives 107712 for half the number of beats in one turn of the dial-wheel; for 8 times 17 is 136, which is half the number of beats in one turn of the centrate-wheel 40; and 9 times 136 is 1224, the half beats in one turn of the second wheel; and 11 times 1224, is 13464, the half beats in one turn

of the great wheel 55; and 8 times 13464 makes 107712. If you multiply this by the two pallets, that is double it, the product will be 215424, which is the number of beats in one turn of the dial-wheel, or twelve hours.

$$4)32(8$$

$$5)55(11$$

$$5)45)9$$

$$5)40(8$$

17

To know how many beats this watch has in an hour, divide the beats in twelve hours into twelve parts, and it gives 17952, the train of the watch, or beats in an hour. By the beats and turns of the fusee, the hours that any watch will go, may be found thus. As the beats of the ballance in an hour are to the beats in one turn of the fusee: so is the number of the turns of the fusee: to the continuance of the watch's going. Thus 20196: 26928 :: 12: 16.

To find the beats of the ballance in an hour, the proportion is, as the hours of the watch's going, to the number of the fusee :: so are the beats in one turn of the fusee: to the beats in an hour. Thus, 16: 12 :: 26928: 20196.

All that has been hitherto said, shews only the *minutes* of an *hour*, and *seconds*, or *quarter seconds* of a *minute*; for nothing has been yet mentioned relating to the mechanism for shewing the *hour* of the *day*. This part of the work lies concealed from sight, between the *upper plate* of the watch-frame and the *dial-plate*. In this work, ABC (See the Plate of MECHANIC ARTS, *Glock-work*, No. 1.) is the uppermost side of the *frame-plate*: as it appears when detached from the *dial-plate*: the middle of this plate is perforated with a hole, receiving that end of the *arbor* of the *center-wheel*, which carries the *minute-hand*; near the plate is fixed a pinion *ab* of ten teeth: this is called the pinion of report; it drives a wheel *cd* of forty teeth; this wheel *cd* carries a pinion *ef* of twelve teeth; and this drives a wheel *gh* with *thirty-six* teeth.

As in the body of the *watch* the *wheels* every where divide the *pinions*, here, on the contrary, the *pinions* divide the *wheels*, and by that means decrease the motion, which is here necessary: for the hour-hand, which is carried on a socket fixed on the wheel *gh*, is required to move but once round, while the pinion *ab* moves twelve times round. To this end the motion of the wheel *cd* is  $\frac{1}{4}$  of the pinion *ab*: again, while the wheel *cd*, or the pinion *ef* goes once round, it turns the wheel *gh*

but

but  $\frac{1}{3}$  part round; consequently the motion of  $g b$  is but  $\frac{1}{3}$  of  $\frac{1}{4}$  of the motion of  $a b$ ; but  $\frac{1}{3}$  of  $\frac{1}{4} = \frac{1}{12}$ , that is, the *hour-wheel*  $g b$  moves once round in the time that the pinion of *report*, on the *arbor* of the *center* or *minute-wheel*, makes twelve revolutions, as required.

Having thus shewn the nature and mechanism of a *watch*, the structure of that part of a *clock* which is concerned in the shewing of the time, will easily be understood.

The mechanism of a *clock* consists of two parts, one to shew time, the other to report it, by striking the hour upon a bell. Each part is actuated or moved by *weights*, as in common clocks; or by *springs* included in boxes or barrels, as that represented by A. (*ibid* No. 2.) This cylinder moves the fusee B, and the great wheel C (to which is fixed) by the line or cord that goes round each, and answers to the chain of the watch.

The method of calculating is here much the same as before: for, suppose the great wheel C goes round once in twelve hours, then if it be a royal pendulum-clock, swinging seconds, we have  $60 \times 60 \times 12 = 43200$  seconds or beats, in one turn of the great wheel. But because there are 60 swings or seconds in one minute, and the seconds are shewn by an index on the end of the arbor of the swing wheel, which in those clocks is in an horizontal position; therefore, it is necessary that the swing wheel should have thirty teeth, whence  $60)432000(=720$  the number to be broken into quotients for finding the number of teeth for the other wheels and pinions, as before.

In *spring-clocks*, the disposition of the wheels in the *watch-part* is such as is here represented in the figure, where the swing wheel F is in an horizontal position, the seconds not being shewn there by an index, as is done by the large *pendulum clocks*. Whence in these clocks, the wheels are disposed in a different manner, as represented in No. 3. *ibid*. where C is the great wheel, D the center or minute wheel, both as before; but the contrate wheel E is placed on one side, and F the swing wheel is placed with its center in the same perpendicular line G H, with the minute wheel, and with its plane perpendicular to the horizon, as are all the others. Thus the minute and hour-hands turn on the end of the arbor of the minute-wheel at  $a$ , and the second hand on the arbor of the swing-wheel at  $b$ .

With regard to the machinery of the striking part of a *clock*, is to be observed that, as in the *watch* part, the prinium mobile is a large spring, in the spring-barrel G, (*ibid*. No. 2.) but in long *pendulums*, it is a weight. Thus, by its cord and fusee, it moves the great wheel H; that gives mo-

tion to the pin-wheel I; that continues it to the detent or hoop-wheel K, and that to the warning-wheel L, which at last is spent on the flying pinion Q; this carries the fly or fan; and by its great velocity it meets with much resistance from the air it strikes, and by this means bridle the rapidity of the *clock's* motion, and renders it equable. All these wheels are quiescent, unless when at the beginning of each hour, the detent O is lifted up, by which means the work is unlocked, and the whole put into motion, by means of the spring in the box G. During this motion the pins  $e, e, e, e$ , of the pin-wheel I, take the tail of the hammer T, and carrying it upwards, removes the head of the hammer S from the bell R; then being let go by the pin, it is made by a strong spring to give a forcible stroke upon the bell, and this is reported as often as the hour requires, by means of a contrivance in another part. This consists of moveable wheels and several leaves and other parts which cannot be understood by a bare description, or even a representation in a draught, so well as any person may have an idea of by taking off the face or dial-plate of a late made eight day clock.

Perhaps we want our *clock* to strike the *quarters*, which are generally a distinct part from that, which strikes the hour. In this case, the *striking-wheel* may be the *first, second, &c. wheel*, according to our *clock's* continuance; unto which *wheel* we may fix the *pinion of the report*. The *locking-wheel* must be divided into 4, 8, or more equal parts, so as to strike the *quarter*, and lock at the first notch; the *half hour*, and lock at the second notch, &c. and in doing this, we may make it to chime the *quarters*, or strike them upon two bells, or more.

It is usual for the *pin-wheel*, or the *locking wheel*, to unlock the hour part in these *clocks*, which is easily done by some cog, or latch, at the end of the last *quarter*, to lift up the *detents* of the hour part.

If we would have our *clock* strike the *hour* at the *half hour*, as well as the *whole hour*, we must make the *locking wheel* of the *hour* part double, *i. e.* it must have two notches of a fort, to strike 1, 2, 3, 4, twice a-piece.

To calculate numbers for CHIMES, and to fit and divide the *chime-barrel*, it must be observed, that the *barrel* must be as long in turning round, as we are in singing the tune it is to play.

As for the *chime-barrel*, it may be made up of certain bars, which run athwart it, with a convenient number of holes punched in them, to put in the pins that are to draw each hammer; by this means, the tune may be changed, without changing the *barrel*. In this case, the pins, or nuts, which

which draw the hammers, must hang down from the bar, some more, some less, and some standing upright in the bar; the reason whereof is, to play the time of the tune rightly: for the distance of each of these bars may be a semibreve; but the usual way is to have the pins which draw the hammers fixed on the *barrel*.

For the placing of these pins, we may proceed by the way of changes on bells, *viz.* 1, 2, 3, 4, &c. or rather make use of the musical notes; where it must be observed, what is the compass of the tune, or how many notes, or bells, there are from the highest to the lowest; and, accordingly, the *barrel* must be divided from end to end. Thus if the tune be of eight notes compass, the *barrel* is accordingly divided into eight parts; these divisions are struck round the *barrel*, opposite to which are the hammer-tails.

We speak here as if there was only one hammer to each bell, that it may be more clearly apprehended; but when two notes of the same sound come together in a tune, there must be two hammers to that bell, to strike it: so that if in all the tunes we intend to *chime*, of eight notes compass, there should happen to be such double notes on every bell, instead of eight, we must have sixteen hammers; and according we must divide our *barrel*, and strike sixteen strokes round it, opposite to each hammer-tail; then we are to divide it round about into as many divisions as there are musical bars, semibreves, minims, &c. in our tune.

Thus the hundredth psalm tune has twenty semibreves, and each division of it is a semibreve; the first note of it is also a semibreve, and therefore on the *chime-barrel* must be a whole division, from five to five.

Indeed, if the *chimes* are to be compleat, we ought to have a set of bells to the gamut notes, so that each bell having the true sound of *sol, la, mi, fa, &c.* we may play any tune, with its flats and sharps; nay, we may, by this means, play both the bass and treble with one *barrel*; and by setting the names of our bells at the head of any tune, that tune may easily be transferred to the *chime-barrel*, without any skill in music: but it must be observed, that each line in the music is three notes distant, that is, there is a note between each line, as well as upon it.

To conclude this treatise of *Clock-making*, we will set down here numbers ready calculated for several movements, for the benefit of those who are unacquainted with the art of calculation.

NUMBERS of an eight DAY-CLOCK, with sixteen turns of the barrel, the pendulum to vibrate seconds, shew minutes, seconds, &c.

<i>The Watch-Part.</i>
8)96
8)60—48)48—6)72
7)56
30

<i>The Clock-Part.</i>
8)78
6)48.8 Pins
6)48

In the *watch-part* the wheel 60 is the minute-wheel, placed in the middle of the *clock*, that its spindle may go through the middle of the dial-plate, to carry the minute-hand. Also, on this spindle is a wheel 48, which drives another wheel of 48, which last has a pinion 6, which drives round the wheel 72 in 12 hours. There are two things to be observed here: 1. That the two wheels 48, are of no other use than to set the pinion 6 at a convenient distance from the minute-wheel, to drive the wheel 72, which is concentrical with the minute-wheel. For a pinion 6 driving a wheel 72, would be sufficient, if the minute-hand had two different centers. 2. These numbers 60—48)48—6)72, set thus, must be read thus, *viz.* the wheel 60 has another wheel 48 on the same spindle, which wheel 48 turns round another wheel 48, which has a pinion 6 concentrical with it; which pinion drives a wheel of 72. For a line parting two numbers, (as 60—48) denotes those two numbers to be concentrical, or to be placed upon the same spindle; and when two numbers have a hook between them, (as 48)48) it signifies one to run in the other.

In the *striking-part* there are 8 pins on the second wheel 48; the count-wheel may be fixed to the great-wheel, which goes round once in 12 hours.

Numbers of a *clock* of 32 days, with 16, or 12 turns both parts; the *watch* shewing hours, minutes, and seconds; and the *pendulum* vibrating seconds.

<i>The Watch-Part.</i>	
With 16 Turns.	With 12 Turns.
16)96	12)96
9)72	9)72
8)60—48)48—6)72	8)60—48)48—6)72
7)56	7)56
30	30

Or thus, with 16 Turns.

12)72
8)64
8)60
7)56
30

The Striking Part.

With 16 Turns. 10)130 8)96 { 24 Pins { 12)39 6)72 double hoop. 6)60	With 12 Turns. 8)128 8)104 { 26 Pins. { 8)24 8)96 double hoop. 8)80
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The pinion of report is fixed on the end of the arbor of the pin-wheel : this pinion in the first is 12, the count-wheel 39 ; thus, 12)39, or it may be 8)26 : in the latter (with 12 turns) it may be 6)18, or 8)24.

Numbers of a two-month clock, of 64 days, with 16 turns; the pendulum vibrates, seconds, and shews minutes, seconds, &c.

Watch Part. 9)90 8)79 8)60—48)48—6)72 7)56 <hr/> 30	Clock-Part. 10)80 10)65 9)54 { 12 Pins. { 8)52 5)60 double hoop. 5)50
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Here the third wheel is the *pin-wheel*, which also carries the pinion of report 8, driving the count-wheel 52.

Or, Thus :

Watch-Part. 8)80 8)76 8)60—48)48—6)72 7)56 <hr/> 30	Clock-Part. 6)144 6)78 { 26 Pins. { 8)24 6)72 double hoop. 6)60
--	--

Numbers for a clock of thirteen weeks, with pendulum, turns, and motions, as before.

Watch-Part. 8)96 8)88 8)60—48)48—6)72 7)56 <hr/> 30	Or, Thus : 6)72 6)60 6)48—48)48—6)72 6)45 <hr/> 30
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Clock-Part. 8)72 8)64—37)30 8)48—12 Pins 6)48 double hoop 5)40	Or, Thus : 5)145 6)90 { —30 Pins { —24)62 6)72 6)60
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Numbers for a seventh-month clock, with turns, pendulum and motions.

The Watch. 8)60 8)56 8)48 6)45—48)48—6)72 5)40 <hr/> 30	The Clock. 8)96 8)88—27)12 8)64—16 Pins 6)48 double hoops. 6)48
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Numbers for a year clock of 384 days, with turns, pendulum, and motions.

The Watch. 12)108 9)72 8)64 8)60—48)48—6)72 7)56 <hr/> 30	The Clock. 10)120 8)96—36)9 6)78—26 Pins 6)72 double hoop. 6)60
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If we will rather have the pinion of report on the spindle of the pin-wheel, it must be 13)39.

Numbers for a clock of 30 hours, the pendulum about 6 inches.

The Watch. 12)8 <hr/> 6)78 6)60 6)42 <hr/> 15	The Clock. 8)48 <hr/> 6)78—13 Pins 6)60 6)48
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Numbers for an eight-day clock with 16 turns, pendulum, about 6 inches, to shew minutes, seconds, &c.

The Watch. 8)96 8)64—48)48—6)72 8)60 8)40 <hr/> 15
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The clock may be the same with the eight-day piece.

All the heretofore described numbers are for large pieces, but the following ones are for pocket-watches.

Numbers

Numbers for a watch to go 8 days, with 12 turns, to shew minutes and seconds, the train 1600.

Note, That the train of a watch is the number of beats, which a watch makes in an hour, or any other certain time.

$$\begin{array}{r} 6)96 \\ 6)48-12)48-12)36 \\ 6)45 \\ 6)42 \\ \hline \end{array}$$

19

On the wheel 42 is the second's hand placed, and on the wheel 48 the minute hand.

Numbers of another such a watch without minutes and seconds, to go with only 8 turns

$$\begin{array}{r} 20)10 \\ \hline 6)66 \\ 6)60 \\ 5)50 \\ 5)45 \\ \hline \end{array}$$

19

Numbers of a pocket watch of 32 hours with 8 turns, to shew minutes and seconds, train as the last.

$$\begin{array}{r} 12)48 \\ 6)48-12)48-12)36 \\ 6)45-Second's\ hand. \\ \hline \end{array}$$

19

If this crown wheel be too large, the following numbers may be used.

$$\begin{array}{r} 12)48 \\ 6)48 \\ 6)45 \\ 6)48\ Second's\ hand. \\ \hline \end{array}$$

15

The usual numbers of 30 hours pendulum watches with 8 turns, to shew the hour and minute.

$$\begin{array}{r} 12)48 \\ 6)54-12)48-12)36 \\ 6)48 \\ 6)45 \\ \hline \end{array}$$

15

## C O I N I N G.

THE *era* of the invention of money is not easy to be determined; the first tidings we hear of it is in the time of *Abraham*, who paid 400 shekels for a burying-place. The *Greeks* refer the invention of money to *Hermodice*, wife of king *Midas*; and the *Latins* to *Janus*. Money being a common measure for reducing wares to a ballance, it was called by the *Greeks* *Nomisma*, not from king *Numa*, but from *Nomos*, as being established by law. By the *Latins* it was called *Pecunia*, either because the wealth of those days consisted in their cattle; or, as *Pliny* will have it, because their first coin was stamped with the figure of a cow. They also call it *Moneta*, à *monendo*, as *Suidas* observes; because when the *Romans* were in want of money, *Juno* admonished them to use justice, and there should be no want of money. The effect whereof, when they had found, she was surnamed *Juno moneta*, and money was coined in her temple.

Copper is that money thought to have been first coined; afterwards silver, and, lastly, gold.

Among the ancient *Britons*, iron rings, or, as some say, iron plates, were used for money; among the *Lacedemonians*, iron bars quenched with vinegar, that they might not serve for any other use.

*Seneca* observes, that there was anciently stamped money of leather, which was also practised during the *barons* wars in *England*, and by *Frederick II.* at the siege of *Milan*. In 1574, the *Hollanders* coined great quantities of pasteboard, reduced to it by necessity; for they had not, then, those tons of gold they have reckoned by since. *Numa Pompilius* made money of wood and leather, neither does it appear that the *Romans* were much acquainted with the art of *coining* in metal, during the time of their kings. The first silver money they coined was in the year of *Rome* 484, and their first gold money in 546.

Some authors pretend, on the contrary, that the first moneys were of metals, and that it was natural for men to have recourse to them, as being almost the only things whose goodnes, and, as it were, integrity, is not diminished by partition, besides their firmness, neatness, cleanliness, durableness, universality, and the conveniences of melting and returning them again into a mass of any size, or weight. That it was this property of metals which first accustomed people, who trafficked together, to account them in lieu of quantities of other merchandizes in their exchanges; and at length to substitute them wholly in their stead. That they would

would not say, that in the first ages, money, or coins of metal, had any determinate form, or shape; that, on the contrary, they are of opinion, that each person could cut his metal into what forms and sizes he pleased, according to the quantity he thought he could give, or according to the demand of the seller, or the quantity stipulated between them; that by degrees it was found more commodious to have pieces ready weighed, and as there were different weights required, according to the value of the different wares, all those of the same weight began to be distinguished with the same mark, or figure; that at length the growing commerce of money beginning to be disturbed by frauds, both in the weight and the matter, the public authority interposed, and hence the first stamp, or impression, on money; to which succeeded the names of the monies, and at length the effigy of the prince, the date, legend, and other precautions, to prevent the alterations of the species; and that thus were coins completed, and a right form given to money: which form has much varied, as to the weight, figure, impression, and value.

It is believed by several, that the *Jews* were the first who made any impression on money; it is true, that we find shekels, in the cabinets of antiquaries, one side whereof is stamped with the golden pot, which contained the manna, and the other with *Aaron's* rod; but we do not know precisely the time when those shekels were stamped: though we have all the reason imaginable to suppose that the shekel was their first coin, which had been perpetuated among them ever since *Abraham*, and, consequently, that they were the first nation who made use of a regular coin. Besides the shekel, they had, in process of time, several other coins, both of gold and silver.

The silver coins were, the *gerah*, *bekah*, *shekel*, *maneh*, or *mina hebraica*, and *talent*. Ten *gerahs* made a *bekah*; twenty *gerahs* made two *bekahs*; and two *bekahs* a *shekel*: Twelve hundred *gerahs* made an hundred and twenty *bekahs*; an hundred and twenty *bekahs* fifty *shekels*; fifty *shekels* a *maneh*, or *mina hebraica*. Sixty thousand *gerahs* made six thousand *bekahs*; six thousand *bekahs* made three thousand *shekels*; three thousand *shekels* sixty *manehs*; and sixty *manehs* a *talent* of silver.

The *Dardans* stamped on their money two cocks fighting; the king of *Macedon*, a horse; the *Athenians*, an owl, or an ox: whence the proverb, on bribed lawyers, *Bos in lingua*. They of *Ægina*, a tortoise; whence that other proverb, *Virtutem & sapientiam vincunt testuæines*.

The current money of the *Greeks* were of three sorts of metals, *viz.* of copper, silver, and gold.

The copper money were the *lepton*, *chalcus*, *dichalcus*, *hemiobolium*, *obolus*, *diabolus*, and *tetrobolum*. That of silver were, the *drachma*, *didrachmon*, *tetradrachmon*, *stater*, and *pentadrachmon*. And that of gold, the *stater aureus*, *stater Cyzicenus*, *stater Philippicus*, *Alexandrinus*, *Daricus*, and *Cræsius*.

Among the *Romans* the *Monetarii* sometimes impressed on the coins the images of men that had been eminent in their families; but no living man's head was ever stamped on a *Roman* coin till after the fall of the commonwealth; from that time they bore the emperor's head on one side, and hence the practice of stamping the prince's image on coins has obtained.

The *Romans* had, likewise, money of copper, silver, and of gold. The copper money were the *teruncius*, *femilibella*, *libella*, and *as*; sometimes *triens*, *sextans*, *uncia*, *sextula*, and *dupondius*. The silver money were, the *sestertius*, *quinarius*, *victoriatius*, and *denarius*. And the gold coin was the *aureus*.

*Chamberlayn*, and others, say, that it was the *Romans* who brought first the use of gold, silver, and brass coin, into *Great-Britain*, when *Julius Cæsar* invaded the island; that soon after the *Britons* imitated them, *coining* both gold and silver with the images of their kings stamped on them. When the *Romans* had subdued the kings of the *Britons*, they also suppressed their coins, and brought in their own, which were current here from the time of *Claudius* to that of *Valentinian the younger*, about the space of 500 years. *Cambden* observes, that the most ancient *English* coin he had known, was that of *Ethelbert*, king of *Kent*, the first *Christian* king in the island, in whose time all money accounts began to pass by the names of pounds, shillings, pence, and mancus.

*Pence* seems borrowed from the *Latin* *pecunia*, or rather from *penco*, on account of its just weight, which was about three pence of the present money; these were coarsly stamped with the kings image on one side, and either the mint-master's, or the city's where it was *coined*, on the other. Five of these pence made their scilling, probably so called from *Scillingus*, which the *Romans* used for the fourth part of an ounce. Forty of these scillings made their pound, and 400 of these pounds were a legacy, or a portion for a king's daughter; as appears by the last will of king *Alfred*. By these names they translated all sums of money in their old *English* testaments, talents by pounds; *Judas's* 30 pieces of silver, by *thirty scillinga*; tribute money, by *Pennining*; the mite, by *furthling*. But it must be observed, that they had no other real money but pence only, the rest being imaginary moneys, *i. e.* names of numbers, or weights. Thirty of these

pence made a *mancus*, which some take to be the same with a mark; *manca*, as appears by an old manuscript, was *quinta pars unciæ*. These *manca's*, or *mancus's* were reckoned both in gold and silver; for in the year 680, we read, that *Ina*, king of the west Saxons, obliged the *Kentish* men to buy their peace at the price of 30000 *manca's* of gold. In the notes on king *Canute's* laws, we find this distinction, that *mancusa* was as much as a mark of silver; and *manca* a square piece of gold, valued at thirty pence.

The *Danes* introduced a way of reckoning money by ORES, *per oras*, mentioned in *Doomsday-book*; but whether they were several coins, or a certain sum, does not plainly appear. This, however, may be gathered from the *abbey-book* of *Burton*, that 20 *ores* were equivalent to two marks. They had also a gold coin called *bizantine*, or *bezant*, as being coined at *Constantinople*, then called *Byzantium*; the value of which coin is not only now lost, but was so entirely forgot, even in the time of king *Edward III.* that whereas the bishop of *Norwich* was fined a *bizantine* of gold, to be paid the abbot of *St. Edmund's-Bury*, for infringing his liberties, (as it had been enacted by parliament in the time of the *Conqueror*) no man then living could tell how much it was; so it was referred to the king to rate how much he should pay; which is the more unaccountable, because but an hundred years before, two hundred thousand *besants* were exacted by the foldan of *Egypt* for the ransom of *St. Louis*, king of *France*, which were then valued at one hundred thousand *livres*.

Though the coining of money be a special prerogative of the king, yet the ancient *Saxon* princes communicated it to their subjects; insomuch, that in every good town there was at least one mint, but at *London* eight, at *Canterbury* four for the king, two for the archbishop, one for the abbot at *Winchester*, six at *Rocheſter*, at *Hastings* two, &c.

The *Norman* kings continued the same custom of coining only pence, with the king's image on one side, and on the other the name of the city where it was coined, with a cross so deeply impressed, that it might be easily parted, and broken into two halves, which so broken, they called half-pence; or into four parts, which they called *fourthings*, or *farthings*.

They who desire a particular account of the variation of the *English* coin, both as to its intrinsic value and form, will find it at large in bishop *FLEETWOOD's Chronicle. Preciosum*, and the historical account of *English* Coins by *STEPHEN MARTIN LEAKE*, esq; *Garter, king at arms*.

The present current coins in *England*, are of gold, silver, and copper. The gold coins are, the

guinea and half guinea; the silver are, the crown, half crown, shilling, and sixpence; the copper are, the halfpenny, and farthing.

Two farthings make a halfpenny; 48 farthings, or 24 halfpence, make a shilling; 120 farthings, or 60 halfpence, or  $2\frac{1}{2}$  shillings, make half a crown; 240 farthings, or 120 halfpence, or 5 shillings, or 2 half crowns, make a crown; 960 farthings, or 480 halfpence, or 20 shillings, or 8 half crowns, or 4 crowns, make a pound sterling; 1008 farthings, or 504 halfpence, or 21 shillings, or 8 half crowns  $\frac{1}{2}$  and  $\frac{1}{4}$ , or 4 crowns and  $\frac{1}{2}$ , or 1 pound and  $\frac{1}{8}$ , make a guinea.

In *Scotland*, by the articles of the Union, it is appointed, that all coins be reduced to the *English*, and the same accounts observed throughout; till then, the *Scots* had their pounds, shillings, and pence, as in *England*; but their pound was but 20 pence *English*, and the others in proportion. Accordingly, their mark was 13 $\frac{1}{2}$ s. *Scotch*, current in *England* at 13 $\frac{1}{2}$ d. their noble in proportion Besides these, they had their turner pence and halfpence, their penny  $\frac{1}{2}$  of that of *England*; besides base money of achisons, babees, and placks; the bodle,  $\frac{1}{2}$  of the penny,  $\frac{1}{4}$  of the achison,  $\frac{1}{3}$  of the babee, and  $\frac{1}{2}$  of the plack.

In *Ireland*, the coins are as in *England*, viz. shillings, pence, &c. with this difference, that their shilling, or harper, is but equal to 9 pence *sterling*; whence their pound is only  $\frac{3}{4}$  of the *English* pound, or 15s.

The art of making of this money is called COINING; in which act there are two things necessary;

The metals to be coined, and the instruments they are coined with.

The metals most commonly coined, are gold, silver, and copper, though in some countries of *Europe*, besides these three metals, they coin bullion, as in *France*, *Holland*, and the low-countries.

The instruments, or rather utensils for coining are, 1. *Furnaces* for the melting of metals, of which there are two kinds, viz. those with wind, and those with bellows. The *wind-furnace* (thus called, because the air entering through the vent-hole at bottom, which is always open, serves the same purpose as bellows in other furnaces) has a bottom, a hearth, made hollow in manner of a cupel, with a vent-hole in the fore-part thereof; over the vent-hole is a grate sealed in the massive of the furnace; and over the grate is the place for the crucible *Furnace with bellows* consists of a flat hearth at bottom, into which the air is admitted by a hole contrived therein. On a level with the hearth

hearth is a second aperture. which gives passage to the pipe of the bellows, from which the *furnace* is denominated. About a foot over this is a moveable grate, which may be taken off and put on at pleasure. Over this is the place where the crucible is set, which is square, and made of the same earth with the crucible; of breadth sufficient to bear a range of coals around the crucible. Gold is usually melted in this kind of *furnaces*, as requiring an intenser heat before it fuses; and silver and copper are commonly melted by the *wind-furnace*.

2. *Earthen crucible* for the melting of gold; and *pots or crucibles of iron* for silver or copper.

3. *Moulds or frames* for casting the metals into long flat-bars.

4. *Models or patterns*, which are flat plates of copper, about fifteen inches long, and nearly of the thickness of the species to be struck.

5. A *mill* to prepare the laminæ or plates of metal, and to give them the proper thickness, hardness, and consistence, before they be struck or stamped. This machine consists of several wheels dented like those of a clock, &c. which moves two cylinders of steel, between which the metal is passed to be brought to its proper thickness. It was formerly turned with water, since with horses.

6. A *cutting instrument* fastened to the lower extremity of an arbor, whose upper end is formed into a screw, which being turned by an iron handle turns the arbor, and lets the steel, well sharpened in form of a punch-cutter, fall on the plate, and thus is a piece punched out.

7. *Files or rasps* to bring the pieces, by filing or rasping, to the weight of the standard, whereby they are to be regulated.

8. *Scales* to adjust the pieces, and to separate those which prove too light from those which are too heavy.

9. *Two copper vessels*, wherein the blanks are blanched or whitened.

10. A *machine*, consisting of two plates of steel, in form of rulers, about the thickness of a line, on which the legend or edging is engraven, half on the one and half on the other, to mark the edges of the planchets, or pieces to be stamped, to prevent the clipping or paring of the species.

11. The *punchions or dyes*, which are pieces of good steel of a cubick form, wherein are engraven the prince's effigies, with the arms, legend, &c. They are also called *matrices*, because in the cavities or indentures thereof the coins seem formed or generated, as animals are in the matrix of their mother. See PLATE I. of MECHANIC ARTS.

12. A *mill or press*, by the *French* called a *balancier*, whose chief parts are a beam, screw, arbor,

&c. all contained in the body of the machine, except the first, which is a long iron bar, with a heavy ball of lead at each end, and rings, to which are fastened cords, which give it motion; it is placed horizontally over the body of the machine.

In the middle of the beam is fastened a screw, which, by turning the beam, serves to press the arbor underneath it; to the lower extremity of which arbor, placed perpendicularly, is fastened the dye or matrice, of the reverse or arms side, in a kind of box, or case, containing the dye of the image side, firmly fastened to the lower part of the engine.

This machine was invented by a *Frenchman*, called *Antoine Brucher*, in 1553, and first tried at the *Louvre*, the king of *France's* palace at *Paris*, for the *coining* of counters; before this invention, *coining* was performed by the hammer, which could never strike the species with that neatness and perfection the *balancier*, or mill, does.

Having thus provided ourselves with all the necessary implements for *coining*, we'll begin by mixing and melting our metal, for the *coining* of guineas, or *louis d'ors*, or *Spanish* pistoles, or what gold species you please; we mix the metal, because there are no species *coined* of pure gold, or silver, but always a quantity of alloy of copper is mixed with them: the reasons are, partly the scarcity of those two metals, partly the necessity of making them harder by some foreign mixture, and partly to defray the expences of *coining*.

There are two kinds of alloying, or mixing; the first where the gold or silver has not been used for money before; the other, where several kinds of species, or ingots of different standards, and values, are to be melted down into a new money. The proportioning of the alloy with the fine metal, is easy in the first case, in the other more difficult; though *M. Boisard* has given us a ready and easy method of doing it, by advising us to write down the several matters to be melted, their quality, weight, and fineness, in two distinct articles; the one containing those above the standard; the other those under it. He says, that by casting up the first, we shall have the excess; and, by the latter, the defect: and by comparing the two sums, afterwards, we shall find, by subtraction, how much alloy must be added, to bring the several matters to the fineness required. We have followed this method, and mixed our metal accordingly, *i. e.* two carats of silver and copper (which is the alloy for gold) with a pound *troy* of gold, to bring our species to the *English* standard.

We put our metal, thus mixed, in an earthen crucible, place our crucible on a little plate of forged iron, which we have before took care to lay over the grate of our bellows-furnace; we cover our crucible with an iron or earthen lid, then fill the furnace with charcoal, and when it is well lighted, and the crucible sufficiently hot, we stop the vent-hole, and throwing on fresh coals, stop the furnace with an iron lid, thus continuing to work the bellows, and supply fresh fuel till the metal being in *balance*, i. e. entirely melted, we stir it with a stirrer of baked earth; then take our crucible off the fire, with a kind of tongs, and pour the metal into our moulds, which we have had the precaution to range near the furnace, to be in readiness to receive it, as it comes out of the crucible.

We take our bars, or plates, out of the mould, when cold, and after we have scraped and brushed them, we heat them again in a furnace, and quench them in water, to soften, and render them more ductile; then pass them several times through the mill, to flatten them further, and bring them to the just thickness of the species to be coined.

These plates, thus reduced, as near as possible, to their thickness, are cut, with our cutting instrument, into round pieces, called *blanks*, or *planchets*, near the size of the intended species; these pieces are given to be adjusted, and brought, by filing, or rasping, to the weight of the standard whereby they are to be regulated, saving what remains of the plate between the circles of the instrument, to be melted again.

To know if the pieces thus prepared are brought at last to the weight of the standard, they are weighed in a balance, and those too light separated from those too heavy; those too light are melted again, and those too heavy filed down: this difference in the weight, proceeds either from that the mill through which the plates have passed to be flattened, can never be so just, but there will be some inequality, whence will arise a difference in the *blanks*, as from the inequality of the matter, some parts being more porous than others.

When the *blanks*, or *planchets*, are exactly brought to the standard, they are sent to the blanching, or whitening house, to be coloured, which is done by heating them in a furnace; and when taken out, and cool, boiling them successively in two copper vessels, with water, common salt, and tartar; when they are of the colour intended, they are taken out of the boiler, and put in a copper sieve; then scoured well with sand, washed with common water, and dried over a wood fire, in the same copper sieve they were put in when taken out of the boilers.

When dry, they are sent to be edged, which is performed by means of those two plates of steel in form of rulers, abovementioned, one whereof is immoveable, and strongly bound with screws to a copper plate, and that again to a strong board, or table; the other is moveable, and slides on the copper plate, by means of a handle, and a wheel or pinion of iron, the teeth whereof catch in a kind of other teeth, on the surface of a sliding plate. The *planchet*, or piece of plate, is placed horizontally between these two plates, and by that time it has made half a turn, it is found marked all round.

The *planchets*, thus edged, are carried to the *balancier*, and laid one after another on the image matrice, upon which two men draw, each on his side, one of the ropes of the beam, and turns the screw fastened to it; which by this motion lowers the arbor to which the dye of the arms is fastened; by which means, the metal being in the middle, at once receives an impression on each side, from each dye.

Silver is coined in the same manner, with these few differences; 1. That the alloy of silver is copper alone, 18 pennyweights of which are allowed in a pound *troy* for standard silver in *England*. 2. Silver is melted in a *wind furnace*. 3. When melted, it is taken with a ladle out of the crucible, to be poured into the aperture of the mould.

When the *blanks*, either of gold, silver, copper, or bullion, have all their marks and impressions both on the edges and faces, they become money, but have no currency till they have been weighed and examined; for which reason, monsieur *Boisard* very pertinently defines money, a piece of matter, to which public authority has affixed a certain value and weight, to serve as a medium in commerce.

The place where the money is coined is called the *MINT*. In *France* there are as many *mints* as there are letters in the alphabet, and it is known by the letter of the alphabet placed in the exergue of the *coin*, where the piece has been struck. All the species coined at *Paris* are marked with the letter A. Those coined at *Rouen* in *Normandy* with the letter B, &c. In the province of *Britanny* there are two *mints*; one at *Rennes*, where the money is marked g. and another at *Nantz*, where they are marked with the letter T.

Though there were antiently *mints* in most cities of *England*, there is at present but one, and that in the *Tower of London*. This *Mint* was made a corporation by a charter of king *Edward III.* and consists, 1. Of the warden or keeper of the exchange and *mint*, whose office is to receive the bullion brought in by merchants, goldsmiths and others, to pay them for it, and to over-see all the other

other officers. 2. The master-worker, who receives the bullion from the warden, causes it to be melted, delivers it to the moneyers, and takes it from them again, when *coined*: his allowance formerly was not any set-fee, but according to the pound weight; as by an indenture under the great seal. 3. The comptroller, who sees that the money be made to the just assize, to oversee the officers, and reprimand them if the money be not as it ought to be. 4. The assay-master, who weighs the silver and gold, and sees whether it be standard. 5. The auditor, who takes and makes up the accounts. 6. The surveyor of the melting, who is to see the silver cast out, and that it be not

altered after it is delivered to the melter, *i. e.* after the assay-master has made trial of it. 7. The clerk of the irons, who is to see that the irons be clean, and fit to work with. 8. The graver who engraves the dies and stamps for the *coinage* of money. 9. The melters, who melt the bullion before it comes to *coining*. 10. The blanchers, who anneal or boil and cleanse the money. 11. The porters, who keep the gate of the *mint*. 12. The provost of the *mint*, who provides for all the moneyers, and oversees them. And *lastly*, the moneyers, some of which shear the money, some forge it, some stamp or *coin* it, and some round and mill it.

## Of C O N F E C T I O N A R Y .

**T**HE art of the CONFECTIONER is to preserve all sorts of *vegetables*, as flowers, fruits, herbs, roots, and their juices, in such a manner, as to preserve their natural form, colour, taste, smell, &c. for a considerable length of time.

This may be performed by *honey*, but the moderns do it with *sugar* prepared different ways; which, according to its different degrees of consistence acquired by boiling, is known by the name of *icy sugar*, *pearl sugar*, *feather sugar* and *breaking sugar*.

*Sugar* is boiled to the consistence of *ice*, if the middle finger, being dipped into it, and applied afterwards to the thumb, the *sugar* remains immoveable, and round, like a small pea, upon the thumb. It is said to be boiled to a *pearl*, when, by opening the finger and the thumb, which had been before joined, the *sugar* forms a small thread. It is boiled to *feathers*, when a spatula, having been dipped into it, and shaken afterwards, the *sugar* flies into the air; for if it runs yet, it is not done. And, lastly, it is reduced to the consistence of *breaking*, if a small stick, which has been before dipped into cold water, being dipped afterwards into the boiling *sugar*, and dipped again into cold water, the *sugar* breaks, and grows dry in the water; for if it be yet sticky, it is not of a right consistence. Of these four preparations of *sugar*, all sorts of *confects* are made.

Mix about a quarter of a pint of water for every pound of prepared *sugar*, and no more, for if there was more, it must be evaporated, before the *sugar* can acquire its due consistence.

*Confects* are reduced to eight kinds, *viz.* *liquid* *confects*, *marmalades*, *jellies*, *pastes*, *dry* *confects*, *conserves*, *candies*, and *dragees*, or *sugar plumbs*.

**L**IQUID CONFECTS, are those whose fruits, either whole, in pieces, seeds, or clusters, are *confited* in a fluid transparent syrup, which takes its colour from that of the fruit boiled in it; if they be too little sugared, and too little boiled, they turn; and if too much sugared, or too much boiled, they candy.

All fruits for *confects* must be a little green, and gathered when they begin to ripen, except *gooseberries*, *cherries*, *pears*, and *quinces*, these must be ripe, and *confited* at a great fire; except *quinces*, which want but a slow fire, as well as the fruits, which are to be green; which fruits must be boiled in water at a slow fire, pouring upon them some acid, as vinegar, or spirit of vitriol, to render them of a still more beautiful green: but when they are in the *sugar*, they must be dispatched at a great fire.

There must be a pound of *sugar* to every pound of fruit; except *cherries*, a pound of which wants but half a pound, or three quarters of a pound of *sugar*; but every pound of *quinces* wants a pound and a quarter of *sugar*.

The manner of performing this art may be sufficiently known by the following preparations, to which examples all others may be reduced.

All sorts of **PLUMBS**, for *confects*, must be taken when they begin to ripen; pare them, and put them into cold water, and afterwards into hot water, ready to boil, in which leave them till they begin to grow green: then take them off the fire, and let them grow cold, in the same water. Being cold

cold take them out, and put them into cold water; from that water, and after they have been well drained of their water throw them into *feathered sugar* boiled at a great fire, and skim them; then boil them, which done, they are to be taken off the fire, and left to grow cold, and put again on the fire, and boiled, till the syrup has acquired the consistence of *pearl*; then they are to be taken off the fire, and put into pots: which pots are to be covered, when the *plumbs* are cold.

CHERRIES are preserved either with their stones, or without. If with their stones, the stalk must be cut very short; if, without, they must be pulled out gently by the stalk, without bruising the *cherries*; which are to be gathered very ripe. the *cherries* called *morella's* are the most proper for *confects*; the *cherries* are put into *feathered sugar*, boiled at a great fire, and skimmed; which done they are taken off the fire, and left to grow cold; then put again on the fire, and made to boil fast, and skimmed again, if it be necessary. When taken off the fire, for the last time, put them into pots and cover them when cold.

*Raspberries* must be gathered as whole as possible, and before they are quite ripe. Their stalks must be pulled off. Then put them into a glazed earthen pan, flat at the bottom; *feathered sugar* poured upon them, and having been left to grow cold, the whole mixture is poured afterwards gently into a copper basin, and made to boil, and skimmed, till the syrup be reduced to the consistence of *pearl*, which done, they are taken off the fire, and put into pots as before.

For green liquid APRICOCKS; they must be gathered green and tender, pared, and thrown into cold water, and afterwards put into warm water, where they are left till they begin to grow green; then they are taken off the fire, and left to grow cold in the same water: being cold, they are put into fresh water, out of which being taken afterwards, and drained, they are put into *icy sugar*; where they are left to boil for a very short space of time; then they are taken off the fire, and left to grow cold a little, and afterwards put again on the fire, and left to boil till the syrup be reduced to a *pearl* consistence: Then they are put into pots, as other *liquid confections*.

For ripe liquid APRICOCKS, they must be pared as well as possible, without bruising or disfiguring them, and afterwards put into boiling water, where they must boil gently for the space of two minutes. Then they are taken off the fire, and thrown into cold water: while they are in the water, *sugar* is boiled in form of a conserve, in which the *apricocks* must boil two or three gallops; which done, they are carried to the stove, where they are left till the

next morning, keeping all the while a small fire under it.

*Peaches* are preserved after the same manner; except that they must be stoned, and boiled in *pearl sugar*.

*Quinces* must be taken very ripe, cut into halves, or quarters, pared, and cleansed of their cores: as they are pared, they are thrown into cold water, and from thence into boiling water, where they are left till they are grown soft; which done, they are taken out, and put into cold water: While they are in the fresh water, *sugar* must be boiled according to our first preparation, into which the *quinces* are put, and made to boil at a slow fire, covering them, if they be wanted very red; they must be taken off the fire by intervals, and put again upon it, till the syrup has acquired the consistence of jelly; then they are put into pots, and covered when cold.

MARMALADES, are a kind of *paste* half liquid, made of the pulp of fruits or flowers.

PASTS are thickened to a degree, by boiling, so as to assume any form, when put into little moulds, and dried in an oven. The most in use, are those of *gooseberries*, *quinces*, *apples*, *apricocks*, and *orange*, *flowers*.

To make a *paste* of *cherries*, take the largest, and ripest, take off the stalks and stones, and boil the fruit a little in a very small quantity of water, strain it afterwards through a cullender putting under it a dish, to receive what passes through while you stir and squeeze the *cherries*. When all the fruit is strained through, it must be put into a very clean copper basin, and dried on the fire, stirring it without intermission, lest it should burn, and till your *cherries* begin to dry, which you'll perceive by their sticking no longer to the basin. Then mix with them half, or three quarters of a pound of sugar, in powder; which done, you must spread your *paste* upon slates, giving it what form you please, and carrying it afterwards to the stove to dry.

To make a *paste* of *raspberries*, you must take them very ripe, pull off the stalks, and strain them through a sieve, proceeding afterwards as in the *paste* of *cherries*.

The *paste* of *apricocks* is made by paring them, when very ripe, taking out the stones, boiling them in water; draining them; straining them through a sieve, and making a *paste* like that of *cherries*.

To make a *paste* of *quinces*, you must take them very ripe, pare them, take out the cores and stones, boil them in water till they be very soft, strain them through a coarse sieve, and afterwards make your *paste* as you did that of *cherries*.

There

There are *pastes* of *sugar*, called *biskets*; as common *biskets*, *biskets* of *orange-flowers*, *jessamine*, *citron*, *savoy biskets*, common, royal, and curled *massépains*, &c.

The *common biskets* are made, by taking eight eggs, or thereabouts, breaking them, and putting the yolks and whites together in a copper bason, and beating them for half an hour with a wooden spatula; which done, a pound of *sugar*, in powder, must be added to it, and the whole very well mixed, and beat together for another half hour: then the *paste* must be left at rest for some time, and afterwards put into moulds of tin, or paper, mixing with it some *sugar*, in powder, to glaze it. The moulds, thus filled, are put into an oven, not so hot as one could not bear his hand in it, or into a copper stove, which must have lighted coals a-top and underneath, but a little more a-top than underneath; where they must be left till the *biskets* be very well risen, and assumed a golden colour; for then they are taken out of the moulds, with the point of a knife, and put into a hot place, till they be thoroughly dry.

The *common massépain* is made in this manner: Take a pound of sweet almonds, blanch them in hot water, and put them afterwards in cold; take them out, dry them upon a napkin, and pound them in a stone mortar, with a wooden pestle, moistening them often with whites of eggs, and rose or orange-flower water, till they be reduced to a *paste*; which done, it must be thrown into feathered *sugar*, mixed together, put on the fire, stirred continually with a spatula, taking care that nothing burn at the bottom or sides of the bason; and when you perceive that nothing sticks to it, you must take out your *paste*, and spin it in what form you please, and carry afterwards your *massépains* to the oven to be baked.

**JELLIES**, are juices of several fruits, wherein *sugar* has been dissolved, and the whole, by boiling, reduced to a pretty thick consistence; so as, upon cooling, to resemble a kind of thin transparent glue, *jellies* are made of various kinds of fruits, especially *gooseberries*, *apple*, and *quince*. There are other *jellies* made of *flesh*, *fish*, *hartshorn*, &c.

To make *jellies*, you may take what sort of fruits you please, cut them into pieces, and boil them in water till they be very soft; they must be strained, with a strong expression, through a clean piece of cloth, to extract from it as much decoction as possible. A quart of that decoction must be put into a bason, with a pound of *sugar*, and boiled together, till the *jely* be formed, which will be known, if by taking some of the composition with a spoon, it falls from the spoon in large lumps, and

not in running or spinning. When it has acquired that consistence, it must be taken off the fire, and put into pots.

The *jelly of hartshorn* is made by boiling a sufficient quantity of hartshorn shavings in white wine for the space of two hours, more or less, at the *confectioner's* discretion; when boiled, it is strained thro' a cloth, and afterwards put in a bason with a sufficient quantity of *sugar*, (*i. e.* a pound of *sugar* for two pounds of hartshorn) and lemon juice; when it is ready to boil, whites of new-laid eggs must be mixed with it, and immediately after the whole mixture must be thrown in the flannel, and kept in a cool place. The *green*, *yellow*, *blue*, &c. *jellies*, are the same *jelly*, only coloured with those different colours.

The *blanc manger* is made of the same *jelly*, warmed with almonds very well pounded, and the whole strained through a cloth.

All sorts of red or green *jellies* must be done at a slow fire, and covered; and all white *jellies* at a great fire, and uncovered.

The *jelly of gooseberries* is made by straining them through a napkin, or other cloth, adding three quarters of a pound of *sugar* to a quart of the juice, and boiling them together till the mixture has acquired the consistence abovementioned.

**DRY CONFECTS**, are those, whose *fruits*, after having been boiled in the *syrup*, are taken out again, and put to dry in an oven. The most considerable are, *citron* and *orange-peel*, *plumbs*, *pears*, *cherries*, *apricocks*, &c.

**ORANGES** are often preserved whole, *i. e.* without being cut in pieces; which is done in this manner: pare oranges, as thin as possible; slit them at the eye; put them in boiling water, and make them boil for about half a quarter of an hour; take them out, and put them in cold water; then, with a spoon or scoop made for that purpose, take out all the pulp; throw them into more cold water, and afterwards into boiling water, making them boil as before; and again into boiling water, repeating the same operation three times successively; and, lastly, put them into the finest *icy sugar*; where they must boil for half a quarter of an hour, and afterwards be taken off the fire, and left to cool: when cold, they are put again on the fire, to boil till the *sugar* be reduced to the consistence of being shaken into flakes; which done, they must be taken off the fire, and when cold, and well drained of the *sugar*, disposed upon clean straw.

There is as much *sugar* wanted to preserve *oranges* and *citrons*, that the fruit may swim in it; but what is left of it, may serve for other things.

**APRICOCKS** are confected, by taking small green *apricocks* very tender, paring them, and having them done in hot water, without boiling, till they begin to grow green; for then they must be taken out, and put in cold water, and after they have been very well drained, boiled in sugar of the consistence of our first preparation, till the syrup be reduced to the consistence of our second preparation of sugar; then they are put into an earthen pan, where they are left for eight days: that time expired, they are put into a copper basin, and boiled till the syrup be once more reduced to a pearl consistence; which done, they are put again into the earthen pan, and when cold they are disposed on slates, and put to dry in the stove, where they are often turned, till they be thoroughly dry. Then they are put into boxes, upon paper, so that they may not touch one another.

For *cherries*, after the stones have been taken out, they must be boiled in a small quantity of water, that they may pour out their juice; and when they have been well drained, they are boiled in sugar reduced to a pearl consistence, till the syrup has acquired, likewise, a pearl consistence; which done, they are put in an earthen pan; where they are left for eight days; after which, they are once more boiled till the syrup has acquired the same consistence as before: when they are done, they are left to grow cold, when cold they are disposed upon slates, and put to dry in the stove, where they must be turned twice every day, if they want it, till they be quite dry: being dry, they are put in boxes upon paper, making one bed of paper, and another of *cherries*, and thus successively, till they are all packed up. The paper must be changed at least every fortnight, and if they be kept long, and the paper under them is found wet, it must be changed likewise, as well as that under all sorts of dry confects, if we design to keep them long. They must even be put, from time to time, to the stove, when they want it.

*Plumbs* must be neatly pared, and as they are pared thrown into cold water, and afterwards into other water ready to boil, where they must be left on the fire, covered, and without boiling, till they grow green; which done, they are thrown again into cold water, and afterwards preserved, and dried like *cherries*. All sorts of *plumbs* are done in the same manner; as also *peaches*.

**CANDIES** are ordinarily entire fruits, and flowers, *candied* over with sugar, after having been boiled in the syrup; which renders them like little rocks crystallized, of various figures and colours, according to the fruits inclosed within them.

*Oranges* are *candied* whole, by taking whole *oranges* newly confected, and not much loaded with

sugar, and putting them in sugar reduced to the consistence of being shaken into flakes; but the vessel which contains the sugar must be flat, that the *oranges* may not touch one another, nor the bottom of the pan: then they are carried to the stove, where they are left twice twenty four hours, which being expired, they are taken out, and put upon straw to dry. *Apricots*, *peaches*, and all other fruits, are *candied* in the same manner.

**CONSERVES**, are a kind of *dry confects*, made with sugar, and pastes of flowers, fruits, &c.

To make the *conservé* of *cherries*; take out the stones, and make the fruit boil in a small quantity of water; when boiled, you must drain them, cut them to pieces, and throw them afterwards in sugar reduced to the consistence of being shaken into flakes; then dress your *conservé* upon paper. The sugar must be off the fire when you throw the fruit into it.

*Conservé* of *roses*, is made by taking *red roses*, in powder, dissolving them in the juice of lemon, and mixing the dissolution with sugar reduced to the consistence of being shaken into flakes.

To make the *conservé* of *violets*, you must take the leaves of flowers of *violets*, pound them in a mortar, strain them through a cloth, to extract the juice, and mix that juice with sugar reduced to the same consistence as above; when you dress the *conservé*, you must mix with it some juice of lemon, to give it a livelier colour.

**SUGAR-PLUMES**, are made of small fruits, or seeds, little pieces of bark, or odoriferous and aromatic roots, &c. incrustated, and covered over with a very hard sugar, ordinarily very white.

To make all sorts of *sugar-plumbs*, there must be had a large copper basin, with two handles to it, suspended with two cords, at the height of the wasteband; under which, there must be an earthen pan, or chafing-dish, with a moderate fire, to make the *pearled sugar-plumbs*: there is wanted, besides, a kind of funnel, through which the sugar must pass, to make *pearled sugar-plumbs*.

*Pearled almonds*, are made of sweet *almonds*, very well dried over the fire, pouring upon them, through a funnel, the sugar, reduced to the consistence of our first preparation, shaking the basin all the while, and turning the *sugar-plumbs*, that they may all take, as near as possible, an equal quantity of sugar. They may also be stirred with the hand, and parted, if they stick together. The syrup can likewise be stopped running, to give time to the *sugar-plumbs* to dry.

The *glazed almonds* are made, by pouring upon them in the basin, with a ladle, about a quarter of a pint at once of sugar, reduced to the consistence of our first preparation, stirring often the *almonds* with

with the hands, and leaving them sometimes at rest. *Carraways, anniseeds, &c.* are prepared in the same manner, after they have been very well cleansed of all their dust, stalks, &c.

## Of C O O K E R Y.

**C**OOKERY, is the art of preparing meats for food, that they may be both wholesome and agreeable to the palate.

I'll begin with the manner of making SOUPS.

Take that piece of beef called the *mouje buttock*, some mutton, and fowls, regulating the quantity of meat, according to the quantity of broth wanted: put that meat in a pot, with a bunch of parsley, young onions, and thyme, tyed together, and a few cloves; fill the pot with water, keeping always warm water ready to re-place that of the pot, which evaporates in boiling; and when the meat is boiled almost to rags, strain the *broth* through a napkin, to use it as occasion serves.

These sorts of *broths* may be eaten without any other addition, except pulse, if one likes it, *viz.* cabbages, turnips, &c. which pulse are to be boiled in a pot a-part, and after they are well drained of their liquor, they are put in the *broth*, to boil two or three gallops more, and afterwards put in a dish, and carried to table.

To make the *soup of jiblets*, after they have been well scalded, they must be fried like a fricassly of fowls, and afterwards put in a pot with our best *broth*, where they are left to stew at a slow fire, for three quarters of an hour.

To make *pease soup with a green goose*, we put our green goose to boil very well in a pot, and our pease in another; when the pease are well mashed, we put in it a bundle of sweet herbs, and fat bacon melted in a frying-pan: we have bread stewed in the *broth* of the green goose, and pour the pease soup upon it.

To make the *soup of fowls with green pease*, put the fowls to boil with *broth*, and skim them well; then pass the green pease through a frying-pan, with butter, or melted bacon; and afterwards have them stewed a-part, with lettices: and when the fowls are done, mix the *broth* and pease together, and send it to the table.

To make the *soup of a capon with rice*; boil the capon in *broth* well seasoned; pick the rice, wash it, and have it dried before the fire; then put it to boil slowly in a very good *broth*, with a blade or two of mace; and when the capon and rice are done, we mix them together, and send them to the table.

The fowls used to make these sorts of *soups*, are commonly served whole a-top of the *soup*, and

the dish garnished either with chicory, mushrooms, truffles, capers, or onions, according to the different sorts of *soups*.

To make *herb soup*, you must wash very well together, sorrel, bugloss, burrage, and a good quantity of lettices; then fry them in fresh butter, and put them afterwards in boiling water, with other fresh butter, and a crust of bread, making it boil slowly, for the space of an hour, at least. When the *soup* is to be carried to table, you may whiten it if you please, with yolks of eggs beaten with some of the *soup*.

To make a *soup of crawfish*; after the *crawfish* have been cleaned well, they are boiled in wine, vinegar, salt, and pepper; being done, the claws and tails are fried with fresh butter and some parsley, and the bodies beaten in a mortar with an onion, hard eggs, and crumbs of bread: this done, the mixture is put to stew with some of the *herb soup*, or other *soup*; when stewed, it is strained through a cloth, and put afterwards before the fire, to keep it hot; then you fry some parsley in fresh butter, which you put, when fried, together with the butter, in your *soup*, well seasoned, which must stew a little longer. When the *soup* is carried to table, the dish must be garnished with the claws and tails of the *crawfish*.

To make a *soup of carps*, we take out all the bones, and put them to boil in pease soup, with some onions, and crumbs of bread; being boiled, they must be fried with some parsley, and put again in the *soup*: while they are boiling, we make a hash of the flesh of the *carps*, which, when done, is put over the toasted bread, and the *broth* poured upon it, garnishing the dish with slices of lemon and mushrooms.

To make a *soup of stuffed mushrooms*; we pick and wash them well, then put them to boil in water, with an onion larded with cloves, thyme, pepper, and salt; when boiled, we strain the *broth* through a cloth, and put it in a pot; then fry the mushrooms with butter, parsley, and capers, and put them afterwards in the *broth*; and when ready to be carried to table, we fill the bottom of the dish with a hash of *carps*, and pour the *broth* upon it, garnishing the dish with mushrooms stuffed with the same hash.

To make *onion soup*, we slice the *onions* very thin, and then fry them; we put them in a pot with

water, and more butter, making them boil till they are well done; then we put a crust of bread in it, with some salt and pepper, leaving it to boil for a little while longer. When fit to be carried to table, we beat yolks of eggs with a drop or two of vinegar or verjuice, with which we thicken and blanch the *soup*. Some add to it, while it is boiling, a few spoonfuls of pease soup, and then it wants no eggs.

To make a *soup of green pease*, you must take them as young as possible, and having been fried in fresh butter, they are put to stew, well seasoned with parsley and young onions; when stewed, they are mixed with *herb soup*, and carried to table.

To make a *ragout of ducks*, they must be larded, fried, very well seasoned with salt, pepper, spices, young onions, and parsley, and put in a pot to stew, with a little of our best broth.

To make a *ragout of pigeons*; they must be larded, fried in lard, seasoned, and put to stew in a little of our best broth, with a small bundle of fine herbs.

To make a *ragout of fowls*; they must be larded, cut in halves, seasoned, and put to stew in broth, with a small bundle of fine herbs, truffles, mushrooms, and a few small pieces of roasted pork, to give them a relish.

To make a *ragout of a pig*; it must be cut in four quarters, well seasoned, and fried; when done, it is garnished with capers, truffles, and mushrooms.

To make a *ragout of calves feet*; when they are well done, they must be floured and fried in lard, and afterwards put to stew in broth, with verjuice, a small bundle of fine herbs, and a piece of lemon, the whole well seasoned, and the sauce short. They must be carried to table with capers.

A *ragout of double tripes*, is made by cutting the tripes very small, frying them in lard, with parsley and onion, and having been seasoned with capers and vinegar, they are left to stew a little while in the frying-pan.

To make a *ragout of a fillet of veal*, it must be larded, and a little more than half roasted on a spit, and afterwards put to stew with very good broth, a small bundle of fine herbs, pepper, and cloves, in a pot covered close. When done, the sauce must be thickened with yolks of eggs well beaten, with a little verjuice, or the juice of a lemon, or some vinegar.

To make a *ragout of the loin of a deer*, after it has been larded, and half roasted, it must be basted till it is quite done, with a sauce made of pepper, vinegar, and broth, and the sauce thickened afterwards with crumbs of bread.

To make a *ragout of a hare*, after it has been

half roasted, it is cut in pieces, fried, and then put to stew, slowly in a dish, with the juice of oranges, capers, and crumbs of bread.

To make a *ragout of soles*, they must be floured, and half fried; then they are opened all along the bone, and the bone taken out; which done, they are filled with a stuffing made of capers, mushrooms, truffles, soft rows, and crumbs of bread; and put afterwards to stew in a pot, with fresh butter, an onion cut small, verjuice, and some broth. When carried to table, the dish must be garnished with slices of lemon.

To make a *ragout of pikes*, they must be cut in slices, and put to stew with white wine, a bundle of sweet herbs, fresh butter, and well seasoned with salt, pepper, capers, and mushrooms; when done, the sauce is thickened with yolks of eggs, beaten with some vinegar, or verjuice.

To make a *ragout of tench*, they must be cut in pieces, well washed, and boiled in water, with salt, pepper, and an onion, adding to it, afterwards, half a pint of white wine, and some hashed parsley. When done, the sauce is thickened with yolks of eggs, as above.

To make a *stew of carps*, they must be cut in pieces, put to boil in a pot with white or red wine, and well seasoned with hashed onion, salt, cloves, pepper, capers, and some crusts of bread; when they are well done, the sauce is thickened with yolks of eggs.

To make a *ragout of stuffed carps*, the carps must be opened all along the back bone, the skin raised, the flesh hashed, and seasoned with parsley, fresh butter, salt, pepper, and yolks of eggs, with which we fill the skin; then we make it boil in broth, seasoned with verjuice, mushrooms, asparagus, young onions, and fresh butter: when almost done, the sauce must be thickened with crumbs of bread, adding capers to it.

To make a *ragout of salmon*, it must be larded with cloves, and roasted; when roasted, it must be stewed slowly in wine, with salt, pepper, and fresh butter, till the sauce grows very short.

To *stew salmon*, it must be cut in slices, larded with cloves, and put to stew in white or red wine, well seasoned, with fresh butter, salt, pepper, capers, and an onion hashed, till the sauce grows very short.

To make a *ragout of oysters*, they must be put to stew in their own liquor, with fresh butter, onions, hashed parsley, capers, and crumbs of bread, well seasoned with pepper and salt.

To make a *ragout of flounders*, they must be put in a stew-pan, with butter, young onions, beaten cloves, salt, pepper, capers, some white wine, or vinegar, and mushrooms; when done

the fauce is thickened with yolks of eggs. *Plaife* are done in the same manner.

To *stew eels*, we cut them in pieces, and *stew* them in white wine or water, with parsley, capers, and fresh butter, the whole very well seasoned, with salt, pepper, and beaten cloves.

To *dress collared eels*; slit the *eel* in half, take out the bone, beat the flesh well, and season the two pieces with pepper, salt, butter, and hashed parsley; then roll them, and tye them very tight with packthread: thus prepared, put them to boil in white wine, well seasoned; and when done, take them out and send them to table in slices.

To *stuff a pike*, it must be slit all along the back-bone, the skin left from the head to the tail, half the flesh taken off with the small bones, and the back-bone left, to keep up the *pike* when stuffed; then we take half the flesh of the *pike*, and half flesh of *carps*, or *eels*, and hash them together, with yolks of eggs raw, parsley, salt, pepper, sweet herbs, butter and milk mixed together, and mushrooms; with which we stuff the *pike*, sew it up, and then put it to boil, making the fauce with fish broth, a drop or two of vinegar, or verjuice, parsley, capers, and mushrooms, well seasoned.

To *broil mackerel*, they must be wrapped in fennel, and put upon the gridiron, at a charcoal fire, turning them often; when roasted, they must be opened, and a good fauce made under them, with butter, parsley, and gooseberries, the whole very well seasoned.

To *broil fresh herrings*, they must be put on the gridiron, and when they begin to roast, rubbed over with butter; when roasted, a fauce must be made with fresh butter, a drop or two of vinegar, salt, pepper, nutmeg, and some mustard.

To make a *ragout of fresh cod*, it must be rubbed over with butter, put upon the gridiron, seasoned with salt and cloves, and while roasting, basted with butter, in which we put parsley hashed and onions, mixing with it some broth, vinegar, and hashed capers; then we put the roasted *fresh cod* to *stew* a little, in that fauce, and carry it to table with some mustard.

To make *à la mode beef*, you must take a piece of the buttock, beat it well, and lard it; then it must be put in a pot, with good broth, pepper, beaten cloves, and a small bundle of fine herbs; and the pot being covered close, is put on a slow fire, where it remains till the beef is done.

To *dress capons with oyster-sauce*, the *capon* must be *larded*, *i. e.* the fore and hind-part covered with a thin slice of bacon, and over it a buttered paper; then it is put to roast; the oysters must be fried with the dripping of the *capon*, and seasoned, while frying, with mushrooms and onion, and a

small bundle of fine herbs: when they are well fried, they are put in the body of the *capon*, the bundle of herbs excepted, before it is quite done.

To make a *ragout of calf's liver*, it must be larded with big *lardons*, well seasoned, with a small bundle of sweet herbs, orange-peel, and capers, and put in a pot to *stew* with some good broth.

To make a *stew of fowls*, they must be cut in small pieces, and put to *stew* with very good broth, white wine, and fresh butter, and well seasoned with onions and parsley hashed together; when they are done, the fauce must be thickened with yolks of eggs well beaten with verjuice, or vinegar.

To *fry a calf's head*, after it has been well boiled, the bones must be taken off; then make a batter, or liquid paste, with flour and eggs, which must be seasoned well with pepper and salt, and in which the flesh of the head must be dipped, and then fried in lard: when well fried, it must be served with slices of oranges, and fried parsley, round the dish.

To *fry calves feet*, after they are well boiled, they are cut in small pieces, and fried with butter; after they have been turned three or four times in the frying-pan, we throw into it onions and parsley, well hashed together, a little good broth, and season well the whole: when they are ready to be carried to the table, we beat some yolks of eggs, with verjuice or vinegar, in proportion to the meat, *viz.* to four calves feet, three yolks of eggs, with which we thicken the fauce.

To *hash roasted mutton*, the meat must be hashed as fine as for minced pies; which done, it must be put to *stew* slowly with some gravy, an onion, some fresh butter, and crumbs of bread. *Hashed partridges* are prepared in the same manner.

To make a *pigeon pye*, we season well the pigeons with salt and pepper, then put them in the paste, with beef marrow, asparagus, mushrooms, bottoms of artichokes, yolks of eggs, truffles, and some verjuice or gooseberries.

To make a *veal pye*, it must be hashed well with twice as much marrow, or beef suet, well seasoned, and afterwards put in paste.

To make a *capon pye*, all the bones of the *capon* being taken out, it must be stuffed with cocks-combs and stones, mushrooms, truffles, marrow, capers, and veal sweetbreads; and being well seasoned, it is put in paste.

To *roast a pheasant*, there must be left to it a wing, the neck, and the tail; and after it is well larded, the wing, tail, neck, and head, where the feathers are left, must be wrapped in buttered paper, then spitted, and roasted; the paper must be taken off before the pheasant is carried to table.

A *bare*, before it is put to roast, must be rubbed over with its blood, and larded; when done, it is served with a sweet sauce, made of white wine, sugar, mace, &c. or with a *poivrade*, gravy, and plain melted butter.

*Partridges* are roasted larded.

*Green geese* are roasted without being larded, but you must make under them a stuffing, with the liver, thyme, parsley, &c. hashed well together, and well seasoned; and fried afterwards in butter, with a few yolks of eggs.

A *young turkey* is roasted larded.

A *plover* is roasted larded, and carried to table with a toast, and sauce under it.

A *haunch of venison* is roasted larded, and a *poivrade* made under it, when carried to table, or a sweet sauce.

An *ortolan* is roasted larded, and wrapped in vine leaves, in their season; in the spring it must be drawn.

A *woodcock* is roasted larded, and a toast made under it, while roasting, with which, and some slices of seville oranges, it is carried to table.

A *fawn* is roasted larded, and with its head on, which must be wrapped in buttered paper, lest the hairs should be singed. It is carried to table with a sweet sauce.

The sweet sauce is made with vinegar, salt, onion, and lemon, or orange-peel, boiled together. The *green sauce* is made with green corn, a toast burnt with vinegar, some pepper, and salt; the whole pounded very well in a mortar, and strained through a cloth. *Pigs* and *lamb* are served with this sauce. The *rabbit* with the juice of oranges, and pepper. The *plover* with a sauce made of verjuice, lemon-peel, vinegar, pepper, salt, and onion; without forgetting a toast.

To dress *pig's ears*, and *feet*, after they have been well boiled, they must be cut in pieces, fried in butter with onions, and well seasoned; when fried, two or three spoonfuls of good broth are put into the pan, and when they have been left to stew for five or six minutes, the sauce is thickened with yolks of eggs beaten with vinegar, and some mustard.

To make a *venison pasty*, if the flesh is hard, it must be well beaten, skinned, larded, well seasoned with pepper, salt, beaten cloves, and vinegar; and afterwards put in paste, and carried to the oven, where it is left for the space of three hours. When done, the hole, which had been left to give it vent, must be stopped.

To make a *ham pye*, after it has been well soaked, it must boil a gallop or two, and afterwards be skinned; when skinned, it is put in paste, like venison, and seasoned with pepper, cloves, and par-

ley: if it be a big one, it must stay five hours in the oven, and thus in proportion to its bigness.

To make a *ragout of truffles*, they must be pared very clean, cut very thin, and fried with butter, some hashed parsley, and broth, where they are left to stew for a little while; they must also be very well seasoned.

To make *fritters of marrow*, we take the biggest pieces of beef marrow we can get, slice, and dip them in a paste, or batter, made of flour, eggs, and milk, well seasoned; and afterwards fry them in butter. The *fritters of apples* are made in the same manner.

*Fritters of artichokes*, are made of bottoms of artichokes half boiled, sliced, and dipped in batter, made as above.

To fry *artichokes*, they must be cut in pieces, the choke, and all the leaves, except one of the smallest, left on each piece, taken off, and thrown into boiling water, to blanch them; afterwards they are dried, floured, and fried in lard, or burnt butter. They are carried to table hot, and garnished with fried parsley.

To make a *ragout of mushrooms*, after they have been well cleaned, they are fried in fresh butter, with parsley and young onions hashed together; well seasoned, and lemon-juice added to it, with some *blanc manger*, when they are ready to be carried to table.

To fry *mushrooms*, they must be blanched in cold water, dried, and afterwards pickled in vinegar, salt, pepper, and onions; and when they are to be fried, a batter must be made, with flour and yolks of eggs, in which the mushrooms are put, and then fried.

To make a *Westphalia ham*, we put our pork in a wine or beer cellar for four days; during which time, a sort of water will come from it, which must be wiped very often; if it be wet weather, it must be left there but two days, and two nights: it is afterwards put to be pressed between two boards, and left there as long as the hog has been dead; after which, it is salted, and seasoned with pepper, beaten cloves, and aniseed. The *hams* must be left in salt for the space of nine days, and afterwards taken out, and put in lees of wine, for nine days more; which elapsed, they are wrapped in hay, and buried in the cellar, in a place not too damp: being taken out, they are hung to smoke, and must be perfumed twice a day, with the smoak of burnt juniper; when dry, and little smoked, they are carried to a dry place, where they are kept, and visited often, lest they should rot, till they be wanted; when, after they have been cleaned, and soaked, they are boiled in a pot full of water, seasoned with fine herbs, and without

wine

wine. When done, the rind must be raised, and the flesh larded with cloves, and spread over with pepper, and hashed parsley; then the rind, or skin, is put upon it, and the *ham* kept in a cool place till wanted.

To make a *rabbit pye*, they must be larded with big lardons, and well seasoned with salt, pepper, beaten cloves, and vinegar.

To make a *chicken pye*, they must be larded, well seasoned, and put in a fine paste.

To make a *veal pye*, you must take a fillet of veal, lard it, season it well, and put it in paste. Another manner of making a *veal pye*, is, to hash the veal with marrow, or beef suet, to season it well, and to garnish it, while in paste, with mushrooms, bottoms of artichokes, sweetbreads, and yolks of eggs hard.

To make a *lamb pye*, the lamb must be larded with big lardons, seasoned with hashed parsley, pepper, salt, beaten cloves, and garnished with mushrooms, morilles, and capers. When baked, it must be carried to table with a white sauce, made of yolks of eggs, beaten with verjuice.

To make an *eel pye*, we cut the eels in pieces, and put them in paste, very well seasoned, with yolks of eggs, parsley, mushrooms, asparagus, verjuice, or gooseberries, in the season, butter, salt, and pepper.

To dress a *turbut*, it must be put to boil gently in white wine, seasoned with salt, pepper, cloves, and sweet herbs, as rosemary, thyme, and onions; being done, it must be sent to table garnished with parsley.

*Puffed paste* is made in this manner: Take four pounds of flour, mix that flour with cold water and a little salt; when mixed, leave it a little at rest, and afterwards work it with two pounds of butter, extending it to cover it with that butter, after which, fold it up in three, extending it again to fold it in four; this done, make again three or four such turns, then carry it to a cool place, to use it as wanted. The *fine paste* is made with four pounds of flour, and a pound and a half of butter,

very well worked together with salt. The *pye*, with *warm water* is made in the same manner, except that you heat the water and butter.

All *fish pies* are baked in two hours.

To make a *pye of salmon*, it must be larded with eels, or carps, and seasoned with pepper, fat, and bearen cloves; then it is put in paste, and over it a bay-leaf, with a good quantity of fresh butter, and a little vinegar; which done, the *pye* is closed, in form of the fish.

To make a *tart of oysters*, they must be blanched in warm water, and afterwards fried in fresh butter, with parsley and onions hashed, and mushrooms, the whole well seasoned, and afterwards put in puffed paste, and garnished with yolks of eggs hard, bottoms of artichokes, morilles, and asparagus. When the *tart* is baked, a sauce is made with two or three young onions, whole pepper, salt, and a little vinegar, tossed in the frying-pan with butter; when the sauce is brown, the onions must be taken out, and two yolks of eggs mixed with it; then the sauce is thrown, boiling hot, into the *pye*.

I'll conclude this treatise of *Cookery*, with a catalogue of all the different meats in season, thorough-out the whole year.

*From Easter to Midsummer, are in season,*

Chickens, young turkies, green geese, lamb, pigeons, young hares, partridges, pheasants, ortolans, and rabbits.

*From Midsummer to the middle of October, are in season,*

Young partridges, young pigeons, turtles, young pheasants, young quails, young hares, turkies, young capons, pigeons, fat geese, fat fowls, ortolans, young ducks, fawns, &c.

*From the middle of October, to Lent, are in season,*

Fat capons, fat fowls, turkies, lamb, hares, partridges, woodcocks, plovers, teals, wood-pheasants, fat quails, fat geese, ducks, both wild and tame, larks, pigs, &c.

## C O S M O G R A P H Y.

**C**OSMOGRAPHY (from *Greek* κοσμος, the world, and γραφω, to describe) is the art which teaches, the construction, figure and disposition of all parts of the world, and

how to represent them on a plane. This art consists of two parts, *Astronomy* and *Geography*. Therefore the reader will find under these two heads all that is necessary to explain it.

## OF CURRYING.

**C**URRYING is the preparation of leather with oil, tallow, or some other matter, to make it pliable, more tightly, and fit for use. By this art the leather receives either a black, white, red, yellow, or green colour on the hair side of the skin.

A *Currier's* shop must be provided with long two-handed knives, to pare the leather with; a steel, made somewhat in form of a bodkin, to turn in the edge of the knife; a flat iron instrument, to beat down the grain; a pommel, or call; a table to stretch the leather upon; a horse, or leg, to pare, and pommel the leather upon; pumice stones, oil, tallow, colours, &c.

There are four manners of *currying* leather, in black, with the grain; for the skins are either put in tallow on both sides, or oil is used in lieu of tallow on the flesh-side: or tallow is used alone, on the hair-side, and nothing on the other: or tallow is used on both sides, and no grain raised.

The two first, are used for *cows* and *calves* leather; the second, is the only way used for *sheep*; and the two last, are used occasionally, for *cow* and *bullock*: for *calf* and *sheep*, they use sumach on the flesh-side, which gives an orange-cast.

For *neat's-skin*, in black; the skin coming from the tanner, is wet several times with a broom, rolled, and trod under foot to make it tractable, drained, and as much of the remaining flesh as possible, taken off with the knife; hung in the air till half dry, then wet and trampled again and again. This done it is rubbed over with a pommel, having niches in manner of teeth, to render it still more pliant, and singed with straw to prepare it to receive the tallow; which is applied boiling hot on both sides. The skin is then singed a second time, laid four hours in a vessel of fresh water, trampled, and worked a second time with the pommel, on each side, and stoutly drained; smeared over with its first black, made of galls and ferailles, boiled in beer-agre, or sour-beer; half dried, stretched on a table, and the grain beat down with the flat iron instrument drawn over it from place to place.

It now receives its second black, made of galls, copperas, and gum-arabick; when dry, and stretched on the table; it is smeared over with beer-agre; then folded from corner to corner, upon the bench, and the pommel drawn over it to cut the grain, first, on the hair-side, then on the flesh-side; the last with a pommel of cork: the beer hanging in it, is taken out with a hair rubber boiled in hatter's

lye; and the skin fastened to the table, and cleaned with the iron instrument above-mentioned, and again wiped with a piece of worsted stocking. The skin is now brightened, on the hair-side, with a lustre made of barberries, to prepare it to receive its last grain. The grain, we already observed, is begun by folding the skin, the hair-side inwards, several ways: to finish it, it is again folded, after its first lustre, two ways first; first from corner to corner, a little slanting, then across, *i. e.* first directly, or from eye to eye; then from head to tail. The grain thus formed, the last lustre, which makes the last preparation is given; composed of gum-arabic, garlick, beer, vinegar, and *Flanders* size, boiled together, and applied cold.

*Calf-skin* in black is prepared much after the same manner; though begun differently. After wetting, taking off as much of the flesh remaining as possible, and drying, they pounce the flesh with a hard, rough, pumice-stone, which makes it more smooth and gentle; then give the grain with the pommel, put on the tallow; the rest as before.

What *sheep skins* in black have peculiar in their preparations, is, that they are first stretched on a table to get off the bourre, or tan, wherewith they are laden; then wet, trod under foot, and tallow added on the hair-side: they are again wet, again trod, stretched on the table, and the water squeezed out with the pommel; then blacked, repassed under the pommel on each side; dyed, and all the roughness and inequality pared off with a flat, round, cutting instrument: the rest as before.

*Sleek-leather*, or that without any grain, made of cows or bullocks skins, differs a little in its preparation from the former. The skins being wet, trod, and passed under the pommel, the flesh is taken off; the rest as in the first article: observing that the tallow be applied on both sides as thick as possible: being now steeped in water, trod, frized, and blacked the first time; the second black is next laid on, till the hair-side be quite smooth; lastly, after receiving the two lustres, they are pressed between two tables; without plaiting or folding them in any manner during the whole preparation.

The method of preparing the *leather*, called *Morocco*, is also a branch of the art of *Currying*.

The *Morocco* is the skin of a goat, or some other animal resembling it, called *menon*, frequent in the *Levant*, dressed in sumach, or galls, and coloured of any colour at pleasure, much used in tapistry, book-binding, slippers, &c.

To prepare *black Morocco*, the skins having been dried, are steeped in clear water three days and nights, stretched on a wooden horse or leg, beaten with a large knife for that purpose, and steeped afresh in water, changed daily till they be well come again. In this state they are thrown into a large vault in the ground, full of water, wherein quick lime has been slaked, where they lie 15 days; whence however they are taken and again returned night and morning: they are then thrown into a fresh vault of lime and water, and shifted night and morning as before, for 15 days longer; then rinsed in clear water, and the hair taken off, on the leg with the knife, returned into a third vault, and shifted as before, for about 18 days; steeped 12 hours in a river, taken out, rinsed, put in pails, where they are pounded with wooden pestles, changing the water twice, then laid on the horse, and the flesh taken off, returned into pails of new water, taken out, and the hair side scraped; returned into fresh pails, taken out, and thrown into a pail of a particular form, having holes at bottom: here they are beaten the space of an hour, and fresh water poured on from time to time; stretched on the leg, and scraped on either side; returned into pails of fresh water, taken out, stretched, and sewed up all around in manner of bags, leaving out the hind legs, which serve to make an aperture for the conveyance of a mixture mentioned hereafter.

The skins thus sewed, are put in luke-warm water, where dogs excrement has been dissolved. Here they are stirred with long poles half an hour, left at rest a dozen hours, taken out, rinsed in fair water, and filled by a tunnel with a preparation of water and sumach, and kept stirring four hours successively, taken out, and heaped on one another; after a little time their sides are changed; and thus they continue an hour and a half, till drained: this done, they are loosened and filled a second time with the same preparation, sewed up again, and kept stirring two hours, piled up, and drained as before. This is again repeated a third time, with this difference, that they are now only stirred a quarter of an hour; after which they are left till the next morning, when they are taken out, drained on a rack, unsewed, the sumach taken out, folded in two from head to tail, the hair-side outwards, laid over each other on the leg, to perfect their draining, stretched out, and dried; then trampled under foot by two and two, stretched on a wooden table, what flesh and sumach remains scraped off, and the hair-side rubbed over with oil, and that again with water.

Having thus received their oil and water, they are wrung in the hands, then stretched and pressed tight on the table, with the iron instrument used

for common leather, the flesh-side uppermost; then turned, and the hair-side rubbed strongly over with a handful of rushes, to squeeze out as much of the oil remaining within as possible. The first course of black is now laid on the hair-side by means of a lock of hair twisted, and steeped in a kind of black dye, prepared of sour beer, wherein pieces of rusty iron have been thrown. When half dry, by hanging in the air, they are stretched on a table, and rubbed over every way with the pumice, to raise the grain, over which is passed a light couch of water, then sleeked, by rubbing them with rushes prepared for the purpose. Thus sleeked, they have a second couch of black, then dried, laid on the table, rubbed over with a pommel of cork, to raise the grain again; and after a light couch of water, sleeked over anew, and to raise the grain a third time, a pommel of wood is used.

After the hair side has thus received all its preparations, the flesh-side is pared with the knife; the hair-side rubbed strongly over with a woollen cap, having first given it a lustre with barberies, citron, or orange. The whole is finished by raising the grain lightly, for the last time, with the pommel of cork, which leaves them in a condition for sale and use.

They prepare the *red Morocco*, by steeping the skins 24 hours in a river, taking them out, stretching them on the leg, beating them with the knife, returning them into the water for 24 hours, rebeating them on the leg, resting, throwing them into a vault, for three weeks, taking them out, and turning them every morning, to dispose them to peel. Being taken out for the last time, they are scraped with the knife, and when the hair is quite off, thrown into pails of fresh water, where they are rinsed; then the flesh-side scraped, thrown into the pails, and thus alternately from the leg to the pails, till they leave the water quite clean: then they are put in luke-warm water, with the sumach as before, and after 12 hours rinsed in clear water, and scraped on the leg on both sides, pounded in pails, and the water changed three times; then wrung, and stretched on the leg, and passed after each other into water, with allum dissolved in it. Thus allumed, they are left to drain till the morning, then wrung out, pulled on the leg, and folded from head to tail, the flesh inwards.

In this state they received their first dye, by passing them after one another into a red liquor, prepared with lacca, and some other ingredients, kept secret among the *Moroquineers*. This they repeat again and again, till the skins have got their first colour: they are then rinsed in clear water, stretched on the leg, and left to drain 12 hours; thrown into water, into which white galls pulverized

rized have been passed through a sieve, and stirred incessantly for a day with long poles, taken out, hang on a bar a-crofs the water all night, white against red, and red against white, and in the morning the water stirred up, and the skin returned into it for 24 hours.

## C U T L E R Y.

**C**UTLERY is the art of making knives, razors, scissars, lancets, and all other edged tools and instruments.

This art is divided by workmen into several branches; some *Cutlers* make only knives, and understand little, or nothing of the other branches; others razors; others lancets; others instruments of surgery; others tools for joiners, carpenters, sculptors, &c. with this difference, that those who can make lancets, and other instruments, can likewise make razors, knives, scissars, penknives, &c. whereas few of those who make knives, or scissars only, don't understand how to make a good razor, a lancet, or any other instruments.

The shop of a *Cutler*, practising any of the above-mentioned branches of *Cutlery*, must be fitted with a forge, anvils, hammers, round whet-stones of different sizes and grain, some coarser, some finer; a large wheel, in the form of a spinning one, to turn round the stones, and the polishing tools, a sink, to keep the water, with which the whet stones are wetted, and on which they are fixed; besides the whet-stones, and the polishing wheels, made of walnut-tree an inch thick, and of a diameter at pleasure: the *Cutlers* for razors, lancets, and other such instruments, must also have hones, to set those instruments upon.

The chief art of *Cutlery* consists in forging, tempering, and polishing well the work.

A *Cutler* cannot use too much precaution, in forging his work; not only in giving it a proper shape, and suitable to the instrument he designs to make, that it may both be useful, and strike agreeably to the eye; but likewise that heat necessary to render it fit for tempering: which heat must neither be too cold nor too hot. For if too cold the igneous particles do not penetrate intimately enough, those of the work, to dispose them to

that closer coadunation, which they must acquire in the tempering; and if too hot, it would red-scar, and crackle, and thereby cause a very great deformity in the piece of work.

The tempering of the work (which is done to render it more compact, hard, and firm; or even more soft, or pliant, according to the respective occasions) is to plunge it, while red-hot, in some liquor, prepared for the purpose: sometimes into pure water, and in effect, locksmiths, &c. scarce use any other; sometimes into a composition of divers juices, liquors, &c. which is varied according to the manner, and experience of the workman; as vinegar, mouse-ear-water, nettles, or Spanish raddish-water, the water oozing from broken glasses, foot, salt, oil, distilled wine, sal-ammoniack, &c. A French *Cutler*, told me once, that there could be no better tempering than tallow.

To harden and temper English, Flemish, and Swedish steel, we must give them a pretty high heat, then suddenly quench them in liquor, to make them hard; but Spanish and Venice steel, will need but a blood-red-heat, before it be quenched.

After the instrument has been tempered, it is grinded upon a grind-stone, or whet-stone, to take off the roughness, and to form the edge; which done, it is polished on the polisher (turned by the great wheel) with emmery and putty: And lastly, (if it be a razor, lancet, &c.) it is set on the hone; and rubbed afterwards, on a strap of leather, prepared for that purpose.

The making of *Sword-blades*, and *foils*, is also another branch of *cutlery*, different from all others. *Sword-blades*, are commonly forged, with the help of a mill, which works heavy hammers for that purpose.

## Of DAMASKEENING.

**D**AMASKEENING, is the art of adorning iron and steel, by making incisions therein, and filling them up with gold or silver-wire; first practised at *Damascus* in *Syria*, and chiefly used in enriching sword-blades, guards, and grips, locks of pistols, &c.

*Damascening*, is partly mosaick work, partly engraving, and partly carving. As mosaick work, it consists of pieces inlaid; as engraving, the metal is indented, or cut in *creux*; and, as carving, gold and silver are wrought thereby in *relievo*.

There are two manners of *damaskeening*; in the first, which is the most beautiful, the artist cuts into the metal with a graver, and other tools, proper for engraving on steel; and afterwards fills up the incisions, or notches, with a pretty thick silver, or gold-wire. In the other, which is only superficial, they content themselves to make hatches, or strokes across the iron, &c.

For the first manner of *damaskeening*, it is necessary, the gravings and incisions, be made in the dove-tail form, that the gold or silver-wire, which is thrust forcibly into them, may adhere the more strongly.

The second method is the most usual, and practised, by heating the steel till it changes to a violet, or blue colour, hatching it over and across with a knife; then drawing the design, or ornament intended, on this hatching, with a fine brass point, or bodkin. This done, a fine gold or silver-wire is taken, and conducting, or chasing it according to the figures already designed, it must be sunk carefully into the hatches of the metal, with a copper tool.

This art of *damaskeening*, was much in vogue in the two last centuries, but is so much disregarded in ours, that we find no artificers capable to imitate the curious pieces of workmanship we have left in that taste.

*Chasing*, or *cuchasing*, is used in lieu thereof; for those pieces, which in past ages were *damaskeened*, as guards, and grips of swords, &c. and which is the art of enriching and beautifying gold, silver, and other metal works, by some design, or figures, represented thereon, in low *relievo*.

*Chasing* is only practised on hollow, thin works; as watches, cane-heads, tweezer-cases, or the like. It is performed by punching, or driving out the metal, to form the figures from within side, so as to stand out prominent from the plain, or surface of the metal. In order to this, they have a number of fine steel blocks or puncheons, of divers sizes; and the design being drawn on the surface of the the metal, they apply the inside upon the heads or tips of these blocks, directly under the lines or parts of these figures. Then with a fine hammer, striking on the metal sustained by the block, the metal yields, and the block makes an indenture, or cavity on the inside; correspondent to which, there is a prominence on the outside, which is to stand for part of the figure. Thus, the workman proceeds to *chase*, and finishes all the parts by successive applications of the block and hammer, to the several parts of the design. And it is surprizing, with what beauty, and exactness, by this simple piece of mechanism, the artists, in this kind, will represent foliages, grotesques, animals, histories, &c.

## Of D A N C I N G.

**D**ANCE is an agreeable motion of the body adjusted by art to the measures, or tune of instruments, or of the voice.

*Dancing*, has always been in use among all nations, both civilized and barbarous; though held in esteem among some, and in conempt among others. Almost every body is of opinion, that of itself, *dancing* is harmless. There is a time, says the preacher, to *dance*, and sometimes it is even made an act of religion. Thus *David* danced before the ark, to honour God, and exprefs his excess of joy for his return into the city of *Sion*. *Socrates* learned to *dance* of *Aspasia*; and the people of *Crete* and *Sparta* went to the attack *dancing*. On the other hand, *Cicero* reproaches *Gabinus*, a consular man, with having *danced*. *Castor* and *Pollux* are said to be the first who taught the art of *dancing*; and that to the *Lacedemonians*: though others attribute the invention to *Minerva*, who *danced* for joy after the defeat of the giants.

The antient had three kinds of *dances*, the first grave, called *emmelia*, answering to our low *dances* and pavaues; the second gay, called *cordax*, answering to our courants, galliards, gavots, and vaults; the

third called *sicinis*, was a mixture of gravity and gaiety. *Neoptolemus*, son of *Achilles*, taught the *Cretans* a new sort of *dance*, called *pirricha*, or the *armed dance*, to be used in going to war; altho' according to the Mythologists, the *Curètes* first invented this *dance*, to amuse and divert the infant *Jupiter*, with the noise and clafh of their swords, beating against their bucklers.

*Diodorus Siculus*, in the 4th of his *bibliotheca*, assures us, that *Cybele*, daughter of *Meneas*, king of *Phrygia*, and *Dindymenis*, his wife, invented divers things, and among others, the flageolet of several pipes, *dancing*, the tabor, and the cymbal. It is certain, that *Numa* instituted a sort of *dance* for the *Salii*, priests of *Mars*, who made use of weapons therein. From these *dances* were composed another, called *saltatio mimicorum*, or the *buffoon's dance*; wherein the dancers were dressed in little corsets, with gilt morions, bells on their legs, and swords and bucklers in their hands.

The chief end of the art of *dancing*, is, that a person should learn to present himself in company, with an easy and unaffected air, and to step gracefully; the generality of mankind, consider *dancing*,

as a noble exercise, or diversion, practis'd with pleasure by persons of all ranks and conditions, even by princes and heroes.

*Dancing* is not like several other arts, for it cannot be learned perfectly, without the assiduous attendance of a master, and a continual practice. A beginner, or pupil, besides the voice of his master, singing to his ears, one two, one two three, &c. must be led by him, by the hand, as an infant who learns to walk, that he may step forward, stop, *cadence*, and bow his knees, when wanted. The man, in a *minuet*, *rigatoo*, &c. must have a gentle motion of his hands, but only as if it was natural, and without the least affectation; and the woman must let fall her hands as gently, close to her sides, the head modestly erect-ed, also without affectation; both enlivening and cadencing their steps, according to the measures of the instruments.

A *country-dance* is nothing but a couplet, or part of a *dance*, always repeated, first by two, by four, six, eight, ten, &c. and at last, by as many couple as the number of people amounts to. I call *couple*, the man and the woman that figure together. A *couplet*, in *country dances*, is a certain quantity of figures that fill up the tune: the same *country dance*, may have several couplets or parts, which are like several verses of songs upon the same tune.

Each couplet of a *country dance*, is divided by figures, *viz.* 1 fig. 2 fig. 3 fig. 4 fig. 5 fig. &c. The first figure is always that by which one begins, and goes on till you arrive at the last, which will be the end of the part, and is to be repeated, not only by them who have begun, but also by all the other couples, who must follow the same way as the first, and shall likewise continue in the same order, till every body be arrived at the same place, from whence they begun; and then the whole part will be entirely finished, and every couple make their honour as they finish. But if there be a second part, you must instead of making your honour, go on in the same order, as you have done in the first, and put off making your honour, till you come to the end of the last part.

*Country dances*, are *danced* with as many persons as you please, provided it be an even number, I mean as many men as women, placed upon two lines, the men on one side, and the women on the other, of which all the couples ought to be distinguished,

*viz.* first couple, second, third, fourth, fifth, sixth, couple, &c

There are two chief designs of *country dances*, upon which all the different figures, that may be invented, are founded. The first design, is, that every person, whatever figure he makes, ends all the repetitions to the same side; that is to say, that the man must not change his place, but with another man, and the woman, but with another woman. The second design, is, when the men end all their repetitions in the women's places, and the women in the men's places.

In the first design, four things are to be observed  
1. When a couple have begun to *dance*, they must not give off till they are come down to the last couple.  
2. Every repetition must begin always at the first couple, at the upper end of the room, and end at the second couple, then to the third couple, to the fourth, &c. and so to come down from couple to couple, till you arrive to the last couple; where then all the repetitions of the last couple are at an end; and that couple *dances* no more, till another couple coming down, in their turn they move up.  
3. That a couple ought not to begin to *dance* till they are come into the first couple's place.  
4. That a couple that is come to the first couple's place, must not begin to *dance*, till the preceding couple have made two repetitions before.

It must be observed, likewise, that every time that a couple end their repetitions under another couple, the couple that is above must move up, and take the place of them that go down.

In the second design, there are also four things to be observed.  
1. When a couple begins to *dance*, from whatever place they begin, they must not discontinue, till they are arrived, not only to the last couple's place, but also to the very place where they have begun.  
2. Every time that a repetition begins again, the same increases always by couples, so that the *dance* which before was but of two, comes to be of four, then of six, of eight, ten, &c. till every body be in motion.  
3. When a couple comes into the first couple's place, they must follow the same way which the preceding couples have gone.  
4. When a couple is come down to the last couple, and finds there nobody more to *dance* with, then that same couple *dances* again together, and afterwards moves up, always *dancing*, till they come to the same place where they have begun, and then all the repetitions of that couple are at an end.

## Of D E S I G N I N G.

**D**ESIGN is used in painting, for the first idea of a large work, drawn roughly, and in little, with an intention to be executed and finished in large.

It is the simple contour, or outlines of the figures intended to be represented, or the lines that terminate and circumscribe them: such design is sometimes drawn in crayons, or ink, without any shadows at all; sometimes it is hatched, that is, the shadows are expressed by sensible outlines, usually drawn across each other with the pen, crayon, or graver. Sometimes, again, the shadows are done with the crayon rubbed so as that there do not appear any lines: at other times, the grains or strokes of the crayon appear, as not being rubbed: sometimes the design is washed, that is, the shadows are done with a pencil in indian ink, or some other liquor; and sometimes the design is coloured, that is, colours are laid on much like those intended for the grand work.

The essential requisites of a design are correctness, good taste, elegance, character, diversity, expression, and perspective. Correctness depends on the justness of the proportions, and knowledge of Anatomy. Taste is a certain manner of correctness peculiar to one's self, derived either from nature, masters, or studies, or all of them united. Elegance gives a delicacy that not only strikes persons of judgment, but communicates an agreeableness that pleases universally. The character is what is peculiar to each thing, wherein there must be diversity, inasmuch that every thing has its peculiar character to distinguish it. The expression is the representation of an object, according to the circumstances it is supposed to be in. Perspective is the representation of the parts of a painting, or a figure, according to the situation they are in with regard to the point of sight.

The design or draught, is a part of the greatest import and extent in painting. It is acquired chiefly by genius and application, rules being of less avail here than in any other branches of the art, as colouring, &c. The principal rules that regard design are, that novices accustom themselves to copy good originals at first sight; not to use squares in drawing, lest they stint and confine their judgment; to design well from life, before they practise perspective, to learn to adjust the size of their figures to the visual angle, and the distance of the eye from the model or object; to mark out all the parts of their design before they begin to shade;

to make their contours in great pieces, without taking notice of the little muscles, and other breaks; to make themselves masters of the rules of perspective; to observe the perpendicular, parallel, and distance of every stroke. to compare and oppose the parts that meet and traverse the perpendicular, so as to form a kind of square in the mind, which is the great and almost the only rule of designing justly; to have a regard not only to the model, but to the parts already designed, there being no such thing as designing with strict justness, but by comparing and proportioning every part to the first. All the other rules relate to perspective.

There are several methods of designing mechanically. The following is the method of the learned Sir CHRISTOPHER WREN, and may be put in practice with great ease.

A is a small sight, with a short arm B (See plate of MECHANIC ARTS) which may be turned round about, and moved up and down the small cylinder CD, which is screwed into the piece ED, at D; this piece ED moving round about the center E, by which means the sight may be removed either towards E or F.

FF is a ruler fastened on the two rulers GG, which rulers serve both to keep the square frame SSSS perpendicular, and, by their sliding through the square holes TT, they serve to stay the sight, either farther from, or nearer, to the said frame; on which frame is stuck on, with a little wax, the paper OOOO, whereon the picture is to be drawn by the pen I. The pen I is, by a small brass-handle V, so fixed to the ruler HH, that the point I may be kept very firm, so as always to touch the paper. HH is a ruler that is constantly, by means of the small strings *aaa*, *bbb*, moved horizontally, or parallel to itself; at the end of which is stuck a small pin, whose head P is the sight, which is to be moved up and down on the out-lines of any object.

The contrivance of the strings is this: the two strings *aaa*, *bbb*, are exactly of an equal length. Two ends of them are fastened into a small leaden weight, which is employed in a socket on the backside of the frame, and serves exactly to counterpoise the ruler HH, being of an equal weight with it. The other two ends of them are fastened to two small pins HH, after they have rolled about the small pulleys MM, LL, KK, by means of which pulleys, if the pen I be taken hold of, and moved up and down the paper, the string moving very easily,

the ruler will always remain in an horizontal position.

The manner of using it is this: set the instrument upon a table, and fix the sight A at what height above the table, and at what distance from the frame SSSS, you please. Then looking thro'

the sight A, holding the pen I in your hand, move the head of the pin P up and down the out-lines of the object, and the point of the pen I will describe on the paper OOOO the shape of the object so traced.

## Of DIALING.

**D**IALING is the art of drawing schemes upon a plane or surface of any given body, so contrived as to find out the measure of just time, by the sun, moon and stars.

The antiquity of *dials* is beyond doubt: some attribute their invention to *Anaximenes Milesius*; others to *Thales*. *Vitruvius* mentions one made by the ancient *Chaldee* historian *Berosus*, on a reclining plane, almost parallel to the equinoctial. *Aristarchus Sanius* invented the hemispherical *dial*. And there were some spherical ones with a needle for a gnomon. The discourse of *Aristarchus* was an horizontal *dial*, with its limb raised up all around, to prevent the shadow stretching too far: but it was late ere the *Romans* became acquainted with *dials*. The first *sun dial* at *Rome* was set up by *Papirius Cursor*, about the year of the city 460, before which time, says *Pliny*, there is no mention of any account of time, but by the sun's rising and setting; it was set up at or near the temple of *Quirinus*, but went ill: about 30 years after, *M. Valerius Messala* being consul, brought out of *Sicily* another *dial*, which he set up on a pillar near the *Rostrum*; but for want of its being made for that latitude, it could not go true. They made use of it 99 years, till *Martius Philippus* set up another more exact.

But there seem to have been *dials* among the *Jews* much earlier than any of these. Witness the *dial* of *Abaz*, who began to reign 400 years before *Alexander*, and within 12 years of the building of *Rome*.

The first professed writer on *Dialing*, is *Clavius*, who demonstrates all, both the theory and the operations, after the rigid manner of the ancient mathematicians; but so intricately, that nobody, we dare say, ever read them all. *Dechales* and *Ozanam*, give much easier in their *courses*, and *Wolffius* in his *elements*. *M. Picard* has given a new method of making large *dials*, by calculating the hour lines; and *M. de la Hire*, in his *dialing*, printed in 1683, a geometrical method of drawing hour lines, from certain points determined by observation. *Eberhardus Welperus*, in 1625, published his *dialling*, wherein he lays down a method of drawing the primary *dials* on very easy foundation:

the same foundation is described at length by *Sebastian Munster*, in his *Rudimenta Mathematica*, published in 1551. *Sturmius* in 1672, published a new edition of *Welperius's dialing*, with the addition of a whole second part, about inclining and declining *dials*, &c. In 1708, the same work with *Sturmius's* additions, was republished with the addition of a fourth part, containing *Picard's* and *de la Hire's* methods of drawing large *dials*, which makes much the best and fullest book on the subject.

In order to perform this art, it will be necessary to be thoroughly acquainted with the circle of the sphere, which is an instrument (as we have already observed in our treatise of *Astronomy*) whereby we explain the daily motion of the celestial bodies, according as they appear to us to move always from east to west, and also the proper motion of the sun, which moves from west to east, and makes its revolution through the twelve celestial signs, in the space of one year. We will only describe here, those circles of which the sphere is composed, that belong to our present subject: those circles, whose planes pass through the center of the earth, are called great circles of the sphere, and all the others are less; but before we speak of these circles, we ought to consider the axis of the sphere, which we have already conceived to be a straight line, about which the instrument is turned. The earth is placed in the middle of this instrument, and consequently the axis passes through the center thereof. The plane of the equinoctial circle, or equator, is at right angles to the axis, and we have been informed in our treatise of *Astronomy*, that this circle divides the sphere into two equal parts, whereof one is called septentrional, and the other meridional. The ecliptic, is another great circle, whose plane makes an angle with the equinoctial, of 23 degrees 30 minutes; the sun moves under this circle, going from the west towards the east, and makes one entire revolution in 365 days and near 6 hours. The inclination of this circle towards the equinoctial, causes the different declinations of the sun, in regard to the equinoctial: it is divided into twelve equal parts, called signs; and we begin from the intersection thereof with the equinoctial, proceeding towards the north.

The *tropicks* are two circles parallel to the *equinoctial*, which touch the *ecliptick* in the points of its greatest distance from the *equinoctial*; therefore these circles are distant from the *equinoctial* 23 degrees 30 minutes, on one side towards the north, and on the other side towards the south; so that it is manifest, that when the sun is in the common intersection of the *ecliptick* and *equator*, the motion of the *sphere* about its *axis*, which goes from east to west, and is called the motion of the *primum mobile*, makes him appear to us in the *equinoctial*; and also when he is in his greatest distance of the *equinoctial*, the same motion of the *primum mobile* makes him appear to us to move in the *tropicks*. The *zenith* is an imaginary point in the *sphere*, marked by a strait line coming from the center of the earth, and passing by some place of the superficies thereof. This line is called the vertical line of that place. The *horizon* is a great circle, whose plane cuts the vertical line, at right angles. The *horizon* of a place distinguishes the visible part of the heaven of that place, from that part of the heaven which is not there seen. The *meridian* is a great circle which passes through the *poles* and *zenith*, the plane whereof, at right angles with the planes of the *equinoctial* and *horizon*; because this circle passes through the *zenith* and *poles*.

If we suppose the *equinoctial* to be divided into 24 equal parts, beginning from the *meridian*, the 6th and 8th part shall fall on the intersections of the *horizon* and *equinoctial*, because the *meridian* and *horizon* are at right angles to one another; and if we imagine other circles, like the *meridian*, that is to say, that pass through the poles of the world, and point of division of the *equinoctial*; those circles, which we call *meridians*, shall be the hour circles, among which is the *meridian* of the place whereof all the planes intersect one with another in the *axis*. We may also conceive others, which divide each parts into two, or four, to mark the half hours, and quarter hours; for if we suppose these circles to be fixed, then when the *primum mobile*, turns the sun with his *ecliptick* about the *axis*, the time of his apparent course shall be divided into hours, halves, and quarters, by these *meridians*. Also we number the declination of the sun, upon the like *meridians*, which do all intersect the *equinoctial* at right angles, which we make to pass through the center of the sun in the *ecliptick*: we number this declination from the *equinoctial* towards the poles; therefore, if it is either south or north, the angles of declination are measured by arches or circles.

Those circles that pass through the vertical lines, are called vertical circles, or *azimuth*, and their planes are perpendicular to the plane of the *horizon*;

they serve to measure the height of the sun above the *horizon*, which is numbered from the *horizon* towards the *zenith*.

It is manifest from that which has been said before, that there are infinite *horizons* and *meridians*, and that there are only these two great circles, which may change according to the different places on the earth, for they are established by the vertical line. The amplitude of rising or setting, is counted on the *horizon*, beginning from the points where the *equinoctial* cuts the *horizon*, and is numbered towards the south or north. If we conceive that in the revolution of one day the *horizon* moves, as being fastened to the *axis*, so as it cannot change its inclination, then when it shall pass by the 24 equal divisions of the *equinoctial*, it shall represent the 24 circles of the *Italian* or *Babylonian* hours.

There are different sorts of *sun dials*, which diversity arises from the different situation of the plane, and the different figure of the surfaces, whereon they are described; whence they become denominated, *equinoctial*, *horizontal*, *vertical*, *polar*, *direct*, *erect*, *declining*, *inclining*, *reclining*, *cylindrical*, &c.

We will begin with a *sun dial*. The principal parts of a *sun dial* are the center of the *dial*, and the different lines it is divided into. The center of the *dial* is any point taken on the superficies of the earth, and considered as its center in relation to the motion of the sun; therefore, if we place a style (which is a pointed rod) upon any plain surface, and then consider the point of that style, as the center of the earth, the intersection of that surface, with the planes of the hour circles, of the *equinoctial* or *equator*, of the *horizon*, and of the other great circles, shall be strait lines, which retain the names of the planes of the circles from whence they are produced. All these lines on that plain surface with the style, make the *sun dial*. The shadow of the point of the style, which is one of the points of the *axis*, shews the hours: and if the *axis* which passes by the points of that style, meets with the plane of the *dial* in any point, that point is called the *center* of the *dial*; for it is evident that all the hour lines shall meet in that point. It is also evident that the shadow of the point of the style gives the hours, and shews when the sun meets with any one of the circles of the *sphere*; for when the sun comes to a great circle, the shadow of the *axis* is extended in the plane of that circle, if that circle passes by the *axis*; and if it passes not by the *axis*, the shadow of the point of the style shall be in the plane of that circle; for the planes of great circles pass by the point of the style.

If we conceive a conical superficies, which has for its base a less circle of the *sphere*, and for its *vertex* the point of the style, that conical superficies shall meet the surface of the *dial* in a curve line; so as when the center of the sun shall touch that less circle, which is the base of the conical superficies, the shadow of the point of the style shall touch the curve line, which is the meeting of that curve superficies with the plane of the *dial*; for the point of the style is on that superficies whereof it is the *vertex*. The foot of the style is that point on the plane of the *dial*, which is the meeting of a strait line drawn perpendicularly to that plane, and which passes by the point of the style.

If the plane of the *dial* be considered as the plane of the *horizon* of any place, the strait line that passes by the point of the style, and by its foot, shall be the vertical line of that place; and the plane that passes by the vertical and by the *axis* shall be the proper *meridian* of that place, considered as the *horizontal* of a place.

The meeting of the *meridian* and surface of the *dial*, is called the *substylar line*, or the *meridian* of the plane or surface of the *dial*, which we ought to distinguish from the *meridian* of the place, which is the meeting of the *meridian* proper to that place, and of the surface of the *dial*, at least if they be not coincident, which happens when the *dial* does not decline from the east or west. We see by the position of these lines, that the *substylar line* is always at right angles with the *equinoctial line*.

We ought to make the *dial* so as the foot of the style be not incumbered, for that point serves for many operations; therefore, the style must be planted a little obliquely upon the surface. By the height and length of the style, is understood the strait line drawn from the point to the foot thereof. The arches of the *signs* on the surface of the *dial*, are the descriptions of the parallels to the *equinoctial*, which pass through the 12 equal divisions of the *ectiptick line*, which shews the beginning of the signs.

How to find those principal parts, and how to mark or draw those lines; or rather, how to reduce the *Art of Dialing* into practice, is our next enquiry.

This practice has for its chief foundation, the marking exactly the *points of shadow*, which the *penumbra* renders very difficult; but which, however, can be effected two ways.

The first is to fit a small round plate to the point of the style, which may be parallel to the plane of the *dial*, whereof the center may be joined to the point of the style; then having drawn the shadow of the said plate on the plane of the *dial*, take the middle of that shadow, which shall be the shadow

of the end of the style, at the same time when we observed the shadow of the plate.

The second way is to make a small round hole in a little piece of paste-board, or thin plate, or other like body, and having applied it to the end of the style, so as the center of the hole may be joined to the point of the style, and that the small plate may regard the sun perpendicularly; the light of the sun shining through the hole, shall make a clear circle, or oval, DE, Fig. 2. in the shadow of the plate on the plane of the *dial*, which we draw on the said plane; and if it be an oval, having drawn a strait line, DPE from the point P; which is the foot of the style, whereof P is the point, which may pass through the center of that oval, and cut it in D and E, or draw DG and EF, parallel to one another, and making any angle with DE, DG being made equal to DS, and EF, equal to ES, the line GF, shall cut DE, in the point A, which shall be the shadow of the point of the style S, at that time when the oval was drawn. But we may take the center of the oval for the point A, without falling into any sensible error, as we may see by the operation in the plate. But if the shadow be a circle, the center of that circle shall be the shadow of the point of the style.

After we have marked the points of shadow, we must draw the *horizontal line*, by applying a rule, Fig. 3. AS, so as one of the edges thereof may be level, and touch the point S, of the style, which is planted upon the plane of the *dial*, and that end of the edge of the ruler, may touch the plane of the *dial* at the point A, which shall be one of the points of the *horizontal line*. By the point A, we draw a level line on the plane of the *dial*, which shall be the *horizontal line*.

From this we pass to the *substylar line*, which is easily found by the amplitude of the sun's rising and setting upon the plane of the *dial*, in this manner: when the sun begins to rise on the plane of the *dial*, we must mark the shadow of a small thread extended from the foot of the style to its point; and do the same when the sun sets on the plane of the *dial*, the angle comprehended between these two lines of shadow, whose *vertex* is at the foot of the style, being divided into equal parts, shall give the *substylar line*.

The *substylar line* being made, we find the *center of the dial*, by placing a style on the plane of the *dial*, whose foot we suppose to be P, and point S, Fig. 4. and the point of shadow A, and *substylar line* CP, we make the angle  $dSa$ , equal to the sum or difference of a right angle, and of the sun's declination;  $Sa$  being made equal to SA, we take any point, as  $d$ , upon the line  $Sd$ , and draw the

frait line  $a d$ . From the point  $A$ , we draw the frait line  $A R$ , perpendicular to the *substylar line*  $C P$ , and from the same point  $A$ , as a center, and at the distance  $a d$ , we describe the arch  $N$ , cutting the *substylar line* in  $N$ . From the point  $R$  as a center, and at the distance  $R N$ , we describe the arch  $N D$ ; then we erect the perpendicular  $P Z$  at right angles to the *substylar line*, and equal to  $P S$  the height of the style, then from the point  $Z$ , as a center at the distance  $S d$ , describe the arch  $G D$  cutting the arch  $N D$  in  $D$ : the line  $Z D$  determines the situation of the *axis*, in respect of the *substylar line*, and if it meets at the *substylar line*, as at the point  $C$ , that point  $C$  shall be the center of the *dial*.

The center of the *dial* being found, we'll draw the *equinoctial line*, by drawing the frait line  $Z E$ , perpendicular to  $Z D$ , meeting the *substylar line* in  $E$ ; the line  $V E$  perpendicular to the *substylar line* drawn through the point  $E$ , shall be the *equinoctial line*.

Our next operation is to place the *substylar* and *equinoctial lines*, and the center of the *dial*, and to determine the position of the *axis* (any two points of shadow being given, with the declination of the sun at the time of observation of the points of shadow) which cannot be done without having placed, first, a style on the plane of the *dial*, whereof the point may be  $S$  and  $P$ . Fig. 5. the foot, and any two points of shadow,  $A$  and  $B$  taken at pleasure; making, besides, upon a certain plane, the angle  $d S a$ , equal to the sum or difference of a right angle, and that of the declination of the sun, on that day on which the points of the shadow were marked, according as the declination is north or south; for we will have a point of the *substylar line* as  $Q$ , which may answer to a point of the *axis*, which may be more north than the point of the style; we must make the angle  $d S a$ , equal to the sum of a right angle, and angle of the declination of the sun, if the declination be north; but equal to the difference of a right angle, and angle of the declination if it be south.

This done, we'll take two small rods of any firm matter, as of wood of a sufficient thickness, or of iron; and make them pointed at the ends, and equal in length to the frait lines  $a d, b d$ ; it is not material whether they be frait or crooked, if the distances between their points be equal to  $a d$  and  $b d$ . We'll put one of the points of that rod which is equal to  $a d$ , on the point of shadow  $A$ , and one of the points of the other rod to the point of shadow  $B$  and join them together by the other points, but so as the points that are joined together, may approach or fall back from the point of the style, without altering the other

points of the rods, which are set on the points of shadow  $A$  and  $B$ ; then we take with the compasses, or otherwise, the distance between the points  $a$  and  $d$ , and set that distance between the points of the style and the points of the rods that are joined together: by this means the common points of the rods being fixed, shall be one of the points of the *axis*, which ought to pass by the point of the style, therefore the situation of the *axis* shall be determined.

By the common point of the rods so fixt, which I call  $D$ , having drawn a line perpendicular to the plane of the *dial* which shall meet it in the point  $Q$ , the line  $P Q$  shall be the *substylar line*. The point  $C$ , on the plane of the *dial*, where it is met by the line  $D S$ , drawn by the point of the style,  $S$ , and by the end of the rod  $D$ , shall be the center of the *dial*; from whence we may draw the *equinoctial line* in the manner above-mentioned.

But suppose we had but one single point of shadow given, with the declination of the sun, and the height of the pole above the horizon; we must place the *substylar line*, the center of the *dial*, and the *equinoctial line* in the following manner:

Having placed a style upon the plane of the *dial*, whose point may be  $S P$ , Fig. 6. the foot, and  $A$  one point of the shadow, we draw a horizontal line, in the manner above demonstrated, and by the point  $P$  draw the lines  $B P H$ , perpendicular to the horizontal line  $b H$ , and  $P Z$  parallel to  $H b$ , and equal to the height of the style  $P S$ ; then from the point  $H$ , where  $P H$  meets with the horizontal line, we draw  $H Z$  and  $Z B$  perpendicular to  $Z H$ , which shall meet with  $H P$  at the point  $B$ ; if the horizontal line passes not through the point  $P$ , first we let it meet at the point  $B$ .

Then we make the angle  $d S a$ , upon some plane, equal to the sum or difference of a right angle, and of the declination of the sun at the time when the point of shadow was observed; and make the angle  $d S b$  equal to the sum of a right angle, and the height of the pole above the horizon. Taking afterwards at pleasure, the point  $d$  on the line  $S d$ , we make  $S b$  equal to  $Z B$ , and  $S a$  equal to the length of the shadow from the point of the style  $S$  to the point of shadow  $A$ , and draw the frait lines  $a d, b d$ . By the points  $A$  and  $B$  we draw the frait line  $A B$ , and from the point  $B$ , as a center, at the distance  $b d$ , we describe the arch  $f b$ , either above or below the line  $A B$ ; and likewise from the point  $A$  as a center, and at the distance  $a d$ , describe the arch  $g d$ , cutting the arch  $L F$  at the point  $L$ , and from the point  $L$  draw the frait line  $O L$  perpendicular to  $A B$ .

From the point  $O$  as a center, at the distance  $O L$  we describe the arch  $D L$ ; and from the point  $P$  draw

P draw the strait line P G K, perpendicular to O L; and from the same point P, at the distance d S, describe the arch I, either on the one or the other side of G, cutting the line L O at the point I. Then we make G K equal to P S, the height of the *style*, and from the point K, at the distance G I describe the arch R D, cutting the arch D L in D, and from the point D draw the strait line D Q perpendicular to L b, and the line P Q, which passes through the points P and Q, is the *substylar line*. If the point Q be too near to P, we may find another, by taking another point d on the line f d; consequently we place the *equinoctial line*, and the center of the *dial*, as we have done it in the preceding practices; having this advantage, besides, that the line which passes through the point B, and through the center of the *dial*, shall be the *meridian line*.

If the *horizontal line*, passes through the point P, or if the point B be too far distant from the point P, we must fasten another *style* upon the plane of the *dial*, whereof the point may pass by the line of the plummet hanged from the point S of the *style*, the point of that second *style* being called B, we perform the operation as before to find the lines d a, d b; but we may use the small rods above-mentioned, otherwise the operation would be too long.

Next we must endeavour to find the points of the hours of 6 and 12 on the *equinoctial line*, Fig. 14. and to draw the *meridian line*, which must be done by supposing P S to be the height of the *style*, whereof P is the foot, and S the point; and supposing, likewise, N S to be the *horizontal line*, and M N the *equinoctial line*; the point N where the *equinoctial line* meets with the *horizontal line*, is the point where the hour of 6 intersects the *equinoctial line*.

From the center N, and at the distance N S, equal to the height of the *style*, we describe the arch K H, and taking any point as O, in the *equinoctial line*, for a center, at the distance O S we describe the arch I H intersecting the arch K H in H, then draw the strait line N H, and H M perpendicular to N H, the point M where H M meets the *equinoctial line*, is the point where the *meridian line* ought to intersect the *equinoctial line*.

Then having hanged up a line with a plummet f, so as the line may pass by S the point of the *style*, we mark any point as C on the plane of the *dial*, so as we may see with one eye, the points M and C both hid together by the line of the plummet, this is called burning, and the line M C shall be the *meridian line*. But if the center of the *dial* was given, and that it was the point C, we must mark some point, as M, on the plane of the *dial*,

which we may see to pass by the line of the plummet, with the point C, and the line C M shall be the *meridian*. We may also draw this *meridian line* in the night with a candle, in holding it at a distance from the line of the plummet, so as the shadow thereof may pass by M, or by the point C, which of them is given; for the shadow of that line shall be the *meridian line*.

When only one point of shadow is given with the height of the pole, and the declination of the sun, we draw the *meridian line*, and find the point of the hour-line of 6, on the *horizontal line*, by placing a *style* on the plane of the *dial*, whose point be S, and the foot P. Fig. 15. drawing the *horizontal line* H b; and from the point P drawing likewise P H perpendicular to H b; drawing afterwards P Z parallel to H b, and equal to P S the height of the *style*, and making H E equal to H Z.

Then having marked the point of shadow A, as far from noon as it is possible, we hang a plummet T, so as the line thereof may pass by S the point of the *style*, and burn it (as we did in the foregoing practice for the *meridian*) marking the point b on the *horizontal line*, by which we see the line pass, then when it also passes by the point of the shadow A, we draw the strait line b E; drawing afterwards an arch of a circle Z o f on the center C at any distance, and making Z o equal to the height of the pole above the *horizon*, and drawing the lines o c, z c, to c the center of the circle.

We then make the arch o m equal to the declination of the sun, at the time when the point of shadow was made towards Z, if the sun be in the north signs, and towards f if it be in the south signs, for those that have their *zenith* in the north part of the sphere; but on the contrary, for those that have it in the south part; and draw a m parallel to o c. We afterwards draw c f perpendicular to c z, from the center c, and make the angle d c f, equal to the angle b S A, and draw the line d e parallel to f c, meeting c z in o, and a m in a.

On the point E, as a center, at the distance d e, we describe the circle B D, meeting E b (prolonged if it be necessary) at the point B; we make B M equal to d a, and from M raise D M, perpendicular to E B, intersecting the circle B D in D, then drawing E D (prolonged if it be necessary) and the point f where it intersects the *horizontal line*, shall be the point of the *meridian* upon the *horizon*; and E G being drawn perpendicular to E D, gives the point G, where the hour-line of 6 meets with the *horizontal line*.

The Line M D, which is drawn perpendicular to B E, may meet with the circle B D on either side of the point B; but we must take care that if the point of shadow A, is marked before noon, to make

make use of the point D, which is on the right hand of the point B, as in the example; and if the point A was marked after noon, we must take the point D where MD meets the circle on the left-hand of B, to have the position of the *meridian line*; if DE meets not with the *horizontal line*, but is prolonged towards E, the point F shall appertain to the line of midnight: all this must be understood of those that have their *zenith* on the north-side of the *equinoctial*, for it is contrary with those which have their *zenith* in the southern hemisphere. If the line ED meets not the *horizontal line*, being likewise prolonged towards E, then the *dial* shall have no line of mid-day, nor of mid-night, and the plane of the *dial* shall be either oriental, or occidental.

The angle HEF, made by the line ED, with the *horizontal line* EH, is the angle of the declination of the plane. By the foregoing practice, the *meridian line*, or the line of midnight, may be drawn by the point f.

Some of the foregoing operations may be abridged in the following manners.

1. Having found the *substylar line*  $pe$ , Fig. 18. and the *equinoctial line*  $ev$  for the style  $Sp$ , if we would remove the *substylar* and *equinoctial* lines to another place of the plane of the *dial*; the line PE parallel to  $pe$  shall be another *substylar line*, and VE parallel to  $ev$ , or perpendicular to PE, shall be the *equinoctial line*, and we determine by the following method, the position of a style for the two lines PE, EV, whereof the height shall be given of any length, or we will determine the height of a style, whereof the position shall be given upon the *substylar line* PE. First, we'll let the line AR be given for the height of the style, which ought to be set for the *substylar* and *equinoctial* lines PE, EV. We'll make EP equal to  $ep$ , and set it the same way, (that is, we'll set the point P above the point E, if the point  $p$  be above the point  $e$ ; and below it, if it be below it) and make EZ equal to  $ps$ , and EZ equal to RA given; and we'll draw  $zP$  and  $ZR$  parallel to  $ZP$ , meeting EP in R; and the point R shall be the foot of the style, the height whereof, RA, is given: therefore if we fix a style, whereof the foot may be R, and the distance between the point thereof A, and foot R may be the height equal to the line ZE, the proposition is satisfied: but if the point R were given for the foot of the style, and the height were required, we'll draw PZ as before, and by the point R, draw RZ parallel to Pz, and EZ shall be the height of the style, whose foot is the given point R.

2. The *substylar line* CE, the *equinoctial line* EV, and the *meridian line* CM, answerable to the

style SP, being given, we may take what point we will in the *substylar line*, ask for the center of the *dial*, without altering the *substylar line*, or *equinoctial*; and the line Km drawn parallel to CM, shall be the *meridian line*; but if the height and position of the style must be changed, by making Ez equal to PS, and drawing MP and PZ, and mR and RZ parallels to MP and PZ, and the point R shall be on the *substylar line*, which is the foot of the style, whereof the height RZ is perpendicular to the point R on the plane of the *dial*.

3. If the *substylar line* CE, was given with the *meridian line* CM, answering to the style PS, we may take any point, as  $p$ , to be the foot of a style, whereof the height is to be determined; or the style being given of any height, to determine the position of the foot  $p$ , without changing either the *meridian*, or the center of the *dial*. If the foot of the style be given, and we are to determine its height by the foot of the style P, for the finding of the *meridian* and *substylar line*, we'll draw PS, perpendicular to the *substylar line*, and equal to the height of the same style, drawing CS by the center of the *dial*, and from the given point  $p$ , drawing likewise  $ps$ , parallel to PS, till it meets CS in the point S, and  $pS$  shall be the length of the height of the style, which ought to be placed at the point  $p$ , and the *meridian* CM, and the center of the *dial* C, are not changed. But if  $pS$  were given for the height of the style, it must be put upon PS prolonged, if it be necessary, then Pz and zS must be drawn parallel to CP, to meet with the line CS in mS, and Sp being drawn parallel to SP, shall give the point  $p$ , on the *substylar line*, for the foot of the style required, whereof the height is given.

4. The *meridian* CM, Fig 19 being given, with the *equinoctial line* EM, we may find another *equinoctial* as  $eM$ , without changing the *meridian*, the which *equinoctial*  $eM$ , shall make the angle EMC, but we must find another style by the following method: If the center of the *dial* be given at the point C, having drawn (by the foot of the style  $p$ , which has served to find the *meridian* and the center C)  $pS$  perpendicular to the *substylar line* Cp, and equal in length to the same style, we'll draw  $eS$  parallel to  $eS$ , and from the point S, Sp parallel to Sp, meeting the *substylar line* in the point  $p$ , which shall be the foot of the style required, whereof  $pS$  shall be the height. But if we have not the center of the *dial*, we must draw the line Sf by the point S, which determines the inclination of the *axis* by the *substylar line*, and we shall find as before, the point  $p$  for the foot of the style required, whereof the height shall be  $pS$ .

5. If after we have drawn the *meridian line* CM, Fig. 20. and the *substylar line* B p, we cannot have the *equinoctial*, because the *style* has been put too long, we may diminish it as much as we please, without changing the foot thereof, or the *substylar line*; but we must find another *meridian* and another *horizontal line*, which may answer to that *style*, and these *meridian* and *horizontal lines*, shall be parallel to the *first meridian* and *horizontal lines*. Therefore we draw the line *em* by any point of the *substylar line* at *e*, which may be perpendicular to it; that line may be the *equinoctial line*: but the height of the *style* must be changed in drawing *eS* perpendicular to the line *Ss*, which determines the inclination of the *axis* with the *substyle*, and that line *eS* meeting *Sp*, which is perpendicular to the *substylar line* by the foot of the *style*, and which is its height, so that for the *equinoctial line em*, *pz* shall be the height of the *style* required; but there must be another *meridian* found, whether the center of the *dial* be found or not.

6. A *dial* being drawn on a plane, we may transfer it into what other place we will on the same plane, by drawing of parallel lines to those that are drawn, so that we keep the same order and the same proportion between them in their meetings, but the *style* ought to be put at the point which answers to the point of the first, which is for its foot.

Though all the foregoing practices seem to be clearly enough demonstrated, as well in the plate, as by the reasoning, they nevertheless, cannot be well executed without some farther instructions, *viz.* With regard to the different expositions of the planes proposed, on which the *sun-dials* are to be drawn. 2. How to mark the points of the *astronomical hours* on the *equinoctial line*, and how to draw by those points, the *hour-lines*. 3. How to mark the points of the *astronomical hours* on the *horizontal line*, and how to draw the *hour-line* by those points. 4. Six intervals of hours following one another being given, how to draw all the other hours. 5. How to draw the parallels of the twelve signs. 6. The *equinoctial line* being given, if we draw a parallel to it by a point given on an *hour-line*. 7. How to draw the *Italian* and *Babylonian hours* upon an *horizontal plane*. 8. How to draw the *Italian* and *Babylonian hours* on a plane which is not *horizontal*. 9. How to continue the description of the *Italian* and *Babylonian hours*, when the parallel of the *equator* is wanting on the plane of the *dial*. 10. Four *astronomical hours* being given, following one another in order, with the *equinoctial line*, how to find the other hours. 11. A *dial* being given, which is already drawn, how to find the foot of the *style*, which served to draw it, and to determine the height thereof. 12. How to

place the *axis*. 13. How to draw *dials* by reflexion.

1. We may know the disposition of the plane in regard of north or south (which must be necessarily known before we begin any thing) by a small declinatory, which presently shews on what side is the north, south, east, or west; which those that are used to observe the sun, may know by seeing in what manner it shines upon the plane, according to the hour and season of the year. Then we may well conceive after what manner the *axis* shall meet with the surface, and consequently may judge of the position of the *substylar line*, of the *equinoctial*, and also of the whole *dial*. But considering a *dial* wholly made, it is not difficult to know, among divers manners, which we may use, that may be most fit, and most easy for the construction of the *dial*; therefore we may easily see that it would be useless to find the center of a *dial*, or the *meridian* of a plane which comes near either to the east or west, and that the *equinoctial line* being set on such a plane, we need not find the point of mid day, and that we must use the point of the sixth hour, to begin the divisions of the horary intervals on that line, or on the *horizontal line*. That on these sorts of planes we cannot use the practices where we ought to have the points of shadows after mid-day, which may be answerable to others taken in the morning; for if the first point has been marked a little too far from the *meridian*, we can never have its correspondent point: that we must not use the practice of correspondent points of shadows, or the tract of the shadow, if the circle that is described from the foot of the *style* as a center, meets that tract in angles too acute; for we cannot determine exactly that meeting, and this inconveniency may happen to all practices on all sorts of planes in any season of the year: that if the *dial* be large, and the declination of the sun has changed considerably between the observations of the points of shadow, we have not exactly the lines which we seek by those practices, where we suppose that it has not been changed between the observations.

In the following practices, we suppose always that the *equinoctial* or *horizontal line* is drawn, and that we have marked on that line, the point where the hour 12 or 6 meets with it; at which points we begin the division of the hours on those lines; but to draw them we must have the center of the *dial*, or at least the inclination of the *axis* to the *substylar line*.

2. We mark the points of the *astronomical hours* on the *equinoctial line*, and by those points draw the *hour lines* in this manner; we suppose P S, Fig. 21. to be a *style*, whereof S is the point, and P the foot, and E 7 is the *equinoctial line*, on which the

the point 7 is the meeting of the *equinoctial* with the *meridian*, and the point 8 is the meeting thereof with the hour of 6 and with the *horizon*; P E A is the *substylar line*, which meets with the *equinoctial* in E.

This presupposed, we make E A on the *substylar* equal to E S, which is the distance between the point E of the *equinoctial*, and S the point of the *style*; we draw A 7 or A 8, or both of them, if we have these two points on the *equinoctial line*; which two lines A 7, A 8, ought to make a right angle at the point A. Then on the point A as a center, at any distance, we describe an arch of a circle *bc*, which cut the lines A 7 and A 8, at the points *b* and *c*, and divide the circle from 15, to 15 degrees, beginning at the point *b*, or at the point C; then we draw strait lines from the center A, and by the points of the division of the circle, which must be prolonged, if it be necessary, to the *equinoctial line*, on which it gives the division of the hours, which are to be marked according to the apparent motion of the sun from east or west: then by the center of the *dial*, and by the points of the hours which are marked upon the *equinoctial line*, we draw strait lines, which are the hour lines.

But if we have not the center of the *dial*, and have only the inclination of the *axis* I z, to the *substylar line* e E, we must take any point as *e*, on the *substylar line* e 12, parallel to the *equinoctial line* E x 11, and drawing e z perpendicular to Z z, make e a equal to e z, and by the point *a* draw the strait lines a 11, a 12, a 1, &c. parallel to the lines A 11, A 12, A 1, &c. and by these points, where these lines meet with the line e 12, and by those which are correspondent to them on the *equinoctial line*, draw the hour-lines 11 XI, 12 XII, 1 I, 2 II, &c.

3. We mark the points of the *astronomical hours* on the *horizontal line*, and draw the hour-line by those points, in the following manner:

We make the line M H D, Fig. 22. the *horizontal line*, and S the point of the *style* given, whereof P is the foot; by that point P, we draw the line P H perpendicular to the *horizontal line*; making M the point, where the *meridian line* intersects the *horizontal line*; upon the line H P, we set H S equal to H S, and draw the strait line S M a, and make the angle M S A equal to the angle of the elevation of the pole above the *horizon*; then from any point as A, taken on the line S A, we raise a perpendicular from 12 to S A, till it meets with S M in 12, and draw the lines 9, 12, 4, perpendicular to S a, and make 12 a equal to 12 A; and from the point A as a center, we describe a circle at any distance, and divide it

into equal parts from 15 degrees to 15 degrees, beginning the division where the line a 12 intersects the circle, and draw lines from the point a to the divisions of the circle, to meet with the line 9, 4, at the points 9, 10, 11, 12, 1, 2, 3, 4, &c. and by the same points and the point S, we draw strait lines, which we make to meet the *horizontal line* in the points of the hours required, which we mark according to the diurnal motion of the sun, of which the point M is noon, and D the point of the hour 6. If the line S D drawn perpendicular to S M, meet with the *horizontal line* at the point D, that point shall be the hour 6 on the *horizontal line*, which is the same point where the *horizontal line* ought to meet with the *horizontal line*.

If we have not the point of mid-day on the *horizontal line*, and we have but D the point of the hour 6; we then draw S D and S M perpendicular to S D; then we do the same as we did before to find the points of the hours on the *horizontal line*. The hour lines are to be drawn from C the center of the *dial*, and by the points of the hours which have been found on the *horizontal line*.

4. We suppose the 6 intervals of hours from Fig. 23. C A to C f to o be given, we draw all the other hours, by making E e parallel to c 5, cutting c A in the point A C B, in the point B C D, in the point D, &c. and we make A b, equal to A B A d equal to A D, &c. and from the center C, and through the points *b d c*, &c. we draw the lines of the hours that follow the precedent hours. When we will also have other hours following the first or last found, we must repeat the operation in drawing another line as E e, parallel to that which is the last of the six intervals of hours. If the *dial* has no center, we must draw another line as S t parallel to E e, on which we are to find the points of the hours as we have found them on the line E e, and in joining the horary points of the two parallel lines E e and S t, we'll have the hour lines required.

5. We draw the parallels of the twelve signs, Fig. 24. by drawing first the lines S C and S a at right angles to it at the point S; we make the angles a S d, a S k, each 20 degrees 30 minutes; and the angles a S f, a S i, each of 20 degrees 11 minutes, and the angles a S g, a S k, each of 11 degrees 30 minutes: the line S a denotes the *equinoctial*, which is the beginning of *Aries* and of *Libra*; the line S K, denotes the beginning of *Taurus* and *Virgo*; S i the beginning of *Gemini* and *Leo*; S k the beginning of *Cancer*, which is the tropick of the same sign; S g the beginning of *Scorpio* and *Pisces*; S f the beginning of *Sagittarius*

and *Aquarius*; *S d* the beginning of *Capricorn*, which is the tropick of the same sign. If the center of the *dial* be towards the North in regard to the point of the *style*, we make *S c* equal to *SC* of the *dial*, which is the distance between the point of the *style* and the center; but if the center be towards the south, in respect of the point of the *style*, we make *S c* upon *c S* prolonged on the other side of the point *S*.

Next we must find the points of the parallels of the signs upon the hour lines; as for example, on the line of mid-day, we must take the distance *S XII*, from the point of the *style S* to the point *XII*, which is the intersection of the line of mid-day with the *equinoctial*, and set it from *S* to *12* upon the line *S a*, and having drawn the line *c 12*, which cuts the lines of the signs in the points *d, f, g, b, i, k*, then we transport the intervals *12 b, 12 i, 12 k, 12 g, 12 f, 12 d*, in *XII H, XII I, XII K, XII G, XII f, XII D*, on the one and other side of the *equinoctial line*, as they are on both sides of the line *S a*. And in the same manner having found the other points upon each hour-line, and likewise on the halves and quarters, or other lines coming from the center, we draw by all the points which belong to the same sign, the line of the parallel of the sign, and thus for each of them in particular. But if we have not the intersection of the *equinoctial line* upon the hour-line, on which we would have the points of the signs, in that case we may have always the center of the *dial*; but if we have not the center of the *dial*, we may have always the *equinoctial line*; therefore having taken (for example) the third hour, on which we would have the points of the parallels of the signs, and the point *R* at pleasure; and having marked *S 3* on the line *S a* equal to *S III*, which is the distance between the point of the *style S*, and the point where the third hour proposed, intersects the *equinoctial line*; on that line *S 3* for the base, we must make the triangle *S 3 r* equal to the triangle *S III R*, which has *S III* for its base; and draw *r 3* prolonged, which shall intersect the lines of the signs in points, which are to be transferred to the line of the third hour.

6. The *astronomical hours* being drawn on the *dial*, Fig. 26. whose center is *C*, and the *meridian CA*, and *V A* the *equinoctial line*; *c E* being divided into two equal parts; to draw the *Italian* and *Babylonian* hours upon an *horizontal plane*, we must find on the hour-lines the points *b, c, d, e, f, g, h, &c.* of a parallel to the *equator*; which done, the line *A 12* parallel to the *equinoctial*, shall be the line of the 12th *Italian* hour. The strait line *b VII*, which passes by the point of the seventh hour in the morning of the *equinoctial*, and by the

point of the first hour after noon of the parallel, shall be the line of the 13th *Italian* hour. The strait line *c VIII*, which passes by the point of the eighth hour in the morning on the *equinoctial line*, and by the point of the second hour after noon of the parallel, shall be the 14th *Italian* hour. The strait line *d IX*, which passes by the point of nine in the forenoon, on the *equinoctial*, and by the point of three in the afternoon, on the parallel, shall be the 15th *Italian* hour, and thus of the rest; there being always six hours distance between the hour of the *equinoctial* and that of the parallel.

The *Babylonian hours* are marked after the same manner, but only that which is done on one side of the *meridian* for the *Italian* hours, is made on the other side of the *meridian* for the *Babylonian* hours, and they are counted after another manner; as for example, the strait line that passes by the point of mid-day of the *equator*, and by the point of the sixth hour in the morning of the parallel, is the sixth *Babylonian* hour; that which passes by the first hour after noon on the *equinoctial*, and by the point of the seventh hour in the morning on the parallel, shall be the seventh *Babylonian* hour, and thus following; so as *A 12* parallel to the *equator*, shall be the 12th *Babylonian* hour for the *horizontal dial*.

7. If we want to draw the *Italian* and *Babylonian hours*, on a plane, which is not *horizontal*, Fig. 28. the *astronomical* hours being described, and the *horizon RH*, which is one of the hours required, being drawn on the plane of the *dial* with the *equinoctial line*, we must draw a parallel to the *equator, d b R e f g*, which passes by *R* the intersection of the *horizon* with any hour line. And seeing that the *horizon*, which is the line of the 24th *Italian* hour intersects the parallel in *R*, at the point of the second hour after noon, on the *equinoctial line* at the point of the sixth hour afternoon, the line of the first *Italian* hour shall pass by the point *e* of the parallel, which is the third hour after noon, and by the point of the *equinoctial*; the line of the second *Italian* hour shall pass by the point *f* of the parallel, which is the fourth hour, and by the point of the eighth hour on the *equinoctial line*, and thus of the rest; for we must find all the points by which the *Italian* hours are to pass, so as the 18 *Italian* hours may pass always by the point of mid-day of the *equinoctial line*, and by a point of the hour of a parallel, which shall be so far from the point of mid-day, as the point *R* of the same parallel, which is the intersection of it with the *equinoctial line*.

But if the point *R*, by which the parallel to the *equator* is described, was the intersection of an hour

hour before noon, we must consider, that *that* parallel ought to meet also the *horizon* in a point of an hour, which is so far from noon, as is that by which we have described it; for example, if the point R was the intersection of nine in the morning with the *horizontal line*, the parallel to the *equator*, described by the point R, ought to meet the *horizontal line* in the point H, which is upon an hour line, so far distant from noon as is the point R; that is to say, that the point H shall be the meeting of the third hour afternoon with the *horizontal line*, and the line of the 24th *Italian* hour, which is an occidental portion of the *horizon*, ought to be taken from the point of the third hour of the parallel, with the point of the sixth hour after noon of the *equator*, and in reckoning as we have done before, we shall find that the first *Italian* hour, shall pass by the point of the fourth hour on the parallel, and by the point of the seventh hour after noon on the *equinoctial*; and that the line of the second *Italian* hour, shall pass by the point of the fifth hour of the parallel, and by the point of the eighth hour of the *equinoctial*, and so on; and we draw only those that are visible, for the others are of no use, and serve only to count and to place those which are of no use.

These rules are for the *Italian* hours, but for the *Babylonian* hours, which have for the twenty-fourth hour the oriental part of the *horizon*, if the parallel, which is described by the point R of the *horizon*, was the meeting of the *horizon*, with the line of the ninth hour before noon, the first *Babylonian* hour shall pass by the point of the tenth hour in the morning of the parallel, and by the point of the seventh hour in the morning on the *equinoctial*; the line of the second *Babylonian* hour shall pass by the point of eleven before noon on the parallel, and by the point of eight on the *equinoctial*, and so of the rest; and if the point R of the parallel, was the point of any afternoon hour, we must take its correspondent before noon, to begin to count the *Babylonian* hours, which is the contrary of that, which we have done for the *Italian* hours.

8. It happens, sometimes, that the parallel, or the *equator*, is wanting on the plane of the *dial*, notwithstanding which, we may continue the description of the *Italian* and *Babylonian* hours; if the point *b* be the last which is found on the parallel, by means of the *equinoctial line*, and the line *b III* be the last *Italian* hour, which we can mark by the help of that parallel; that line *b III*, shall meet with some astronomical hour in some point, as *m*, if we find the points *l n o* of the parallel which passes by *m*, and if they be on the hour before, or after that, on which is the point *m*; for

then we continue to draw the lines of the *Italian* or *Babylonian* hours, by the points of the hours of the parallel *m n o*, and by the points of the hours of the *equator*, in following the same order as before, and if the *equator* be wanting, we shall find the points of another parallel, by the parallel that is given, and then we may join the points of the hours on the two parallels, in following the former order.

9. These four hour lines following one another, Fig. 31. viz. *A a*, *B b*, *C c*, *D d*, with the *equinoctial line* *E f* being given, we find the other hours, by drawing from a point *a* taken at pleasure, in one of the last lines *A a*, the line *a D* which cut *B b* in *B*, and *C c* in *g*; also by the same point *a*, having drawn *a C* which cuts *B b* in *b*, and *A b* which meets *C c* in *c*, and *B g* which meets *D d* in *d*; we prolong *c b*, *c d*, to the points *E f* in the *equinoctial line*; and the hour lines *E e*, *f f*, drawn by the points *E f*, shall be the hour lines required, whereof *E e* shall be distant from *A a* one hour, and *f f* shall be two hours from *D d*; therefore *B D* being prolonged to *f* in the line *f f*, and *f d* to *b* in the line *B b*, having drawn *C f* which cuts *D d* in *i*, *l i* prolonged shall meet the *equinoctial* in *M*, by which the hour line *M m*, shall be between the two hour lines *D d*, and *f f*, and these seven hour lines being found, we may have all the rest by the practice of the third article.

There are many cases where three hour lines are sufficient with the *equinoctial* and *horizon*; for example, if we have three hour lines, Fig. 31. *a 2*, *b 3*, *c 4*, and the *equinoctial line* *2 4*, and *horizontal line* *a c*, having drawn *a 4* which cuts *b 3* in *d*, and having drawn *d 2* which cuts *c 4* in *f*, drawn *c 2* which cuts *b 3* in *e*, and *e 4* which cuts *a 2* in *b*; a straight line must pass by the three points *f b b*, which shall meet the *equinoctial* in the point *g*, which is one point of the hour as far from *b 3*, as is the hour line of six: Therefore, if the hour line *b e*, be the fourth hour, *a b* shall be the third, and *g i* the second; but in this example, *b e* being the third hour, *g i* shall be the twelfth hour. The first hour between *12* and *2*, is found by drawing *g c* which cuts *a 2* in *k*, and *k 4* which cuts the hour line *g i*, which was drawn by the point *g* to the point *i*, and in drawing *i 2* which cuts *g b* in *n*, the hour line by the point *n* shall be the first hour.

I. We find the foot of the *style*, Fig. 32. which has served to draw a *dial*, and determine the height thereof, by supposing, first, the line *A B* to be the *equinoctial line*; and the distance *A B* on the line, to be the interval of any six hours: then having divided *A B* into two equal parts in the point *G*,  
from

from the point G as a center, we describe on the diameter A B, the circle A S B *df*, and mark the points L and *f*, which divide the semicircle into two equal parts: A *f*, *f* D and D B, are each the interval of two hours on the *equinoctial line*; the lines *d* D, *ff*, ought to meet the circumference of the circle at the point S, and the like S E P drawn perpendicular to the *equinoctial line* shall be the *substyle*. If we have C the center of the *dial*, having described on the diameter C E, the semicircle C Z E, and having drawn in it the line E Z equal to E S; Z P being drawn perpendicular to the *substyle* line E P, and meeting it at the point P, that point shall be the foot of the style, whereof P Z shall be the height. But if we have not the center of the *dial*, having drawn *a e* parallel to the *equinoctial*, and from the point *a* draw *a* S parallel to A S, which meets the *substyle* line in S, from the point *e* as a center, and semidiameter S, we'll describe the arch *x*, and draw the strait line *x z*, which shall touch the two arches *x* and *z*, and that line *x z* shall determine the inclination of the *axis* to the *substyle*-line, and having drawn E z perpendicular to *x z*, from the point E, and from the point z, the strait line z P perpendicular to the *substyle* line E P, the point P shall be the foot of the style, whereof P Z shall be the height.

II. If we would have the hours shewn only by the shadow of the point of the style, we must make, and place it after such a manner, as may serve without changing it; and though we can give it various forms, the best is to make it waved to the end, that the shadow thereof may not unite with the hour lines in any place, and that we may always know, that it is only the shadow of the point that serves to shew the hours. But if we would have a portion of the *axis* to shew the hours, and that the *axis* be represented by an iron rod, the style we have placed ought to have the point very small, that it may enter into a little hole made in the rod, so as the point of the style, may exactly answer to the middle of the thickness of the rod; the style may remain if we would have it to support the *axis*; but if the *axis* be not very long, and if it be strong enough to sustain itself alone, being fastened at one end, we may take away the style when the *axis* is fixed on the surface of the *dial*. We may do the same, if we fasten to the end of the style a point of an iron wire, which there may be very small, and take but half the thickness of the rod, so as the *dial* being drawn to that point, there remains nothing to be done, but to take it away to place the *axis*, the middle of the thickness whereof ought to answer to that point; therefore, whether the style remains to uphold the *axis*, or whether we take it away when the *axis* is fixed in its place, we must fasten it to

the end of the style to stay it, which ought to answer to the center of the *dial*, if it has any.

The rod which serves for the *axis*, may be made as marked in the figure, so as the hole signified by A, Fig. 33. can be made to lodge the point of the style: and that it may be let in as far as the middle of the thickness of the rod, the point B, which answers also to the middle of the rod, ought to be applied exactly to the center of the *dial*: this rod being thus stayed at the point B, and at the point A, we must fasten the foot on the plane of the *dial*. But if we would not have a foot to the *axis*, as G, and that we would only fix the rod to the center of the *dial*, we must draw various lines, which may pass by the center of the *dial*, and stay the rod on the point of the style A, so that the end may enter in a hole made in the plane of the *dial*, at the place of the center, and be divided by the middle of its thickness, by each line that passes by the center.

If we make use of a thin plate, cut according to the inclination of the *axis* with the *substyle* line; it must be set perpendicularly on the plane of the *dial*, in applying one of its sides to the *substyle* line, and the other line passing by the point of the style shall serve for the *axis*.

Thus far we have instructed our pupils, who design to make some progress in the *art of Dialing*, in all the general and particular rules belonging to that art; and thereby rendered them capable to draw all the different lines which compose a *fundial*. I propose no particular construction on the horizontal and vertical planes, which only gives particular rules for each case; and which, in the ordinary way happens very seldom; therefore these methods are for all sorts of planes indifferently considered. I know very well that there are various cases where we might find abridgments, but these abridgments consist only in certain lines and points, which come to be united in the general practices, which I have given here.

*Dials* are also drawn by *reflection*, in making use of a small piece of polished metal, very even and flat; of a round form, and of about an eighth part of an inch in diameter, and having placed and fastened it in a firm place, we mark the points of light on the plane where we design to draw the *dial*, which serve instead of the points of shadow; the middle of the mirror or glass, ought to be considered as the point of a style, whereof we find the foot in drawing from the middle of the glass, a line perpendicular to the plane of the *dial*; the point where this line meets with the plane of the *dial*, shall be the foot of the style. We may find the *substyle* line, the *equinoctial line*, the center of the *dial* and *meridian*, by the practices, where we make

no use of the *horizontal line*, nor of the height of the pole.

Having found the *equinoctial line*, and the point where the *meridian line* intersects it, we draw the hours, following the methods heretofore described.

If the inclination of the glass be never so little changed, it will cause a considerable alteration in the *dial*; therefore this sort of *dials*, seldom lasts many years in good condition; but there always happens some alteration to the wall on which they are fixed. But if in the place of the glass, we fill some small vessel, either of glass or potter's earth, of about an inch in diameter, with water or quick-silver, that vessel being put upon a place marked on some *transum* of a window, or the like, shall give the hours on the *dial*.

Besides *sun-dials*, there is a *nocturnal*, or *night-dial*, which shews the hours of the night: of this there are two kinds, *lunar* and *siderial*.

The MOON-DIAL, or LUNAR-DIAL, is that which shews the hours of the night, by means of the light or shadow of the moon, projected thereon from an index.

To describe a MOON-DIAL, suppose, *e. g.* a *horizontal moon-dial*; there must be drawn first a *horizontal sun-dial*, then two perpendiculars erected to the line of 12 o'clock, and dividing the interval into twelve equal parts, through the several points of division, there must be drawn lines parallel thereto. Now appropriating the first line to the day of the new-moon, and the second, to the day when the moon comes an hour later to the *meridian* than the sun; their intersections with the hour-lines will give points, through which draw a curve line 12 12, for the *meridian line* of the moon. After the like manner are determined the hour-lines 1 1, 2 2, 3 3, &c. which the shadow of the moon, projected from the style of the *dial*, intersects at the respective hours. We must blot out the hour-lines of the *sun-dial*, together with the perpendiculars, whereby the *lunar-hours* were drawn, and divide the interval by other parallel lines into 15 equal parts, answering to the 15 days between new and full-moon. Lastly, to these lines we must write the several days of the moon's age. Now the moon's age being learned from the *calendar*; the intersection of the line of the moon's age, with the *lunar hour-lines*, will give the hour of the night.

We draw a *portable moon-dial*, by describing a circle on a plane that may be raised according to the elevation of the *equator*, and dividing its circumference into 29 equal parts. From the same center we describe another moveable circle, which we divide into 24 equal parts, or hours. In the center we erect an index, as for an *equinoctial dial*.

This *dial* being daily placed after the manner of an *equinoctial dial*, and the 12 o'clock line brought to the line of the moon's-age: the shadow of the index will give the hour.

To find the hour of the night by a *sun-dial*, we observe the hour which the shadow of the index points at by moon-light; find the moon's age in the *calendar*, and multiply the number of the days by three-fourths; the product is the number of hours, to be added by the hours shewn by the shadow, to give the hour required.

There are also *ring-dials*, and *quadrantal-dials*.

A RING-DIAL, is a kind of *dial* usually small and portable, consisting of a brass-ring, or rim, seldom exceeding two inches in diameter, and one third of an inch in breadth. In a point of this rim is a hole, through which the sun-beams being received, make a lucid speck on the concavity of the opposite semicircle, which gives the hour of the day in the divisions marked therein; but it only holds good about the time of the *equinox*. To have the *dial* perform throughout the whole year, the hole is made moveable; and the signs of the *zodiack*, or the days of the month are marked on the convex side of the ring, by means whereof, the *dial* is rectified for the time. To use it, put the moveable hole to the day of the month, or the degree of the *zodiack* the sun is in; then suspending it by the little ring, turn it towards the sun, till his rays, as before, point out the hour among the divisions on the inside.

An *universal* or *astronomical ring-dial*, is a *ring-dial* which serves to find the hour of the day in any part of the earth; whereas the former is confined to a certain latitude. It consists of two rings, or flat circles, from two to six inches in diameter; and their breadth, &c. proportionable. The outward ring represents the *meridian* of any place you are at; and contains two divisions of 90 degrees each, diametrically opposite to one another; serving, the one from the *equator* to the north, the other to the south pole. The inner ring represents the *equator*, and turns exactly within the outer, by means of two pivots, in each ring at the hour of 12. Across the two circles, goes a thin riglet or bridge, with a cursor, that slides along the middle of the bridge. In the cursor is a little hole for the sun to shine through. The middle of this bridge is conceived as the *axis* of the world, and the extremities as the poles; and on the one side are drawn the signs of the *zodiack*, and on the other, the days of the month. In the edge of the *meridian* slides a piece, to which is fitted a ring to suspend the instrument by.

To use this *universal ring-dial*, we must place the line which is on the middle of the sliding piece, over

over the degree of latitude of the place (for example 51 degrees for *London*) and put the line which crosses the hole of the cursor to the degree of the sign, or day of the month. Then we open the instrument, so as the two rings be at right angles to each other, and suspend it by the rings, that the *axis* of the *dial*, represented by the middle of the bridge, may be parallel to the *axis* of the world. Afterwards we turn the flat side of the bridge towards the sun, so as his rays striking through the little hole in the middle of the *cursor*, fall exactly on a line drawn round the middle of the concave surface of the inner ring; in which case, the bright spot shews the hour of the day in the said concave surface of the ring.

The hour of 12 is not shewn by this *dial*, by reason the outer circle being then in the plane of the *meridian*, hinders the sun's rays from falling on the inner circle; nor will this *dial* shew the hour when the sun is in the *equinoctial*, by reason his rays, then, fall parallel to the plane of the inner circle.

QUADRANTAL-DIAL, or *horodical quadrant*, is a pretty commodious instrument, thus called from its use in telling the hour of the day. Its construction is simple and easy, and its application ready.

We first make a *quadrant*, and from the center of that *quadrant*, whose limb is divided into 90 degrees, we describe seven concentrick circles at intervals, at pleasure, and to these add the signs of the *zodiack*, in the order they are represented in the scheme. Secondly, applying a ruler to the centre and the limb, we mark upon the several parallels, the degrees corresponding to the altitude of the sun when therein, for the given hours; we connect the points belonging to the same hour with a curve line, to which we add the number of the hour. We fit a couple of sights to the *radius* and tie a thread with a plummet to the center of the *quadrant*, and upon the thread a bead to slide.

If now the bead be brought to the parallel wherein the sun is, and the *quadrant* directed to the sun, till a visual ray passes through the sight, the bead will shew the hour; for the plummet in this situation cuts all the parallels in the degrees corresponding to the sun's altitude: since, then, the bead is in the parallel which the sun then describes, and thro' the degrees of altitude, to which the sun is elevated every hour, there pass hour-lines; the bead must shew the present hour.—Some persons, who are not mighty nice, represent the hour-lines by arches of a circle, or even by strait lines; and that without any sensible error.

## Of DISTILLING, see CHYMISTRY.

## Of DIVING.

**D**IVING is the art of descending under water, to considerable depths, and abiding there a competent time; the uses of which are considerable, particularly in fishing for pears, corals, sponges, wrecks of ships, &c.

There have been various *engines* contrived to render the business of *diving* safe and easy; the great point is to furnish the diver with fresh air, without which he must either make but a short stay, or perish. Those who dive for sponges in the *Mediterranean*, carry down sponges dipt in oil in their mouths, but considering the small quantity of air that can be contained in the pores of the sponge, and how much that little will be contracted by the pressure of the incumbent air, such a supply cannot subsist a diver long, since a gallon of air is not fit for respiration above a minute.

Hence it was necessary to contrive a more safe conveyance of a *diver* to any reasonable depth, and whereby he may stay more time under water: which is the DIVING BELL.

That the reader may have a just idea of the *diving-bell*, according to the latest improvements by Dr. HALLEY, and Mr. TRIEWALD of *Stockholm*, we have exhibited two figures of it, on the first plate of *Mechanic Arts*. The first is that of Dr. HALLEY's form, which was three feet wide at top, five at bottom, and eight feet high, and contained about sixty three cubic feet, or near eight hogheads in its concavity.

This was coated with lead, so heavy, that it would sink empty, and the weight was distributed about the bottom I K. so that it would do down in a perpendicular position, and no other. In the top was fixed a strong but clear glass D, to let in the light from above; and likewise a cock, as at B, to let out the hot air that had been breathed; and below, was fixed a circular seat LM, for the divers to sit on; and lastly, from the bottom was hung, by three ropes, a stage for the divers to stand on, to do their business.

This machine was suspended from the mast of a ship by a sprit, which was sufficiently secured by stays

flays to the mast-head, and was directed by braces to carry it over-board, clear of the side of the ship, and to bring it in again.

To supply the bell with air under water, two barrels such as C, of about sixty-three gallons each, were made, and cased with lead, so that they might sink empty, each having a hole in its lowest part, to let in the water, as the air in them is condensed in their descent, and to let it out again when they were drawn up full from below. And to a hole in the top of the barrel was fixed a hose, or hollow pipe, well prepared with bees-wax and oil, which was long enough to fall below the hole at the bottom, being sunk with a weight appended, so that the air in the upper part of the barrels could not escape, unless the lower end of these pipes were first lifted up.

These air barrels were fitted with tackle proper to make them rise and fall alternately, like two buckets in a well. In their descent, they were directed by lines fastened at the under edge of the bell to the man standing on the stage to receive them, who, by taking up the ends of the pipes above the surface of the water in the bell, gave occasion for the water in the barrels to force all the air in the upper parts into the bell, while it entered below, and filled the barrels; and as soon as one was discharged by a signal given, it was drawn up, and the other descended to be ready for use.

As the cold air rushed into the bell from the barrel below, it expelled the hot air (which was lighter) through the cock B, at the top of the bell, which was then opened for that purpose. By this method air is communicated so quick, and in such plenty, that the Doctor tells us, he himself was one of the five who was at the bottom in nine or ten fathom water, for above an hour and a half at a time, without any sort of ill consequence; and he might continue there so long as he pleased, for any thing that appeared to the contrary.

In going down, it is necessary it should be very gentle at first, that the dense air may be inspired to keep up, by its spring, a ballance to the pressure of the air in the bell: upon each twelve feet descent, the bell is stopp'd, and the water that enters is driven out by letting in three or four barrels of fresh air.

By the glass above, so much light was transmitted, when the sun shone, that he could see perfectly well to write and read, and by the return of the air-barrels, he could send up orders, written with an iron pen, on small pieces of lead, directing, that they were to be moved from place to place: but in dark weather, when the sea was rough and troubled, it would be as dark as night,

in the bell; but then the Doctor perceived he could keep a candle burning in the bell, as long as he pleased, it being found, by experiment, that one candle consumes much about the same quantity of confined air, as one man does, *viz.* about a gallon *per* minute.

The only inconvenience the Doctor complained of, was, that upon first going down, they felt a small pain in their ears, as if the end of a quill were forcibly thrust into the hole of the ear. This may proceed from its being some time before the air can get from the mouth, through the small canal of the *eustachian* tube, which leads to the inner cavity of the ear, where, when it comes, it makes an *equilibrium* with the outward air, pressing on the tympanum, and thus the pain, for a short time, ceases: then descending lower, the pain of the ear returns, and is again abated; and so on, till you come down to the bottom, where the air is of the same density continually.

This bell was so improved by the Doctor, that he could detach one of his divers to the distance of fifty or a hundred yards from it, by a contrivance of a cap, or head-piece, somewhat like an inverted hand-basket, as at F, with a glass in the fore-part, for him to see his way through. This cap was of lead, and made to fit quite close about his shoulders; in the top of it was fixed a flexible pipe, communicating with the bell, and by which he had air, when he wanted, by turning a stop cock near his head-piece. There was also another cock at the end in the bell, to prevent any accident happening from the person without. This person was always well cloathed with thick flannels, which were warmed upon him, before he left the bell, and would not suffer the cold water to penetrate. His cap contained air enough to serve him a minute or two: then by raising himself above the bell, and turning the cock F, he could replenish it with fresh air. This pipe he coiled round his arm, which served him as a clue to find his way to the bell again.

This *diving-bell* received its last improvement from Mr. MARTIN TRIEWALD, F R S. and military architect to his *Swedish* Majesty. The manner and form whereof is shewn in a figure of his own drawing (*ibid.* N<sup>o</sup> 2.) A B is the bell, which sinks with leaden weights D, D, appended at the bottom: the substance of the bell is copper, and tinned within all over: the bell is illuminated with three strong convex lenses G, G, G, with copper lids H, H, H, to defend them. The iron ring, or plate E, serves the diver to stand on, when he is at work, and it is suspended at such a distance from the bottom of the bell, by the chains F, F, F, that when the diver stands upright, his head is

just above the water in the bell, where it is much better than higher up in it, because the air is colder, and consequently more fresh, and fit for respiration: but as there is occasion for the *Diver* to be wholly in the bell, and his head of course in the upper part, Mr. TRIEWALD has contrived that, even there, when he has breathed the hot air as long as he well can, by means of a spiral copper tube *b c*, placed close to the inside of the bell, he may draw the cooler and fresher air from the lowermost parts; to which end, a flexible leather tube, about two feet long, is fixed to the upper end of the tube at *b*; and to the other end of this tube is fixed an

ivory mouth-piece for the *Diver* to hold in his mouth, by which to respire the air from below.

*Borelli*, contrived another machine for diving under water to great depths, called a DIVING-BLADDER, to be made of brass or copper, and about two feet diameter. This is to contain the *Diver's* head, and is to be fixed to a goat's skin exactly fitted to the body of the *Diver*. Within the vesica are pipes, by means of which, a circulation of air is contrived, and the person carries an air-pump by his side, in order to make himself heavier and lighter, as the fishes do by contracting or dilating their air-bladder.

## Of D Y I N G.

**D**YING is the art of giving a lasting colour to silks, cloths, and other things, whereby their beauty is much improved, and their value increased.

The *Art of Dying* is of great antiquity, as it appears from the traces of it in the oldest sacred, as well as profane writers. The honour of the invention is attributed to the *Tyrians*, though what lessens the merit of it, is, that it is said to have owed its rise to chance. The juices of certain fruit, leaves, &c. accidentally crushed, are supposed to have furnished the first hint. *Pliny* assures us, that even in his time, the *Gauls* made use of no other *dyes*: it is said, that coloured earths and minerals, washed and soaked with rain, gave the next *dying* materials. But *Purple*, an animal juice, found in a shell-fish called *Murex*, *Conchyliani*, and *Purpura*, seems from history, to have been before any of them, and reserved for the use of Kings and Princes; for private persons were forbidden by law to wear the least scrap of it.

Till the time of *Alexander*, we find no other *dye* in use but purple and scarlet. It was under the successors of that monarch, that the *Greeks* applied themselves to the other colours; and invented, or at least perfected blue, yellow, green, &c. For the ancient purple it has been long lost.

Among the *Romans*, *Dye-houses*, *Baphia*, were all under the direction of the *Comes sacrarum largitionum*, though they had each their particular *Præpositus*, as at *Alexandria*, *Tyre*, &c. The *Dyers* of *London* make the thirteenth company of of the city; incorporated under *Henry VI.* consisting of a master, wardens, and livery. The *Persian Dyers*, notwithstanding all their *Mahometanism*, have chosen *Jesus* for the patron of their art; inasmuch, that among them a *dye-house* is called *Christ's-shop*.

All persons occupying the trade of *dying* woollen manufactures within the city of *London*, or ten miles round it, shall be subject to the inspection of the company of *dyers* of *London*; and the master, wardens, and court of assistants of the said company may appoint searchers within the said limits; and out of these limits, justices, at their quarter-sessions, may appoint such searchers, who taking to their assistance a constable, or other peace-officer, may, at all seasonable times, enter the shop or work-house of any person using the trade of *dying*, and search all cloths or other woollen goods to be dyed black or blue; and any person opposing, forfeits 10 *l.*

Every person *dying* cloths, &c. maddered, and not woaded, shall, before delivery, fix a seal of lead to them, with the letter *M*, on forfeiture for every yard, &c. 3 *s.* 4 *d.* Any person within *England*, *Wales*, or *Berwick*, *dying* black any bays, or other woollen goods, as madder-blacks, not being dyed throughout with woad, indigo, and madder only, or *dying* any cloths, long ells, &c. for woaded blacks, not being woaded throughout, shall forfeit for every long *Book*-bays, containing seventy yards, 44 *s.* For every *Colchester* bays, containing thirty-five yards, 22 *s.* and so in proportion for other bays. For every cloth dyed black, not being woaded throughout, containing forty-four yards, 40 *s.* All woollen goods truly maddered black, shall be marked with a red and blue rose; and all woollen goods truly woaded black, with a blue rose; and any person counterfeiting the said marks, or fixing such to any goods falsely dyed, for maddered or woaded blacks, forfeits 4 *l.* for every piece so marked. Any person using logwood in *dying* blue, shall forfeit 40 *s.* for every piece so dyed, containing forty-four yards.

This

This art depends chiefly on three things, *viz.*  
 1. Disposing the surface of the stuffs to receive and retain the colours, which is performed by washing them in different lyes, digesting, beating them, &c. in which human urine putrified, a sharp salt of ashes, divers soaps, and galls of animals, are of principal use; by means whereof the viscous gluten of the silk-worms naturally adhering to their threads, is washed and cleansed from them, and thus they become fitted gradually to imbibe the colours. By these also the greasy foulness adhering to wool and flax is scoured off.

2. So to grind the colours, as that they may enter the body duly prepared, and preserve their brightness undiminished.

3. The third consists in having beautiful colours. According to Sir W. PERRY's account of what is done in particular trades by the art of dying,

1. There is a whitening of wax, and several sorts of linen and cotton cloths by the sun, air, and reciprocal effusions of water. 2. Colouring of wood and leather, by lime, salt and liquors, as in stoves, canes, and marble leathers. 3. Colouring of paper, *viz.* the marbled paper, by distemping the colours with ox-gall, and applying them upon a stiff gummed liquor. 4. Colouring, or rather discolouring, the colours of silks, tiffanies, &c. by brimstone. 5. Colouring of several iron and copper-works into black with oil. 6. Colouring of leather into gold-colour, or rather silver leaves into gold by varnishes, and in other cases by urine and sulphur. 7. Dying of marble and alabaster, with heat and coloured oils. 8. Colouring silver into the brass-colour, with brimstone or urine. 9. Colouring the barrels and locks of guns into blue and purple, with the temper of small-coal heat. 10. Colouring of glass (made of sands, flints, &c.) as also of crystals and earthen-ware, with the rusts and solutions of metals. 11. The colouring of live hair, as in *Poland*, horse and man's hair: as also the colouring of furs. 12. Enameling and annealing. 13. Applying colours, as in the printing of books and pictures, and as in making of playing cards, being each of them performed in a different way. 14. Gilding and tinning with mercury, block-tin, sal ammoniac. 15. Colouring of metals, as copper, with calamy, into brass, and with zink or spelter into a golden colour, or into a silver one with arsenic; and of iron into a resemblance of copper with *Hungarian* vitriol. 16. Making painters-colours by preparing of earth, chalk, and slates; as in umber, ochre, cullen-earth, &c. as also out of calces of lead, as ceruse and minium; by sublimes of mercury and brimstone, as in vermilion; by tinging whole earths variously, as in verdeter, and some of the lakes; by concrete

juices, or *fæculæ*, as in gambogium, indigo, pinks, sap-green, and lakes; as also by rusts, as in verdigrease, &c. 17. The applying these colours by the adhesion of ox-gall, as in the marble paper aforesaid; or by gum-water, as by limning; or by clammy drying oils, such as the oils of linseed, nuts, &c. 18. The watering of tabbies. 19. The colouring of wool, linen, cotton, silk, hair, feathers, horn, leather, and the threads and webs of them with woods, roots, herbs, seeds, leaves, salts, limes, lixiviums, waters, heats, fermentations, macerations, and other great variety of management; an account of all which is a short history of *dying*.

The materials used in the art of DYING, are iron and steel, or what is produced from them, in all true blacks called *Spanish* blacks, though not in *Flanders* blacks, *viz.* they use copperas, steel-filings, and slippe; they also use pewter for *Bw-dye* scarlet, *viz.* they dissolve bars of pewter in *aqua fortis*; *libarge* is also used by some, though acknowledged by few to add weight to dyed silk. *Antimony* is much used to the same purpose. *Arsenic* is used in *crimson* upon pretence of giving lustre. *Verdigrease* is also used by *linen-dyers* in their *yellow* and *greenish* colours; though, of itself, it strikes no deeper colour than that of a pale straw.

Of *mineral salts* used in *dying*, the chief is *alum*; the true use whereof seems to be in regard to the fixation of colours. The next mineral salt is *salt-petre*, not used by ancient dyers, and but by few of the modern: nor is it yet used but to brighten colours, by back-boiling of them, for which *argol* is more commonly used: *lime* is much used in working *blue-vats*.

Of the *animal family* are used *cobineal*, urine of labouring men kept till it be stale and stinking, *honey*, yolks of *eggs*, and *ox-gall*; the use of the urine is to scour, and help the fermenting and heating of *woad*; and is used also in *blue-vats* instead of *lime*: it dischargeth the *yellow*, and therefore is used to spend *weld* withal.

*Dyers* use two sorts of water, *viz.* river and well-water; the last, which is harsh, they use in reds and other colours wanting restraining, and in dying materials of the slacker contextures, as in *callicoe*, *fustian*, and the several species of *cotton-works*; but is not good for blues, and makes yellows and greens look rusty. River-water is more fat and oily, and is therefore used in most cases, and must be had in great quantities for washing and rinsing their cloths after dying. Water is called by *Dyers* white liquor; but a mixture of one part bran, and five of river-water boiled an hour, and put into leaden cisterns to settle, is what they call liquor absolutely.

*Gums* have been used by *dyers* about silk, viz. gum arabic, tragacanth, mastick, dragon's blood. These tend little to the tincture, any more than gum in writing ink, which only gives it a consistence; so gum may give the silk a glossiness; and, lastly, to increase the weight.

The three peculiar *ingredients* for *black* are *copperas* filings of *steel*, and *slipje*: the restraining binding materials are *alder-bark*, *pomegranate-peels*, *walnut rinds* and *roots*, *oaken-sailing bark* and *saw-dust* of the same, *crab-tree-bark*, *galls*, and *sumach*.

The *salts* are alum, salt petre, sal ammoniac, pot-ashes, and stone lime; among which urine may be enumerated as a liquid salt.

The *liquors* are well and river-water, urine, *aquavitæ*, vinegar, lemon-juice, *aquafortis*, honey, and molasses.

*Ingredients* of another class are bran, wheaten-flour, yolks of eggs, leaven, cummin-seed, fenugreek-seed, agaric and fenna.

The *absterjive*, are fuller's earth, soap, linseed-oil, and ox gall.

The *metals* and *minerals* are pewter, verdigrease, antimony, litharge, and arsenic.

The *colourings* are blue, yellow, and red; of which logwood, old fustic, indigo, and madder, are the chief.

#### General observations upon DYING.

1. All materials which of themselves do give colour are either red, yellow, or blue; so that out of them, and the primitive fundamental colour white, all that great variety which we see in dyed stuffs doth arise.

2. That few of the colouring materials, as cochineal, foot, wood wax, woad, &c. are in their outward and first appearance of the same colour, which by the slightest distempers and solutions in the weakest menstrua, they dye upon cloth, silk, &c.

3. That many of them will not yield their colour without much grinding, steeping, boiling and fermenting, or corrosion by powerful menstrua, as red-wood, woad, woad, arnotto, &c.

4. That many of them will of themselves give no colouring at all, as copperas or galls, or with much disadvantage, unless the cloth or other stuff to be dyed be as it were first covered, or incrustated with some other matter, though colourless beforehand, as madder, weld, brazil, with alum.

5. That some of them, by the help of other colourless ingredients, do strike different colours from what they would of themselves, as cochineal, brazil, &c.

6. That some colours, as madder, indigo, and woad, by reiterated tinctures, will at last become black.

7. That although green be the most frequent and most common of natural colours, yet there is no simple ingredient now used alone to dye green with upon any material; sap green being the nearest, which is used by country people.

8. There is no black thing in use which dyes black, though both the coal and foot of most things burnt or scorched be of that colour, and the blacker, by how much the matter before being burnt was whiter, as in ivory black.

9. The tincture of some dying stuffs will fade even with lying, or with the-air, or will stain with water only, but very much with urine, vinegar, &c.

10. Some of the dying materials are used to bind and strengthen a colour; some to brighten it; some to give lustre to the stuff; some to discharge and take off the colour, either in whole, or in part; and some out of fraud, to make the material dyed, if costly, heavier.

11. That some dying ingredients, or drugs, by the coarseness of their bodies, make the thread of the dyed stuff seem coarser; and some, by shrinking them smaller; and some by smoothing them, finer.

12. Many of the same colours are dyed upon several stuffs with several materials, as red-wood is used in cloth, not in silks; arnotto in silks, not in cloth, and may be dyed at several prices.

13. That scouring and washing of stuffs to be dyed, is done with special materials, as sometimes with ox-galls, sometimes with fullers-earth, and sometimes soap; this latter being, in some cases, pernicious, where pot-ashes will stain, or alter the colour.

14. Where great quantities of stuffs are to be dyed together, or where they are to be done with any speed, and where the pieces are very long, broad, thick, or otherwise, they are to be differently handled, both in respect to the vessels and ingredients.

15. In some colours and stuffs the tingent liquor must be boiling, in other cases blood-warm, and in some it may be cold.

16. Some tingent liquors are fitted for use by long keeping, and in some the virtues wear away by the keeping.

17. Some colours or stuffs are best dyed by reiterated dippings in the same liquor, some by continuing longer, and others a lesser time therein.

18. In some cases, the matter of the vessel wherein the liquors are heated, and the tincture prepared, must be regarded, as the kettles must be pewter for *Bow-dye*.

19. There is little reckoning made how much liquor is used in proportion to the dying drugs, it being rather adjusted to the bulk of the stuffs, as the vessels

vessels are to their breadth; the quantity of dying drugs being proportioned both to the colour, higher or lower, and to the stuffs; as likewise the salts are to the dying drugs.

Concerning the weight that colours give to silk, (in which it is most taken notice of, being sold by weight, and a commodity of great price) it is observed that one pound of raw silk loseth four ounces by washing out the gums, and the natural serdes. That the same scoured silk may be raised to above thirty ounces from the remaining twelve, if it be dyed black with galls, &c.

Next to galls, old fustic encreases the weight about  $1\frac{1}{2}$  in 12; madder, about one ounce; weld, half an ounce. The blue vats in deep blues of the fifth stall, give no considerable weight; neither doth logwood, cochineal, nor even copperas, where galls are not; slippe adds much to the weight, and giveth a deeper black than copperas itself.

For *black*, in *woollen-manufactures*, it is begun with a strong decoction of woad and indigo, that communicate a deep blue; after which the stuffs being boiled with alum and tartar, or pot-ash, are to be maddered with common madder, then dyed black with Aleppo-galls, copperas, and sumach, and finished by back-boiling in weld. Wools for tapestry are only to be woaded, and then put in black. For scarlet, wool and woollen manufactures are dyed with kermes and cochineal, with which may also be used agaric and arsenic. Crimson-scarlet is dyed with cochineal, mastic, aquafortis, sal ammoniac, sublimate, and spirit of wine. Violet-scarlet, purple, amaranth, and pansy-scarlets, are given with woad, cochineal, indigo, braziletto, brazil, and orchal. Common reds are given with pure madder, without any other ingredient. Crimson-reds, carnations, flame and peach colours, are given, according to their several hues, with cochineal, mastic, without madder or the like. Crimson-red is prepared with *Roman* alum with cochineal. Orange aurora, brick colour, and onion-peel colour, are dyed with woad and madder, mixed according to their several shades. For blues, the dark are dyed with a strong tincture of woad; the brighter with the same liquor, as it weakens in working. Dark browns, minims, and tan colours, are given with woad, weaker in decoction than for black, with alum and pot ashes, after which they are maddered higher than black: for tan-colours, a little cochineal is added. Pearl-colours are given with galls and copperas; some are begun with walnut-tree roots, and finished with the former; though to make them more useful, they generally dip them in a weak tincture of cochineal. Greens are begun with woad, and finished with weld. Pale yellows, lemon-colour, and sulphur-colour, are given with

weld alone. Olive-colours of all degrees are first put in green, and taken down with foot, more or less, according to the shade that is required. *Feule-mort*, hair colour, musk, and cinnamon-colour, are dyed with weld and madder. *Nacaret*, or bright orange, is given with weld and goats hair boiled with pot ashes.

DYING of *silks* is begun by boiling them in soap, &c. then scouring and washing them in water, and steeping them in cold alum-water. For crimson, they are scoured a second time, before they are put into the cochineal-vat. Red crimson is given with pure cochineal, mastic, adding galls, turmeric, arsenic, and tartar, all mixed in a copper of fair water, almost boiling: with these the silk is to be boiled an hour and an half, after which it is allowed to stand in the liquor till next day. Violet-crimson is given with pure cochineal, arsenic, tartar, and galls; but the galls in less proportion than in the former: when taken out, it is washed and put in a vat of indigo. Cinnamon crimson is begun like the violet, but finished by back-boiling, if too bright, with copperas, and if dark, with a dip of indigo. Light blues are given in a bath of indigo. Sky blues are begun with orchal, and finished with indigo. For citron-colours, the silk is first alumed, then welded with indigo. Pale yellows, after aluming, are dyed in weld alone. Pale and brown auroras, after aluming, are welded strongly, then taken down with rocou and dissolved with pot-ashes. Flame colour is begun with rocou, then alumed, and afterwards dipped in a vat or two of brazil. Carnation and rose-colours are first alumed, then dip in brazil. Cinnamon-colour, after aluming, is dip in brazil, and braziletto. Lead colour is given with fustic, or with weld, braziletto, galls and copperas. Black silks of the coarser sort, are begun by scouring them with soap, as for other colours: after which they are washed out, wrung, and boiled an hour in old galls, where they are suffered to stand a day or two: then they are washed again with fair water, wrung and put into another vat of new galls; afterwards washed again, and wrung, and finished in a vat of black. Fine black silks are only put once into galls of the new and fine sort, that has only boiled an hour: then the silks are washed, wrung out and dipped thrice in black, and afterwards taken down by back-boiling with soap.

The dying of thread is begun by scouring it in a lye of good ashes: afterwards it is wrung, rinsed out in river-water, and wrung again. A bright blue is given with braziletto and indigo: bright green is first dyed blue, then back-boiled with braziletto and verdeter, and lastly woaded. A dark green is given like the former, only darkened more before

before woading. Lemon and pale yellow is given with weld mixed with rocou. Orange isabella, with fustic, weld, and rocou. Red, both bright and dark, with flame colour, &c. are given with brazil, either alone or with a mixture of rocou. Violet, dry rose, and amaranth, are given with brazil, taken down with indigo. Feulemort and olive-colour are given with galls and copperas, taken down with weld, rocou, or fustic. Black is given with galls and copperas, taken down and finished with braziletto wood.

Thread is dyed likewise of all sorts of colours, and begun by scouring it in lye of good ashes; after which it is wrung, rinsed out in river water, and wrung again. Thus prepared the dyer gives it what colour he pleases, with the following drugs, viz. red colour, both bright and dark, flame colour, &c. with brazil, either alone, or with a mixture of rolac. Violet, dry rose, and amaranth, with brazil, taken down with indigo. Bright blue, with braziletto and indigo. Bright green, is first dyed blue, then back boiled with braziletto, and verdet, and lastly woaded. Dark green, is given like the former, only darkening more before woading. Lemon or pale yellow, with weld mixed with rolac. Feulemort and olive colour, with galls and copperas, taken down with weld, rolac, or fustic. And black with galls and copperas taken down and finished with braziletto wood.

Hats are dyed with braziletto, galls, copperas, and verdigrease, dissolved and boiled in a copper capable of receiving, besides the liquor, twelve dozens of hats on their blocks or moulds. Here the hats are left to boil some time; after which they are taken out, and left to stand and cool; then dipped again, and thus alternately, oftner or seldomer as the stuff is of a nature to take the dye with more or less difficulty.

Leather, skins, &c. are also dyed red, blue, sky colour, purple, green, yellow, orange colour, &c.

The red colour is given by washing the skins, and laying them two hours in galls, then wringing them out, dipping them in a liquor made with ligustrum, alum, and verdigrease, in water; and lastly, in a dye made of brazil wood made with lye. Blue by steeping the leather or skins a day in urine and indigo, then boiling it with alum; otherwise by tempering the indigo with red wine, and washing the skins therewith. Sky colour is given with indigo steeped in boiling water, and the next morning warmed and smeared over the skin. Purple by wetting the skin with a solution of roch alum in warm water, and when dry again, rubbing them with the hand with a decoction of logwood in cold water. Green by smearing the skin with sap-green and alum water boiled; and a little more

indigo may be added to darken the colour. Dark green is given with steel filings and sal ammoniack steeped in urine till soft, then smeared over the skin; which is to be dried in the shade. Yellow by smearing the skin over with aloe and linseed oil dissolved and strained; or by infusing it in weld. And orange colour is given by smearing with fustic berries boiled in alum water; or for a deep orange with turmeric.

Bones, horn and ivory, are also dyed of different colours, viz. Black by steeping brass in aqua fortis till it be turned green, washing the bone, horn or ivory, once or twice with this liquor, and then putting it in a decoction of logwood and warm water. Red by boiling it first in alum water, and afterwards in a decoction of quick lime steeped in rain water, strain it, adding to every pint an ounce of brazil wood, in which the ivory, &c. must boil till it be sufficiently red. Green by boiling the bone, &c. first in alum water, then with verdigrease, sal ammoniack, and white wine vinegar; keeping it hot therein till sufficiently green.

To discover whether a cloth has been duly treated by the dyer, and the proper foundations laid, a white spot, by the French called *rosette*, of the bigness of a shilling, ought to be left, besides a white stripe between the cloth and the list. Further proof is had by boiling the dyed stuff in water with other ingredients different according to the quality of the dye to be proved. If the colour sustain the test, i. e. do not discharge at all, or very little, so that the water is not tinged by it, the dye is pronounced good: otherwise false.

There are also proofs of the dyes of silks, viz. For red crimson, the proof is made by boiling the silk with an equal weight of alum. For scarlet crimson, it is boiled with soap, almost of the weight of the silk. For violet crimson, with alum of equal weight with the silk, or with citron juice about a pint to a pound of silk. These ingredients are to be mixed, and put in fair water, when it begins to boil; after which, the silks are also to be put in; and after boiling the whole for half a quarter of an hour, if the dye be false, the liquor of the red crimson will be violet, in case it have been dyed with orchal, or very red, if with brazil. That of crimson scarlet, if rolac have been used, will become of an aurora colour, or if brazil has been used, red. And that of violet crimson, if brazil or orchal have been used, will be of a colour bordering on red. On the contrary, if the three sorts of crimson be truly dyed, their liquor will discover very little alteration.

To discover whether other colours have been dyed with galls, the silk is put in fair boiling water, with pot ashes, or soap, nearly of the weight of

of the silk, after some time, it is taken out; upon which if it has been dyed with galls, the colour will be all vanished, and nothing but that of the galls left, which is a sort of *feulenort*, or wood colour. The *dying* silk with galls may also be detected by putting it in boiling water, with a gallon of citron juice; being taken out and washed in cold water, and then dipped in a black *dye*, if galls have been used it will turn black, if not it will be of a brown bread colour.

To discover whether black silks have been over-dyed with galls, steel filings, or slippe, it is boiled in fair water, with twice its weight of soap: if it be laden with galls, it will turn reddish, otherwise it will keep its colour.

To discover whether black cloths have been first woaded and maddered, a sample of it, and at the same time a sample of standard black, kept for that purpose by the *dyer's* company, is to be taken; and

then as much *Roman* alum as is equal in weight to both, together with a like weight of pot ashes, is to be put over the fire in a pan of bran-water; when it begins to boil the two samples are to be put in; and after half an hour to be taken out and compared; the piece which has only been woaded will be found blucish, with somewhat of a dull green; if it hath been both woaded and maddered, it will be of a tan or minim colour; and if it hath been neither woaded nor maddered, its colour will be dunnish between yellow and fallow. For cloths *dyed* of a minim colour, the proof is to be made after the same manner as that of blacks.

To know whether scarlet, or crimson cloth have been *dyed* with pure cochineal, they are to be boiled with an ounce of alum to a pound of cloth. For cloths of other colours, the proof is to be made in the same manner as that of blacks and minims.

## ELECTRICITY.

**E**LECTRICITY is that property in certain bodies, whereby, after being rubbed, excited, or heated in some particular degree, they acquire a power of *attracting* and *repelling* other remote bodies; and frequently of *emitting* sparks and streams of *light*.

The ancients, having observed that *amber*, which they called *electrum*, upon being rubbed, attracts bits of straw, down, and other light bodies. first gave this property the name of *Electricity*, which they thought peculiar to amber and a few stones mentioned by *Theophrastus*, *Pliny* and some others. But the philosophers of the last, and more particularly of the present age, have found that numbers of other bodies possess this quality; and made so many discoveries in *Electricity*, that there is scarce any other subject in *natural philosophy* that has given occasion to more experiments.

This quality is of two sorts, viz. *Vitreous Electricity*, or that which belongs to *glass*; and *resinous Electricity*, or that which belongs to *amber*, *rosin*, *wax*, *gum*, and such like substances.

The bodies susceptible of *Electricity*, are also divided into two classes: the one are *electrical* of themselves, or *electrica per se*; that is, they contain that quality in themselves, and need only be rubbed, &c. to excite it: the others do not contain that virtue in themselves, or they have so little of it, as to be reckoned to have none at all; yet they acquire it by communication, or by emanation derived to them by a body that is electrical *per se*: those bodies are simply called *non-electrics*, or *non electrica per se*.

The *electrics per se*, or, as they are otherwise called, the *originally electrics*, are, according to *MUSCHENBROECK*, all sorts of gems, several stones, all crystals and resinous substances, sulphur, red-arsenick, salts, alum; all sorts of glass, porcellane, dried vegetables; all woods, ropes, threads of lint, paper, the leaves of trees, the harder resins, pitch, cotton; parts of animals, as their feathers, hair, horns, bones of ivory, whale-bone, the hide, parchment, the shells of fishes, silk, strings made of dried guts, gum, sealing-wax, feathered or hairy living animals, as cats, dogs, cocks, &c.

The *non-electrics* are several naked animals, or such as are covered with neither hair nor feathers; metals, semi metals, earths and dust, which, by reason of its minuteness, will not bear to be rubbed separately; all watry gums, opium, galbanum, ammoniac, assa fœtida, camphor; all sorts of bodies that liquify with a small heat, all moist bodies, all fluids which will not bear rubbing, &c.

*Electricity*, according to the same author, consists in subtle exhalations, which, in exciting the *electrical body* are put into motion; and which, by flying to and from it, agitate all those light bodies that fall within the sphere of their attraction.

That these exhalations, or subtle effluvia, constitute *Electricity*, appears from hence. 1. From the touch as these bodies are perceived to be surrounded with a most subtle atmosphere, or covered with a gentle blast of wind, that continues to breathe every where around them. 2. From that offensive smell, which resembles phosphorus, the phlegm of

*aqua regia*, or the spirit of vitriol. 3. Being taken into the mouth, they yield an acid and a stringent taste. 4. They seem to adhere to the extremities of the bodies which they surround, and from which they recede, in the form of sparks, and of a subtile lucid flame. 5. This flame is sometimes attended with an explosion, that may be heard at the distance of two hundred paces: besides, the greater flames occasion a continued hissing, or crackling noise in the air. Since, therefore, the *electrical effluvia* affect all the human senses, we can no longer doubt of their being a *corporeal fluid*.

Mr. WATSON thinks, that *Electricity* is not furnished from the *electric bodies* employed in the experiments, nor from the circumambient air; but that it is the effect of a very subtile and elastic fluid occupying all bodies, in contact with the terraqueous globe; that every where, in its natural state, it is of the same degree of density; that glass and other bodies, which are *electrics per se*, have the power of taking this fluid from one body and conveying it to another, in a quantity sufficient to be obvious to all our senses; that, under certain circumstances, it is possible to render the *Electricity* in some bodies more rare than it naturally is, that by communicating this to other bodies, to give them an additional quantity, and make their *Electricity* more dense; and that these bodies will thus continue, until their natural quantity is restored to each; that is, by those which have lost part of theirs, acquiring what they have lost, and by those to whom more has been communicated, parting with their additional quantity. Both one and the other of these is, from the elasticity of the electric matter, attempted to be done from the nearest *non-electric*; and when the air is moist, this is soon accomplished by the circumambient vapours, which here may be considered as preventing, in a very great degree, our attempts to insulate *non-electric* bodies.

In order to illustrate the phenomena of *Electricity*, we shall give some select experiments.

1. Get a glass tube A B, of about three feet and a half in length, an inch and a half in diameter, and its sides a line thick: rub it with a piece of fluff, paper, or, which is still better, with the hand, provided it be very dry: you will succeed better if your hands be rubbed with chalk, or white lead. Afterwards bring this rubbed tube near any light bodies, as gold leaf laid up on a glass stand C D; then will the gold-leaf be attracted and repelled in the manner represented in the plate, Fig. 1.

If you do this in such a manner, that the gold-leaf, for example, be perpendicularly repelled above the tube, and that it meet with no other body, it will sustain itself in the air, always at the

same distance from the tube, and may be conveyed in this situation quite round the room; but if it touch any other body, it will come back and adhere to the tube, and then it will be repelled anew as at the first.

2. Again, if the tube be rubbed anew, pretty briskly, it will attract a feather, or other light body, at a considerable distance; and after they have stuck to it for some time, they are again driven off, and it will constantly repel them, till they are touched by some other *non-electric* body, as a finger or stick: on which they will be again attracted by the tube; and if the finger be held pretty near the tube, the feather will alternately fly from the tube to the finger, and back again; always stretching out its fibres the way that it is going, and that before it comes off from the finger or tube. See plate, No. 2.

Before we proceed to more complicated experiments, it will be proper to observe, that, in order to know that *non-electrics* have received the communicated *Electricity*, they must be insulated: that is, they must not be suspended from, nor supported by any body, but what is an *electric per se*. For if one *non-electric* be touched by another, and this by a third, &c. all the *Electricity* received by the first will go to the second, and from this to the third, &c. till at last it be lost upon the ground. But, if several *non-electric* bodies, touching one another, are at length terminated by *electric bodies*, in that respect they make but one body, and receive and retain *Electricity* for some time. From hence it may be observed, that *non-electrics* are conductors of *Electricity*. Water conducts it very well, but metals are the most convenient conductors.

3. Let an iron-rod, pointed at one end, be suspended on silk lines, and by means of a glass or rosin-sphere (which can be more regularly and constantly excited than a tube) be electrified, it will be found to have all the properties of the excited tube already mentioned: that end of the iron rod, suspended as already mentioned, which is next the sphere, must point to it at the distance of a quarter of an inch. This apparatus being disposed, as represented, *ibid.* No. 3 the globe will be electrified in whirling round against a leather cushion rubbed with whiting, or dry-hand rubbed in the same manner. When the rod, by this means, is strongly electrified, a stream of light, in diverging rays, will be seen to issue from that point of it which is most distant from the sphere; and if any *non-electric* body, as a finger, be placed within a quarter of an inch of the said flame, it will perceive a gentle blast of wind from the end of the iron; that is, the *electrical fire* will issue out from the point in such a manner, as to blow against the finger very sensibly;

bly; and if the finger be still held nearer, the large pencil of rays will be condensed in such a manner, as to run out from the point upon the finger, in a stream, or body of dense, yellow fire, and strike the finger like a gentle *jet d'eau*. The rod suspended before the glass-sphere, is properly termed the prime conductor in this machine.

4. While the flame continues to appear from the end of the iron-rod, the finger being placed any where upon it, the flame at the end disappears immediately; and when the finger is taken off, it again instantly appears; and so by putting the finger off and on successively, the electric flame will appear and disappear alternately. These eruptions of the electrical fire will snap very sensibly, both to the eye and the ear, upon any part of the rod that the finger is pointed to. See *ibid* No. 3.

5. If a chain, or hempen cord, be suspended by silken strings all round the room, of any length you please, and one end thereof be hung, by a loop, across the rod, the electrical fire will instantly be transmitted through the whole length of the chain, and appear upon every part of the approach of the finger, and be heard to snap and strike with as great force as from the rod itself.

6. Take two plates of metal, very clean and dry, whose surfaces are nearly equal; hang one of them horizontally to the electrified rod, and bring under it, upon the other, any thin light body, as silver leaf, &c. When the upper plate is made electrical, the silver will be attracted by it; and if the under plate is held at a proper distance, will be perfectly suspended at right angles to the plates, without touching either of them; but if they are either brought nearer together, or carried farther asunder, the leaf will cease to be suspended, and will jump up and down between them.

The same effect will be produced, if the experiment is reversed by *electrifying* the bottom plate, and suspending the other over it.

7. The following improvement, upon the *electrical* machine of the *Abbe NOLLET*, already exhibited, was made by Mr. *WATSON* in 1746. In the periphery of his machine, see *ibid*. No. 4. were cut four grooves, corresponding with four globes, which were disposed vertically: one, two, or the whole number of these globes might be used at pleasure. They were mounted upon spindles, and the leather-cushion with which they were rubbed, was stuffed with an elastic substance, as curled hair, and rubbed over with whiting. One of the globes was lined to a considerable thickness with a mixture of wax and rosin, but no difference appeared in the power of this globe from the others.

For performing most of the following experiments, some have imagined a gun-barrel absolutely

necessary, as the prime conductor; but Mr. *WATSON* says, that a solid piece of metal, of any form, is equally useful: having observed the stroke from a sword, as violent as that from a gun-barrel.

If, to the suspended barrel, a sponge, thoroughly dry, be hung, it gives no appearance of fire, which shews it to be an *electric* substance; but if when the sponge has been immersed in water, it be suspended to the barrel, and the finger applied near it, the fire issues out with considerable force and snappings; and the drops, which, before the sponge was applied, fell very slowly, will now fall as fast: if the room be darkened, these drops will appear to be drops of fire, and illuminate the basin into which they fall,

8. If a phial of water is suspended to the prime conductor by a wire, let down a few inches into water through the cork; and some metallic fringes inserted into the barrel, touch the globe in motion, the electrical power may be so accumulated in the phial, that a man grasping it with one hand, and touching the gun-barrel with a finger of the other, will receive a violent shock through both his arms, especially at his elbows and wrists, and across his breast.

The commotion arising from the discharge of accumulated *Electricity* in a phial, may be felt by a great number of men at once. *M. LE MONNIER*, at *Paris*, is said to have communicated this shock through a line of men, and other *non-electrics*, measuring nine hundred toises, being more than an *English* mile; and the *Abbe NOLLET* made the experiment upon two hundred persons ranged in two parallel lines.

9. If the *electrical machine*, and the man who turns the wheel thereof, be mounted on *electrical* cakes, the *electrical* power is so far from being increased, that, on the contrary, it is so much diminished, as to be oftentimes not at all perceptible.

10. A person standing on a cake of rosin, holding a chain fastened to the prime conductor, will be *electrified*; that is, he will be all over possessed with *electric* virtue; and, at the same time, feel nothing of it, unless some person, standing by, put his finger near to any part, and then the virtue will be emitted in form of fire, and snap and become very sensible to both parties. See *ibid* Fig. 5.

11. A person standing on rosin, holding the chain of the conductor, points his finger to the warm spirits of wine; and by communicating the *electric* fire thereto, kindles the rising vapour, and so sets the whole on fire. In this manner any sort of matter, which, when warmed, will send forth an inflammable vapour, will be set on fire. See *ibid*. Fig. 6.

The *electrical* commotion, mentioned in *experiment 8*, arising from an accumulation of the *electrical* fire, has been made very sensible quite across the river *Thames*, by the communication of no other medium than the water of that river, and spirit of wine fired at that distance.

By comparing the respective velocities of *Electricity* and sound, that of *Electricity*, in any distance yet experienced, appears instantaneous.

12. If the globe be exhausted of all its air, and then whirled about, the *Electricity* will be observed to act wholly within the globe, where it will appear, in a darkened room, in form of a cloud or flame of reddish or purple coloured light, filling the whole capacity of the globe.

13. If a loadstone, armed with iron, be hung on to the gun-barrel by an iron-wire, the *electric* virtue will rush out from every part, but more forcibly from the iron than from the stone itself: for from the stone, it seems to be emitted in a more lax manner, and diffused in a sort of steam, or fiery vapour; whereas from the iron, it issues in a more impetuous, dense, and penetrating steam; by which we learn, that the two most considerable powers of nature, *Electricity* and magnetism, do not always interfere, or impede each other's actions.

14. The method of firing gunpowder by the *electric* flame, has something particular in it; as it does not require any inflammable vapour to be previously raised. The powder may be fired thus: a small cartridge is filled with dry powder, hard rammed, so as to bruise some of the grains: two pointed wires are then thrust in, one at each end, the points approaching to each other in the middle of the cartridge, till within the distance of half an inch: then the cartridge being placed in the circle, when four *electrified* glass jars are discharged, the *electric* flame leaping from the point of one wire to the point of the other within the cartridge, among the powder, fires it, and the explosion of the powder is at the same instant with the crack of the *electrical* discharge.

15. As to metals, Mr. FRANKLIN tells us, that he has been able, by *electricity*, to give polarity to needles, and to reverse it. A shock from four large glass-jars sent through a fine sewing needle, gives it polarity.

16. In consequence of Mr. Franklin's hypothesis, of being able, by a proper apparatus to collect the *electricity* from the atmosphere during a thunder-storm, it has been found, that a pointed bar of iron, forty feet high, being placed upon an *electric* body; and a stormy cloud having passed over the place where the bar stood, those, appointed to observe it, attracted from it sparks of fire, perceiving

the same kind of commotions as in the common *electrical* experiments. The like effect followed when a bar of iron ninety-nine feet high was placed upon a cake of rosin two feet square, and two inches thick: these were the first experiments made, but they have since been sufficiently varied and verified, so that it seems now certain. 1. That a bar of iron, pointed or not, is *electrified* during a storm. 2. That a vertical, or horizontal situation, is equally fitting for these experiments. 3. That even wood is *electrified*. 4. That, by these means, a man may be sufficiently *electrified* to set fire to spirit of wine with his finger, and repeat almost all the usual experiments of *electricity*.

17. Mr. FRANKLIN has contrived a very ingenious and easy method of trying experiments of this kind, by means of an *electrical* kite, made of a large thin silk handkerchief, extended and fastened, at the four corners, to two slight strips of cedar, of sufficient length for this purpose. This kite being accommodated with a tail, loop, and string, will rise in the air like those of paper. To the top of the upright stick of the cross, is to be fixed a very sharp pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribband; and, where the twine and silk join, a key may be fastened. The kite is to be raised when a thunder gust appears to be coming on; and as soon as the thunder clouds come over the kite, the pointed wire will draw the *electric* fire from them, and the kite, with all the twine, will be *electrified*; and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. When the rain has wet the kite and twine, so that it cannot conduct the *electric* fire freely, it will stream out plentifully from the key on the approach of a man's knuckle. At this key a phial may be charged; and from the *electric* fire, thus obtained, spirits may be kindled, and all the other *electrical* experiments be performed, which are done by the help of a glass-sphere or tube; and the sameness of the *electric* matter with that of lightning, may thereby be completely demonstrated.

From this identity some have conceived hopes of depriving the clouds of all their thunder, and thereby rendering thunder storms harmless.

18. Mr. STEPHEN GRAY, just before he died, hit upon an experiment which seemed to indicate, that the attractive power, which regulates the motions of the heavenly bodies, is of the *electric* kind. The experiment was thus: he fixed a large, round, iron-ball upon the middle of a large cake of rosin and wax; and exciting the virtue strongly in the cake, a fine feather, suspended by a thread, and held near the iron-ball, was carried round it, by

the effluvia, in a circular manner, and performed several revolutions: it moved the same way with the planets, from west to east, and its motion, like theirs, was not quite circular, but a little elliptical.

These being most of the capital experiments hitherto exhibited, in *Electricity*, we shall conclude this head by mentioning some of the *medicinal virtues* lately attributed to this subject of philosophy.

It has been pretended, that odours will pervade *electrified* globes and tubes of glass; and that the medicinal effects of drugs might likewise be transmitted this way; as also, that, if persons were to hold in their hands, or place under their naked feet, odoriferous or purging substances, and were then to

be *electrified*, they would be sensible of the effects of these substances; but this seems now to be an imposition on the credulity of the world, no such effects having ever been perceived. However, it does not follow that medicinal advantages are not to be gained from *electricity* itself; so subtle and so elastic a fluid admitted in a large quantity into our bodies, as, from undoubted experience, it greatly heats the flesh and quickens the pulse, may more especially, when assisted with the expectation of success in the patient, in particular cases, be attended with advantages. In effect, we meet with some cures performed in paralytic cases, by the force of *electricity*.

Of E M B R O I D E R Y.

**E**MROIDERY is a work with gold, or silver, or silk thread, wrought by the needle upon cloth, stuffs, or muslin, into various figures. In *embroidering* stuffs, the work is performed in a kind of loom, because the more the piece is stretched, the easier it is worked. As to muslin, they spread it upon a pattern ready designed; and sometimes, before it is stretched upon the pattern, it is starched, to make it more easy to handle. *Embroidery* on the loom is less tedious than the other, in which while they work flowers, all the threads of the muslin, both lengthwise and breadthwise, must be continually counted; but on the other hand this last is much richer in points, and susceptible of greater variety. Cloths too much milled are scarce susceptible of this ornament, and in effect we seldom see them *embroidered*. The thinnest muslins are the best for this purpose: and they are *embroidered* to the greatest perfection

in *Saxony*: in other parts of *Europe*, however, they *embroider* very prettily, and especially in *France*.

There are several kinds of *embroidery*; as, 1. *Embroidery* on the stamp, where the figures are raised and rounded, having cotton or parchment put under them to support them. 2. *Low embroidery*, where the gold and silver lie low upon the sketch, and are stitched with silk of the same colour. 3. *Guimped embroidery*: this is performed either in gold or silver; they first make a sketch upon the cloth, then put on cut vellum, and afterwards sow on the gold and silver with silk-thread: in this kind of *embroidery* they often put gold and silver cord, tinsel, and spangles. 4. *Embroidery* on both sides; that which appears on both sides of the stuff. 5. *Plain embroidery*, where the figures are flat and even, without cords, spangles, or other ornaments.

Of E N A M E L L I N G.

**E**NAMELLING is the art of laying *enamel*\* upon metals, as gold, silver, copper, &c. and of melting it at the fire, or of making divers curious works in it at a lamp. It signifies also to paint in enamel. *The painting in*

*enamel*, is performed on plates of gold or silver, and, most commonly of copper, enamelled with the white enamel; whereon they paint with colours, which are melted in the fire, where they take a brightness and lustre like that of glass. This painting

N n n 2

\* ENAMEL, a kind of coloured glass, used in enamelling and painting in enamel.

Enamels have for their basis a pure crystal-glass or frit, ground up with a fine calx of lead and tin prepared for the purpose, with the addition usually of white salt of tartar. These ingredients fused together, are the matter of all enamels, which are made by adding colours of this or that kind in powder to this matter, and melting or incorporating them together in a furnace.

ing is the most prized of all for its peculiar brightness and vivacity, which is very permanent, the force of its colours not being effaced or sullied with time, as in other painting, and continuing always as fresh as when it came out of the workman's hands. It is usually in miniature, it being the more difficult the larger it is, by reason of certain accidents it is liable to in the operation. Enamelling should only be practised on plates of gold, the other metals being less pure: copper, for instance, scales with the application, and yields fumes; and silver turns the yellows white. Nor must the plate be made flat; for in such case, the enamel cracks; to avoid which, they usually forge them a little round or oval, and not too thick. The plate being well and evenly forged, they usually begin the operation by laying on a couch of white enamel (as we observed above) on both sides, which prevents the metal from swelling and blistering; and this first lay serves for the ground of all the other colours. The plate being thus prepared, they begin at first by drawing out exactly the subject to be painted with red vitriol, mixed with oil of spike, marking all parts of the design very lightly with a small pencil. After this, the colours (which are to be before ground with water in a mortar of agate extremely fine, and mixed with oil of spike somewhat thick) are to be laid on, observing the mixtures and colours that agree to the different parts of the subject; for which it is necessary to understand painting in miniature. But here the workman must be very cautious of the good or bad qualities of the oil of spike he employs to mix his colours with, for it is very subject to adulterations.

Great care must likewise be taken, that the least dust imaginable come not to your colours while you are either painting or grinding them; for the least

speck, when it is worked up with it, and when the work comes to be put into the reverberatory to be red hot, will leave a hole, and so deface the work.

When the colours are all laid, the painting must be gently dried over a slow fire to evaporate the oil, and the colours afterwards melted to incorporate them with the enamel, making the plate red hot in a fire, like what the Enamellers use. Afterwards that part of the painting must be passed over again which the fire hath any thing effaced, strengthening the shades and colours, and committing it again to the fire, observing the same method as before, which is to be repeated till the work is finished.

Most *enamelled* works are wrought at the fire of a *lamp*, in which, instead of oil, they put melted horse-grease, which they call *caballine oil*. The lamp, which is of copper or white iron, consists of two pieces, in one of which is a kind of oval plate, six inches long, and two high, in which they put the oil and the cotton. The other part, called the box, in which the lamp is inclosed, serves only to receive the oil which boils over by the force of the fire. This lamp, or where several artists work together, two or three more lamps are placed on a table of proper height. Under the table, about the middle of its height, is a double pair of organ-bellows, which one of the workmen moves up and down with his foot, to quicken the flame of the lamps, which are by this means excited to an incredible degree of vehemence. Grooves made with a gauge in the upper part of the table, and covered with parchment, convey the wind of the bellows to a pipe of glass before each lamp; and that the Enamellers may not be incommoded with the heat of the lamp, every pipe is covered at six

For *white enamel*, NERI *De Arte Vitriar.* directs only manganese to be added to the matter which constitutes the basis. For *azure*, zaffer mixed with calx of brass. For *green*, calx of brass with scales of iron, or with crocus martis. For *black*, zaffer with manganese, or with crocus martis; or manganese with tartar. For *red*, manganese or calx of copper and red tartar. For *purple*, manganese with calx of brass. For *yellow*, tartar and manganese. And for *violet-coloured enamel*, manganese with thrice calcined brass.

In making these *enamels*, the following general cautions are necessary to be observed. 1. That the pots must be glazed with white glais, and must be such as will bear the fire. 2. That the matter of *enamels* must be very nicely mixed with the colours. 3. When the *enamel* is good, and the colour well incorporated, it must be taken from the fire with a pair of tongs. 4. The general way of making the coloured *enamels* is this; powder, sift, and grind all the colours very nicely, and first mix them with one another, and then with the common matter of *enamels*; then set them in pots in a furnace, and when they are well mixed and incorporated, cast them into water; and when dry, set them in a furnace again to melt; and when melted, take a proof of it. If too deep coloured, add more of the common matter of *enamels*; and if too pale, add more of the colours.

*Enamels* are used either in counterfeiting or imitating precious stones, in painting in *enamel*, or by *enamellers*, jewelers, and goldsmiths, in gold, silver, and other metals. The two first kinds are usually prepared by the workmen themselves, who are employed in these arts. That used by jewelers, &c. is brought to us chiefly from *Venice* or *Holland*, in little cakes of different sizes, commonly about four inches diameter, having the mark of the maker struck upon it with a punchion. It pays the pound 1s. 7 $\frac{1}{2}$ d. on importation, and draws back 1s. 5 $\frac{1}{2}$ d. at the rate of 4s. per pound, a manufacture of this kind is now erected with great approbation in *London*.

inches

inches distance with a little tin plate, fixed into the table by a wooden handle. When the works do not require a long blast, they only use a glass-pipe, into which they blow with their mouth.

It is incredible to what a degree of fineness and delicacy the threads of enamel may be drawn at the lamp. Those which are used in making false tufts of feathers are so fine, that they may be wound on the reel like silk or thread. The fictitious jets of all colours, used in embroideries, are also made of enamel; and that with so much art, that every small piece hath its hole to pass the thread through wherewith it is sewed. These holes are made by blowing them into long pieces, which they afterwards cut with a proper tool.

It is seldom that the *Venetian* or *Dutch* enamels are used alone; they commonly melt them in an iron-ladle, with an equal part glass or crystal; and when the two matters are in perfect fusion, they draw it out into threads of different sizes, according to the nature of the work. They take it out of the ladle while liquid, with two pieces of broken tobacco-pipes, which they extend from each other at arms length. If the thread is required still

longer, then another workman holds one end, and continues to draw it out, while the first holds the enamel to the flame. Those threads, when cold, are cut into what lengths the workman thinks fit, but commonly from ten to twelve inches; and as they are all round, if they are required to be flat, they must be drawn through a pair of pincers while yet hot. They have also another iron-instrument in form of pincers, to draw out the enamel by the lamp when it is to be worked or disposed in figures. Lastly, they have glass tubes of various sizes, serving to blow the enamel into various figures, and preserve the necessary vacancies therein; as also to spare the stuff and form the contours. When the Enameller is at work, he sits before his lamp with his foot on the step that moves on the bellows, and holding in his left hand the work to be enamelled, or the brass or iron-wires the figures are to be formed on, he directs with his right the enamel thread, which he holds to the flame with a management and patience equally surprising. There are few things they cannot make or represent with enamel; and some figures are as well finished, as if done by the most skilful carvers, and painters.

## Of ENGRAVING.

**E**NGRAVING (from lat. *cavare*, to hollow) is the art of cutting metals, and precious stones, to represent figures, letters, or other matters thereon.

The ancients excelled in the art of *engraving* on precious stones, there being divers antique agates, berils, cornelians, and onixes, which surpass any thing of that kind the moderns have produced. *Pyrgoteles* among the *Greeks*, and *Dioscorides* under the first emperors of *Rome*, are the most eminent engravers we read of. The former was so esteemed by *Alexander*, that he forbade any body else to engrave his head; and *Augustus's* head, engraven by the latter, was found so beautiful, that the succeeding emperors chose it for their seal. All the polite arts having been buried under the ruins of the *Roman* empire, the art of *engraving on stones* met the same fate.

That art was retrieved in *Italy* at the beginning of the fifteenth century, when one *John* of *Florence*, and after him *Dominic* of *Milan*, performed work of this kind no way to be despised. From that time, pieces of that kind became common enough in *Europe*, and particularly in *Germany*, whence great numbers were sent into other countries; but they came short of the beauty of those of the ancients, especially those on precious stones; as for those on crystal, the *Germans*, and after their example,

the *English* and *French*, have very well succeeded.

ENGRAVING, properly a branch of sculpture, is divided into several other branches, according to the matter whereon it is employed, and according to the manner of performing it.

These branches are denominated *cutting in wood*; *etching*, *mezzotinto*, and, what is properly and originally called, *engraving*.

We are indebted for the invention of *cutting in wood*, as well as that in copper, to *Maso Finiguerra*, a goldsmith of *Florence*, in the year 1460; and for its perfection to *Albert Durer*, *Martin* of *Antwerp*, and *Mark Antony*. At the same time, *Hugo* of *Carpi*, an *Italian* printer, invented a manner of *cutting in wood*; by means whereof, the prints appeared as if printed in *clear-obscure*: In order to this he made three kinds of stamps for the same design, which were drawn after one another, through the press, for the same print; they were so conducted that one served for the grand lights, the second for the demi-tints, and the third for the out-lines and the deep shadows.

The art of *cutting in wood* was certainly carried to a very great pitch about 150 years ago; and might even vie, for beauty and justness, with that of *engraving on copper*: At present it is in a very low

low condition, as having been long neglected; and the application of artists wholly employed on copper, as the most easy and promising province: Not that but wooden cuts have the advantage of copper on many accounts; chiefly for figures and devices in books, as being printed at the same time, and on the same press as the letters; whereas for the other, there is required a particular impression.

The *cutters in wood* need no other instruments than little sharp knives, little chisels, and gravers of different sizes, according to the bigness or delicacy of their work. The first thing they do is to take a block of pear-tree, or box; box is the best, they prepare that block, of the size and thickness intended, and make it very even and smooth on the side to be cut. On this block, thus prepared, they draw their design with a pen or pencil, just as it ought to be printed. Those who cannot draw their own design, make use of a design furnished them by another, which they fasten upon the block with piasse made of flour and water, with a little vinegar; the strokes or lines turned towards the wood.

When the paper is dry, they wash it gently over with a sponge dipped in water; which done, they take off the paper by little and little, still rubbing it a little first with the tip of the finger, till at length there be nothing left on the block but the strokes of ink that form the design, which mark out so much of the block as is to be left standing: The rest they cut off, as curiously as they can, with the points of their sharp tools.

This sort of *engraving* is used for various purposes; as for initial or figured letters, head and tail pieces of books; and even for schemes and other figures, to save the expence of *engraving* on copper; and for prints and stamps for paper, callicoes, linens, &c.

ETCHING is a method of *engraving* on copper, in which the lines or strokes, instead of being cut with a tool or graver, are eaten in with *aquafortis*.

*Etching* is done with more ease and expedition than *engraving*: it requires fewer instruments, and represents most kind of subjects better and more agreeable to nature, as *landscapes*, *ruins*, *grounds*, and all *small*, *faint*, *loose*, *remote* objects, buildings, &c.

The method of *etching* is as follows: choose a well polished copper-plate, and furnish yourself with a piece of *ground*, tied up in a bit of thin silk, kept very clean, to be laid upon the plate when both have been warmed; proper *needles* to hatch with on the ground; a *pencil* or *brush*, to wipe away the bits of ground which rise after hatching; a *polishe*; two or three *gravers*; a pair of *compasses*, to measure distances and draw circles; a *ruler*, to hatch strait lines; *green wax*, to

make the wall round the edges of the plate, to contain the *aquafortis*; an *oil-stone*; a bottle of *aquafortis*; some *red-lead*, to colour the backside of the copy; a *sift*, and a *band-vice*, to hold the plate over the candle.

To make the *ground*; take three ounces of asphaltum, two ounces of clean rosin, half an ounce of burgundy-pitch, three ounces of black wax, and three ounces of virgin's wax: let all these be melted in a clean earthen pipkin over a slow fire, stirring it all the time with a small stick; if it burn to the bottom, it is spoiled. After the ingredients are well melted, and it boils up, put it into a pan of fair water; and before it be quite cold, take it out, and roll it into small lumps to be kept from dust: this *ground* is what others call the *varnish*.

The next thing is to clean the plate to receive the *ground*: take a piece of lising, roll it up as big as an egg, tie it very tight, so as to make it a rubber, and having dropped a small quantity of sweet oil, and added a little powder of rotten-stone on the plate, rub it with this ball, till it will almost shew your face. Then wipe it all off with a clean rag, and after that, make it quite dry with another clean rag, and a little fine whiting.

The next thing is to lay on the *varnish*; to do which aright you must take a *band vice*, and fix it at the middle of one part of the plate, with a piece of paper between the teeth of the *band-vice* and the plate, to prevent the marks of the teeth: then laying the plate on a chaffing dish, with a small charcoal fire in it, till the plate be so hot, that, by spitting on the backside, the wet will fly off: rub the plate with the *ground* tied up in silk, till it be covered all over; and after that dawb the plate with a piece of cotton wrapped up in silk till the *ground* be quite smooth, keeping the plate a little warm all the time. The *varnish* being thus smoothed upon the plate, it must be blacked in the following manner: take a thick tallow candle that burns clear, with a short snuff, and having driven two nails into the wall, to let it rest upon, place the plate against the wall with the *varnish* side downward, and take care not to touch the *ground* with your fingers: then taking the candle, apply the flame to the *varnish* as close as possible, without touching the *varnish* with the snuff of the candle, and guide the flame all over it, till it become perfectly black.

On this *ground* thus blackened, the back of the design or draught is laid. This done, the design remains to be chalked or transferred upon the plate; which is more easily effected than in the common *graving*; for the back of the design having been before rubbed over with red chalk, nothing remains but to trace over all the lines and strokes of the draught with a needle or point; which pressing the paper

paper close down to the *ground*, occasions the wax therein to lay hold of the chalk, and so bring off the marks of the several lines; so as at length to shew a copy of the whole design in all its correctness. The draught thus chalked, the artist proceeds to draw the several lines and contours, with a point, through the *ground* upon the copper. To finish his work, he makes use of points, of diverse sizes, or bigness; and presses on them sometimes more strongly, and other times more lightly, according as the several parts of the figures require more or less strength or boldness; some of the points being as fine as needles, for the tender hair-strokes, and the remoter, fainter objects; and others again as big as bodkins, made oval-wise, for the deeper shadows, and the figures in the front of the work.

Things thus prepared, a rim, or border of wax, is raised round the circumference of the plate, and *aquafortis* poured on; which by the said border is kept from running off at the edges. The *ground* being impenetrable to that corrosive water. The plate is defended from it every where but in the lines or hatches, cut through it with the points; which, lying open, the water passes through them to the copper, and eats into the same, to the depth required. Which done, it is poured off again. The *aquafortis* having done its part, the *ground* is taken off, and the plate washed and dried; after which nothing remains but for the artist to examine the work with the *graver* in his hand, to touch it up and heighten it, where the *aquafortis*, &c. has missed.

*Etching-grounds* are either soft, or hard: and the *aquafortis*, either white, which is only used with the soft *ground*, and is applied as above directed; or green, made of vinegar, common salt, sal-ammoniac, and verdigrease: This is used indifferently with either kind of *ground*: Its application is somewhat different from that of the white. Without making any border, they pour it on the plate, which is placed for that purpose a little inclined; and as the water runs off, it is received in a vessel placed underneath. This they repeat, pouring it again and again, till it has eaten deep enough; and, the *aquafortis*, of which kind soever it be, must not continue equally long, or be poured equally often, on all the parts of the design: the remote parts must be eaten more slightly, than those nearer to the view. To manage this, they have a composition of oil and grease, wherewith they cover the parts that are to be bitten no farther: or else they lay the composition on as a defensive at first, and take it off again when they think proper. In effect, they are every now and then covering and uncovering this or that part of the design, as occasion requires; the management of the *aqua-*

*fortis* being one of the principal concerns in the whole art, and that on which the effect of the whole very much depends. The operator is also to be very attentive to the *ground*, that it do not fail or give way, in any part to the water; and where 'it does, to stop up the place with the composition aforesaid. Lastly, it is to be remembered, that a fresh dip of *aquafortis* be never given, without first washing out the plate in fair water, and drying it at the fire.

MEZZOTINTO is the art of representing figures on copper in imitation of painting in *Indian* ink.

The discovery of the art of engraving, in *taille douce*, on copper, is ascribed, to *Maso Finiguerra*, a goldsmith of *Florence*, who used to engrave on his works, and who, in moulding them in melted sulphur, perceived that what came out of the mould marked, in its impressions the same things, which were engraved on the piece of work, by the black which the sulphur had extracted from the lines; he attempted the same thing on plates of silver with wet paper, in running over it a very smooth roller, in which he succeeded. This new discovery prompted another goldsmith of the same city, called *Baccio Baldini*, to try the same thing; and the success encouraged him to engrave several plates of the invention and design of *Sandro Botticello*; and on these proofs *Andrew Montaigne*, who was then at *Rome*, engraved several of his own works.

The knowledge of this invention having passed into *Flanders*, *Martin of Antwerp*, who was then a famous painter, engraved several plates of his own invention, and sent several prints of them into *Italy*, which were marked thus; *M. C.*

*Mezzotintos* are made in the following manner: take a well polished copper plate, and beginning at one corner, rake or furrow the surface all over with a knife or instrument made for the purpose, first one way, and then the other, till the whole is of a regular roughness, without the least smooth part to be seen; in which state, if a paper was to be worked off from it at the copper-plate press it would be all over black. When this is done, the plate is rubbed over with charcoal, black chalk, or black lead, and then the design is drawn with white chalk, after which the out-lines are traced out, and the plate finished by scraping off the roughness, so as to leave the figure on the plate. The out-lines and deepest shades are not scraped at all, the next shades are scraped but little, the next more, and so on till the shades gradually falling off, leave the paper white, in which places the plate is neatly burnished.

By an artful disposition of the shades, and different parts of a figure on different plates, *mezzotintos*

*tintos* have been printed in colours, so as nearly to represent very beautiful paintings.

ENGRAVING properly so called, is performed on *steel, copper, or stones.*

ENGRAVING on *steel* is chiefly employed in cutting seals, punches, matrices, and dyes proper for striking coins, medals, and counters. The method of *engraving* with the instruments, &c. is the same for coins as for medals and counters: All the difference consists in their greater or less *relievo*, the *relievo* of coins being much less considerable than that of medals, and that of counters still less than that of coins.

*Engravers* in steel commonly begin with punches, which are in *relievo*, and serve for making the *creux* or cavities, of the matrices, and dyes: though sometimes they begin with the *creux*, or hollowness, but then it is only when the intended work is to be cut very shallow. The first thing done, is that of designing the figures; the next is the moulding them in wax, of the size and depth they are to lie, and from this wax the punch is *engraven*. When the punch is finished they give it a very high temper, that it may the better bear the blows of the hammer with which it was struck to give the impression to the matrix.

The *steel* is made hot to soften it, that it may the more readily take the impression of the punch; and after striking the punch on it, in this state, they proceed to touch up or finish the strokes and lines, where, by reason of their fineness, or the too great *relievo*, they are any thing defective, with steel gravers of different kinds, chisels, flatters, &c. being the principal instruments used in graving on steel.

The figure being thus finished, they proceed to engrave the rest of the medal, as the mouldings of the border, the engrailed ring, letters, &c. with little steel punches, well tempered, and very sharp.

ENGRAVING on *copper*, is employed in representing portraits, histories, landskips, foliages, figures, buildings, &c. either after paintings, or designs, for that purpose.

It is performed with the *graver* on a plate of *copper*, which, being well polished, is covered over thinly with virgin-wax, and then smoothed, while warmed, with a feather, so that the wax be of an equal thickness on the plate; and on this the draught or design, done in black lead, red chalk, or unguimed ink, is laid with the face of the drawing on the wax: then they rub the backside, which will cause the whole design of the drawing to appear on the wax. The design, thus transferred, is traced through on the copper, with a point, or needle; then heating the plate, and taking off the wax, the strokes remain to be followed,

heightened, &c. according to the tenor of the design, with the graver, which must be very sharp, and well pointed.

In the *conduct* of the *graver* consists almost all the art, which depends not so much upon rules, as upon *practice*, the habitude, disposition, and genius of the artist, the principles of *engraving* being the same with those of painting; for if an *engraver* be not a perfect master of design, he can never hope to arrive at a degree of perfection in this art. In conducting the strokes, or cuts, of the *graver*, he must observe the action of the fingers, and of all their parts, with their out-lines; and remark how they advance towards, or fall back from his sight, and then, conduct his *graver*, according to the risings or cavities of the muscles, or folds, widening the strokes in the light, and contracting them in the shades; as also at the extremity of the out-lines, to which he ought to conduct the cuts of the *graver*, that the figures or objects represented, may not appear as if they were gnawn; and lightening his hand that the out-lines may be perfectly found, without appearing cut or slit; and, although his strokes necessarily break off; where a muscle begins, yet they ought always to have a certain connection with each other, so that the first stroke should often serve to make the second, because this will shew the freedom of the *graver*.

If hair be the subject, let the *engraver* begin his work by making the out-lines of the principal locks, and sketch them out in a careless manner, which may be finished, at leisure, with finer and thinner strokes to the very extremities.

The *engraver* must avoid making very acute angles, especially in representing flesh, when he crosses the first strokes with the second, because it will form a very disagreeable piece of tabby-like lattice-work; except in the representation of some clouds in tempests, the waves of the sea, and in representations of skins of hairy animals, and leaves of trees. So that the medium between square and acute seems to be the best and most agreeable to the eye.

He that would represent sculpture, must remember that, as statues, &c. are most commonly made of white marble, or stone, whose colour does not produce such dark shades as other matters do, have no black to their eyes, nor hair of the head, and beard flying in the air.

If the *engraver* would preserve one quality and harmony in his works, he should always sketch out the principal objects of his piece before any part of them are finished.

The instruments necessary for this sort of *engraving* are, besides a *graver*, a *cushion*, or *sand bag*, made of leather, to lay the plate on, in order to give it the necessary turns and motions; a *burnisher*, made,

made of iron, or steel, round at one end, and usually flattish at the other, to rub out slips and failures. soften the strokes, &c. a *scraper*, to pare off the surface, on occasion; and a rubber of a black hat, or cloth rolled up, to fill up the strokes that they may appear the more visible.

In engraving on precious stones, they use either the diamond, or the emery. The diamond, which is the hardest of all stones, is only cut by itself, or with its own matter.

The first thing to be done in this branch of engraving, is to cement two rough diamonds to the ends of two sticks big enough to hold them steady in the hand, and to rub or grind them, against each other, till they be brought to the form desired. The dust, or powder that is rubbed off serves afterwards to polish them, which is performed with a kind of mill that turns a wheel of soft iron. The diamond is fixed in a brass-dish, and, thus applied to the wheel is covered with diamond-dust, mixt up with oil of olives, and when the diamond is to be cut facet wise, they apply first one face, then another, to the wheel.

Rubies, sapphires, and topazes, are cut and formed the same way on a copper wheel, and polished with *tripoli* diluted in water. As to agates, amethysts, emeralds, hyacinths, granates, rubies, and others of the softer stones, they are cut on a leaden wheel, moistned with emery and water, and polished with *tripoli*, on a pewter wheel. *Lapis-*

*lazuli*, opal, &c. are polished on a wooden wheel. To fashion and engrave vases of agate, crystal, *lapis-lazuli*, or the like, they make use of a kind of lathe, like that used by pewterers to hold the vessels, which are to be wrought with proper tools; that of the engraver generally holds the tools, which are turned by a wheel; and the vessel is held to them to be cut and engraved, either in *relievo* or otherwise; the tools being moistned, from time to time, with diamond dust and oil; or, at least, emery and water.

To engrave figures or devices on any of these stones, when polished, such as medals, seals, &c. they use a little iron wheel the ends of whose axis are received within two pieces of iron, placed upright, as in the turner's lathe; and to be brought closer, or set further apart, at pleasure: at one end of the axis are fitted the proper tools being kept tight by a screw. Lastly, the wheel is turned by the foot, and the stone applied by the hand to the tool, and is shifted and conducted as occasion requires.

The tools are generally of iron, and sometimes of brass: their form is various, but it generally bears some resemblance to chissels, gouges, &c. Some have small round heads, like buttons, others like ferrels, to take the pieces out, and others flat, &c. when the stone has been engraven, it is polished on wheels of hair-brushes and *tripoli*.

## E T H I C S.

**E**THICS, or *moral philosophy*, is the science of MANNERS or DUTY, which it traces from man's nature and condition, and shews to terminate in his happiness: therefore it is called ETHICS or *moral discipline*; and may be properly defined the knowledge of our DUTY and FELICITY; or, the art of being virtuous and happy.

It is an art, because it contains a system of rules to promote our happiness, for whoever practises those rules, attains an habitual power or facility of becoming virtuous and happy.

It is also a science, because it deduces those rules from the principles and connections of our nature, and proves that the observance of them is productive of our happiness.

Hence it is evident, that men's duty, or his conduct in the several moral capacities and connections, which he sustains is the object of this philosophy; and that its office is to direct us in the practice of the great duties to GOD, our neighbour, and ourselves.

Therefore this treatise will be properly divided into four parts.

*First*, We will treat of the sovereign good, or final object of all human actions.

*Secondly*, Of human arts, and their rules.

*Thirdly*, Of virtues and vices.

*Fourthly*, Of the various offices of life, in regard to GOD, our neighbour, and ourselves.

*First*, Let us be well inform'd what is the sovereign good.

There is but one essential good, which is God himself, who alone is properly, and of himself, good. As *Christ* witnesses it, *Luke* v. 19.

Good by participation is a created good, and this is either a thing or Substance, which is good to us; as are the aliments, cloaths, &c. or the modification or affection of a thing, which helps us likewise, whether it has a report to the body or to the mind. Hence good is commonly distributed into the good of the body; such as health, strength, beauty, &c. Good of the mind; as, science, virtue, &c. and goods of fortune; such as houses, lands, money, &c.

We desire all these things, because they are useful, or agreeably only, or honest; whence that famous division of *good*, into honest, agreeable, and useful. We call *honest*, that which is agreeable to order, or rather to the rules of our reason, as probity, or virtue: *agreeable*, that which pleases or delights us; *v. g.* some are pleased with plays and spectacles, some in company, others with studying the liberal arts, and the practice of virtue, others with telling their money, &c. Lastly, the *utile*, which is that which procures us some other good, as a bitter potion, which can procure the recovery of health.

Our next enquiry must be for the *final* object of all human actions; or, the *end of things*: we are very sure, that the Creator has appointed an *end* for each created thing in particular.

Therefore all corporeal things, either celestial or sublunary, even the brutes, which have no faculty to govern themselves, or reason, are directed and moved by the omnipotent being towards their end, as an arrow is directed by the archer.

But rational creatures tend toward their end of their own proper will; and chuse the ways which they judge the most proper to conduct them to their ends: Whence they are invited by the end; neither could they ever be persuaded to act, without some end; but move themselves of their own accord, and with a previous knowledge of their understanding towards that end, which they know very well to be such.

An *end* is defined by *Aristotle*, *lib. 2. physic. c. 3. id ejus gratia fit aliquid*; *i. e. that in view whereof something is done.*

There are two sorts of *ends*, *viz.* the *end* which is desired, and the *end* for which something is desired. For example, the end desired in the construction of a house, is a commodious habitation; and the end for which that commodious habitation is desired, is the person who is to live in it. Again, there is the *end of the work*, and the *end of the workman*.

The *end of the work*, or operation, is that intended by the work itself, as the end of study is the knowledge of truth; because we must study only to discover the truth.

The *end of the operator*, or artificer, is that intended by him; as the end of him who learns or teaches philosophy, can be the love of truth, or a vain curiosity, or something else.

Lastly, the *end* either of the work, or of the workman; one is the first, which is first intended; the other the second, or that which is placed between two, and the other the last, to which all the others have a relation. Which last end is nothing else, but God himself, from whom all things flow, and to whom they all return.

But though all things tend towards procuring the glory of the Creator, and are all moved by his special favour; the rational creatures are said, notwithstanding, to have that tendency towards God, as their sovereign good in a more particular manner; as being sole capable of his possession.

This last *end* is defined by *Cicero*, *lib. 2. de finib. bon. & mal. That, by which all things are done well, and are related, and itself is related to nothing.* In the same sense it is defined in the schools, *that which is desired for itself, and all things desired for it.* This *end* is either the true, proper, and natural end of all things, *i. e.* to which all other things have a natural tendency; or is arbitrary, depending either on the levity, or impetuosity, or affection of the mind; such is money with respect to the avaricious, voluptuousness with respect to the voluptuous, &c.

But however, let it be how it will, it is certain, that the last, true, proper, and natural *end* of all created beings, is GOD himself.

But that motion whereby all men incline towards God, is often interrupted by them; especially when they repose themselves in the creatures, and search the sovereign good where there is no true and solid good, but only an apparent one to be found. Tho' this cannot be an obstacle to God's being called the proper and natural end of all created beings, but more particularly of men; either because all things and all actions are terminated in God, or because God alone is, lastly, searched by us, though sometimes we know nothing of it ourselves; because he can alone appease our desires, or gratify them. *Est enim*, says *Boetius*, *lib. 3. de Consolat Philosoph. prof. 2. Omnium summum bonorum, cunctaque intra se bona continens, cui si quid absoret, summum esse non posset; quoniam non relinqueretur extrinsecus quod posset operari.* Therefore in him alone, and not in a created good, confin'd within very narrow limits, we ought to put our whole felicity, which according to the definition of the same *Boetius*, *is a state perfect by the assemblage of all sorts of goods.*

*Secondly*, In search after the *human acts*, and enquire how many there are, to be directed by the rules of *Ethicks* towards this end.

We must search, *first*, what is a human act, and how many. *Secondly*, if all human acts be voluntary. *Thirdly*, if it be free. *Fourthly*, if all human acts be good or bad, and none indifferent. *Fifthly*, which is the usage of the affections of the soul; and if they be subject to the rules of the *Ethicks*.

I call, with *Thomas Aquinas*, *1. 2. quest. 1. art. 1.* a human act that which is done by a man, acting like a man; *i. e.* with prudence and reflection: so that a human act may be distinguished from that called

called the act of a man, and which is done without the least reflection.

Of those *human acts*, some are interiors, gain'd from the will, and are accomplished in it; as the acts of *love* and *hatred*.

Others are *exterior acts*, commanded from the will; but are executed by our corporeal strength, as *walking, speaking, writing, &c.* and even of these acts several are called *transitory*; because they pass from the active cause, to a foreign object, as *writing, striking, building, &c.* Others are called *immanent*; because they produce nothing sensible beyond the active cause, as shaking the head, the motion of the arm, rubbing the eye, &c. But however, those are more properly called *imminent acts*, which remain in the mind, as *love* and *hatred*.

To find the number of the *interior acts*, every one must be attentive to what passes within him.

For *first*, we irresistibly desire *good* in general, or our beatitude, and avoid evil or misery; whence the first act of our will, is the *love of good* in general, or of our felicity, and a hatred for evil or misery. Therefore good in general, or our felicity, if it be considered as it is convenient to us, is very well term'd, the primary object of our will. But if it be considered as it fixes and terminates our desires, it is called the last end. Lastly, if it be considered as rendering us happy by its possession, it is called our felicity.

*Secondly*, That we may gain the *good* and avoid the *bad*, there are means to be taken; therefore the second act of our will is *consultation*, or an enquiry into the means to conduct us to our end.

*Thirdly*, After that *consultation*, we chuse one of those means, and thus the third act of our will is *election*; which is not ill defined, the assumption of one means before another, in order to gain our end.

*Fourthly*, Where through that means we have gained our end, we repose ourselves in it and enjoy it, especially if nothing remains to be desired; whence the last act of our will is *fruition*. But if by misfortune, any body was conducted to a bad end, he would complain and grieve at it; especially if he could not extricate himself from it.

All *human acts*, *i. e.* acted by a man in a human manner, are always *voluntary*, unless violence, or a great fear, or an insuperable ignorance, interferes.

The next thing we are to consider, is, if all *human acts* be free.

We call a free act, that which is done without compulsion, or can be done or omitted, at pleasure. For divines distinguish two sorts of liberty, *viz.* liberty from an *external necessity*, or *coaction*, and liberty from an *intrinsic or natural necessity*.

Divines call *liberty from coaction*, or *liberty of spontaneity*, that, which removes all external vio-

lence, *i. e.* proceeding from an external principle against the propensity of the will. By which liberty the will loves good in general, and hates evil in general; and therewith the blessed are said to love God, because they freely, and without constraint, adhere to him by love. Therefore liberty from *coaction* is the same as voluntary or spontaneous; inasmuch as it is done by the will without coaction; and therefore all *voluntary acts* are free from *coaction*.

*Liberty from necessity*, or *liberty of election* and *indifference*, which is also called *free-will* and *simple liberty*, is that which excludes all kinds of necessity, either natural or internal, or external, or of coaction. I call *natural necessity*, a certain determination or propensity, which our liberty has naturally to pursue, or avoid necessarily, certain things; *v. g.* to love necessarily, and by election, good in general, and hate evil. I call likewise *necessity of coaction*, or *coaction itself*, a certain violence offered to some body against his own inclination; as when any body is put in prison.

Therefore the *coaction* differs from a *natural necessity*, in that coaction proceeds from an intrinsic principle, against the inclination of the will, and therefore deprives us of our liberty. And the *necessity of natural inclination*, proceeds from the will itself; and therefore does not deprive us of our will, but only of our liberty, taken in a strict sense, which proceeds from election.

That if the necessity of acting or not acting be only hypothetical, and follows the consent or election of the will, it by no means affects our free-will, or *liberty of indifference* and *election*: *v. g.* Suppose I have determined myself to speak, I speak necessarily: but that necessity does not force me to speak, nor hinders me from speaking: whence a free-will remains in me still, since I have still the power of election, which consists in this, that one may act, or abstain from acting as he pleases.

Therefore *liberty of election*, is very well defined an *elective faculty*, *i. e.* a faculty to chuse one thing before another: and as in election, *one is to act or not act*; and the other, *to act this or that, in this or that manner*; we distinguish two sorts of liberty of *election* and *indifference*; one to act or not act, call'd *liberty of contradiction*, because *acting* or *not acting* are contradictories; and the other to act this or that, in this or that manner, *v. g.* to love or to hate, to speak or to write, which is called liberty of *contrariety*, or *diversity*; because to *love* and to *hate*, are contrary or opposite; and to *speak* and to *write*, are different.

*Free-will*, can also be defined a faculty determining itself; or, a faculty which having all things requisite to act, can act, or not act, or even act the

contrary;

contrary; whence it may be inferred, that the liberty of the will does not regard generally the chief end of our actions, or our felicity, because it is impossible we should not desire our felicity. Neither does it tend towards those things which have a necessary connection with our sovereign good, and without which we cannot gain that sovereign good; such as are *to be*, and *live*, since we are necessitated to love those things.

From this I'll pass to the *goodness of the human acts*.

Human actions, compared with the *rules of manners*, are called *moral*; and if they be agreeable to those rules, are esteemed *good*; but if they decline from them, *bad*; so that the *morality* is nothing else but its *relation to its rule, whereby it is determined morally good or bad*.

The *rules of manners* (at least the primary rules) whereby a human act must be measur'd, are the *eternal degrees*, or *divine law*, and right reason. An human act is to be with these rules, as well with regard to the object, and the end, as to the circumstances; for every body knows that an human act, consists in the object, end and circumstances.

The object of a human act is that, towards which that act tends, and which can be considered either *materially* or *formally*.

It is considered *materially*, as far as it is a matter subject to certain acts, with regard to which, several other moral acts, though of a different kind, can be done; as the same man can be an object of love or of hatred; of adulation or of reproaches, &c. An object thus considered is always good, of an identical goodness, it being either God who is perfectly good, or a created thing, which is good by participation; but has neither a moral goodness, nor a moral vitiosity; because it is neither agreeable to the rules of manners, nor contrary to them; and consequently cannot give to the action, either a good or bad species, in the gender of manners.

The object is considered *formally*, when considered under some form, either physical or moral; and then it establishes a species of the act, either physical or moral; and as far as it is agreeable or repugnant to physical or moral principles, communicates to the action either a physical or moral goodness, or vitiosity. But it might happen that an object is good *formally*, according to a physical species, and bad *formally* according to a moral species, and the contrary. For instance, if a painter paints in an elegant manner some obscene figures, the object will be good physically, and bad morally; so that the action will be good *formally*, according to the physical species, and with regard to the execution of the rules of his art of painting; but will be bad *formally*, according to the moral species, that is to say, if compared with the rules of manners.

The end of a *human act*, is that for which the act is done; and can likewise be considered, either *physically*, or *morally*, *v. g.* if any body takes a medicine for the recovery of his health, this end is good *physically*; but is neither good nor bad *morally*, but when compared with the *rules of manners*; therefore the end is good *morally*, if any body wish for his health, with the intention of making it subservient to God's glory; and bad if he desires it to gratify his passions.

The *formal object* of a human act, is also sometimes called  *motive*; *v. g.* God's goodness, or the relation he has with our nature, which wants several things from him, *viz.* his assistance, and that he may perfect it, is called the  *motive*, or reason why we love him. Sometimes the  *motive* is taken for the end, as when health is said to be the  *motive*, which induces such a person to take a medicine. Lastly,  *motive* is also taken, though very seldom, for the efficient cause; as the advice which has engaged somebody in a good or bad action, is said to be the  *motive*, whereby it has been done.

Lastly, We call  *circumstances of an action*, all the things which accompany the action, as the  *place*, the  *time*, the  *manner*, and the  *assistance*, and all these things are included together, with the  *object*,  *end*, and  *effective cause*, in the following verse:

*Quis, quid, ubi, quibus auxiliis, cur, quomodo, quando,*

We must next inform ourselves of the  *rules of moral goodness and malice*.

*Aquinas*, 1. 2. *quæst.* 71. *art.* 6. has established two rules of the human acts; one which is the first, and remote, *viz.* the  *eternal law*, which is the absolute will of God, or the  *order* whereby all things are wisely disposed; the other  *derived*, and nearer, *viz.*  *human reason*, which is like a certain participation of that absolute and divine will.

All law is either  *positive* or  *natural*; that is mutable, and this is not subject to change.

The  *natural law* is either considered in God, or in us: in God, it is called an  *eternal law*, or an  *eternal order*; and in us, it is either called  *right reason*, or  *natural light*; or retains the name of  *natural law* only.

It is a general received opinion, that the  *eternal law* is the source of all others, and the first rule of the human actions. This eternal law is nothing else but an eternal order, established by the sovereign wisdom, and which contains all that we are to do, or to avoid. The  *eternal law*, says St. *Augustin*, *lib.* 22. *contr. faust.* c. 27. is a  *divine order*, or  *God's will*, commanding to preserve the  *natural order*, and forbidding to disturb it. The same father explains, *lib.* 1. *de ordi.* c. 10. what the  *natural order* is. It is an  *order*, says he, by which every thing is done that

that God has established: therefore the eternal law is an immutable order. To which is agreeable, all that's done right; and all that's done wrong, disagreeable. Whence the same St. Augustine, lib. 1. de lib. arbit. c. 6. To explain to you, says he, as much as I am capable, and as concisely as possible, what that notion is of the eternal law, which is imprinted within us, it is that whereby it is just that all things should be in order. Then lower, expounding in the same book, c. 15. which is the first precept of that same law, he says, that the eternal law commands, to turn our heart from things temporal towards the eternal. Neither does he believe that men can otherwise sin, than by turning themselves from God towards the creatures, either to fix their affections on them, or to enjoy them: for though we are to make use of things created, we are never to enjoy them. Neither are we to make use of them, but inasmuch as they are conducive towards obtaining the fruition of the sovereign good. The good, says the same doctor, lib. 15. de civit. Dei, c. 7. num. 1 make use of the world to attain to the fruition of God; and the bad, on the contrary, want to make use of God to enjoy the world.

The natural law, which is also called right reason, natural light, and natural order, is that same eternal law, or a certain participation of the eternal law in a rational creature, whereby she is rendered capable to make the difference betwixt good and evil. According to Aquinas 1, 2 quæst. 91, art. 2. where he quotes the words of the royal prophet, Psal. iv. 6. Offer the sacrifices of righteousness; and put your trust in the Lord. And if any body was asking which are the deeds of justice, the same royal prophet adds, There be many that say, who will shew us any good? Answering that question, he says, Thou hast made the light of thy countenance to shine upon us; i. e. the light of a natural reason, whereby we make the difference between good and bad: which natural law is within us naturally. According to Cicero, lib. 1. de leg. b. Lex est ratio summa insita in natura, quæ jubet ea quæ faciunda sunt, prohibetque contraria: eadem ratio cum sit in hominis mente, confirmata & consecrata lex est.

The first principles of that natural law consist in the love of God above all things; and of our neighbours, for the sake of God.

First, We should love God with all the faculties of our soul, and above all things; and return him perpetual thanks for the daily favours we receive from him. Therefore the apostle, Rom. i. 20. declares *inexcusable those who when they knew God, they glorify'd him not as God, neither were thankful; but became vain in their imaginations, and their foolish heart was darkened.*

Secondly, If we love God as we ought; because order requires it, from which the natural reason can-

not deviate without sin; we must also love other men, created by the same being, for his sake; and give to every one of them his own. Therefore, says St. Peter, 1 Epist. ii. 13. *Submit yourselves to every ordinance of man for the Lord's sake: whether it be to the king, as supreme; or unto governors, as unto them that are sent by him for the punishment of evil doers, and for the praise of them that do well; and all other men, either our equals or inferiors, we must love as our brethren; not only by doing them no harm, but rather by rendering them all the good offices we can. Therefore we'll bare no false witness, we'll commit no theft, no murder, &c. because those things are contrary to order, and consequently to the love of God and our neighbours.*

Therefore all the moral duties of men, are contained in these two precepts, or are deduced from them. As Christ himself witnesses it, Matt. xxii. 37. and following; where a physician and a doctor of the law asking him, which was the greatest commandment in the law, he answers thus: *Thou shalt love the Lord thy God with all thy heart, and with all thy soul, and with all thy mind. And the second is like unto it; thou shalt love thy neighbour as thyself. On these two commandments, hang all the law and the prophets.* Therefore the first precepts of the natural law consist in the love of God above all things, and of our neighbour for the sake of God.

To understand better what has been said, and what is to be said, we must propose in this place some definitions relating to the love of God and of our neighbour.

1. LOVE, is a propensity of our will towards the object which delights us; and that propensity is so great or so strong towards the sovereign good, or our felicity, that we cannot resist it. We are never otherwise induced to love, but by the appearance of the good, or of the delectable, and often of both; without which there could be no love excited within us. For if we pursue riches, honours, and pleasures, it is because we discover something in them which flatters our nature. If we love our parents, friends, and relations, we are attracted to it by an inward sense of pleasure, which can be better felt than explained. Therefore in all kinds of love, there is always something agreeable to our nature, which affects us.

If love be considered with regard to its object, it is of two kinds; for, one is the love of God, and the other is the love of creatures; viz. either of us, of other men, or of other things, as riches, honours, pleasures, &c. Again, if it be considered with regard to the manner we incline towards the thing we love, one is called *love of desire*, whereby we pine after an absent object; and the other *love of fruition*, whereby we cleave to the object we possess, &c. but we must remember,

ber, all kinds of love for the created things ought to be referred to God, as to the origin or source of all sorts of goods; so that God must be beloved above all things, and the creatures for his sake.

2. To love God above all things, is to prefer him to all created beings, or to incline towards him as the sovereign good, with all the faculties of our soul; and to love all other things for his sake, and as it is agreeable to order.

3. Our love for God, ought to be alone, and properly a *love of complaisance*, or a love whereby we are pleased, or delighted in God as in our sovereign good. And as that love has no other object but God himself, and is divested of all human views or considerations, it must be called *gratuity*, not *mercenary*, which, say the antient fathers, *it is required of you that you should serve him gratis; not because he gives the temporal things; but because he warrants the eternal.* St. Augustine, in *Psalms* xliii. 16, 17. and on *Psalms* liii. 6. says, *God will be served gratis, be loved gratis, i. e. of a chaste love; not be loved because he gives something besides himself, but because he gives himself.*

4. The love of our neighbour, is a *love of benevolence*; whereby we wish him all the good we desire for ourselves. When this love has for its object our parents, or our country, it is called *piety*; if there is a reciprocal love between us and our neighbour, it is called a *love of friendship*, or it is a true *amity*.

Hence every person, that cannot plead invincible ignorance, may easily infer, that he ought not to do to his neighbour, what he would not have done to himself; whence it follows, that he is not to rob, nor to kill, &c.

The precepts of the *natural right*, are also immutable, and no body can be excused from observing them.

The moral good and evil, or the honest and dishonest, are distinguished not only by men, but by nature itself; because the honest is conformable to the good order established among us by our divine Creator, and the dishonest contrary to it. *Cicero* has confirmed this truth, by several very solid and persuasive arguments. *Lib. 1. de leg.* *Nothing certainly is more charming, says he, than to understand clearly, that we are all born to justice, not only in man's opinion, but of a natural right.* And a little lower, *Where is the nation that does not love a complaisant and grateful spirit? And where is that people which does not despise and hate the proud, the vindictive, the cruel, and the ungrateful? Whence it follows, that we are all naturally born just, for a mutual communication with one another.*

From this I'll pass to *Conscience*, which some confound promiscuously with *Synteresis*; though

*Aquinas* distinguishes the one from the other, and says, that *conscience* is properly the act whereby we apply our knowledge to our actions; and *synteresis*, an habit, which inclines us to give our assent to the first moral and practical principles. Whence in that sense the habitual knowledge of the first moral principles, or intelligence, is *synteresis*; and their applications, which is like the conclusion of a practical syllogism, is *conscience*; thereby every one knows actually, not only that he exists and understands, but likewise when he acts, or has acted right or wrong; therefore our conscience approves or reproves all our actions; and though it seems to be in some measure, asleep, in the obdurate and impious; it, notwithstanding, never is entirely extinguished, not even in the damned souls, according to this passage of *Isaiah* lxvi. 24. *For their worm (i. e. the remorse of their conscience) shall not die.*

Therefore *Cicero* speaks thus of the conscience, *lib. de senect.* *The conscience of a good life, and the remembrance of a great number of good deeds, is agreeable.*

Those who treat of manners, distinguish different states of the conscience. For the conscience is either true and certain, or probable, or dubious, or erroneous, or false.

The *conscience* is said to be true and certain, when we understand clearly and distinctly, what is commanded or forbidden; and therefore what we must do or omit, *v. g.* every body knows, that we are not to do to others what we would not have done to us: because that law is engraven on our mind.

A *probable conscience* is that founded on probable arguments. So that if the arguments on both sides be of an equal strength, the conscience becomes dubious. Whence a *conscience* is called dubious, whereby the mind remains uncertain of what it ought to do; and has not a plain security. There is a great affinity between this and a scrupulous conscience; which though she walks upright, is nevertheless retarded, by some scruple or other.

*Scruple*, is properly a small sharp stone, which hurts the foot, and hindereth from walking with ease. But metaphorically, it is the anxiety of the mind, proceeding from a true and just reason, or from a vain and ridiculous one. Whence *Cicero*, *orat. pro Sexto*, speaks thus of *Cornelius Chrysofonus*: *He desires you would be pleased to eradicate from his mind that scruple which night and day teazes and pricks him.*

An *erroneous*, or *false conscience*, is that which dictates what is forbidden by the law, or forbids what the law commands.

What is done against our conscience, is always morally bad; and what is done according to the dictates of our conscience, is not always good.

All that is acted against the dictates of our conscience is bad, because it always includes a perversity of mind, and an inclination to sin; and he that acts thus, knows that he acts ill.

Likewise all that is done according to the dictates of our conscience, is not always good; because it may be done against the order and the law, as it happens when the conscience errs. As that of those mentioned by Christ, to his apostles, *John xvi. 2. Yea the time comes, that whosoever kills you, will think that he does God service.*

Therefore the conscience, generally speaking, cannot be considered as a very secure rule of our action; but only when it is true and certain, or when it is agreeable to good order and the law; all that is agreeable to it being good, and all that is repugnant to it being bad.

A *conscience* which errs, excuses from sin, when the error proceeds from that ignorance which renders an action involuntary; but if it does not proceed from such an ignorance, it cannot excuse from sin.

A *probable conscience*, seems secure in the practice; as far as the arguments whereby it is supported are solid, and morally certain, and are not in concurrence with a contrary authority, or reason of an equal force.

When the *conscience* is dubious, we must make use of the rule prescribed by *St Paul, Epist. 1. Thessal. v. 21. Prove all things, hold fast that which is good.* And consequently if the reasons are of an equal force on both sides, we must either abstain from acting, if possible, or incline on that side, which is more agreeable to the good order, and favours less our cupidity: for though that side should not appear, perhaps, the more probable, or supported with the strongest reasons; it is, notwithstanding, the most secure, and farthest from danger.

If we follow that rule of *St. Paul*, it will be difficult to determine, if we can, with a safe conscience follow the doctrine of *probability*, in our conduct. That doctrine consists in this, that a probable opinion, provided it be probable, though in concurrence with one more probable and sincere, can be proposed a false rule of our actions or conduct. Whence it follows,

1. That any probable opinion, can be preferred to one more probable.

2. That when a divine is consulted, he can answer according to a less probable opinion, tho' in concurrence with one more probable; and even against his own sentiment, give advice according to the opinion of another, tho' less probable; because that opinion less probable, is notwithstanding probable; and consequently according to that doctrine, very secure.

They distinguish two sorts of *probability*, viz. an *intrinsic probability*, and an *extrinsic probability*,

They call *intrinsic probability*, that taken from a probable argument, whereby the mind is inwardly affected. And *extrinsic probability*, that which is supported by the sentiment and authority of some eminent divines. Thus talk the Schoolmen: But,

For my part I am of opinion, that this doctrine of *probability* is to be banished from among us, as very prejudicial to the good order of a civil society; and for other reasons.

The next thing we are to do, is to enquire if the affections of the soul are subject to the precepts of a moral discipline, and what is their use.

The Schools distinguish two sorts of principles of the human acts, viz. those which are *born with us*, and those which are *acquired*: those have been granted to us by nature, viz. understanding and will; and these are acquired by application, and repeated acts. These are good and ill habits, or *virtues* and *vices*: of which I'll treat in this place, as well in general, as in particular; and first we must know what's *virtue* and what's *vice*.

Three things are to be considered in the soul, says *Aristotle, lib. 2. ethic. c. 4. viz.* its thoughts and motions, as, perception, love, &c. afterwards the faculties or natural powers necessary to act or suffer, as, the *understanding* and *will*. Lastly, the *habits*, either good or bad: that's to say, which incline us either to good or evil. The good habits are called *virtues*, and the bad *vices*.

I'll speak first of the virtues infused, which are those infused into us by the Almighty without our concurrence; such are the virtues called *theological*, viz. *faith*, *hope*, and *charity*. To these are joined, by a certain tie of affinity, the habitual and sanctifying grace, the gift of perseverance, or the grace of persevering in the practice of virtues, to the latter end of one's life, the gifts of the Holy Ghost, &c.

FAITH is a theological virtue, divinely infused, whereby a created soul consents or agrees, that all that God has revealed is true, though it be far above our apprehension or understanding. Whence the *material object of faith* is God; and the *formal one*, or the manner, wherewith God is considered by *faith*, is commonly expressed in these words, *inasmuch as God is the first truth*; that is to say, as he cannot deceive or be deceived; and consequently he deserves the consent of our will, and the subjection of our understanding, in all those things he proposes for objects of our faith; whence it appears, that our natural knowledge of God, and even of our own mind, precedes faith: for if we were not to know that God is sovereignly true, and sovereignly potent, and that our mind is much limited in its conceptions, we could not easily subject ourselves to the mysteries of faith.

HOPE,

HOPE, is a theological virtue, which regards the sovereign good, as absent; and with a certain confidence, that it is sometimes to be obtained or possessed. Or, it is a virtue divinely infused, whereby we expect, with a certain confidence, our salvation, or eternal felicity; its *material object*, is also God; and its formal object, is expressed in these terms, inasmuch as God is to be obtained or possessed in time to come; therefore *hope* includes the desire of an absent good; and without that desire there would be no hope.

CHARITY, is a theological virtue, whereby God is beloved above all things; and for himself, or for his supreme goodness; and all the other things for God. For this is the order of love, that the supreme good should be beloved for himself, and all other things for him. And as that order, when it invites us by its beauty, is nothing else but God himself: Charity is nothing else, likewise, but a supernatural love of the order, whereby God is beloved for himself, because he is sovereignly good, and all other things for him.

The natural and acquired virtues, are those acquired by repeated acts, and these are called either intellectual, or moral.

Those are called intellectual virtues, which promote the knowledge of the mind; and which, consequently, have a greater relation to the understanding; since knowledge, or perception, is the office of the understanding.

*Aristotle*, lib. 6. *Ethic.* c. 2. reckons five of these habitual virtues, *viz.* *understanding*, *wisdom*, *science*, *prudence*, and *art*.

Several, after *Aristotle*, define WISDOM, a certain sublime science, or a knowledge of sublime things.

*Understanding* is the knowledge of the first principles, or most common actions, which is not so much a new habit of the mind, as it is the mind itself, naturally considered. For the mind, by the sole dictates of nature, perceives and embraces the common notions, or actions; such as these, it is impossible to be, and not to be, at one and the same time. The whole is greater than a part thereof, &c.

The name of *wisdom*, is to be taken in two manners, *viz.* either for a collection of all sorts of sciences, or for the knowledge of all things, as well universal as sublime.

SCIENCE, is commonly defined, a true, certain, and evident knowledge of every thing necessary, and immutable, for the true and proper causes for which it is such; or for which it is constantly affirmed or denied that it is such.

It is first said a knowledge, or cognition, not actual as they speak, but habitual, *i. e.* the facility

of knowing, not the act or motion of him that knows. For the science of a thing, remains even in a person while asleep, and not at all thinking of that thing; provided he has before rendered himself perfect in that knowledge, by his assiduous application and study; that he may understand it when he reflects on it.

Secondly, It is a true knowledge, not of all things indifferently, but of a necessary thing, or of a thing which cannot be otherwise. Thus he who knows that the eclipse of the moon, happens from the interposition of the earth between the sun and the moon, knows a thing which cannot be otherwise; for it is impossible that the moon should not suffer an eclipse, by the interposition of so opaque a body as is the earth, between her and the sun, from which she borrows her whole light. In which, *science* is distinguished from *prudence* and *art*, which are employed about things contingent, as well as about those which are necessary.

*Science*, is, besides, a cognition or knowledge of a thing by its causes, or the reason why that thing is; or else, for which it is affirmed or denied to be so. Whereby it is evident, that science is not a bare perception of a thing, or to speak the language of the schools, an apprehension, without affirmation or negation; but a knowledge acquired by ratiocination, and consequently joined with the judgment, or also a collection of several perceptions and judgments. However, *science*, besides the perception of the understanding, which is passive, includes the assent of the will, or the judgment which is active. For we do not only conceive a thing by means of the sciences, but affirm, besides, that what we conceive, is such as we conceive it.

*Science* is also a sure knowledge, *i. e.* firm, permanent, and supported by certain immutable arguments; to distinguish from opinion, which is uncertain.

Lastly, it is an evident knowledge, *i. e.* manifest and perspicuous, or established on clear and evident principles, to distinguish it from *faith*; which is true and certain. but dark. Thus it is true and certain that in the blessed Trinity there is one nature and three persons, but that is obscure, and known by the sole authority of God, who has revealed it, and not by an evident reason.

*Prudence*, as well as *wisdom*, is taken in two senses, *viz.* either for *science*, or general knowledge of things, which pertains to life and manners, and this is called a *general prudence*; or for the practical and efficacious knowledge of those things, which on all occasions are to be acted by an honest man, and is called *particular prudence*, or *cardinal virtue*: of which I will speak by and by.

Lastly,

Lastly, *art*, is the *practical knowledge of things which can be accomplished by industry*; which consists of two parts, the first and superior part of *art*, is the knowledge of the mind; if it be either intelligence only, or *science*: the second and inferior, is the execution, or work of the artist. Though *Aristotle*, lib. 6. *Ethic. c. 4.* makes a difference between what is called *effection*, and *action*, or *practice*; that *practice is a moral action, in which the intention of the person that acts, is considered comparatively to a moral honesty*; and *effection* is any *operation*, in which the industry or skill of the person, who acts, is considered. In which sense the *effection* is good, while the *action* is bad, as when a person robs another of his purse with great dexterity; and the *action* good, while the *effection* is bad, as it happens in a mother, who to save her son from an imminent danger, suffocates him.

*Moral virtues are those, which incline our will to a moral good*, which the infused virtues do, as well as the moral ones. Therefore, *virtue*, generally speaking, is very well defined by *St. Augustin*, lib. octogint. quest. 31. *An habit of the mind, agreeable to nature and reason, i. e. inclining to act, what is placed in so just a mediocrity, that it neither exceeds the just limits of reason and order, nor falls short from it.*

A *virtue*, or good habit of what kind soever, consists of two parts, one *superior*, which commands and governs, and the other *inferior*, which serves and obeys.

The superior part of *virtue* is that *affection or disposition of the mind*, which follows every where an honest temperament, with regard to the person that acts, the place, the time, and all the circumstances. For the same things do not become every one, nor the same things become the same person at all times.

The inferior part of *virtue* is the facility of acting, which is placed entirely in the impressions received in the brain, in the determination of the animal spirits, and in the other dispositions of the body, and consequently is corporal.

This inferior part may be considered, as the *body of virtue*, since it is this part that operates, or acts, *v. g.* he that has the *virtue of temperance*, this through an inclination to order, moderates the sensuality of the *taste* and *touch*; and has acquired to him by a long use and often repeated acts, the facility of refraining his appetite. And that facility, which has its seat in the body, is rather an act of virtue, than virtue itself. Because without the least inclination for a good order, any body may acquire the facility of practising some acts of temperance, *viz.* when he refrains his appetite through infirmity, or to avoid sickness, or for any

other cause: and likewise, he can have the virtue of temperance, or a constant love for order in the object of temperance, though he cannot very well practise the acts of temperance.

The next thing, which falls under our consideration, is *the division of the moral virtues*.

If *virtue* can be considered as nothing else, but an *habitual love of order*, or a *firm and constant love of an honest mediocrity, governed, or directed in any subject, by right reason*: there is certainly a general virtue, which for the different reasons, or manners, by which order is preserved in different material objects, can be divided into different kinds; and is in fact, divided into *cardinal virtues*, i. e. those, which ought to give motion to, or influence all the actions of our life; and in *adjunct*, or *concomitant*, which flow from the *cardinals*, and are referred to them.

We commonly reckon four *cardinal virtues*, *viz.* prudence, justice, fortitude, and temperance. This number is asserted by the authority of several living writers: and first, *Wisd. viii. 7.* *For the wise teacheth sobriety, i. e. temperance and prudence, justice and virtue, i. e. fortitude; nothing in life being more useful to mankind.*

*Cicero* enumerated those four virtues, lib. 1. *de officiis*. *All that is honest, says he, proceeds from some of these four parts; for it is either employed in the consideration of the truth, or in securing the good order in a civil society, by promoting and countenancing the distributive justice, and encouraging probity; or in supporting magnanimity and courage; or preserving a good order, or a just subordination, in which consists modesty and temperance.*

Those virtues, either *cardinal* or *adjunct*, are so well united together, that none of them can be obtained in a perfect state, without the others: For a perfect virtue being a *firm and constant love of order*, that love includes all virtues, or rather is but one and the same virtue, which to be perfect, requires a perfect will to pursue what is right and just in every subject: For, that man, *v. g.* is not perfectly just, who wants fortitude, or temperance, or liberality, *i. e.* if he wants the love of order, or the subject of temperance, or of liberality, or of fortitude; an intemperate judge, for example, can be tempted by pleasure, an avaricious one corrupted by money, and a pusillanimous one frightened by menaces. Likewise, no body can obtain temperance in a perfect state, without prudence, and the other virtues.

Therefore one virtue cannot be perfect in a subject, but in society with all the others. I say that it cannot be perfect without the others, for it can be imperfect without them; since we commonly distinguish after *Aristotle*, lib. 7. *Ethic. c. 1.* three

different states of *virtue*, viz. the *imperfect state*, called the *state of continence*; the *middle state*, called the *state of temperance*; and lastly, the *perfect state*, called the *heroical*.

The *imperfect state of virtue* is that, in which one is agitated by the motions of his affections, to which he resists, though with a certain reluctance; and this state is that of the *beginners*, who are not yet confirmed in virtue. To which state is opposed that of *infirmity*, or *incontinence*, in which he is not yet abandoned to vice, and entirely reprobate, but is conquered by *concupiscence*, though he faintly resists it.

The *middle state of virtue* is that, in which one is so confirmed in *goodness*, that though he be tempted by his *concupiscence*, he notwithstanding resists to it the easier; because he has made a long practice of that resistance; and this is the state of those, who make a progress in virtue. To which is opposed the state of *perversity*, or *malice*, in which he is so used to vice, that he seldom resists it.

Lastly, the *state of perfection of virtue*, or the *heroical*, is that whereby the affections are so well conquered, that they cannot make the least impression on *virtue*; which state is that of the *perfect*. To which is opposed the state of *brutality*, whereby one is brought so much beneath the common condition, even of the weakest, that he in some measure degenerates to that of the *brutes*; which state is commonly called the state of *obduracy*, of *blindness*, and of *Pharaoh*. In both states, viz. the middle state, and the perfect, but more particularly in the perfect, or heroic, all the other virtues, either cardinal or concomitant, are united together; but not in the imperfect state.

I must at present, speak of each *moral virtue* in particular, their potential and integrant parts.

I will begin by *prudence*, which is *an habit acting in concert with right reason, in those things which are either good or bad, with respect to man*, i. e. an habit whereby we know, not only what must be done or avoided, but likewise, whereby we love to act, and act what is to be acted, and abstain from what is to be avoided, because order requires it.

In the same sense, *prudence* is defined by *Cicero*, lib. 2. *de invent.* The science of good and bad things, and of both. And by *St. Augustin*, lib. 1. *de liber. arbi.* c. 13. the science of things to be desired, and to be avoided.

We commonly reckon after *Aristotle*, three potential parts, or three offices of *prudence*, viz. to consult well, to judge right, and to reduce into practice, what has been judged or decreed.

*Thomas Aquinas*, 2 *quæst.* 48. mentions eight integrant parts of *prudence*, and has taken them in

part from *Aristotle*, lib. 6. *ethic.* c. 10, 11, and 12. in part from *Tully*, lib. 2. *de invent.* in part from *Macrobius*, lib. 1. *in somn. Scipion.* c. 8. or also from *St. Augustin*, lib. 83. *quæst.* 31. where he has transcribed *Cicero* word for word. And those integrant parts are these, *memory*, *intelligence*, *fore-sight*, *reason*, *docility*, *dexterity* (to which must be added *sagacity*) *circumspection*, and *caution*.

Therefore, to render the *prudence perfect*, is necessary, 1. *Memory*, i. e. the remembrance of things past. 2. *Intelligence*, i. e. the knowledge of things present. 3. *Fore-sight*, i. e. the presence of things to come. 4. *Reason*, i. e. the facility of collecting what is to be done from the things past, present, and to come. 5. *Docility*, or a good disposition of mind to take and follow the advice and counsels of others. 6. *Sagacity* and *dexterity*, i. e. an easy apprehension, and application of the means conducive to the end; for *sagacity* finds and *dexterity* executes happily. 7. *Circumspection*, or a serious consideration of all the circumstances. 8. *Caution*, or care, or solicitude, to avoid all that could be an obstacle to the undertaking.

The *species* or kinds of *prudence*, are the *prudence* wherewith we govern ourselves, and the *prudence* wherewith we govern others. And this last sort of *prudence* is again divided into other kinds; for it is either *aeconomical*, whereby a family is governed; or *political*, whereby a city or republic is governed: but these *species* do not differ among themselves, with regard to their principles, viz. to a mind loving order; but only with regard to the object it considers; and then they differ only with regard to the material object, viz. with regard to what is acted in a family, or a city; but not with regard to the formal objects.

The *vices*, opposite to *prudence*, wound it either through excess or defect.

The *vices* which affect *prudence* through excess, are, 1. The *prudence of the flesh*; which is employed in gratifying our sensual appetites. 2. A too great solicitude for temporal goods; which proceeds either from an immoderate desire of possessing them, or from an excessive fear of losing them. 3. *Fraud*, or *finesse*, or *deceit*; which is concerting dangerous measures to deceive others. When *deceit* consists only in words, it is called *finesse*; and *fraud*, when it proceeds to facts: though oftner *deceit* and *fraud* are indifferently taken for one and the same thing.

The *vices* opposite to *prudence*, proceed very often from ignorance; and therefore may be generally styled *want of prudence*: of this there are several kinds, viz. *precipitation*, *inconsideration*, *inconstancy*, and *negligence*.

*Precipitation* is a vice whereby any one undertakes something without a mature deliberation, and this opposite to consultation.

*Inconsideration* is a vice, whereby a judgment is given, or pronounced without the least attention to the means; and this opposite to a good understanding or intelligence.

*Inconstancy* is changing one's opinion, on any slight or frivolous account.

*Negligence* is a want of diligence, or care in the execution of our affairs.

The term JUSTICE is often taken in a wide sense, viz. for sanctity, or the assemblage of all sorts of virtues: thus it is used in the sacred scriptures, *Matth. i. 19.* *Joseph* is called *just*, i. e. eminent for sanctity.

The first kind of justice is commonly called *general justice*, or *legal justice*; which contains all the law, and all the other virtues: but there is another sort of justice, called *particular or special*, the second among the cardinal virtues; and properly called *distributive justice*, whereby we give every one his own. This *justice* is defined by the emperor *Justinian*, a constant and perpetual will, to give every one his due, or right.

*Right* is all that is just and equitable; or what is a medium between two vicious extremes: therefore, those who contend or dispute for something, have recourse to a judge, as to a divisor or partitioner, who divides between them what they contend for, according to the rules of equity, and declares what part belongs to every one.

The *special justice*, which is the second among the cardinal virtues, is divided into *commutative*, and *distributive*, as into species.

The *commutative justice* is that which keeps or maintains an equality, in commutations of goods, in contracts and covenants.

The *distributive justice* is that which distributes rewards, or recompence, according to the merit and condition of persons; and when it inflicts any punishment, according to the atrocity of the crime, it is called *vindictive*.

Both establish a certain equality: but in the *distributive justice*, is observed a *geometrical proportion*; and in the *commutative*, an *arithmetical one*. For when the *distributive justice* is employed in distributing recompences, or inflicting punishments, it has not only regard to the merit, recompence, or to the pain, but likewise compares the persons; for there is to be the same difference between the pains, or the rewards, as there is between the persons, or the merits or deserts; and therefore as much as a captain surpasses a private soldier in rank or dignity, so much greater must be his recompence, when they have both equally done a brave action.

But the *commutative justice* wants a perfect equality, and has no regard to persons or to any other circumstances. So that as much as the thing deducted in the commutation, or in the contract, is worth; as much must be worth the price given for that thing, without the least regard to the persons who change, or to the manner they change in; or, which is the same, as much one thing exceeds the other, as much must the price of that one thing surpass the price of the other.

There are two integrant parts of *justice*, viz. to *abstain from evil*, and to *do good*; because those parts are requisite for a perfect act of *justice*.

There are eight potential parts of *justice*, whereby it performs its operations, as if they were so many faculties or organs, viz. *religion*, *piety*, *respect*, *truth*, *gratitude*, *correction*, *liberality*, and *amity*, to which they add *affability*. See *Cicero*, *de inventione*.

*Religion* is that moral virtue, which renders to God the worship due to him, in confessing his supreme power and excellence. That worship, is rendered to God, either inwardly, i. e. by *devotion* and *meditation*, or outwardly, by adoration, vows, &c.

*Piety*, according to *Cicero*, is a virtue, whereby we acquit ourselves of our duties to our prince, to our country, to our parents, and to all our other relations. *Piety* is also taken among christians for devotion.

*Respect* is that part of *justice*, whereby men respect and reverence those, who are above them, either by their age, wisdom, honour, or dignity.

*Truth*, or as some others call it *veracity*, is a moral virtue, whereby we take care that nothing should be said but what really is, has been, or is to be.

*Gratitude* is that which contains the remembrance of past service, or kindnesses, and the will of rewarding them.

*Correction*, according to *Tully*, is a virtue whereby we repel the violence and affronts offered to us, to ours, and all those, who are dear to us, and whereby we punish crimes. But it is not licit, but to those only, who are placed above the rest, to correct the delinquents, or at least reprimand them, to procure, or maintain the public tranquillity, and to countenance *justice*.

*Liberality* is defined by *Aristotle*, *lib. 4. ethic c. 1.* a virtue, which keeps a medium between given and receiving money. It is said to differ from *beneficence*, in that *beneficence* consists in the distribution of all sorts of goods; and *liberality*, only in that of money.

*Affability* is a virtue, whereby we study to behave ourselves in a civil society, with that freedom and complaisance, which become us; to which are opposed, *insolence*, *haughtiness*, and *morosity*.

*Aristotle* defines *amity*, *lib. 8. ethic. c. 2.* an open mutual benevolence, founded on some good, either profitable, agreeable, or honest; but that only, which is founded on the honest good, deserves that appellation; because it is a part of justice whereby we return love for love.

The vice generally opposed to justice, is *injustice*, and which can offend justice in different manners, *viz.* either through *excess* or *defect*, though in both it retains the name of *injustice*.

Therefore, 1. The *distributive justice*, can be offended through defect, either in the distribution of recompences, or of pains; for if a prince grants more honour, more glory, and greater recompences to a person than he really deserves, he sins, thro' excess; if less, through defect. Likewise, when greater punishments are inflicted on the guilty, than their crime deserves, the excess is in the matter of the *vindictive justice*, and is called cruelty; if the punishment is much more less than the crime, it is a *defect*, or a *too great indulgency*.

2. *Excess* and *Defect*, have place in the matter of *commutative justice*, *v. g.* when something is sold or bought too dear, or when in commutation of goods, something is given or received besides the principal, justice is offended through *excess*; if less is paid than received, then we deviate from justice, through *defect*. Whence justice can be offended not only through *defect*, but likewise through *excess*, with regard to its matter, or as they call it, its material object.

*Fortitude* is defined by *Aristotle*, *lib. 3. ethic. c. 9.* *A mediocrity or medium, between temerity and fear.* It can also be defined, *A virtue between temerity and fear, in the dangers our reason commands us to encounter, or in supporting with constancy, the adversities.* Therefore, the material subject of *fortitude* are the perils we are to encounter, when our reason requires it, *v. g.* in a just war, undertaken in the defence of religion, of our prince, or of our country; or the adversities, which are either to be repelled where they assail, or supported with constancy.

Therefore, there are two opposite acts in *fortitude*. *viz.* to *encounter*, or admit the peril when it is proper, and *support*, or suffer with an heroic constancy, the greatest adversities; both acts must be entirely directed by right reason, or the love of order. For we are not to attempt any thing with a too great temerity, nor fear it without reason. But a brave man must be always in a certain medium between temerity and fear.

*Aquinas*, 2. 2. *quest. 128. art. 1.* reckons four integrant parts of *fortitude*, which can be called potential, *viz.* *confidence*, *magnificency*, *patience*, and *perseverance*. Which *Tully* remembers also, *lib. 2*

*de invent.* of these, *confidence* and *magnificency*, regard more particularly the *aggression*, and *patience*, and *perseverance*, the act of supporting; though every one of them seems to be agreeable to both acts.

Therefore, *confidence* can be defined that part of *fortitude*, whereby the mind imagines, that it can undertake and support the most difficult things, where, and when it is proper. But if those thorny and arduous things are not common, and not to be undertaken by ordinary acts, then they become the object of *magnanimity*, which differs both in name and effect from *fortitude*.

*Magnificency*, according to *Tully*, is the execution of great and pompous things, which if it consists in expences, has a very strict connection with liberality.

*Patience*, or *constancy*, is a virtue whereby our mind is sustained, and strengthened in adversities.

*Perseverance*, is a firm resolution in what we have once determined, if it be either to attack, defend, or support.

It would be needless to rehearse here, the vices opposite to *fortitude*, since they are contained in its definition. For temerity is opposed to it, through *excess*, and fear and cowardice, through *defect*. Thus pride and pusillanimity are opposed to magnanimity, says *Aristotle*, *li. 4. ethic. c. 9.* for a man must be intrepid, but not mad, as the *Gauls*, who, says *Aristotle* again, *lib. 3. ethic. c. 10.* were afraid neither of earthquakes, nor of tempests.

I call *temperance*, with *Aristotle*, *lib. 3. ethic. c. 13.* *a cardinal virtue which moderates the sensual appetite, especially in the taste and touch.*

The species or kinds of *temperance*, are *abstinence*, *sobriety*, *chastity*, and *purity*.

*Abstinence* is imagined to consist in eating, and sobriety in drinking; chastity is to abstain from all illicit pleasures; purity from all impure sights and touch or feeling: but there are three degrees of chastity, *viz.* virginal, conjugal, and of viduity.

*Purity* is derived from *pudor*, and *pudor* is a trouble of the mind, occasioned by any thing which can cause shame.

There are two integrant parts of *temperance*, *viz.* *modesty*, and *honesty*. *Modesty* is the flying from all that has the least mark of intemperance, and honesty is what appears most honourable in the acts of temperance. Therefore, *honest* and *honourable*, in this place, signify the same thing; in which sense, *Tully* says, *lib. 1. de offic.* that *what is honourable is honest*, and *what is honest honourable*.

It is very difficult to tell exactly the number of the potential parts of *temperance*. The first is *continence*, which resists the motions of the concupiscence

science provoking to intemperance. The second is *humility*, which inclines a man to confess ingenuously his imperfections. The third is *meekness*, which moderates rather, as clemency does vengeance. The fourth is *modesty*, which keeps in due order the internal and external motions of the mind; and is defined by *Cicero*, lib. 2. *de invent. a virtute, whereby an honest sham, acquires a just and permanent authority.* The fifth is *studiousness*, which confines the desire of knowledge within just limits. The sixth, *urbanity*, which regulates our recreations and diversions. The seventh, *moderation*, which directs us in the care we take of our person.

The vices opposite to temperance are either thro' excess, or thro' defect; but several of them have no name. Therefore, 1. *Intemperance*, whereby one abandons himself beyond measure to the pleasures of the *taste* and *feeling*, is opposed to temperance through excess and through defect; *insensibility*, when the sensual pleasures, ordered even by God himself, for the preservation of human nature, are neglected without reason. 2. *Gluttony, drunkenness, luxury, and impurity*, are opposed through excess to *abstinence, sobriety, chastity, and purity*; and through defect, the vices which have no name. 3. To *modesty, and honesty*, are opposed through excess *immodesty, impudence, and turpitude*; and through defect the vices which have no proper names. 4. *Incontinence to continence, pride to humility, wrath to meekness, curiosity to studiousness, fierceness to urbanity, and luxury to parsimony*, are repugnant through excess. The vices opposed to them, through defect, have no name.

From the principle heretofore established, can be deduced certain general rules, whereby all human actions may be directed towards the salutary end proposed to all men.

We will therefore proceed to examine the duties of men in general.

Those duties are either of a man to God, and to himself; or of a man to other men, either with regard to a family, or to a republic. Which different duties are all as follow.

It seems that man was formed to God's image, and created for no other reason, and for no other end than to know and love him; and to obtain, through means of a religious worship, the fruition of that divine object, who alone can render him truly happy. Which to facilitate, God himself has infused within him an immortal soul, capable of understanding, of religion, and of an eternal felicity; so that though this visible world were entirely destroyed, that soul will remain, by the condition of its nature, always the same, and uncorruptible; which is more than sufficient to inspire us with the

greatest sentiments of gratitude towards that supreme and eternal Being, who has been pleased to distinguish us in so particular and excellent a manner from the rest of his creatures; and to raise our mind from the contemplation of our own excellency, to that of the divine architect, who has made us his master-piece. That contemplation will soon make us understand that we ought to love him, with all the faculties of that soul he has created of so noble and so excellent a nature; and modelize all the actions of our life, according to those salutary rules, which in his great wisdom he has established to render them agreeable to him; and which is not to be considered as a laborious, but rather as an honourable task. For what must we be, whose vows and prayers a supreme and immense Being will have the condescension to hear and excuse? therefore none but those who forget themselves, will also forget so much honour done to them. But however, if we believe the royal prophet *Psalms* xlix. 12. *Nevertheless, man being in honour abides not: he is like the beasts that perish.* Which is the greatest punishment which can be inflicted on those ungrateful men, who are not sensible of the advantages of their condition, to be reduced to that of the brutes, to have no taste but for terrestrial things, to nauseate the celestial, and refuse to be cured of the wound they do not feel.

Therefore we must persuade ourselves, 1. That God is the principal and end of all things: that his power is diffused throughout this vast universe. And his wisdom in the government and disposition of all things, *attains powerfully from end to end, and disposes all things with pleasure*; that all that is done, may be done with a just œconomy and for him, that we all live, move, and rest in him, so that he can never be too much worshipped and beloved by us, and we always love him less than we ought to do.

2. And because the figure of this world passes, and we have but one essential obligation, which is to observe the law of God; we must learn as perfectly as possible, that divine law, make it the subject of our most serious meditations, and not neglect, if possible, even the least article of it.

3. We must not content ourselves with an inward worship, but likewise practise an outward one, consisting in public *vows* and *prayers*, in the company of the faithful, that others may be edified by our example. *Cœlius in cœtum & congregationem*, says *Tertullian, Apologet. c. 39. ut ad Deum quasi manu factâ precationibus ambiamus orantes. Hæc vis Deo grata est.*

4. With regard to the *prayer*, whereby we ask something of God, we must seriously consider what and from whom we ask. For we are not to ask of God trifling things, much less those, which are illicit or unjust;

unjust; but ask only those, which can be necessary to our salvation, and comfortable to life.

Therefore what it is just we should ask of God, is that which can be advantageous to us and to others, *viz.* a mind ready to execute the divine commandments, and a will inclined to do good to those we live with.

5. We must also be thankful for all the benefits or favours we have received from him: and the best manner to shew our gratitude on those occasions, is to shew always the same equality of mind, and the same tranquility, either in adversity or prosperity; for God does not love less those he is pleased to tempt by adversity, than those he loads with temporal favours.

From the love of God we will pass to the love of our neighbours: for none is nearer to us than our selves.

That a man may love himself with that love which is useful and just, *viz.* with regard to an everlasting life, he must lay apart all superfluity of malice, and keep himself unspotted from the world; according to St. James, *epist.* i. 21, 27. Whence it is necessary to take a great care to moderate all the faculties and affections of our soul.

And, 1. With regard to our body, it must be fed with necessary but not superfluous aliments, that we may neither fall under its burthen, nor revolt against the spirit.

2. We ought not to be idolaters of our body, nor break it by idleness; but, on the contrary, strengthen it by exercise and labour: for there is nothing more prejudicial to it than to indulge it in luxury and indolence, which not only weakens and corrupts it, but likewise proves contagious to the soul, and plunges it into all sorts of irregularities and vices.

*Otia si tollas, teriere Cupidinis arcus,  
Contemptæque jacent, & sine luce sæces.*

3. We must put a guard to our senses; since what enters through our ears, or eyes, make often so great an impression on our mind, as to excite its affections beyond measure, as to be almost impossible afterwards to conquer them when you please. Whence *Juvenal*, *Satyr* 14.

*Nil diæta sædum visuque hæc limina tangat,  
Intra quæ puer est.*

4. We must endeavour to adorn our soul with virtue and knowledge; that with their assistance it may, with greater facility, govern herself, and the body, which is under her command.

5. It is necessary to describe every one of the duties of a man to himself, since they are different ac-

ording to the difference of persons: but however, these general rules may be prescribed; that there is a certain medium, or subordination, to be observed, either in the judgment, which every body forms of himself; or in his external gestures or motions; or in his outward apparel; or in his table and equipage. For as *Juvenal* says, *Satyr.* 11.

*Nascenda est mensura sui, spectandaque rebus  
In summis minimisque: etiam cum piscis emetur,  
Ne multum capias, cum sit tibi gobio tantum  
In oculis.*

Therefore we are not to live either with more splendour, or with a greater parsimony; but every one must have regard to his birth, fortune, and faculties; that there may be a certain subordination, in the houses, equipage, and cloaths.

*Auream quisquis mediocritatem  
Diligit, tutus caret obsoleto  
Sordibus tecti, caret invidendâ?  
Sæbrius aula?*

Neither are we to envy those who live in a more elegant manner than we do, for every condition has both its advantage and difficulties. Whence the apostle St. Paul wisely admonishes us, *1 Cor.* vii. 20. that every man must abide in the same calling wherein he was called; without envying that of another.

Therefore they act with prudence, who study carefully all that belong to their vocation, follow it, and remain in it. But that kind of life, to love, what becomes us most, is the work of heaven, and not a human one. And the difficulty is still greater, when we have made choice of a state of life, when we were too young, yet, to make that choice: Therefore, in an affair of that importance, we are first to implore heaven's assistance, that we may chuse what is more convenient to us, and more agreeable to God: and afterwards consult our friends, not every one, but those only we know to have a greater share of judgment, prudence, and discretion, and a real friendship for us.

This leads us insensibly to the consideration of a man's duty towards his family, which *Aristotle* has described in two books, and which is called *Oeconomic Doctrine*, (to which I refer the reader). The first consists of six chapters, where he shews the difference between the *æconomic* and *politic*; and treats of the different parts of a house, of the manner of acquiring wealth, of the conjugal duties of husband and wife, masters and servants: the last, which is not divided into chapters, is almost entirely historical, where he describes several forms of the *æconomic*. He has also inserted in his first book of *politics*, several things relating to the same subject;

ject; all which are so fully explained in WOOLASTON'S *Nature delineated*; bishop WILKIN'S *Religion of Nature*; and, under the *Relative duties*, in the NEW *Whole Duty of Man*, which are in the

hands of most readers, that makes it needless to take up your time in repetition of those duties in this place.

## F A L C O N R Y.

**F**ALCONRY is the art of taming, managing, feeding, &c. the *falcon*, or other kinds of *hawks*, and employing them in the pursuit of taking of birds or game. This by others is called *Hawking*, much used by our ancestors.

The birds employed in this sport are first divided into *long winged* and *short winged* HAWKS.

To the *long winged hawks*, belong the *falcon*, *haggard falcon*, *ger falcon*, *lanner*, *bobby*, *saker*, *merlin*, and *hawler*; all which are reclaimed, manned, fed, and mewed much after the same manner. Of the *short winged hawks*, properly so called, are the *gos-hawks*, and *sparrow hawks*.

The former are generally brought to the *lure*, and seize their prey with their foot, breaking their neck bone with their beak before they plume, or tear it. The latter are brought to the fist, and kill their game by strength, and force of wing, at random, and proceed immediately to plume them.

The FALCON, or *Falcon*, is a bird of prey of the *hawk kind*, superior to all others for courage, docility, gentleness, and nobleness of nature. The best is that whose head is round, the beak thick and short, the neck long, the shoulders broad, long thighs, short legs, large feet, the feathers of the wings slender, the pounces black, &c.

The *Falcon* is excellent at the river, brook, and even in the field, and flies chiefly at the largest game, as wild goose, kite, crow, heron, crane, pye, shoveller, &c.

The *haggard falcon*, called here, also, *peregrine falcon*, *passenger*, and *traveller*; because no native of this land; is not inferior for strength, courage, hardiness, and perseverance. She is larger, longer, armed with a longer beak and talons, a higher neck, &c. than the common *falcon*. She will lie longer on the wing, and is more deliberate, and advised in her stooping, &c.

The *ger falcon*, or *gyr falcon*, is the largest bird of the *falcon kind*, and of the greatest strength, next an *eagle*. She may also be called a *passenger*, her *ayrie* being in *Prussia*, *Muscovy*, and the mountains of *Norway*.

The *saker*, or *sacte*, is the third in esteem next the *falcon*, and *ger falcon*, but difficult to be managed, being a *passenger*, or *peregrine hawk*, whose *ayrie* has not yet been discovered, but chiefly found

in the islands of the *Levant*; she is somewhat longer than the *haggard falcon*; her plume rusty and ragged: the fear of her foot and beak like the *lanner*; her pounces short, and her train the longest of all birds of prey; she is very strong and hardy to all kind of fowl, being a great deal more disposed to the field, than the *brook*, and delighting to prey on great fowl, as the heron, goose, &c. but for the crane she is not so free as the *haggard falcon*; she also excels for the lesser fowl, as pheasants, partridges, &c. and is much less dainty in her diet, as long winged hawks usually are.

The *lanner*, or *laner*, is a hawk common in most countries, especially in *France*; making her *ayrie* on lofty trees in forests, or on high cliffs near the sea side. She is less than the *falcon*, gentle, fair plumed, and has shorter talons than any other *falcon*. Such as have the largest and best seasoned heads are esteemed the best. There is none so fit for a young falconer as this, because she is not inclined to surfeits, and seldom melts grease by being over-flown.

There is another sort of *lanners*, whose *ayrie* is in the *Alps*, having their heads white, and flat aloft, large and black eyes, slender nares, short and thick beaks: their tail marbled and ruffet; breast feathers white and full of ruffet spots, and the points and extremities of their feathers full of white drops; their sails and trains long, short legged, with a foot less than that of a falcon, marble leared. This hawk never lies upon the wing, after she has flown to a mark; but after once stooping, makes a point, and like the *gos-hawk* waits the fowl. She is flown at field or brook, and will maintain long flights, by which means much fowl is killed. To fly them they must be kept very sharp; and because they keep their castings long, they must have hard castings made of tow, and knots of hemp.

The *Merlin* is the smallest of all birds of prey, and bears a resemblance to a *haggard falcon* in plume, as also in the fear of the foot, beak, and talons, and not unlike her in conditions; when well manned, lured, and carefully looked after, she proves an excellent hawk; especially at partridge, thrush, and lark.

The *bobly* is a sort of hawk, that naturally creeps on doves, larks, and other small game. She is a hawk of the *lure*, and not of the *fil*, and is an high flyer,

flyer, being in every respect like the faker, but she is of a much less size; for she is not only nimble and light of wing, but dares to encounter kites, buzzards, or crows, and will give blow for blow, till sometimes they seize, and come tumbling down to the ground both together. But she is chiefly for the lark. The *hobby*, also, makes excellent sport with nets and spaniels, for when the dogs range the fields to spring the fowl, and the *hobby* soars aloft over them, the poor birds think it safer to be close on the ground, and so are taken in the nets. This sport is called *daring*.

The *gos-hawk*, or *gofs-hawk*, q. d. *gross-hawk*, is a large short winged hawk, of which there are several sorts differing in goodness, force, and hardiness, according to the diversity of their choice in cawking. There are *goshawk*, from most countries, but none better than those bred in the north of *Ireland*. To distinguish the strength of the bird, the divers of them in several places of one chamber, or mew; and that hawk that flies and mutes highest and farthest off, may be concluded to be strongest. The *goshawk* flies at the pheasant, mallard, wild goose, hare, and coney, nay she will venture to seize a kid or goat. She is to be kept with care, as being very choice and dainty in eating, &c.

The *sparrow hawk*, is also a kind of short winged hawk, whereof there are several sorts, different in plumes: some small plumed and black, others of a larger feather, some plumed like the quail, some brown or canvas mail, &c. She serves both for winter and summer with great pleasure, and will fly at all kinds of game, more than the *falcon*.

• TERMS proper for the several ACTIONS of *falcons*.

When the bird flutters with her wings, as if striving to get away, either from perch or fit, she is said to *bate*.

*Crabbing*, is when the birds standing too near, they fight with each other.

*Cowering*, is when the young ones quiver and shake their wings in obedience to the elder.

To *seak*, is when the bird wipes her beak after feeding.

To *jack*, is when she sleeps.

*Intermewing*, is the interval between exchanging her coat, and turning white again.

*Treading*, is called *cawking*.

*Mantling*, is when she stretches one of her wings after her legs, and then the other.

Her dung is called *muting*; when she mutes a good way from her, she is said to *slize*; when she does it directly down instead of jerking backwards, she is said to *slime*; and if it be in drops, it is called

*dropping*; when she, as it were, sneezes, it is called *saiting*.

To *rouze*, is when she raises and shakes herself.

To *warble*, is when after mantling, she crosses her wings together over her back.

To *bind*, is when she scares.

To *plume*, is when after seizing she pulls off the feathers.

*Trussing*, is when she raises a fowl aloft, and at length descends with it to the ground.

*Stooping*, is when being aloft, she descends to seize her prey.

To *rake*, is when she flies out too far from the game.

To *check*, is when forsaking her proper game, she flies at pyes, crows, &c. that chance to cross her.

To *fly on head*, is when missing the fowl, she betakes herself to the next check.

The *quarry*, is the fowl or game she flies at.

The *pell*, is the dead body of the fowl killed by the hawk.

To *carry*, is when she flies away with the quarry.

*Canceling*, is when in stooping she turns two or three times on the wing, to recover herself ere she seizes.

*Seizing*, is when she seizes the prey, yet does not trust it.

*Reclaiming*, is the making a hawk tame and gentle.

*Manning*, is the bringing her to endure company.

A *make hawk*, is an old stanch one, used to fly and set example to a young one.

Besides the above-mentioned terms, there are also several others proper to the *art of falconry*, viz. *casting*, *plumage*, *rangle*, *gleaming*, *enfeaming*, *gurgitting*, *imping*, *tiring*, *ink*, *pill*, or *pell*.

*Casting*, is something given a hawk, to cleanse and purge her gorge.

*Plumage* are small feathers given to make her cast.

*Rangle*, is gravel given her to help bring down her stomach.

*Gleaming*, is her throwing up filth from the gorge after casting.

*Enfeaming*, is the purging of her grease, &c.

A being stuffed is called *gurgitting*.

*Imping*, is the inserting a feather in her wing, in lieu of a broken one.

*Tiring*, is the giving her a leg, wing, or pinion of a fowl to pull at.

The *ink*, is the neck of a bird the hawk preys on.

The *pill*, or *pell*, is what the hawk leaves of her prey.

The terms proper for her furniture are,

The *bewits* or the leathers, with bells buttoned on her legs.

The *leafe*, or *leath*, is a leathern thong where-by the falconer holds the hawk; the little straps by which the *leafe* is fastened to the legs, are called *jeffes*; and a line or pack-thread fastened to the *leafe*, in disciplining the hawk, a *creance*.

*Hood*, is a cover for her head to keep her in the dark; a large wide hood, open behind, to be wore at first, is called a *rafter hood*; and to draw the strings, that the hood may be in readines to be pulled off, is called unstriking the hood.

*Seeling*, is the blinding a hawk, just taken, by running a thread through her eyelids, and thus drawing them over the eyes, to prepare her for being hooded.

A *lure* is a figure or resemblance of a fowl, made of leather and feathers.

The *perch* is her resting place, when off the falconer's fist.

The *back* is the place where her meat is laid.

The *mew* is the place wherein she is set, while her feathers fall and come again.

The MANAGEMENT and DISCIPLINE of the *falcon*, is the next subject, and the foundation of the *art of falconry*.

When a young *falcon* is first taken, she must be seeled, and the seeling at length gradually slackened, that she may be able to see what provisions are brought her. Her furniture is to be *jeffes* of leather, mailed *leafes*, with buttons at the end, and *bewits*; besides a small round stick, hanging in a string, to stroke her frequently withal; which the oftner it is done, the sooner and better will she be manned: two bells on her legs, that she may be the more readily found, or heard, when she stirs, scratches, &c. and a hood raised, and bossed over her eyes. Her food to be pigeons, larks, and other live birds, of which she is to eat twice or thrice a day, and till she be full gorged. When the falconer is about to feed her, he must hoop and lure, that she may know when to expect it; then unhooding her gently, he gives her two or three bits, and putting her hood on again, gives her as much more; but takes care that she be close seeled, and after three or four days, lessens her diet; at going to bed he sets her on a perch by him, that he may awake her often in the night, continuing to do so till she grows tame and gentle. When she begins to feed eagerly, he gives her sheep's hearts; now he begins to unhood her by day, but it must be done far from company; feeds her and hoods her again, as before, but takes care not to fright her with any thing when he unhoods her, and if

he can, reclaims her without over-watching. The falcon must be borne continually on the fist, till she be thoroughly manned, and induced to feed in company: for two or three days, give her washed meat, and then plumage, according as you discern her foul within; if she casts, hood her again; and give her nothing, till she gleams after her casting: but when she has gleamed and cast, give her a little hot meat in company; and towards evening, let her plume a hen's wing, likewise in company; cleanse the feather of her casting, if foul and slimy; if she clean within, give her gentle casting; and when she is well reclaimed, manned and made eager and sharp set, venture to feed her on the lure.

Three things are to be considered *before you lure your falcon*. 1. That she be bold and familiar in company, and not afraid of dogs and horses. 2. Sharp-set and hungry, having regard to the hour of morning and evening, when you would lure her. 3. Clean within, and the lure well garnished with meat on both sides. When you intend to give her the length of a leafe, you must abscond yourself; she must also be unhooded, and have a bit or two given her on the lure, as she sits on your fist; that done, take the lure from her, and so hide it that she may not see it; when she is unseeled, cast the lure so near her, that she may catch it within the length of her leafe; and as soon as she has seized it, use your voice as falconers do, feeding her upon the lure on the ground.

After you have lured your *falcon*, in the evening give her but little meat, and let this luring be so timely, that you may give her plumage, &c. next morning on your fist; when she has cast and gleamed, give her a little beaching of warm water: about noon, tie a creance to her leate, go into the field, there give her a bit or two upon the lure, and unseel her; if you find she is sharp-set, and has eagerly seized on the lure, let a man hold her to let her off to the lure; then unwind the creance, and draw it after you a good way, and let him who has the bird, hold his right hand on the tassel of her hood, ready to unhood her as soon as you begin to lure; to which if she comes well, stoop roundly upon it, and hastily seize it, let her cast two or three bits thereon; that done, unseize, take her off the lure, and deliver her again to the person that held her, and going further off the lure, feed her as before; and so daily further and further off the lure. Afterwards you may lure her in company, but do not fright her; and having used her to the lure on foot, do it also on horseback, which may be sooner accomplished, by causing horsemen to be about you, when you lure her on foot; it is also sooner done by rewarding her upon the lure

on horseback, among horsemen. And when she is grown familiar this way, let some body a foot hold the hawk, and he that is on horseback must call, and cast the lure about his head, while the holder takes off the hood by the tassels; and if she seizes eagerly on the lure, without fear of a man or horse, then take off the creance, and lure at a greater distance. Lastly, if you would have her love dogs as well as the lure, call dogs when you give her phanage.

If the hawk be intended for some particular sort of game, her lure must be a resemblance of that sort of game; and the falconer ought to make a frequent practice of feeding, and rewarding her thereon, or on a train of the same kind; calling

her when feeding, as if she was called to the lure.

A *brancher*, *soar-hawk*, or *ramage-hawk*, needs no nurling; she is to be brought down from her wildness, and habituated to another course of life; and in pursuance of her own views and interests, to be made subject to those of her master. An *eyess*, needs no reclaiming, she is to be carefully nursed, and brought up in her natural taments.

The person, who brings up, tames, and makes, that is, tutors and manages birds of prey, as falcons, hawks, &c. is called *falconer*; the emperor of the *Turks* usually keeps six thousand *falconers* in his service. The king of *France* has a grand *falconer*.

## F E N C I N G.

**F**ENCING is a genteel accomplishment, as it teaches a man to place himself in a proper upright posture, and instructs him in the means of self defence. Hence

*Fencing* is the art of defence, or of using the sword, to wound an enemy, and shelter one's self from his attacks.

The art of fencing is acquired by practising with foils, called in *latin*. *rules*.

*Pyral* assures us, that the art of fencing is so highly esteemed in the *East Indies*, that princes and noblemen teach it. They wear a badge or cognizance on their right arms, called in their language *Ejara*, which is put on with great ceremony, like the badges of our orders of knighthood, by the kings themselves.

*Fencing* is divided into two parts, *simple* and *compound*.

*Simple*, is that performed directly, and nimbly on the same line; and is either offensive, or defensive. — The principal object of the first, is, whatever may be attempted in pushing or making passes from this or that point, to the most uncovered part of the enemy. — The second consists in parrying and repelling the thrusts aimed by the enemy.

The *compound*, on the offensive side, includes all the possible arts and inventions to deceive the enemy, and make him leave that part we have a design on, bare and unguarded, upon finding we cannot come at it by force, nor by the agility of the simple play.

The principal means hereof are feints, appeals, clashings, and intanglings of swords, half thrusts, &c. and in the defensive, to push in parrying.

*Parrying* is the action of defending a man's self, or of staying off the strokes offered by another. — Good fencers push and parry at the same time. — The *Spaniards* parry with the poniard; the *ancients* parried with their bucklers.

*Feint* is a false attack, or a shew of making a stroke or push in one part, with design to bring the enemy to guard that part, and leave some other part unguarded, where the stroke is really intended.

*Feints* are either single, or double, high, or low, without, or in the whole circle; of one, two, or three measures.

The *simple feint* is a meer motion of the wrist, without stirring the foot, &c.

*Guard* is an action or posture proper to screen the body from the attacks of an enemy's sword.

There are four general *guards* of the sword: to understand which, it will be necessary to imagine a circle drawn on an upright wall, and divided into four cardinal points, *viz.* top, bottom, right, and left.

Now when the point of the sword is directed to the bottom point of the circle, and consequently the head of the sword tilted up to the top point, with the body inclining forwards; this is called *prima*, or the *first guard*. — The *second guard*, which some improperly call the *third*, is when the point of the sword is directed to the right, or second point of the same circle, a quadrant distant from the first; with the foot of the sword turned to the right, and the body raised proportionably. — *Tierce*, or the *third guard*, is performed by directing the sword's point to the uppermost point of the same

same circle, diametrically opposite to that of *prime*; in which case the body, arm, and sword, are in their natural disposition, being the mean between the extremes of their motion.——*Quart*, or the *fourth guard*, is, when the point of the sword is directed to the fourth point of the circle, descending to the right, as far as one fourth of the *terce*, with the external side of the arm, and the flat of the sword turned towards the ground; and the body out of the line to the right, and the fort of the sword towards the line to the left.——There is also *quint*, or a kind of *fifth guard*, being the return of the point of the sword on the right, after transverſing the circle, to the point of the *prime*, whence it had departed; and yet, with a different disposition of the body, arm, and sword.

These guards are also called *figures* and *postures*;

and the common center of all their motions, is to be in the shoulder.

In all these kinds of guards there are high *advanced*, high *retired*, and high *intermediate* guards, when disposed before the upper part of the body, either with the arm quite extended, quite withdrawn, or in a mean state.——*Mean advanced* guard, or simply *mean guard*, is when the sword is disposed before the middle part of the body —— *Low advanced*, *retired*, or *intermediate* guards, are those where the arm and sword are advanced, withdrawn, or between the two extremes, before the lower part of the body.

Some will have *prime* the principal guard; others *quint*; others, with better reason, *terce*, because it consists of right lines, which are easier defended than oblique ones; such as those of *prime*, *second*, *quart*, and *quint*.

## F I S H I N G.

**F**ISHING is the art of catching fish with nets, spears, lines, rods, hooks &c. either in *salt-water*, or in *fresh-water*, rivers or ponds.

We will begin with the *salt-water fishery*, and confine our pen to those subjects as shall seem most interesting and entertaining, such as

**ANCHOVY FISHERY.** *Anchovies* are fished on the coast of *Provence*, in the months of *May*, *June*, and *July*, at which season shoals of this fish regularly come into the *Mediterranean* through the *Streights of Gibraltar*. They are likewise found in plenty in the river of *Genoa*, on the coast of *Sicily*, and on that of the island of *Gorgone*, opposite to *Leghorn*; these last are reckoned the best. It is remarkable, that *anchovies* are seldom fished but in the night-time. If a fire be kindled on the poop of the vessels used for this fishing, the *anchovies* will come in greater numbers into the nets; but then it is asserted, that the *anchovies* taken thus by fire, are neither so good, nor so firm, and will not keep so well as those which are taken without fire. When the fishery is over, they pull off the heads of all the *anchovies*, gut them, and afterwards range them in barrels of different weights, the largest of which do not weigh above 25 or 26 pounds, and they put a good deal of salt in them. Some also pickle them in small earthen pots made on purpose, of two or three pounds weight, more or less, which they cover with plaster, to keep them the better.

**The COD-FISHERY.** There are two kinds of *cod-fish*, the one *green* or *white-cod*, and the other *dried* or *cured-cod*, tho' it is all the same fish differently prepared; the former being sometimes salted

and barrelled, then taken out for use; and the latter having laid some competent time in salt, is dried in the sun or smoke. We shall therefore speak of each of these apart, and first of

**The GREEN COD-FISHERY.** The chief fisheries for *green cod* are in the bay of *Canada*: on the great bank of *Newfoundland*, and on the isle of *St. Peter*, and the isle of *Seble*: to which places vessels resort from divers parts both of *Europe* and *America*. They are from 100 to 150 tons burden, and will catch between 30 and 40 thousand cod each. The most essential part of the fishery, is to have a master who knows how to cut up the cod, one who is skilled to take the head off properly, and above all, a good salter, on which the preserving them, and consequently the success of the voyage, depends. The best season is from the beginning of *February* to the end of *April*; the fish, which in the winter retire to the deepest water, coming then on the banks, and fattening extremely. What is caught from *March* to *June* keeps well, but those taken in *July*, *August*, and *September*, when it is warm on the banks, are apt to spoil soon. Every fisher takes but one at a time: the most expert will take from 350 to 400 in a day, but that is the most; the weight of the fish and the great coldness on the bank fatiguing very much. As soon as the cods are taken, the head is taken off; they are opened, gutted and salted, and the salter stows them in the bottom of the hold, head to tail, in beds a fathom or two square; laying layers of salt and fish alternately, but never mixing fish caught on different days. When they have lain thus three or four days

to drain off the water, they are replaced in another part of the ship, and salted again; where they remain till the vessel is loaded. Sometimes they are cut in thick pieces, and put up in barrels for the conveniency of carriage.

**The DRY COD-FISHERY.** The principal fishery for *dry cod*, is from *Cape Rose* to the *Bay des Exports*, along the coast of *Placentia*, in which compass there are divers commodious ports for the fish to be dried in. These though of the same kind with the fresh cod, are much smaller, and therefore sifter to keep, as the salt penetrates more easily into them. The fishery of both is much alike, only this latter is most expensive, as it takes up more time, and employs more hands, and yet scarce half so much salt is spent in this as in the other. The bait is herrings, of which great quantities are taken on the coast of *Placentia*. When several vessels meet and intend to fish in the same port, he whose shalloop first touches ground, becomes intitled to the quality and privileges of admiral: he has the choice of his station, and the refusal of all the wood on the coast at his arrival.

As fast as the masters arrive, they unrig all their vessels, leaving nothing but the shrouds to sustain the masts, and in the mean time the mates provide a tent on shore, covered with branches of trees, and sails over them, with a scaffold of great trunks of pines, twelve, fifteen, sixteen, and often twenty feet high, commonly from forty to sixty feet long, and about one third as much in breadth.

While the scaffold is preparing, the crew are a fishing, and as fast as they catch they bring their fish ashore; open and salt them upon moveable benches; but the main salting is performed on the scaffold. When the fish have taken salt, they wash and hang them to drain on rails; when drained, they are laid on kinds of stages, which are small pieces of wood laid across, and covered with branches of trees, having the leaves stripped off, for the passage of the air. On these stages, they are disposed, a fish thick, head against tail, with the back uppermost, and are turned carefully, four times every twenty-four hours. When they begin to dry, they are laid in heaps ten or twelve thick, in order to retain their warmth; and every day the heaps are enlarged, till they become double their first bulk; then two heaps are joined together, which they turn every day as before; lastly, they are salted again, beginning with those first salted, and being laid in huge piles, they remain in that situation, till they are carried on board the ships, where they are laid on the branches of trees disposed for that purpose, upon the ballast,

and round the ship, with mats to prevent their contracting any moisture.

There are four kinds of commodities drawn from cod, *viz.* the *zounds*, the *tongues*, the *roes*, and the *oil* extracted from the liver. The first is salted at the fishery, together with the fish, and put up in barrels from 6 to 700 pound. The *tongues* are done in like manner, and brought in barrels from 4 to 500 pounds. The *roes* are also salted in barrels, and serve to cast into the sea to draw fish together, and particularly *pilchards*. The oil comes in barrels, from 400 to 520 pounds, and is used in dressing leather. The *Scots* catch a small kind of cod on the coasts of *Buchan*, and all along the *Murray Firth* on both sides; as also in the *Firth of Forth*, *Clyde*, &c. which is much esteemed. They salt and dry them in the sun upon rocks, and sometimes in the chimney. They also cure *skait*, and other smaller fish in the same manner, but most of these are for home consumption.

**The CORAL-FISHERY.** Red coral is found in the *Mediterranean*, on the shores of *Provence*, from *Cape de la Couronne* to that of *St. Tropez*; about the isles of *Majorca* and *Minorca*; on the south of *Sicily*; on the coasts of *Africa*; and, lastly, in the *Ethiopic* ocean, about *Cape Negro*. The divers say, that the little branches are found only in the caverns whose situation is parallel to the earth's surface, and open to the south. The manner of fishing being nearly the same wherever coral is found, it will suffice to instance the method used at the bastion of *France*, under the direction of the company established at *Marseilles* for that fishery. Seven or eight men go in a boat commanded by the patron or proprietor, and when the net is thrown by the caster, the rest work the vessel, and help to draw the net in. The net is composed of two rafters of wood tied cross-wise, with leads fixed to them: to these they fasten a quantity of hemp twisted loosely round, and intermingled with some large netting. This instrument is let down where they think there is coral, and pulled up again when the coral is strongly entangled in the hemp and netting. For this purpose, six boats are sometimes required; and if in hauling in, the rope happens to break, the fishermen run the hazard of being lost. Before the fishers go to sea, they agree for the price of the coral, which is sometimes more, sometimes less a pound; and they engage, on pain of corporal punishment, that neither they nor their crew shall embezzle any, but deliver the whole to the proprietors. When the fishery is ended, which amounts one year with another to twenty five quintals for each boat, it is divided into thirteen parts, of which the proprietor hath four, the caster two, and the other six men one each,

each, the thirteenth belongs to the company for payment of the boat furnished them. See DIVING.

*The HERRING-FISHERY.* Herrings are chiefly found in the *North-sea*. They are a fish of passage, and commonly go in shoals, being very fond of following fire or light, and in their passage they resemble a kind of lightning. About the beginning of *June*, an incredible shoal of herrings, probably much larger than the land of *Great-Britain* and *Ireland*, come from the north on the surface of the sea; their approach is known by the hovering of the sea fowl in expectation of prey, and by the smoothness of the water; but where they breed, or what particular place they come from, cannot be easily discovered. As this great shoal passes between the shores of *Greenland* and the *North-Cape*, it is probably confined, and as it reaches the extremities of *Great-Britain*, is necessarily divided into two parts. For we find one part of the herrings, steering west, or south-west, and leaving the islands of *Shetland* and *Orkney* to the left, pass on towards *Ireland*, where being interrupted a second time, some keeping the shore of *Britain*, pass away south down *St. George's Channel*; while the other part edging off to the south west, coast the western ocean, till they reach the south shore of *Ireland*, and then steering south-east, join the rest in *St. George's Channel*. The other part of the first division made in the north, parting a little to the east and south-east, pass by *Shetland*, and then make the point of *Buchan-ness*, and the coast of *Aberdeen*, filling as they go, all the bays, firths, creeks, &c. with their innumerable multitudes. Hence they proceed forward, pass by *Dunbar*, and rounding the high shores of *St. Abbe's Head*, and *Berwick*, are seen again off *Scarborough*; and even then not diminishing in bulk, till they come to *Yarmouth-Roads*, and from thence to the mouth of the *Thames*; after which, passing down the *British Channel*, they seem to be lost in the western ocean.

The vast advantage of this fishery to our nation is very obvious, when we consider that tho' herrings are found upon the shores of *North America*, they are never seen there in such quantities as with us; and that they are not to be met with in considerable numbers in any of the southern kingdoms of *Europe*, as *Spain*, *Portugal*, or the south parts of *France* on the side of the ocean, or in the *Mediterranean*, or on the coast of *Africa*.

There are two seasons for fishing herring, the first from *June* to the end of *August*, and the second in *Autumn*, when the fogs become very favourable for this kind of fishing.

The *Dutch* begin their herring-fishing on the 24th of *June*, and employ no less than two thousand vessels therein called *busses*, being between forty-

five and sixty tons burthen, and carrying three or four small cannon. They never stir out of port without a convoy, unless there be enough together to make about eighteen or twenty cannon among them, in which case they are allowed to go in company. Before they go out, they make a verbal agreement, which has the same force, as if it were in writing.

The regulations of the admiralty of *Holland* are partly followed by the *French*, and other nations, and partly improved and augmented with new ones: as, that no fisher shall cast his net within a hundred fathoms of another boat: that while the nets are cast, a light shall be kept on the hind part of the vessel: that when a boat is by any accident obliged to leave off fishing, the light shall be cast into the sea: that when the greater part of a fleet leaves off fishing, and casts anchor, the rest shall do the same, &c.

By the late act of parliament in *Great Britain*, the regulations are, that every vessel intitled to the bounty, must carry twelve *Winchester* bushels of salt in new barrels, for every last of fish such vessel is capable of holding; and as many more new barrels as such vessels can carry; and two fleets of tanned nets, that is, a vessel of seventy tons shall carry one fleet of fifty nets, each net to be thirty yards full upon its rope, and seven fathoms deep; and so in proportion for greater or smaller vessels; and be provided with one other fleet of fifty like nets, on board a tender, or left on shore in a proper place for the use of the said vessel, &c.

There is nothing particular in the manner of this fishing. The nets wherein the fish are drawn, should regularly have their meshes an inch square to let all the lesser fry go through.

*The curing and preparing herring.* The commerce of herring, both *white* or *pickled*, and *red*, is very considerable. The *white Dutch herrings* are the most esteemed, being distinguished into four sorts, according to their sizes; and the best are those that are fat, fleshy, firm, and white, salted the same day they are taken, with good salt and well barrelled. The *British herrings* are little inferior, if not equal to the *Dutch*, for in spite of all their endeavours to conceal the secret, their method of curing, lasting, or casking the herrings, has been discovered, and is as follows.

After they have hawled in their nets, which they drag in the sterns of their vessels backwards and forwards in traversing the coast, they throw them upon the ship's deck, which is cleared of every thing for that purpose: the crew is separated into sundry divisions, and each division has a peculiar task: one part opens and guts the herrings, leaving the melts and roes: another cures and salts them, by

by lining or rubbing their inside with salt: the next packs them, and between each row and division they sprinkle handfuls of salt: lastly, the cooper puts the finishing hand to all by heading the casks very tight, and stowing them in the hold. It is customary with us to wash the herring in fresh water, and steep them twelve or fifteen hours, in a strong brine, before we proceed to barrel them.

*Rd Herrings* must lie twenty-four hours in the brine, in as much as they are to take all their salt there, and when they are taken out, they are spitted, that is, strung by the head on little wooden spits, and then hung in a chimney made for that purpose. After which, a fire of brush-wood, which yields a deal of smoke, but no flame, being made under them, they remain there till sufficiently smoked and dried, and are afterwards barrelled up for keeping.

**The MACKREL-FISHERY.** The *Mackrels* are found in large shoals in the ocean, but especially on the *French* and *English* coasts. They enter the *English Channel* in *April*, and proceeding as the summer advances; about *June*, they are on the coasts of *Cornwall*, *Suffex*, *Normandy*, *Picardy*, &c. where the fishery is most considerable.

They are taken either with a line or nets: the latter is preferable, and is usually performed in the night-time. They are pickled two ways, first by opening and gutting them, and cramming their bellies, as hard as possible, with salt, by means of a stick, and then laying them in row: at the bottom of the vessel, strewing salt between each layer. The second way is putting them directly into tubs full of brine, made of salt and fresh water, and leaving them to steep till they have taken salt enough to keep. After this, they are barrelled up and pressed close down.

**The PILCHARD-FISHERY.** The chief pilchard fisheries are along the coasts of *Dalmatia*, on the coast of *Bretagne*, and along the coasts of *Cornwall* and *Devonshire*. That of *Dalmatia* is very plentiful: that on the coasts of *Bretagne* employs annually about 300 ships. The *pilchards* caught on our coasts, tho' bigger, are not so much valued as those on the coasts of *France*, owing principally to their not being so thoroughly cured. They naturally follow the light, which contributes much to the facility of the fishery: the season is from *June* to *September*. On the coasts of *France* they make use of the roes of the cod-fish, as a bait, which, thrown into the sea, makes them rise from the bottom, and run into the nets.

On our coasts there are persons posted ashore, who bying by the colour of the water where the shoals are, make signs to the boats to go among them to cast their nets. When taken, they are

brought on shore to a warehouse, where they are laid up in broad piles, supported with backs and stiles, and as they are piled, they salt them with bay salt, in which lying to soak twenty or thirty days, they run out a deal of blood, with dirty pickle and bitter: then they wash them clean in sea-water, and when dry, barrel and press them hard down to squeeze out the oil, which issues out at a hole in the bottom of the cask. The *Cornish* men observe of the pilchard, that it is the least fish in size, most in number, and greatest for gain, of any they take out of the sea.

**The SALMON-FISHERY.** The chief salmon-fisheries in *Europe* are in *England*, *Scotland*, and *Ireland*, in the rivers, and on sea coasts adjoining to the river mouths. Those most distinguished for salmon in *Scotland*, are the river *Tweed*, the *Clyde*, the *Tay*, the *Dee*, the *Don*, the *Spey*, the *Nesj*, the *Bewley*, &c. in most of which it is very common about the height of summer, especially if the weather happens to be very hot, to catch four or five score of salmon at a draught. The chief rivers in *England* for salmon are the *Tyne*, the *Uar*, the *Trent*, the *Severn*, and the *Thames*. The fishing usually begins about *January*, and in *Scotland*, they are obliged to give over about the 15th of *August*, because, as it is then supposed the fish come up to spawn, it would be quite depopulating the rivers to continue fishing any longer. It is performed with nets, and sometimes with a kind of locks or wears made on purpose, which in certain places have iron or wooden grates so disposed, in an angle, that being impelled by any force in a contrary direction to the course of the river, they may give way and open a little at the point of contact, and immediately shut again, closing the angle. The salmon, therefore, coming up into the rivers, are admitted into these grates, which open, and suffer them to pass thro', but shut again, and prevent their return. Salmon are also caught with a spear, which they dart into him when they see him swimming near the surface of the water. It is customary likewise to catch them with a candle and lantern, or wisp of straw set on fire; for the fish naturally following the light, are struck with the spear, or taken in a net spread for that purpose, and lifted with a sudden jerk from the bottom.

**The curing Salmon.** When the salmon are taken, they open them along the back, take out the guts and gills, and cut out the greatest part of the bones, endeavouring to make the inside as smooth as possible, then salt the fish in large tubs for the purpose, where they lie a considerable time soaking in brine, and about *October*, they are packed close up in barrels, and sent to *London*, or exported up the *Mediterranean*. They have also in *Scotland*, a great deal

deal of salmon salted in the common way, which after soaking in brine a competent time, is well pressed, and then dried in smoke: this is called *kipper*, and is chiefly made for home consumption, and if properly cured and prepared, is reckoned very delicious.

*The STURGEON-FISHERY.* The greatest *sturgeon-fishery* is in the mouth of the *Volga*, on the *Caspian-sea*, where the *Muscovites* employ a great number of hands, and catch them in a kind of inclosure formed by huge stakes, representing the letter Z, repeated several times. These fisheries are open on the side next the sea, and close on the other, by which means the fish ascending in its season up the river, is embarrassed in these narrow angular retreats, and so is easily killed with a harpooning iron.

*Sturgeons*, when fresh, eat deliciously, and in order to make them keep, they are salted or pickled in large pieces, and put up in cags from thirty to fifty pounds. But the great object of this fishery is the *roe*, of which the *Muscovites* are extremely fond, and of which is made the *caviar* or *kavia*, so much esteemed by the *Italians*.

*The WHALE-FISHERY.* *Whales* are chiefly caught in the *North-sea*: the largest sort are found about *Greenland*, or *Spitzbergen*.

The *whale-fishery* begins in *May*, and continues all *June* and *July*; but whether the ships have good or bad success, they must come away and get clear of the ice by the end of *August*.

The manner of taking *whales* at present is as follows. As soon as the fishermen hear the *whale*'s blow, they cry out, *fall! fall!* and every ship gets out its long-boat, in each of which there are six or seven men: they row till they come pretty near the *whale*, then the harpooner strikes it with his harpoon. This requires great dexterity, for through the bone of his head there is no striking, but near his spout there is a soft piece of flesh, into which the iron sinks with ease. As soon as he is struck, they take care to give him rope enough, otherwise, when he goes down, as he frequently does, he would inevitably sink the boat: this rope he draws with such violence, that, if it were not well watered, it would by its friction against the sides of the boat, be soon set on fire.

The line fastened to the harpoon is six or seven fathoms long, and is called the *fore-runner*: it is made of the finest and softest hemp, that it may slip the easier: to this they join a heap of lines of 90 or 100 fathoms each, and when there are not enough in one long boat, they borrow from another.

The man at the helm observes which way the rope goes, and steers the boat accordingly, that it

may run exactly out before. When the *whale* is struck, the other long-boats row before, and observe, which way the line stands, and sometimes pull it; if they feel it stiff, it is a sign the *whale* still pulls in strength; but if it hangs loose, and the boat lies equally high before and behind upon the water, they pull it in gently; but take care to coil it so, that the *whale* may have it again easily if he recovers strength: they take care, however, not to give him too much line, because he sometimes entangles it about a rock, and pulls out the harpoon.

The fat *whales* do not sink as soon as dead, but the lean one's do, and come up some days afterwards. The *whale* being lashed along-side, they lay it on one side, and put two ropes, one at the head, and the other in the place of the tail, which together with the fins is struck off, as soon as he is taken, to keep those extremities above water. On the off side of the *whale* are two boats to receive the pieces of fat, utensils, and men, that might otherwise fall into the water on that side.

These precautions being taken, three or four men with irons at their feet, to prevent slipping, get on the *whale*, and begin to cut out pieces of about three feet thick, and eight long, which are hauled up at the capstane or windlafs. When the fat is all got off, they cut off the whiskers of the upper jaw with an ax. Before they cut, they are all lashed to keep them firm, which also facilitates the cutting, and prevents them from falling into the sea: when on board, five or six of them are bundled together, and properly stowed, and after all is got off, the carcass is turned adrift, and devoured by the bears, who are very fond of it.

In proportion as the large pieces of fat are cut off, the rest of the crew are employed in slicing them smaller, and picking out all the lean. When this is prepared, they stow it under the deck, where it lies till the fat of all the *whales* is on board; then cutting it still smaller, they put it up in tubs in the hold, cramming them very full and close. The fat is to be boiled and melted down into train oil.

Besides these fisheries, there are several others both on the coasts of *Great Britain* and in the *North-seas*, which although not much the subject of merchandize, nevertheless employ great numbers both of ships and men; as, 1. The *oyster-fishing* at *Colchester*, *Faversham*, the isle of *Wight*, in the *Swailes* of the *Medway*, and in all the creeks between *Souhampton* and *Colchester*, from whence they are carried to be fed in pits.

2. The *lobster-fishing* all along the *British Channel*, the *Firth* of *Edinburgh*, on the coast of *Northumberland*, and on the coast of *Norway*; from whence great quantities are brought to *London*. And lastly, the fishing of the *pet-fish*, *fin-fish*, *sea-*

unicorn, sea-horse, and the seal, or dog-fish; all which are found in the same seas with the whales, and yield blubber in a certain degree.

*The PEARL-FISHERY.* Pearl is a hard, white, shining body, is usually roundish, found in a testaceous fish resembling an oyster: and though esteemed in the number of gems, and highly valued in all ages, proceeds only from a distemper in the creature that produces it.

The fish in which pearls are usually produced, is the *East Indian pearl oyster*, as it is commonly, though not very properly, called. It has a very large and broad shell, of the bivalve-kind, sometimes measuring twelve or fourteen inches over, but those of eight inches are more frequent: it is not very deep; on the outside it is of a dusky brown, and within of a very beautiful white, with tinges of several other colours, as exposed in different directions to the light.

Besides this shell, there are many others that are found to produce pearls; as the *common oyster*, the *muscle*, the *pinna marina*, and several others; the pearls of which are often very good, but those of the true *Indian-berberi*, or *pearl-oyster*, are in general superior to all.

The small or seed-pearls, also called *ounce pearls*, from their being sold by the ounce, and not by tale, are vastly the most numerous and common. The finest, and what is called the true shape of the pearl, is a perfect round. Their colour ought to be a pure white, and that not a dead and lifeless, but a clear and brilliant one; they must be perfectly free from any foulness, spot, or stain, and their surfaces must be naturally smooth and glossy; for they bring a natural polish with them, which art is not able to improve.

All pearls are formed of the matter of the shell, and consists of a number of coats spread with perfect regularity one over another, in the manner of the several coats of an onion, or like the several strata of the stones found in the bladders or stomachs of animals, only much thinner.

This valuable article of commerce is not the product of any peculiar part of the world. The east *Indies* and *America* produce the pearl shell-fish in abundance, and it is found with good pearls in many parts of *Europe*. The coasts of the island *Ceylon* afford pearls superior to those of all the *East* in the beauty of their colour, but there are no very large ones found there. The *Persian Gulph* abounds with the *pearl-fish*, and fisheries are established on the coasts of the several islands in it. In *America*, there are fisheries in the gulph of *Mexico*, and along the coast of *Terra Firma*, all which yield considerable advantage. The *European* pearls are principally found on the coasts of *Scotland*, and the neighbouring parts.

There are two seasons for *fishing pearls*, in the *East Indies*; the first in *March* and *April*, the second in *August* and *September*; the more rain falls in the year, the more plentiful are the fisheries. In the opening of the season, there appear, sometimes, two hundred and fifty barks on the banks. In the larger barks are two divers; in the smaller, one. Each bark puts off from shore e'er sun-rise, by a land-breeze, which never fails; and returns again by a sea-breeze, which succeeds at about noon. As soon as the barks are arrived, and have cast anchor, each diver binds a stone six inches thick, and a foot long under his body; which is to serve him as a ballast, and prevent his being driven away by the motion of the water; and to enable him to walk more steadily a-cross the waves. Besides this they tie another very heavy stone to one foot, whereby they are sunk to the bottom of the sea in a moment. And as the oysters are usually strongly fasten'd to the rocks, they arm their fingers with leathern mittens, to prevent their being wounded in scraping them violently off; and some men carry an iron rake for the purpose. Lastly, each diver carries down with him a large net, in manner of a sack, ty'd to his neck by a long cord, the other end whereof is fastened to the side of the bark. The sack is intended for the reception of the oysters gathered from the rock, and the cord to pull up the diver when the bag is full, or he wants air. In this equipage he precipitates himself, sometimes above sixty feet under water. As he has no time to lose there, he is no sooner arriv'd at the bottom, than he begins to run from side to side, sometimes on a sand, sometimes on a clayey earth, and sometimes among the points of rocks; tearing off the oysters he meets withal, and cramming them into his budget. At whatever depth the divers be, the light is so great, that they easily see whatever passes in the sea, with the same clearness as on land.

The best divers keep under water for half an hour, the rest do not stay less than a quarter. During which time, they hold their breath without the use of oils, or any other liquors; when they find themselves straitened, they pull the rope to which the bag is fastened, and hold fast by it with both hands; when the people in the bark taking the signal, heave them up into the air, and unload them of their fish. Some of the divers need a moment's respite to recover breath; others jump in again instantly, continuing this violent exercise, without intermission, for many hours. See DIVING.

On the shore they unload their barks, and lay their oysters in an infinite number of little pits, dug four or five feet square in the sand; raising heaps of sand over them to the height of a man, which, at a distance, look like an army ranged in battle.

In

In this condition, they are left till the rain, wind, and sun, have obliged them to open, which soon kills them. Upon this the flesh rots and dries, and the *pearls*, thus disengaged, tumble into the pit, upon taking the oysters out.

The season for *fishing* in the *West Indies*, is usually from *October* to *March*. In this time there set out from *Carthagena* ten or twelve barks, under the convoy of a man of war, called *Larmadilla*, each bark has two or three slaves for divers. Among the barks there is one called *Cajitana*; to which all the rest are obliged to bring at night what they have caught in the day, to prevent frauds. The divers continue sometimes under water above a quarter of an hour. The rest is the same as in the *East India fishery*.

The *fishing* in fresh water is commonly performed by *Angling*. For this purpose, there must be provided rods, lines, hooks, floats, both natural and artificial *flies*\*, &c.

The *FISHING-ROD* is a long taper rod or wand, to which the line is fastened for *angling*. Of these there are several sorts; as, 1. The troller, or trolling-rod, which has a ring at the end, for the line to go through, when it runs off a reel. 2. The whipper, or whipping-rod, which is weak in the middle, and top-heavy, but very slender. 3. The dopper, which is a strong rod, and very light. 4. The snapper, or snap-rod, which is a strong rod, peculiarly used for the pike. 5. The bottom-rod, which is the same as the dapper, only somewhat more pliable. 6. The snigging or poking-stick, which has a bow'd stick at the end, a strong line and needle baited with a lob-worm: this is only used for eels in their holes.

To make a *line*, after the best manner, the hairs ought to be very round, of an equal bigness, and twisted even: afterwards lay them in water for a quarter of an hour, to find which hairs do shrink; then twist them over again: some mix silk in the twisting, which is never so good as a line of all hairs,

or all silk. The best colour for lines is, the forrel, white, and grey; the two last for clear waters, and the first for muddy rivers. In the making your line, leave a bow at both ends, the one to put it to and take it from the rod, the other to hang your lowest link upon, to which your hook is fastened.

The *hook* ought to be long in the shank, somewhat round in its circumference, the point standing even and straight; and let the bending be in the shank. Strong, but small silk, is to be used in the setting on of the hook; and the hair laid on the inside of it.

The *floats* are made divers ways: some use the *Muscovy* duck quills, which are the best for still waters; but for strong streams, take good sound cork, without flaws or holes, and bore it through with a hot iron; then put into it a quill of a fit proportion; then pare your cork into a pyramidal form, of what bigness you think fit; after this grind it smooth.

To *plumb* your *ground*, you must carry with you a musket-ball, with a hole made through it, or any other sort of plummet, tying this to a strong twine, hang it on your hook, and so you will find the depth of the water. And that you may not incommode your tackle, it will be very requisite to make several partitions in pieces of parchment sewed together, by which each utensil may have a place by itself; not forgetting to carry a little whetstone with you to sharpen your hooks, if you find them blunt and dull; and having several bags of divers sizes for your hooks, corks, silk, thread, lead, flies, &c. Likewise linen and woollen bags for all sorts of baits; and a small pole with a loop at the end thereof, to which you may fasten a small net to land great fish withal.

There are many different sorts of *natural flies*, but some better beloved by some sort of fish; which is easily distinguished, when coming in the morning to the river-side, you beat the bushes with your rod, and take up what variety you may of all sorts of flies, and try them all, by which means you will

\* To make the *palmer fly*, the angler must arm his line on the inside of the hook; then with a pair of scissors cut so much of the brown of a mallard's feathers, as he shall think sufficient to make the wings; then lay the outermost part of the feather next the hook, and the point of the feather towards the shank of the hook; and afterwards whip it three or four times about the hook, with the same silk he armed it with, then he makes his silk fast; which done, he takes a plover's top, or the hackle of the neck of a cock, of which he takes one side of the feather; then takes the hackle, silk, or gold or silver thread, and makes all these fast at the bend of the hook, working them up to the wings; every turn shifting his fingers, and making a stop, that the gold may fall right, which is to be made fast; and the hackle worked up to the same place, and also made fast: then he takes the hook betwixt his finger and thumb, in the left hand, and with a needle or pin parts the wings in two: then with the arming silk he twists it about, as it falls cross between the wings, and with his thumb must turn the points of the feathers towards the bend of the hook, working it three or four times about the shank, and afterwards fastening it. If he makes the ground of hog's wool, sandy, black, or white, or of bear's wool, or of a red bullock, he must work these grounds on a waxed silk, and must arm and set on the wings as above mentioned. The body of the *May-fly*, must be wrought with some of these grounds; which will be very well, when ribb'd with black hair. He must make the *cak-fly*, with orange-tawney, and black for the body; and the brown of the mallard's feather for the wings.

quickly know which are in the greatest esteem among them.

Though there are reckoned no less than twelve sorts of the *artificial fly*, it is much better to find the fly proper for every season, and that which the fish at that time most eagerly cover, and make one as like it as possible you may, in colour, shape, and proportion; and for your better imitation, lay the natural fly before you. See the note on p. 490.

The best RULES for *artificial fly-fishing*, are,

1. To fish in a river somewhat disturbed with rain; or in a cloudy day, when the waters are moved by a gentle breeze; the fourth wind is best; and if the winds blow high, yet not so but that you may conveniently guard your tackle, the fish will rise in plain deeps; but if the wind be small, the best angling is in the swift streams.

2. Keep as far from the water-side as may be; fish down with the stream, with the sun at your back, not suffering your line to touch the water, but only your fly.

3. In clear rivers, ever angle with a small fly, with slender wings; but in muddy places use larger.

4. When after rain the water becomes brownish, use a red or orange fly; in a clear day, at night, a colour'd fly; a dark fly for dark waters, &c.

5. Let the line be twice as long as the rod, unless the river be encumbered with wood.

6. For every sort of fly have several of the same differing in colour, to suit with the different complexions of several waters and weathers.

7. Have a nimble eye, and active hand, to strike presently with the rising of the fish; or else he will be apt to spew out the hook.

8. Let your fly fall first into the water; for if your line fall first it scares the fish, and therefore you must draw again and cast.

9. In slow rivers, or still places, cast the fly cross over the river; and let it sink a little in the water, and draw it gently back with the current.

Lastly, *Salmon flies*, should be made with their wings standing one behind the other, whether two or four. That fish delights in the gaudiest colours that can be; chiefly in the wings, which must be long as well as the tail.

In *angling* the following rules are to be observed.

1. To place yourself so that your shadow do not at any time lie upon the water if shallow. 2. To angle in a pond near the ford where the cattle go to drink, and in rivers, in such places as the fish you intend to angle for, usually frequent; as for *breams*, in the deepest water; for *cels*, under banks; for *chub*, in deep shaded holes; for *perch*, in fowrs; for *roach*, in the same places; for *trouts*, in quick streams.

The best times for angling are from *April* to *October*; for in cold stormy weather, or bleak

easterly winds, the fish will not bite. The time of the day, in the warm months, is in the morning, about nine o'clock, and in the afternoon, between three and four.

In order to attract the fish to the place intended for angling, it will be proper once in four or five days to cast in some corn boiled soft, garbage, worms chopt to pieces, or grains steeped in blood, and dried; and if you fish in a stream, it will be best to cast in the grains above the hook.

The best way of *angling* with the *fly*, is down the river; and in order to make them bite freely, be sure to use such baits as you know they are naturally inclined to, and in such manner as they are accustomed to receive them.

If you fish for *carp*, you are to arm yourself with patience, for they are very subtle: they always chuse to lye in the deepest places; they seldom bite in cold weather, and in hot, a man cannot be too early, or too late for them; when they do bite, there is no fear of the hold. The baits are, the red-worm, in *March*; the cadew, in *June*; and the rashopper, in *July*, *August*, and *September*. Proper pastes may also be prepared for them; as honey and sugar, wrought together, and thrown in pieces into the water, some hours before you begin to angle. Honey, and white crumbs of bread mix'd together, do also make a good paste.

If for *dace*, and *dare*, which resemble much one another, in kind, size, goodness, feeding, cunning, &c. The *dace*, or *dare*, will bite at any fly, but especially the *stone cadice fly*, or *May fly*, the latter end of *April*, and the beginning, or most part in *May*, is a most excellent bait, floating on the top of the water, which they rarely refuse in a warm day; but when you fish under water for them, it is best to be within a handful, or something more of the ground. To catch *dace* in water, the bait is a white worm, with a read head, as big as the top of a man's little finger, gather'd after the plough, in heaths, or sandy grounds.

The *silver eel* may be caught with divers baits; particularly powder'd beef, garden worms, or lob, minnows, hens guts, fish, garbage, &c. But as they hide themselves in the mud, without stirring out for six months, and in the summer, take no delight to be abroad in the day, the most proper time to take them is in the night; by fastening a line to the bank-side, with a laying hook in the water, or a line plumb'd with a float, to discover where the line lies in the morning. The roach does here very well for a bait, the needle being laid in his mouth.

There is another way of taking *cels*, called *snig-gling*, perform'd in the day-time, by taking a strong line and needle, baited with a lob, or garden worm,

and resorting to such holes and places, as *eels* used to abscond in, near mills, weirs, or flood-gates, where the bait being gently put into the hole, by the help of a cleft stick, fixt at the end of our rod, the *eel* will certainly bite.

*Bobbing for eels*, is done by taking very large lobs, scouring them well, and with a needle, run some strong twisted silk through them from end to end; taking so many as may be wrapped a dozen times round a board: then they must be tied fast with the two ends of the silk, that they may hang in so many links. This done, they are to be fastened all to a cord, and about an handful and a half above the worms, a plummet is fixed, three quarters of a pound weight; and the cord made fast to a strong pole. *Fishing* with these in muddy water, the *eels* will bite hastily at the bait; when you think they have swallow'd it, gently drawn up the line, and bring them ashore.

Others use an *eel* spear, with three or four forks, or jagged teeth, which they strike at random into the mud.

In *April, May, June, and July*, you may fish for *flounders* all day long, either in a swift stream, or in the still deep, with red-worms, wasps, and gentles.

If you fish for *gudgeon*, which is a small fish of a delicious taste, and spawns three or four times in the summer season, feeding in streams, and on gravel: bait with a small red-worm, fishing near the ground. The *gudgeon* may either be fished for with a float, the hook being on the ground; or by hand with a running line on the ground, without cork, or float. He will bite well at wasps, gentles, and cod-baits. When you angle for *gudgeons*, stir up the sand or gravel with a long pole, which will make them gather to the place, and bite the faster.

The *perch*, or *perch*, spawns but in *February* or *March*, and seldom grows longer than two foot. He bites best when the spring is far spent. The proper baits are the *minnow*, and *small frog*; but a worm called a *brandling* is best; though the *minnow* yields the best sport, which is to be alive and stuck on the hook through the upper lip, or back-fin, and kept swimming about mid-water, or somewhat lower: for which purpose, you must have an indifferent large cork, with a quill on your line. When you fish with a frog, you must fasten the hook through the skin of his leg, towards the upper part thereof. You may also bait with lob-worms well scour'd, bobs, oak worms, gentles, colewort worms, minnows, dors, wasps, and cad-baits. When the fish bites, as he is none of the leathern-mouth'd kind, he must have time to pouch his bait. The best place to fish for him, is, in the turning of the water eddy, in a good gravel bot-

tom. He bites well all the day long, in cool cloudy weather; but chiefly from eight in the morning till ten, and from three in the afternoon till about six; but will not bite at all the seasons of the year, especially in winter, for then he is very abstemious; yet if it be warm, he will bite then in the middle of the day; for in winter, all fish bite best about the heat of the day.

There are two ways of *fishing* for the *pike*; by the *ledger-bait*, and the *walking-bait*.

The *ledger-bait*, is that fixed in one certain place, and which the *angler* may leave behind him. And this must be a living bait, either *fish* or *frog*. Of fish, the best are the dace, roach, or perch; for frogs, the yellowest are the best.

To apply it; if a fish, stick the hook through his upper lip; then fastening it to a strong line, ten or twelve yards long, tie the other end of the line, either to some stake in the ground, or to some bough of a tree, near the pike's usual haunt, or where you think it is like he may come. Then wind your line on a forked stick (big enough to keep the bait from drawing it under water) all about half a yard, or somewhat more, and your stick having a small cleft at the end, fasten your line therein; but so, that when the *pike* comes, he may easily draw it forth, and have line enough to go to his hold and pouch. If the bait be a frog; the arming wire is to be put in his mouth, and out at his gills, and one of the legs to be stitched or tied over the upper joint of the wire.

The *walking-bait*, is that which the fisher casts in, and conducts with a rod, &c. This is perform'd by a trole, with a winch to wind it up withal. At the top of the rod is to be placed a ring for the line to run through. The line for two yards and a quarter next the hook, to be of silk double, and armed with wires, the length of seven inches: on the shank of the hook is to be fastened a smooth piece of lead, so as to sink the fish bait, which is to be a *gudgeon* with his head downwards. Thus dispose the bait to be cast up and down, and if you feel the fish at the hook, give him length enough to run away with the bait, and pouch it; then strike him with a smart jerk.

To fish with a dead bait, use a minnow, yellow frog, dace, or roach, anointed with gum of jey, dissolved in oil of spike; and cast it where the *pike* frequents. After it has lain a little while at the bottom, draw it to the top, and soup the stream, and you'll soon perceive a *pike*, in earnest pursuit thereof. This fish bites best about three in the afternoon, in clear water, with a gent'e gale, from the middle of summer, to the end of autumn; but in winter all day long; and in the spring he bites best early in the morning, and late at night.

To angle for *roaches* in *April*, the cads, or worms, are proper baits; and small white snails, or flies; which baits must be under water, for *roaches* will not bite at the top. Others use a *May-fly* in that season with good success. In autumn you may fish for them with paste, only made of the crumbs of fine white bread, moulded with a little water; and the labour of your hands, into a tough paste, coloured, not very deep, with red lead, with which you may mix a little fine cotton, or lint, and a little butter; these last will make it hold on, and not wash off your hook, with which you must fish with most circumspect on, or you lose your bait. In winter *gentles* are the best bait. Sprouted malt, the young brood of wasps, and bees dipped in blood, and the thick blood of sheep, half dried, are *nostrums* in this sort of fishing.

The season for catching *trout*, is in *June*, *July*, and *August*, very early and late, or even all night, in the still part of rivers. His bait is a large red worm, at which he bites very eagerly, if first dipt in tar. He also delights in all sorts of pastes, made up of strong scented oils, or with tar: or a paste of brown bread and honey; nor does he refuse the cad-worm, lob-worm, flag-worm, green gentles, cad bait, or soft boil'd bread grain.

The *trout* is usually caught with a worm, minnow, or fly, natural or artificial. There are several sorts of worms, which are baits for the angler; the earth-worm, the dung-worm, the maggot, or gentle; but for the *trout*, the lob-worm, and brandling are the best; or the squirrel-tail, having a red head, streak'd down the back, and a broad tail. The brandling is commonly found in an old dunghil, cow-dung, hogs-dung, or tanners-bark.

Whatever worms you fish withal, they are the better for keeping; which must be in an earthen pot with moss, to be changed often in summer, that is, once in three or four days, and in twice as long time in winter.

When you fish for a *trout* by hand, on the ground, take a lob-worm, and run your hook through him, a little above the middle, and out again a little below it; then draw your worm above the arming of your hook, making your first entrance at the tail-end, that the point of the hook may come out at the head. When you fish with a minnow, take the whitest and middle size, slip the hook through his mouth, and the point and beard out of the tail, so as it may lie almost straight on the hook; then try against the stream whether it will turn. In defect of a minnow, a small loach may serve the turn; or for want of either, an artificial one may be made of cloth, to the life, which is found every whit as good a bait as the natural one.

We'll finish this treatise with some observations on *fish ponds*, and on the feeding, breeding, and preserving of fish.

*Fish-ponds* are no small improvement of watry and boggy lands, many of which are fit for no other use.

In making of a pond, its head should be at the lowest part of the ground, that the trench of the flood-gate or sluice, having a good fall, may not be too long in emptying. The best way of making the head secure; is to drive in two or three rows of stakes above six feet long, at about four feet distance from each other, the whole length of the pond head, whereof the first row should be rammed at least about four feet deep. If the bottom is false, the foundation may be laid with quick-lime, which, slacking, will make it as hard as a stone. Some lay a layer of lime, and another of earth dug out of the pond, among the piles and stakes; and when these are well covered, drive in others, as they see occasion, ramming in the earth as before, till the pond-head be of the height designed.

The dam should be made sloping on each side, leaving a waste to carry off the overabundance of water in times of floods or rains; and as to the depth of the pond, the deepest part need not exceed six feet, rising gradually in shoals towards the sides, for the fish to sun themselves, and lay their spawn.

Gravelly and sandy bottoms, especially the latter, are best for breeding; and a fat soil with a white fat water, as the washings of hills, commons, streets, sinks, &c. is best for fattening all sorts of fish.

For storing a pond, *carp* is to be preferred for its goodness, quick growth, and great increase; as breeding five or six times a year. A pond of an acre, if it be a feeding and not a breeding one, will every year feed two hundred carps of three years old, three hundred of two years old, and four hundred of a year old. Carps delight in ponds that have marl or clay-bottoms, with plenty of weeds and grafs, whereupon they feed in hot months.

Your pond should be drained every three or four years, and your fish sorted. If it is a breeding one, the smaller ones are to be taken out, to store other ponds with; leaving a good stock of females, at least eight or nine years old, as they never breed before that age. In feeding ponds, it is best to keep them pretty near of a size.

When fish are fed in large pools or ponds, either malt boiled, or fresh grains, is the best food; thus carps may be raised and fed like capons, and tenches will feed as well. The care of feeding them is best committed to a gardener, or the butler, who should be always at hand. In a stew, any sort of grain boiled, especially peas, and malt coarse ground; also the grains after brewing, whilst fresh and sweet: but one bushel of malt not brewed, will go as far as two of grains.

## OF FORTIFICATION.

**F**ORTIFICATION is *military architecture*, or the art of fortifying or strengthening a place, by raising works around it for defence against a powerful enemy.

Some authors go back to the beginning of the world for the author, or origin, of *military architecture*, or *fortification*. According to them, God himself was the first engineer; and paradise, or the garden of *Eden*, the first fortress. *Cain* improved on the hint, in building the first city, *Gen. iv. 17.* after him came *Nimrod*, *Gen. x. 10.* then *Semiramis*, as *Polyænus* relates, *Stratagem. lib. 8. c. 27.* the *Canaanites*, *Numb. xiii. 19.* *Deut. i. 28.* *David*, *2 Kings v. 9.* *Solomon*, *2 Chron. iii. 5.* *Rehoboam* his son, *2 Chron. viii. 5.* and other kings of *Judah* and *Israel*; and at length the *Greeks* and *Romans*, *Vitruv. lib. 10. c. ult. and lib. 1. c. 5.*

Such is the series of those who fortified places; to which might be added *Pharaoh*, the persecutor of the *Israelites*, who built the cities of *Pihom*, and *Raamses*, *Exod. i. 11.*

But how ancient soever the surrounding of cities with walls, towers, &c. may be, the name *fortification*, and the art now understood thereby, are of no very old standing. They had their rise since the invention of cannons; the terrible effects whereof rendered it necessary to change the structure of the ancient walls, and add so many things thereto, that those changes were thought enough to constitute a new art, which was called *fortification*, by the strength it afforded those in cities, to defend themselves against an enemy.

The first authors, who have wrote on *fortification*, considered as a particular formed art, are *Ramelli* and *Cutaneo*, *Italians*; after them *Errard*, engineer to *Henry the Great*, king of *France*; *Stevinus*, engineer to the prince of *Orange*; *Marolbois*, the chevalier de *Ville*, *Lorini*, *Coeborn*, the count de *Pagan*, and the marshal de *Vauban*: Which last two noble authors contributed greatly to the perfection of the art.

FORTIFICATIONS are either *durable* or *temporary*.

*Durable* fortifications are the walls, &c. of cities, frontier towns, &c.

*Temporary* fortifications are those erected for the security of a camp, for seizing and maintaining a post or pass, and on such like emergent occasions.

Again: the *durable* kind are divided into *regular* and *irregular*.

The *regular fortification*, has the bastions all equal; built in a regular polygon: whose sides and angles are generally about a musket-shot from each other. In this sort of *fortification* the parts being all equal, have the advantage of being equally defensible, so that there are no weak places.

The *irregular fortification* is that wherein the bastions are unequal and unlike; or the sides and angles not all equal and equidistant. In this sort of *fortification* the defence and strength being unequal, there is a necessity for reducing the irregular figure, as near as may be, to a regular one. And as the irregularity of a figure depends on the quantity of angles and sides; the irregularity of a *fortification* arises either from the angles being too small, or the sides being too long or too short. Consequently an irregular figure being proposed to be fortified, all the angles, with the quantity of the sides, must be found, to be able to judge how it is to be fortified.

*Fortifications* are represented either by designs on paper, or by models of wood, plaister, or paste-board. There are four sorts of delineations, *viz.* the *design*, *ichnography*, *orthography*, and *scenography*.

The **DESIGN** is the first draught of a *fortification*, by simple lines, to know the length thereof.

The **ICHOGRAPHY** denotes the plan, or representation of the length and breadth of a fortress: the distinct parts of which are marked out, either upon the ground itself, or upon paper.

The **ORTHOGRAPHY** is the profile, or representation of a *fortification*, or a draught so conducted, as that the length, breadth, height, and thickness of the several parts are expressed: such as they would appear, if it were perspective.

The **SCENOGRAPHY** is the representation of a *fortification*, on a perspective plan, or a description thereof in all its dimensions, such as it appears to the eye.

Before we proceed we must give some general rules to be necessarily observed in the *fortification* of places. 1. The manner of *fortifying* must be accommodated to that of attacking; so that no one manner can be assured will always hold, unless it be assured the manner of besieging be incapable of being altered; and to judge of the perfection of a *fortification*, the method of besieging at the time when it was built, must be considered. 2. All the parts of a *fortification*, should be able to resist the  
most

most forcible machines used in besieging. 3. A *fortification* should be so contrived, that it may be defended with as few men as possible. 4. That the defendants may be in the better condition, they must not be exposed to the enemies guns and mortars; but the aggressors be exposed to theirs.

Hence, 5, all the parts of a *fortification* should be so disposed, as that they may defend each other; in order to this, every part therein is to be flanked, *i. e.* capable of being seen and defended from some other, so that there be no place where an enemy can lodge himself either unseen, or under shelter. 6. All the campaign around must lay open to the defendants, so that no hills or eminences must be allowed; behind which the enemy might shelter himself from the guns of the *fortification*, or from which he might annoy them with his own. The fortrefs, then, is to command all the place round about; consequently the outworks must be lower than the body of the place. 7. No line of defence to be above point blank musket-shot, which is about one hundred and twenty fathom. 8. The acuter the angle at the centre, the stronger is the place; as consisting of more sides, and consequently more defensible.

Mr. *Vauban*, as well as count *Pagan*, admits of three sorts of *fortifications*, *viz.* the great, where the exterior polygon has always two hundred fathoms; the middle, which has always one hundred and eighty; the small which has but one hundred and sixty fathoms.

All *fortifications* consist of *lines* and *angles*, which have various names according to their different offices.

The *angles*, Fig. 1. are the *angle of the centre*, the *angle of the polygon*, the *angle of the bastion*, the *angle of the courtine*, the *angle of defence*, the *flanking angle*, the *flanked angle*, and the *angle of the epaule*.

The *lines* are those of the exterior polygon, of the interior polygon, of the perpendicular, of the line of defence, of the complement, of the great semi-diameter, of the little semi-diameter, of the capital, of the face, of the demi-gorge, of the flank, and of the courtine.

Of these *lines* and *angles*, are formed *bastions* and *courtines*, and sometimes *demi-bastions*, according to the situation of the ground; *cavaliers*, *ramparts*, *fausse-braye*, *ditches*, *counter-scarps*, *covert-ways*, *half moons*, *ravelins*, *horn-works*, *crown-works*, *out-works*, *esplanades*, *redoubts*, and *tenailles*,

A BASTION, in the modern signification, is a huge mass of earth, usually faced with sods, sometimes with brick, rarely with stone, standing out from a rampart, whereof it is a principal part,

and answers to what in the ancient *fortifications* is called *bul-wark*.

A *bastion* consists of two faces, and two flanks: the faces are the lines BC, and CS; including the angle of the *bastion*. The flanks are the line B A S D, Fig. 1. in the plate FORTIFICATION.

The union of the two faces makes the outmost or salient angle, called also the *angle of the bastion*, B C S. fig. 1. The union of the two faces to the two flanks, makes the side angles, called the *shoulders*, or *epaules of the bastion*. And the union of the two other ends of the flanks to the two courtines, the *angles of the flanks of the bastion*.

The foundation of the *bastion*, *i. e.* of a work consisting of flanks and faces, is, that great rule in *fortification*, *viz.* that every part of a work must be seen and defended from some other part; mere *angles* therefore are not sufficient, but flanks and faces are indispensably requisite. If the *bastions* EFG, and HIK, Fig. 8. consisted of faces alone, the angles G and H could not be defended from the lines FG, or IH; but if the *bastion* consists of flanks and faces, as ABCSD, all the points may be defended from the flanks, there being none, *v. g.* in the face BC, but what may be defended from the opposite angle EL, nor any in the courtine AE, but what may be defended from the adjacent flanks BA, and EL; nor any in one flank BA, but may be defended from the other EL.

For the proportion of the faces, they are not to be less than twenty-four rhine-land perches, nor more than thirty.

The flanks of the *bastion*, the longer they are, the better; provided they stand at the same angle, under the line of defence. If the angle of the *bastion* be less than sixty degrees, it will be too small to give room for guns; and besides so acute as to be easily beaten down by the enemies guns: Therefore a triangle can never be fortified, in regard some, or all the angles will be either sixty degrees, or less than sixty.

*Degree*, in this place, is a division of a circle, including a three hundred and sixtieth part thereof. Every circle, great and small, is supposed to be divided into 360 parts, called *degrees*; the *degree* is subdivided into 60 lesser parts, called *minutes*; the minute into 60 others, called *seconds*, the second into 60 thirds, &c.

*Bastions* are of divers kinds, *solid*, *void*, *flat*, *cut*, &c. The solid *bastions* are those that are filled up entirely, and have the earth equal to the height of the rampart, without any void space towards the center. Void or hollow *bastions*, are those surrounded with a rampart, and a parapet only ranging round their flanks and faces, so as to have

a void

a void space towards the center; where the ground is so low, that if the rampart be taken, no retrenchment can be made in the center, but what will lie under the fire of the besieged. A flat bastion, is a bastion built on a right line in the middle of a courtine, when it is too long to be defended by the bastion at its extremes. A cut bastion, is that, whose point is cut off, and in lieu thereof, has a re-entring angle, or an angle inwards, with two points outwards; sometimes also called a bastion with a tenaille; used either when without such a contrivance, the angle would be too acute, or when water or other impediment hinders the carrying on the bastion to its full extent.

There are, likewise, composed, regular, irregular, deformed, demi, and double bastions. A composed bastion, is when the two sides of the interior polygon are very unequal, which makes the gorges also unequal. A regular bastion, is that which has its due proportion of faces, flanks, and gorges; the faces being of an equal length, the flanks the same, and the two angles of the shoulder equal. An irregular bastion is where this proportion and equality is not observed. A deformed bastion is where the irregularity of the lines and angles makes the bastion out of shape, as when it wants one of its demi-gorges, one side of the interior polygon being too short. A demi-bastion, is that which has but one face and one flank, called also an epaulement; to fortify the angle of a place that is too acute, they cut off the point, and make two demi-bastions, which form a tenaille, or a re-entring angle. Their chief use is before a horn-work, or crown-work. A double bastion, is that which on the plain of the great bastion, has another bastion built higher, somewhat after the manner of a cavalier; leaving twelve or eighteen feet between the parapet of the lower, and the foot of the higher.

Every bastion hath its capitals, gorges, and distances. The capital of a bastion, is a line drawn from the angle of the polygon, to the point of the bastion. Those capitals are from thirty-five, to forty fathom long, from the point of the bastion, to the point where the two demi-gorges meet. The gorge of a bastion is what remains of the sides of the polygon of a place, after retrenching the courtines: In which it makes an angle in the center of the bastion; such is AHD, Fig. 1. The demi-gorge, or half-gorge, is the entrance into the bastion; not taken directly from angle to angle, where the bastion joins to the courtine,

from the angle of the flank to the center of the bastion, or angle the two courtines would make, were they thus protracted to meet in the bastion. The distance of the *bastions* is the sides of the exterior polygon.

The COURTINE, *curtain*, or *curtin* (the next piece of *fortification* which falls under our consideration) is that part of a wall or rampart, which is between two bastions; or which joins the flanks thereof: *qq*, Fig. 8. The courtine is usually bordered with a parapet five foot high; behind which the soldiers stand, to fire upon the covert-way, and into the moat. Besiegers seldom carry on their attacks against the courtine, because it is the best flanked of any part.

The courtine has its angle and complement. The angle of the courtine, or of the flank, is that made by or contained between the courtine and the flank. The complement of the courtine, is that part of the interior side thereof, which makes the demi-gorge.

The CAVALIER is a mount, or elevation of earth, either round or oblong, having a platform on the top, bordered with a parapet, to cover the cannon placed on it, and cut with embrasures to fire through; serving to overlook and command all around the place. *Cavaliers* are raised in sieges on the bastions and courtines of ramparts, in order to fire on the eminences around, and oblige the enemy to get farther off, as well as to scour the trenches. But the gorge of the bastion, is the place where *cavaliers* are most properly erected; those raised on the courtine, being rather called platforms.

A PLATFORM, is an elevation of earth, on which cannon is placed to fire on the enemy. Such are the mounts on the middle of the courtine; and there is always one on the ramparts where the cannon are mounted. The platform is made by heaping up of earth on the rampart; or by an arrangement of *madriers*,\* rising insensibly for the cannon to roll on; either in a casemate, or on an attack in the outworks.

The RAMPART, is a massy bank, or elevation of earth, raised about the body of a place, to cover it from the great shot. Upon the rampart the soldiers continually keep guard, and pieces of artillery are planted for the defence of the place.

To shelter the guard from the enemies shot, the outside of the rampart is built higher than the inside, *i. e.* a parapet is raised upon it with a plat-

\* Long and broad planks for supporting earth.

form The rampart is built with a *talus*\*, or slope, both on the inner and outer side. The rampart is sometimes lined, *i. e.* fortified with a stone wall within side; otherwise it has a *berme* †. It is encompassed with a moat or ditch, out of which the earth that forms the rampart is dug. The height of the rampart should not exceed three fathoms, this being sufficient to cover the houses from the battery of the cannon; neither ought its thickness to be above ten or twelve, unless more earth be taken out of the ditch, than can be otherwise bestowed. The ramparts of half-moons are the better for being low, that the small fire of the defendants, may the better reach the bottom of the ditch: but yet they must be so high, as not to be commanded by the covert-way.

FAUSSE-BRAYE, is an elevation of earth, two or three fathoms broad, round the foot of the rampart on the outside, defended by a parapet, which parts it from the *berme*, and the edge of the ditch: Its use is for the defence of the ditch.

The DITCH, called *fosse* and *moat*, is a trench dug round the rampart, or wall of a fortified place, between the scarp and counterscarp, *b b b*, Fig. 8. Some ditches are dry, others full of water; each whereof have their advantages. The ditch should be of such a breadth, as that the tallest tree may not reach over it, *i. e.* from 15 to 20 fathoms.

The COUNTERSCARP is properly the outward, or exterior talus of the ditch; though at present is understood, under that name, the *covert-way*, with its parapet.

But they are mistaken, for the *covert-way* is a space of ground, level with the adjoining country, on the edge of the ditch, ranging quite round the half-moons, and other works without-side the ditch. *b b*, Fig. 8. It is otherwise called *corridor*, and has a parapet together with its banquette and glacis, which form the height of the parapet. One of the greatest difficulties in a siege is to make a lodgment on the *covert-way*; because, usually, the besieged pallisade it along the middle, and undermine it on all sides. This is also, sometimes, called the counterscarp; because it is on the edge of the scarp.

A BANQUETTE, is a little foot-bank, or elevation of earth, forming a path which runs along the

inside of a parapet; by which the musqueteers get up, to discover the counterscarp, or to fire on the enemies in the moat, or in the covert-way. The banquette is generally a foot and a half high, and almost three feet broad; having two or three steps to mount it by. Where the parapet is very high, they make a double banquette, one over another.

A parapet or breast-work, is a defence or skreen, on the extream of a rampart, or other work, serving to cover the foldiers, and the cannon from the enemies fire. Parapets are raised on all works, where it is necessary to cover the men from the enemies fire, both within and without the place, and even the approaches. The parapet royal, or that of the rampart, is to be of earth, cannon-proof, from eighteen to twenty feet thick, six feet high towards the place, and four or five towards the rampart. This difference of height, makes a glacis, or slope, for the musqueteers to fire down into the ditch, or at least the counterscarp. The parapet of the wall is sometimes of stone. The parapet of the trenches is either made of the earth dug up, or of gabions, fascines, sacks of earth, or the like.

GLACIS is a sloping bank, which reaches from the parapet of the counterscarp, or covert-way, to the level side of the field, *a a a c*, Fig. 8. The glacis, otherwise *esplanade*, is about six feet high, and loses itself by an insensible diminution in the space of ten fathoms.

The HALF-MOON, is an out-work consisting of two faces, forming together a saliant angle, whose gorge is turned like an half-moon. Half-moons are sometimes raised before the courtine, when the ditch is wider than it ought to be; in which case it is much the same with the ravelin, only that the gorge of an half-moon is made bending in like a bow, or crescent, and is chiefly used to cover the point of the bastion; whereas ravelins are always placed before the courtine.

RAVELIN is a detached work, composed only of two faces, which make a saliant angle, without any flanks; and raised before the courtine on the counterscarp of the place. A ravelin is a triangular work, resembling the point of a bastion, with the flanks cut off, *i i i*, Fig. 8. Its use before

\* There is an exterior talus, and an interior one. The exterior talus for work, is its slope on the side towards the country; which is always made as little as possible, to prevent the enemies scalado; unless the earth be bad, and then it is absolutely necessary to allow a considerable talus for its parapet. The interior talus of a work, is its slope on the inside towards the place.

† A small space of ground, four or five feet wide, left without the rampart, between its foot and the side of the moat, to receive the earth that rolls down from the rampart, and prevent its falling into, and filling up the moat. This is also called *leziere*, *relais*, *retraite*, *pas de jouris*, *foreland*, &c. Sometimes for more security, the *berme* is pallisaded.

a courtine is, to cover the opposite flanks of the two next bastions. It is used also to cover a bridge or a gate, and is always placed without the moat. What the engineers call a ravelin, the soldiers generally call a half-moon. There are also double ravelins, which serve to defend each other. They are said to be double when they are joined by a courtine.

To cover and defend a courtine, bastion, or other places suspected to be weaker than the rest, as also to possess a height, there is a sort of out-work erected, and advancing towards the field called horn-work, which consists of two demi-bastions, as LMN and OPQ. Fig. 9 joined by the courtine NO. Its sides or flanks are usually parallel, though sometimes they approach or contract towards the place, forming what they call a *swallow's tail*; when the flanks are too long, they sometimes make epaulements to flank them. The parts of the horn-work, next the country, is to be defended by a parapet.

Two horn-works joined together make a crown-work, which is an out-work running into the field; designed to keep off the enemy, gain some hill, or advantageous post, and cover the out-works of the place, *ll*, Fig. 8. The crown-work consists of two demi bastions at the extremes, and an entire bastion in the middle with courtines.

All those works made without side the ditch, or *fossé*, to cover and defend it are called out-works which serve to cover the body of the place, and to keep the enemy at a distance, and to prevent their taking advantage of the cavities and elevations, usually found in the places about the counterscarp.

There is a kind of work indented in form of the teeth of a saw, with saliant. and re-entering angles, to the end that one part may flank or defend another, called REDENS, *redans*, or *redant*. It is also called *saw-work*, and *indented work*, and is frequently used in the *fortifying* of walls, where it is not necessary to be at the expence of building bastions; as when they stand on the side of a river, a marsh, the sea, &c. The parapet of the *corridor* is frequently redented, or carried on in the way of *redans*.

There is also a kind of out-work, consisting of two parallel sides, with a front wherein is a re-entering angle, called TENAILLE, which is of two kinds, *viz*, *simple* and *double*. The *simple*, or *single tenaille*, is a large out-work, as D A B C E. consisting of two faces or sides, AB, and CB, including a re-entering angle B, Fig. 9, and Fig 8, *d*. *Double*, or *flanked tenaille*, is a large out-work, consisting of two *simple tenailles*, or three saliants, and two re-entering angles, FGH, and HIK,

Fig. 8, *e*. The great defects of *tenailles* are, that they take up too much room, and on that account are advantageous to the enemy; that the angle B, is undefended; the height of the parapet hindering the seeing down into it, so that the enemy can lodge there under covert: and that the sides AD and CE, are not sufficiently flanked. For these reasons, *tenailles* are now excluded out of *fortifications* by the best engineers, and never made, but where there wants time to form a horn-work. The *tenaille* of the place, is the front of the place, comprehended between the points of two neighbouring bastions; including the courtine, the two flanks raised on the courtine, and the two sides of the bastions which face one another; so that the *tenaille* is the same with what is otherwise called the face of the fortress. The *tenaille* of the ditch, is a low work raised before the courtine in the middle of the *fossé*, or ditch. It is of three sorts, the first is composed of a courtine, two flanks, and two faces: the rampart of the courtine, including the parapet and talus, is but five fathoms thick; but the rampart of the flanks and faces, seven, *e* Fig. 8. The second, which M. *Vauban* says he found to be of very good defence, is composed only of two faces, made on the lines of defence, whose ramparts and faces are parallel. The third sort only differs from the second in this, that its rampart is parallel to the courtine of the place. All three sorts are good defences for the ditch, and lie so low, that they cannot be hurt by the besiegers cannon, till they are masters of the covert-way, and have planted their artillery there.

There have been invented various methods of *fortifying*; the principal, and those which chiefly obtain through *Europe*, are those of *Vauban*, *Blondel*, *Pagan*, *Coeborn*, and *Scheiter*, from which all the rest are easily conceived.

The figure, or perimeter (*i. e.* the *ambit*, or extent that binds a figure, or body) of a *fortress*, or *fortified* place, is called POLYGON, which is a figure whose perimeter consists of more than four sides, and angles. If the sides and angles be equal, the figure is called a *regular polygon*. *Polygons* are distinguished according to the number of their sides. Those of five sides, are called *pentagons*; those of six, *hexagons*; those of seven, *heptagons*; those of eight, *octagons*, &c. The *polygon* of a place is distinguished into exterior, and interior *polygon*. The exterior *polygon* is a right line drawn from the *vertex*, or point of a bastion, to the *vertex*, or point of the next adjacent bastion. The interior *polygon* is a right line drawn from the center of one bastion, to the center of another.

We will begin by making a draught of a regular *pentagon*, according to M. *Vauban's* method of his

middle *fortification*, which has always 180 fathoms. Therefore, to divide the circumference, we will take 76 (*o b* 1. and make a circle of it, which we will divide into five equal parts, each whereof will have 90, (*o*, we will divide the sides into two parts, and draw from the center, as well through the angles of the figure, as through the points found in the middle of the sides, right lines. We will give from the same middle, on the lines drawn towards the center, to the square the eighth part, to the pentagon the seventh, and to all the others, the sixth part of the exterior side; which, makes the perpendicular *A I*, Fig. 2. afterwards we will draw through that point of the double angle of the neighbouring gorges, the lines of defence *A P*, *O B*.

To form the flank, the faces, and the courtine, we will put on the lines of defence, the faces of the angles *A B*, &c. which are at all the polygons; at the first rank, 27 (*o*, at the second 25; and at the third 23, (as *A a B b*) we will take, besides, the distance between the two extremes of the faces, as *a b*, placing first one leg of the compasses in *a*, and directing the other towards the line of defence, where we will make the point *P*, and afterwards rest the compasses in *b*; and directing it, likewise, from the point *a* towards *o*, we draw *a o b* and *P* together, to make up the flanks, and *o P* to make up the courtine.

To form the *orillon*, as well as the *brifures*, and the hollow tower, we divide the flanks found into three equal parts, and put on the superior parts semi-circles, which touch the lines of defence, and that is what makes the *orillon*. Besides which, we draw lines from the points *A*, *B*; for example from the points *u*, *o*, *r*, *P*, &c. towards the capital, as *r*, *f*, *u*, *t*, &c. *O o*, *P p*, &c. of three verges in length. We afterwards take the distance, *u o*, or *r P*, and make of *u* and of *o*, as well as of *P* and *r*, outward interfections, which will give the center for the arch *t o f p*, which is called the hollow tower.

To make the *tenaille of the fausse-braye*, we put the angles of the shoulder, or *epaule*, three verges from *a* and *b*, on the lines of defence, in *c* and *e*, dividing what remains, by the interfection of the lines of defence, as *C c*, and *e i*, into two parts in *d* and *f*, thus *c d* and *e f*, make the faces of the *tenaille* in the ditch or *fosse*. We draw from *d*, the line *d g*, so that it be perpendicular, or make a right angle, with the line of defence *g f*. Likewise, we draw *f b*, to be perpendicular on the line *d b*, thus those lines will be the flanks, and *g b* will give the courtine.

The *icnography* of the *pentagon*, on the draught, is made by means of this table. which may be used in all works, either regular, or irregular.

	Feet.
The base of the rampart	66
The base of the parapet,	21
The banquette of the parapet,	3
The other banquette,	1 $\frac{1}{2}$
The ditch,	120
The covert-way,	36
The gorge of the place of arms,	60
Its face six verges, six verges and a half, to seven.	

The glacis ten to twelve verges.

The use of this table is as follows:

We take 66 feet for the *base of the rampart*, and draw them parallel, inwards, with the faces, hollow towers, inferior brifures, and the courtines. But if we would have solid bastions, we make no lines to the hollow towers, nor to the faces, but join the lower ones with the brifures by a right line, or by demi-circles. To make the line, round the hollow tower, parallel, we must put the 66 feet of the brifure, still more inwards, and take the distance of the hollow tower to that place, with which the parallel is drawn from the same center.

We take, besides, for the parapet, 21 feet, and draw, likewise, with the line of the draught, parallels inwards, to the faces, orillons, hollow towers, inferior brifures, and to the courtines, before the *icnography* of the parapet. To that line we draw another parallel three feet more inwards, and still more inwards, another of a foot and a half broad.

The *ditch* is drawn parallel to the faces, 120 feet broad, its lines cutting one another before the courtine, and it is made round at the point of the bastion, that it may be of an equal breadth every where. If the ditch is marshy, it must be full of small herbs, if dry, of small points; and, if to be filled with water, of something, which can represent water.

For the *covert way*, we trace round the ditch, outwards, a parallel, 36 feet long. Of the re-entring angles of those lines, *a b* and *c*, we put on each side (in *b c* and *d c*) five verges outwards, for the gorges of the places of arms; we make of those points, with the breadth of six verges, interfections, in *f* and *g*; and join the lines *b f*, and *c f d g*, and *e g*, together; closing, lastly, on both sides, the angles *b i k*, and *m n o*, and drawing afterwards the line *p h i k f m n o q*, as the interior line of the glacis.

For the *traverses*, we continue the faces of the places of arms, *viz.* of *c d e f*, downwards as far as the ditch; and afterwards make parallels outwards of the places of arms, 18 feet broad. Lastly we draw on both sides, inwards, banquettes of two feet broad, so that the space in the middle be 14 feet

feet broad; and that is what is called *traverses*. Further, we draw parallels with the interior line of the glacis, inside, towards the covert-way, with the breadth of eight feet for a large banquette, in the middle thereof we place palisadoes; we afterwards draw, besides, still more inwards, an ordinary banquette of a foot and a half. Lastly, we draw an exterior line, of the breadth of 10 to 12 *verges*, and join them together with transverse lines.

We draw parallels to the faces and flanks of the *tenaille* of the *fausse-braye*, inwards, five *verges* broad, and join them together before the *courtine*, by a parallel from two and a half to three *verges* in breadth, which makes the base of the *rampart*. The parapet to the faces, is equal to that of the great rampart, or thereabouts; but that of the courtine is but eight feet broad.

To put a *half-moon*, or *ravelin* before the courtine, we take the distance of the angle of the flank, and of the courtine, as far as the angle of the *epaule*, or shoulder, over-against it, and draw from thence an arch which intersects the line drawn through the middle of the polygon; there is found the point of the half-moon; then draw from thence the faces, on each side towards the angles of the *epaule*, as far as the ditch. If we want to make flanks, we put a rule to the interior line of the glacis, and mark the points where it intersects the faces of the half-moon, or ravelin: from hence we make lines fall perpendicularly on those of the ditch; these are the flanks of the ravelin.

For the base of the rampart, it is made parallel to the flank and faces, five *verges* in breadth; the parapet is every where equal to that of the great rampart; the ditch is parallel to the faces, and six yards broad.

To make a *horn work* before the curtain, we put the point of the capital of the ravelin, on the line which comes out through the middle of the polygon, 44 *verges* outwards, (as Q G, Fig. 5.) we make of the point G, on each side, an arch of 30 yards, and intersect those two arches of the *epaule*, with 70 yards in H and f, and draw H f. Afterwards we will put, from the middle of that line in G, 10 yards inside towards H, and draw from E and f lines of defence cross-wise, on which we will put the faces 18 yards long; forming the flanks with their orillons and hollow towers, in the same manner we have done it to the body of the place, except that four yards must always be taken from

the flank for the orillon, and the rest remains for the covert-flank, with the hollow tower.

The *orillon* is a small rounding of earth, lined with a wall, raised on the shoulders of those bastions which have casemates; to cover the cannon in retired flank, and prevent their being dismounted by the enemy. There are other sorts of *orillons* properly called *epaulements*.

From E f we draw the wings towards the angles of the shoulder, as far as the ditch; and thus the design of the *horn-work* is made in the same manner as that of the body of the place, except that the measures are different, *viz.* the base of the rampart has four yards, that of the parapet 18 feet, and the breadth of the ditch five yards.

To make a *horn-work* before the bastion, we put the point of the bastion lengthened 44 yards, outwards, as far as B, Fig. 6; draw through B, the line C D, which intersects the lengthened diameter into right angles. We make B C, B D 30 yards each, and form on that the *horn-work*, with its faces, flanks and courtines. We place the angle of the shoulder of the body of the place on the faces, six yards and a half in o and p, and draw towards those points the wings of our *horn-work*, which compleats the design. But these sorts of works are seldom used.

We make a *crown-work*, Fig. 7 before the courtine, by placing the point of the ravelin (or in case there was none in the place where that point should be) 50 yards outwards towards B. Making of that point on each side, an angle of the line A, Fig. 7. each whereof is to have from 64 to 70 degrees, as C B A, and D B A; we put on those lines B C and B D twice 25 yards in E C, and f D. From E and f, we draw perpendiculars of nine yards each, as E G, f H; and draw thereby, from E and f, the lines of defence cross-ways; on which we place the faces, of 15 yards in length, and form the flanks, as in the *horn-work*; and thus the courtines form themselves. We put the angle of the shoulder of the body of the place five yards on the faces, and draw towards those points the wings of the crown-work as far as the ditch. If we should want to place a ravelin before the courtine of the *horn-work*, or crown-work, the process is the same as demonstrated in the body of the place; the base of the rampart has three yards, that of the parapet 15 feet; and the ditch three yards and a half.

When we design to make the great *lunettes* \* of

\* The *lunette* is an enveloped counter-guard, or elevation of earth, made in the middle of the *fesse*, before the courtine, about five fathoms in breadth. *Lunettes* are usually made in ditches full of water, and serve to the same purpose as *fausse-brayes*, to dispute the passage of the ditch. The *lunette* consists of two faces, which form a re-enting angle and its *terreplain* being only twelve feet wide, is a little raised above the level of the water, having a parapet three fathoms thick.

M Vanban, having made the draught of the ravelin, which ought to be done, previously to any thing else, we continue its faces on both sides, from A (Fig. 9. A) into B and C, placing afterwards the lines BD, and EC, of the ditch of the ravelin outwards, which must be from 22 to 25 yards long. On the lines BD, and CE, we make the angles DBf, and ECG, of 60 degrees; and thus the *lunettes* will be made. The profile of the rampart, and of the ditch, is the same as to the *horn-work*.

If we will make small *Lunettes*, as well as *Counter-guards*, of the re-entring angles A B. Fig. 9. B, which the *feffé* of the ravelin, and the great ditch make; we must put on each side, outwards, in CD, and EF, 10 yards for the demi-gorges of the *lunettes*, and make the interfections in G and H, 12 or 13 yards broad, placing the compasses on the points found of the demi-gorges; and thus CG, DG, EH, FH, will give the faces of the *lunettes*.

For the design of the *counter-guards*, we put of the ditch, five yards outwards, and draw from the ditch to the lengthened diameters. thro' those points, lines parallel to the ditch; as IK, and LM. For the *icnography* thereof, we give to the rampart the thickness of three and a half or four yards; to the parapet, without the banquettes, eighteen feet; for the breadth of the ditch from four to four yards and a half.

The *profile* must be drawn in this manner. After we have made a long right line, as A R, Fig. 3. and AB, which represents the ground or the horizon; we put first upon it, according to Fig. 10. the *profile* of the rampart of the body of the place. a, is the first point of the base, behind which we put immediately on the same line, for,

The <i>talus</i> of the interior Wall,	1
The <i>cordon</i> which is on the wall,	1
The <i>talus</i> of the terreplain,	3
The breadth of the <i>terreplain</i> of the rampart,	30
The breadth of the first <i>banquette</i> ,	1½
The breadth of the second <i>banquette</i> ,	3
The interior <i>talus</i> of the parapet,	1
Its superior breadth,	18
The exterior <i>talus</i> of the parapet,	2
The <i>cordon</i> above, at the exterior lining,	2
The <i>talus</i> of the exterior lining,	3
<hr/>	
Base of the rampart, or sum,	66

We afterwards erect perpendiculars on the first and last point, and place upon them the following *measures*, one after another; for,

The height of the interior lining,	12
That of the terreplain,	6

That of the first <i>banquette</i> ,	1½
That of the second <i>banquette</i> ,	1½
The exterior height of the parapet,	0½
The interior height	4½
<hr/>	
Sum,	26

From the points which are on the horizontal line, we draw lines upwards to be parallel to the perpendiculars already drawn, and from the points of the perpendiculars, we draw other lines, to be parallels to the horizontal. In that manner the interfections give us a *retz*, in which we can easily trace the lines of the *profile* a c d e f g h i k l m n o p, in drawing only, according to the figure, from one point of interfection to the other. The horizontal line is marked with small points; but for those of the *retz*, or net, they are easily blotted out afterwards.

The *profile* of the ravelin is made in the same manner; it is but of earth, except the ditch, which must be lined

The measures of the rampart, are the following ones, marked on the horizontal line, Fig. 3. For,

The interior <i>talus</i> ,	6
The <i>terreplain</i> ,	25½
The breadth of the first <i>banquette</i> ,	1½
The breadth of the second <i>banquette</i> ,	3
The interior <i>talus</i> of the parapet,	1
The superior breadth of the parapet	15
The exterior <i>talus</i> of the parapet and rampart } together,	8

The base of the rampart, a o, Sum 60  
On the *Perpendiculars*, for

The height of the rampart,	13
That of the first <i>banquette</i> ,	1½
That of the second <i>banquette</i> ,	1½
The exterior height of the parapet,	1
Its interior height,	4½
<hr/>	
Sum,	21½

In the same manner is made the design of the ramparts of the outworks, the measure thereof can be ordinarily this, Fig. 3.

On the *horizontal line*, for

The exterior <i>talus</i> ,	6
The <i>terreplain</i> ,	15½
The first <i>banquette</i> ,	1½
The second <i>banquette</i> ,	3
The interior <i>talus</i> of the parapet,	1
The superior height,	15
The exterior <i>talus</i> of the rampart with the } parapet,	6

Base of the rampart, Sum,	48
On	

On the perpendiculars, for

The height of the rampart,	8
That of the first banquette,	1½
Of the second, ———	1½
The exterior height of the parapet,	1½
Its interior height, ———	4
Sum ———	16½

As for the *profile* of the ditches, it is made in this manner; where the ramparts are only made of earth, without being lined, a *berme* is left at the bottom, six feet broad, as *o q*, Fig. 3. But when the rampart is lined, the ditch is joined immediately to the rampart; the superior breadth of the ditch having been marked on the horizontal line, we place likewise on both sides of the ditch inwards, the breadth for the *talus*; and lower from thence, perpendiculars, on which we put the depth of the ditch. Afterwards we make the ditch with its two *talus*'s, and inferior breadth. The measures of the *ditch* are the following ones,

To the <i>ditch</i> of the body of the place,	Feet.
The superior height, ———	114
The base of the interior and exterior <i>talus</i> ,	3
The inferior breadth, ———	108
The depth, ———	18

To the <i>ditch</i> of the ravelin.	Feet
The superior breadth, ———	72
The base of the interior and exterior <i>talus</i> ,	2
The depth, ———	12
The inferior breadth, ———	68

To the <i>ditches</i> of the other out-works.	
The superior breadth, ———	54
The base of the interior and exterior <i>talus</i> ,	1½
The depth, ———	8
The inferior breadth, ———	51

Lastly, the *covert-way* with its parapet, is made thus: We put on the horizontal line 27 feet for the *covert-way*, and one foot and a half for the first banquette as usual; for the second eight feet, on which are placed pallisadoes, almost in the middle. All the rest is made in the manner of the other parapets; putting at the end 144 feet, on the horizontal line, for the breadth of the parapet, and drawing a right line from the inferior height, as far as there.

The pieces of the profiles may be all joined one to another, as plainly seen in Fig. 3.

We must now trace a **FORTRESS** in the field. The best instrument he can use for that purpose is a circle, or demicircle, divided into 360 degrees,

each whereof also should be subdivided into four or six parts. Commonly this design is made outwards to the polygons; but is far better, if it be possible, to make it of the center. I'll shew both methods in the regular pentagon.

M *Vauban*'s new method is most esteemed, as best answering the end proposed in the *fortifications* of places; and founded on the seven following excellent maxims; *viz.* 1. The defence of the flank must be such, that both the cannon and musquetry may be used at one and the same time. 2. The flank ought to be so well covered, as to be not entirely ruined by the enemy. 3. The ditches, horizontally raised. 4. The bastions are to be so contrived, that those who defend them may be sheltered against the bombs. 5. Some places and passages are to be contrived for the sallies. 6. The greater the number of ditches, the better. 7. The counterscarp must be well covered.

To reduce the first of these maxims into practice, M. *Vauban* makes his flanks in such a manner, that the line of defence may have 70 yards.

To cover well the flank, which is M. *Vauban*'s second maxim, he places a good ravelin before the courtine, and contrives the flank so, that two pieces of cannon, at least, may be hidden behind the orillon.

To raise the ditch, which is the third maxim, M. *Vauban* will have made, under the flank of the *tenaille* of the *fausse-braye*, arches, under which cannons may be planted on carriages used for ship's cannons. The embrasures are shut, and never opened, but when the enemy wants to cross the ditch under the face. There are also arches made for three pieces of cannon, over-against the ditch of the ravelin.

M. *Vauban* has found three means to shelter, as much as possible (according to his fourth maxim) the bastions against the bombs; of traverses, of the separation of the *tenaille* of the *fausse-braye*, from the body of the place, by a ditch, and of vaults under the ramparts.

To order securely places and passages for the sallies, which is M. *Vauban*'s fifth maxim, he intersects in several places the glacis of the counterscarp with narrow passages, garnished with three strong gates, *enfiled*, or enladed, with works; as *no*, Fig. 9.

To oblige the enemy to cross several ditches, M. *Vauban*, according to his sixth maxim, makes a great many out-works; and even uses dry ditches round the glacis of the counterscarp: as plainly seen in Fig. 9.

To cover well the counterscarp, which is the seventh maxim, the same excellent engineer has found three expedients: first, he makes the *covert-*

covert-way, so as to be always higher at the points than at the re-entering angles. Secondly, he makes the parapet of the counterscarp very high. Lastly, he uses traverses near the places of arms. Fig. 4.

The method how to make the angle of the bastion, or flanked angle, the best manner is to make the perpendicular to the polygon from 15 to 20 yards.

M. Blondel makes the *flanking angle* obtuse; the Count de Pagan, and Rufenstein make it right; but most of the other engineers make it more or less acute. M. Vauban causes his orillon to make with the line of defence, an angle somewhat acute; the re-entering flank, an angle a little obtuse; and that of the tenaille of the fausse-bray, a right angle.

The *line of defence*, is that which represents the course or flight of the bullet, of any sort of fire-arms, more especially of a musket-ball, from the place where the musketeer must stand to scour, and defend the face of the bastion: there is a line of defence *sichant*, and a line of defence *razant*.

The line of defence *sichant*, is drawn from the angle of the courtine, to that of the opposite bastion; without touching the face of the bastion: This must never exceed 800 feet, which is reckoned the distance at which a musket-ball will do execution.

The line of defence *razant*, is that drawn from the point of the bastion along the face, till it comes to the courtine; and shews how much of the courtine will scour or clear the face.

M. Vauban puts his first flank on a line of defence of 70 yards, and that of the fausse braye on a line of defence of 57 yards.

As the FACE is always attacked, and it is a very great advantage for the enemy to attack a line of a large front, the faces should always be small; the faces of 25 or 27 yards, as those of M. Vauban, are always in a condition to make a tolerable good counter-battery; especially when provided with a risen fausse-braye.

The FLANKS must be made large enough, and strong enough. A simple flank can never be large enough, therefore a low one must be made near it, at a reasonable distance from the high flank, and even to part it from it by a ditch.

It is also very proper, that the flank should not be every where of the same height; but it must be higher at the angles of the shoulder, always going in diminishing towards the courtine.

From these we'll pass to the out works; beginning with the *ravelins*, which must be made so strong that the cannon may be played upon it boldly.

The HORN-WORKS, or CROWN-WORKS, are very proper to fortify a suburb; which, otherwise, the besieged are forced to abandon, and destroy, when the place is attacked; for those works are not so good as redoubts of stone, to occupy and inclose a height; for they require a vast number of men to be well defended.

Before an engineer has entirely finished the body of the place, he must take a particular care to make a very good COUNTERSCARP, since it is of a very great use for the defence of a fortress. To make a very good counterscarp, the *covert-way* must be very large; room must be left to put up pallisades, at the places which are attacked; the points of the counterscarp ought to be covered with bonnets; they must be mined; there must be caponieres at the angles, to shelter the soldiers; places of arms well covered; a good conveniency to make sallies; it should be easily separated into several parts; and it would be very proper to make it in such a manner, that some pieces of cannon may be easily planted upon it. A counterscarp, with all these advantages, would not cost so much as a few out-works; though it could be capable so to fatigue an enemy, that but very little strength would be left him for the attack of the body of the place: because the counterscarp has this advantage over all the other works, that it cannot be ruined by the cannon of the enemy. Whence the three best engineers, Vauban, Rimpler, and Coeborn, have used all their best endeavours to strengthen this part of the fortification.

A RAMPART, all entirely of earth, without countermines, or arches, is good for nothing.

A PARAPET must be of earth, but very hard and tight, interwoven with twigs; it should have embrasures, also interwoven with twigs: but that interwoving ought not to be all of a piece, for fear some mischance should happen to the parapet by fire, or some ebraulement.

Where the water is from seven to eight feet above the horizon, there will be beautiful ditches, if they be made ten yards broad, and eight yards only near the body of the place, but towards the covert-way, they should remain dry, at two yards in breadth: as it may be seen Fig. 9.

There are besides these great works, some small ones, auxiliary to the construction, as the *caponieres*, *bonnets*, *small ditches of separation*, the *blous's*, and the *traverses*.

The CAPONIERES is a covered lodgment, sunk four or five feet into the ground, encampified with a little parapet about two feet high, serving to support several planks covered with earth. The *caponiere* is large enough to contain fifteen or twenty soldiers; and is usually placed in the glacis, on the extremity

extremity of the counterscarp, and in dry moats, having little embrasures or holes for the soldiers to fire through.

The *BONNET* is a kind of little ravelin, without a ditch, having a parapet three feet high; antiently placed before the point of the salient angles of the glacis; being pallisadoed round: of late also used before the angles of bastions, and the points of ravelins, and sausse brayes; in Fig. 8. *m*. The *bonnet* has two faces, from ten to fifteen, or more rods long: the parapet is made of earth, from thirty to thirty-six feet thick, and from nine to twelve feet high: it is environed with a double row of pallisadoes, ten or twelve paces distant from each other; hath a parapet three feet high, and is like a little advanced *corps de guard*.

For an example of the fundamental rules above-described, there will be found in the plate of FORTIFICATION Fig. 9. A. a design to fortify in the manner of M. Vauban; with a new ordinance of a *fausse-bray* before the face, and a particular manner of covering the ravelin.

A *CITADEL* is also a fortress, composed of all the works above-mentioned; but as they are ordered in a particular manner, we'll join here the general rules, and particularly of that ordinance, and reduce them into practice.

A *citadel* (Fig. 8.) is a fort, or place fortified with four, five, or six bastions, built sometimes in the most eminent part of a city, and sometimes only near the city. In the first case the *citadel* serves to defend the city against the enemies; in the latter it serves to command it, and to keep the inhabitants in their obedience: for which purpose the city is left *unfortified* on the part towards the *citadel*; but the *citadel* is fortified towards the city. The most usual form of a *citadel* is that of a pentagon, a square being too weak, and a hexagon too big.

The general rules for *citadels* are these: 1. The most exalted place must be chosen for a *citadel*: 2. If the city be provided with a navigable river, the *citadel* must be situated at the influxion: 3. The river disembouging into the sea, it is best to place the *citadel* at the mouth of the river: 4. In case the *citadel* could not be built on the most eminent place of the city, the eminence must be so near the *citadel*, that it may be joined to it by a line of communication, and be separated from the city: 5. The *citadel* ought to be so well fortified towards the country, that the enemy may find more difficulty to attack it on the outside, than he would have to attack it on the inside after the taking of the city: 6. There must be a large esplanade between the *citadel* and the city: 7. It must have two gates, one towards the city, and the other towards the country.

To trace such a *citadel*, there must be made first, an exact ichnography of the city and of all its fortifications; after which is drawn on a paper one part of the design of the *citadel*, whose interior polygon must have no less than 80, nor more than 90 yards. We take it afterwards, cut it all around, and put it on the ichnography of the city, turning it from side to side till we find it well placed: then we mark that design with small points, and make the whole plan, but with colours different from those of the city, that we may easily know what must be demolished of the fortrefs. Care must be taken besides, that the two last lines of the fortification of the city near the *citadel*, may not be opposite to it, but easily enfiled by it.

From this we'll pass to the *irregular fortification*, which is practised especially in three cases: 1. When a fortification is to be made in a place, which does not allow a regularity in the design. 2. When a city irregularly built, must be fortified. And 3. When old fortifications are to be corrected.

In the first case the fortification of the exterior polygon inside, is the most commodious. In the second it is best to fortify the interior polygon outwards. In the third case the body of the place must be left as it is, according to M. Vauban's custom.

Places on rivers are also fortified in a particular manner, and in this case an engineer must mind not to make too many works, nor too few. Simple lines in form of tenailles without flanks, as it is seen at *Dresden*, are not sufficient, though it be not necessary to build whole bastions on the river's side; therefore it is best to make ordinary bastions, whose polygons and faces ought to be larger, and the flanks smaller than usual; which is done in proportion to the breadth and depth of the river.

If there be a bridge over the river, a small fortification must be placed beyond, and before it; and the best for that purpose is half a regular hexagon, whose polygon must have from 50 to 70 yards. In case there should be an island in the river, before the city, the bridge must be carried upon it, and the fortification adjusted before the bridge, that it may be fired from the island, by means of batteries made on purpose.

The small flanks of such Fortification, of a city on a river, can very well be double; and in that manner it suffices, that one could put three cannons abreast, taking a particular care to place those cannons in vaults under the rampart, which razes the river horizontally.

If the river runs through the city, the fortification must be ordered in such a manner, that a bastion may touch each side of the river with its flank, and the river run through where the courtine should be;

be; and a courtine should even be made, with arches, over the river. It is also necessary to raise, out of the city, out-works on both sides of the river, which should raze it cross-ways: but in case the river should be so wide, that the out-works on both sides could not reach one another (though rivers of such a breadth seldom run through a city) a work ought to be erected in the middle of the river. At large navigable rivers it is best to inclose the principal part of the city towards the river with a rampart, and part it from the other, as a different town. In this manner the *Elbe* passes between the old and the new city of *Dresden*.

The waters of small rivers being necessary for the mills of the city, and being stopt for that purpose with dikes, such dikes are commonly made in the ditch, which are of a double use; for first, they hinder the waters, which are round the city, from running, without passing through the mills of the city; and secondly, the ditches are, thereby, always kept in good condition. It must be observed, that those dikes are to be placed at the point of the bastions, for fear the enemy should make use of it; though others are of opinion, that they are better placed before the middle of the courtine, because the reason why the enemy seldom attacks the point of the bastion, is, that he would be obliged to cover his passage with sides, which would be too difficult; but if he finds there a dike to cover himself with, he will make no difficulty to fasten himself to the point, where the musketeers cannot so well fire, as at the bottom of the face.

There is also a particular manner of fortifying places, situated on eminences.

The cities which are situated on hills, as *Mons* and *Straßbourgh*, are much exposed, because neither the houses nor the streets can be covered by the *fortifications*; though, without this inconveniency, such places are very proper to be fortified; but the *fortifications* on a mountain ought to be made very high at the bottom, and come sloping down, for fear they should be enfiled. If the lines are so long, that they must be raised at the bottom, it is best to make them by degrees, covering them with parapets and traverses.

None but small forts and citadels are built on high rocks, because of the narrowness of the space. The best method is to adapt, as much as possible, the lines of the *fortification*, to the sides and figure of the mountain; the ramparts must be made low; and as the ditches are commonly dry, the best defence must be made at the bottom. The road to the fortrefs must have from distance, in distance, retrenchments very well defended. The engineer must also take care to make all sorts of works,

whence the foot of the mountain can be beaten most, they ought to be disposed in such a manner, that those who defend them may retreat from them in safety, and annoy, without interruption, the enemy, when he has rendered himself master of them.

Against the eminences, which are near a fortrefs, there should be erected not only good ravelins on the ramparts, but those eminences themselves should also be fortified, by works capable to resist the enemy. At the highest place of the mountain is drawn a line of the height and thickness of a parapet, so that it may be enfiled by the cannon of the fortrefs. Farther towards the fortrefs, where the mountain grows lower, are erected redoubts of stone, which are open on the side of the fortrefs, and distant from one another of a musket-shot; and contrived so low that they should raze the mountain. Taking care besides, lest the enemy should cut the retreat into the fortrefs to the soldiers, who are lodged on those redoubts, or annoy them with his cannon.

The *fortification*, according to Count *Pagan's* method, supposes, in the larger *fortifications*, the external polygon *AB*, to be 100, the face *AG*, 30 perches; in the smaller, the first 80, and the second 25; and in the middle size, the first 90, and the second  $27\frac{1}{2}$ : The perpendicular *CD*, 15; and the flanks *GF*, and *HE*, perpendicular to the lines of defence *AF* and *BE*, covered with an orillon, and three-fold: to which add a ravelin and counterguard to serve for out-works. This method was received with great applause. But it has its defects; for besides that the *fortifying* of places by it, is very expensive, its triple flank is too close, so as to be exposed to the violence of the bombs; the orillon is so large as to prejudice the length of the flanks; the outer rampart of the bastion is too big, &c.

*M. Blondel's* method (See the *Plate*,) has a great affinity with that of the Count *Pagan*, only that the quantity of the angles and lines are differently determined, thus a right angle being subtracted from the angle of the polygon, and to a third part of the remainder fifteen added; the sum gives the diminished angle. In the greater *fortifications*, the outer polygon is one hundred, and the smaller eighty-five. The internal polygon being divided into ten parts, seven of them give the lines of defence, and the faces are half those of the tenaille. This method is very well calculated for the purposes of architecture, only being somewhat expensive, it is but little used.

*Scheiter*, in his method of *fortification*, supposes, the external polygon, in the larger *fortifications*, to be 100 perches; in the middle size, 90; in the lesser, 80; the flanks perpendicular to the lines of defence:

defence : and the lines of defence in the greater fortifications, 70 perches ; in the middle size, 65 ; and in the lesser, 60. It detaches bastions from the courtine, and forms a kind of inner recess behind the courtine ; it assumes the angle of the bastion in a square, to be 64 degrees ; to this adding eight, the product is the angle of the pentagon ; to which adding six degrees, the sum is the angle of the bastion in an hexagon, and adding five to this, the sum is the same angle in an heptagon.

When the general has resolved upon the places for carrying on the attacks, the engineers must go to survey the ground so accurately, as to be able to make the most advantage of it ; and to see whether there are ridges, hedges, or ditches, to run the trenches along them ; if there are any dales or hollows, to make use of them for places of arms ; to contrive the situation of the redoubts, so that they may defend the trenches, and look down into the said deeps and hollows ; and though the way be longer by those places, than if the trenches were carried along the plain ; yet it is generally safer, for taking the advantages that lie in the way.

The works made for the attacks, by means whereof we approach the place, and force it at last to surrender, are generally understood under the name of *trenches*, and consist in *places of arms*, *approaches*, *beyaux*, and *ditches of communication*, *batteries*, *lodgments*, *saps*, *galleries*. &c.

A PLACE OF ARMS, in a siege, is a spacious place covered from the enemy, by a parapet, or epaulment, where the soldiers are posted ready to sustain those at work in the trenches against the soldiers of the garrison.

APPROACHES, or *lines of approach*, are particularly used for trenches dug in the ground, and their earth thrown up on the side next the place besieged ; under shelter or defence whereof, the soldiers may approach, without loss, to the parapet of the covert-way ; and plant guns, &c. wherewith to cannonade the place. The *lines of approach* are to be connected by parallels, or lines of communication. The besieged frequently make *counter-approaches*, to interrupt and defeat the enemies *approaches*. See the PLATE.

BOYAU is a branch of the trenches, or a line, or cut, which runs from the trenches to cover some spot of ground ; being drawn parallel to the defence of the place, that it may not be enfiladed,

that is, that the shot from the town may not scour along it.

A BATTERY denotes an eminence cast up, whereon to plant artillery, that it may play to better advantage. In all *batteries*, the open faces to put the muzzles of the great guns out at, are called *embrasures*, and the distances between the *embrasures*, *merlons*. The guns are generally twelve feet distant from one another, that the parapet may be strong, and the gunners have room to work. The *battery* of a camp, is generally surrounded with a trench and palisades at the bottom ; as also with a parapet on the top, having as many holes as there are pieces of artillery, and two redoubts on the wings, or certain places of arms, capable of covering the troops, which are appointed for their defence.

There are different forts of *batteries*, viz. *sunk*, or *buried batteries*, *cross batteries*, *battery d' enfilade*, *battery en echarpe*, *battery de revers*, *battery joint*, or *par camarade*, and *battery en rouage*.

SUNK, or BURIED BATTERY, is that, whose platform is sunk or let down in the ground, with trenches cut in the earth against the muzzles of the guns, to serve for *embrasures*. This fort is generally used upon the first making approaches, to beat down the parapet of the place.

CROSS-BATTERIES, are two *batteries*, at a considerable distance from each other, which play a-thwart one another at the same time, and upon the same point, forming right angles ; where, what one bullet strikes, the other beats down.

BATTERY *d' enfilade* sweeps the whole length of a strait line, a street, &c.

BATTERY *en echarpe* plays obliquely.

BATTERY *de revers*, or *murdering battery*, is one that plays on the back of any place ; and being placed on an eminence, sees into it.

BATTERY *joint*, or *par camarade*, or *earmaretta*, is when several guns play at the same time upon one place.

BATTERY *en rouage* is that used to dismount the enemies cannon.

LODGMENT is a work cast up by the besiegers, during their approaches, in some dangerous post, which they have gained, and where it is absolutely necessary to secure themselves against the enemy's fire. *Lodgments* are made by casting up earth, or by *gabions*\*, or palisades, wool-packs,

\* *Gabions* are large baskets, made of osier twigs, woven of a cylindrical form, six feet high, and four wide ; which being filled with earth, serve as a defence, or shelter from the enemy's fire. They are commonly used in *batteries*, to screen the engineers, &c. in order to which, one is placed on either side each gun, only leaving room for the muzzle to appear through. There are also a smaller sort of *gabions*, used on parapets, trenches, &c. to cover the musqueteers ; being placed so close, as that a musket can but just peep through. They also serve as a parapet on lines, lodgments, &c. where the ground proves too hard to dig into. To render the *gabions* useless, they endeavour to set them on fire, by throwing pitched faggots among them.

fascines †, mantelets ‡, or any thing capable of covering foldiers, in the place they have gained, and are determined to keep.

There must be prepared, from the very beginning, at the tail of the trench, a place of fascines, sacks of earth, and the like, for a secure retreat against the cannon of the place, for those who cover the works, who are most cavalry; for the infantry is commanded to the approaches: hence a trench is dug, four feet deep, and which has, at the beginning, but four or six feet in width; the earth being thrown up on the side of the place. That trench is seldom made longer than 40 yards, and always made in the night; taking all the precautions imaginable to hinder it from being enfiladed, either from the place, or from the counter-approaches, the besieged could build.

Three nights and two days, are generally spent in putting batteries into good condition; and the third night the guns are planted; but if care be taken, batteries of two or three cannons may be finished in two nights and one day.

The trenches are to be carried on, and a place of arms made the sixth night.

A redoubt shall be made the seventh night, and all behind is put into a good posture.

The trenches shall be carried on the eighth night, and a great place of arms made within a hundred paces of the glacis.

The more the approaches are advanced, the deeper they must be. At the beginning they are made greater by degrees; so that having at first but four feet in width, they are made, afterwards, from eight to nine feet broad, that the cannon may be transported that way to the batteries. The places of arms must be, as much as possible, over-against one another, that they may flank one another, though traverses must be put to those places of arms, to shelter those posted in them against the bombs. The approaches must intersect one another; and every where, if practicable, there ought to be deep places, covered with trees, and earth, against the bombs; and if a ditch must be conducted directly towards the place, it is proper it should be made towards the end of the faces of the ravelin, towards the angles of the epaule of the ba-

tion, and obliquely towards the points of the ravelin; but an engineer must be very exact in tracing them.

These rules also are to be followed with regard to the *batteries*: 1. Those made to beat the place, ought not to be above 500 paces distant from it. 2. The beginning of the breach can be made at 300 paces. 3. To end the breach, batteries must be erected on the glacis, carried off from the counter-scarp. 4. Against works lined with stones, the batteries are erected perpendicularly, the shots which strike perpendicularly being, in that case, the best: but against works of earth, it is best to dispose them so, that it may be beaten with the heavy cannon perpendicularly, and on both sides, also cross-ways. 5. The parapets must be very high and thick, well interwove with hosiery, twigs, and faggots, and provided with good embrasures; and, in case of necessity there must be used gabions and wool packs: there should be always a space from 18 to 24 feet between each piece of cannon, according to their bigness; whence the place of a battery of 12 cannons, of the second rank, must have 24 yards in length. 6. The embrasures must be made from two to three feet broad on the inside, and from 10 to 12 on the outside. 7. The floor for the cannons is composed of good boards, and must be very even, that the gunner may be more sure in pointing his cannon. 8. A ditch must be made behind the batteries for the powder, the inside very well lined with boards, covered a top with cows skins, and defended with gabions, covered with earth against the bombs. There are also made behind the batteries several cross ditches, like the approaches, where the munition is distributed into several places.

When the works are advanced near the place, if there be no ridge of ground, or hollow capable of covering men, a serjeant and fifteen men only shall be posted at the head of the work, and battalions in the nearest places of arms, and behind the redoubts, which are nearest the place, to sustain the workmen in case of a sally.

If the lines drawn from the last place of arms, cannot come within four or five paces of the foot of

† *Fascines*, are small branches of trees, or bavin, bound up in bundles; which being mixed with earth, serve to fill up ditches, to screen the men, make the parapets of trenches, &c. Some of them are dipped in melted pitch or tar; and being set on fire, serve to burn the enemy's lodgments, or other works. A pitched *fascine* is a foot and a half about: a *fascine* for defence two or three feet.

‡ *Mantelets*, are a kind of moveable parapets made of planks, about three inches thick, nailed one over another, to the height almost of six feet, generally cased with tin, and set upon little wheels; so that in a siege, they may be driven before the pioneers, and serve as blinds to shelter them from the enemy's small shot. There are other sorts of *mantelets* covered on the top, whereof the miners make use to approach the wall of a town or castle.

the glacis, one, or rather two saps \* should be made toward the angle, till you are within the said distance, and from thence you must attempt to lodge yourself on the covert-way, which is generally the most difficult and bloody action of a siege; and which is done in several manners: For, some are for marching bare-faced to dislodge the enemy, when the trench is within 12 or 15 feet of the glacis, and make a lodgment on the angle at the same time. But the *English, Germans, and Dutch*, are of a contrary opinion judging it more safe to make their lodgments by saps.

In order to make the lodgments, by gaining ground without open force, the trenches must be carried on to the nearest place that may be, without exposing them to enfilade; then three or four saps must be carried on by steps, descending directly towards the angle-saliant of the *covert-way*: They are made by driving a mantelet, set on two wheels before them, or else rolling along a *jaucisse*, and placing fascines or gabions on the right, or left, as they draw near the place, and blinds at certain distances, to prevent the enemy from looking into the trenches: This work must be continued day and night, and the men being relieved from time to time, that being always fresh they may do the more work. When the sap has been carried on eight or ten fathom, lines must be drawn on the right and left, parallel to the place, and four or five fathom long, which are made small places of arms to contain some soldiers, both to sustain the head of the work, and make the necessary provisions for advancing it. When you come within a stones throw of the *covert-way*, the sap must be covered with clay, and some earth thrown at the top of them, to defend them against stones, and hand grenades: And when you come to the foot of the glacis, you must begin the *fourneaux*, which are still to be carried on descending, to avoid the counter-mines; and that having more earth upon them, they may take the more effect; and they must be carried far enough to blow up the parapet of the angle.

When the *fourneaux* are carrying on from middle lines, the other saps must be carried on as far as

may be on the glacis; and mines must also be carried on to disappoint the enemy, if you apprehend that he will make other *fourneaux*.

As soon as the *fourneaux* are ready, they must be sprung by night or day, and armed workmen shall be sent at the same time, sustained by good soldiers, to place some gabions on the part demolished by the *fourneaux*, and to fill them with earth, which may be easily done, because the blowing up will loosen it all.

As soon as the lodgment is finished, there must be saps carried on, both to go down into the *covert-way*, and to continue the lodgments on the top of the glacis. The descent into the *covert-way* must be very deep, that it may not be seen by the opposite flank, and not be opened till night-fall, at which time a traverse is to be made on each side, and the head of the lodgment on the edge of the ditch. While one part of the workmen are employed about the lodgment, the rest are to carry on the trenches along the edge of the glacis, which must be done by sap, if the enemy make a good defence; but if they make a bad one, this lodgment must be done like that of the angle, that is, with gabions filled with earth; and the empulements with chandeliers or wooden frames full of faggots to cover the workmen instead of a parapet.

If you would attack the left face of the bastion, the lodgment R shall be made a battery to dismount the guns on the opposite flank, and ruin it as much as may be. While the battery R is firing, the lodgment V is to be made to cover it, from whence the traverse X, shall be drawn and made cannon-proof. The battery shall be enclosed behind, by the line Y, and if the enemy be strong and daring, the redoubt Z shall be made to secure the batteries against sallies, and all the head of the trenches. When the battery R is finished, and secured by works, the line S shall be pushed on towards the gorge of the half moon, and descents and traverses shall be made into the *covert way* at 3 and 4, as also the line 2. If you are incommoded by the enemies traverses in the *covert-way*, they must be attacked in the rear by night, and when

\* Sap, denotes a work carried on under ground, to gain the descent of a ditch, counterscarp, or the like. It is performed by digging a deep trench, descending by steps from top to bottom under a corridor; carrying it as far as the bottom of the ditch when that is dry, or the surface of the water when wet. When the *covert-way* is well defended by musqueteers, the besiegers make their way down into it by sapping. When they are got near the foot of the glacis, the trench is carried on directly forwards; the workmen covering themselves with blinds, wool-packs, sand bags, and mantelets upon wheels. They also make empulements or traverses, on each side, to lodge a good body of men. The sap is usually made five or six fathoms from the salient angle of the glacis, where the men are only covered side ways; for which reason they lay planks over-head with hurdles, and earth above them. When they have forced the enemy to quit the *covert way*, the pioneers immediately with sand bags, wool-packs, or other fences, make a lodgment, and cover themselves as well as they can, from the fire of the opposite bastion.

they are dislodged, you may lodge yourself there, if the head of the work be not far off, or else you must raze them. See the PLATE.

The lodgments on the *covert-way* of the half-moon, which are of the same nature as those that are made on the angle that covers the point of the bastion, are to be perfected, first if you can only make one at once, or both together, provided that you have men enough to carry on both. There must be trenches along the edge of the glacis, and in the *covert-way*, to meet at the gorge with those made before the face of the bastion.

If the half moon can be battered with cannon, the parapet beaten-down, the descent into the ditch easy, and little or no water in it, then you may march boldly, and lodge yourself on it, being provided with all things necessary to make a good lodgment, and a way to go to and come from it, under *cover*. If the ditch of the place is full of water, and the enemy can have no communication with it but by boats, there will be no very great danger in attempting this sort of lodgment; but if the ditch be dry, or if the enemy have one side of the *covert-way* free to succour the half-moon, and the garrison is strong, it must be attempted with more precaution.

To pass the ditches of half-moons, when they are full of water, after you have made the descents on the edge of the water, fascines, loaded with stones, must be thrown into the ditch, till they are above water, and then earth or stones cast over both to settle them; and to prevent their being burnt, and an empalement made with earth and fascines next the place.

As soon as you are master of the half moon, you must contrive to pass the ditch of the place, in order to fix the miner to the face of the bastion; but before you attempt to pass, lodgments must be made all along the *covert-way*, both on the top of the glacis, and the edge of the ditch.

If the ditch is dry, and its counterscarp is very steep, or faced with a wall, you must begin the descent from the foot of the glacis of the *covert-way*; or further off, if the ditch be very deep; if it were but eight or ten feet deep, you might begin the descent within the *covert-way*. If the enemy be strong and bold, several descents must be made, that the lodgments may be succoured with more ease, and the men in the ditch.

The passage of the ditch being secured, all possible care must be taken to advance the mines; and to oblige the miners to work more vigorously, you must encourage them with money. It is also expedient to enhance their price according to the expedition they make in finishing the mine: as for example, if they are to have fifteen pounds for mak-

ing a good one in three or four days, promise them double, if they perform it in two.

Opinions vary as to the part of the face of the bastion, to which the miner is to be fixed: Some will have him towards the angle, because the semi-circle made in the bastion, by the effect of the mine, is not seen from the bastions of the place: others will have the mine made nearer the flank than the flanked angle, to blow up the retrenchment, if there be any.

If the opposite faces B and A are attacked, the miners will be better in the midst of the place, or rather nearer the flank to ruin entirely the face of the bastion, and the first retrenchment, and to draw the nearer to the gorge of the bastion, where is generally a second retrenchment. But if only one face of the bastion be attacked on one front of the place, the mine will be better at the angle, to prevent the effect of the mine's being laid in the view of the opposite bastion: most men desiring that the effect of the mine may be great, making a large breach in the wall, and overthrowing abundance of earth, that there may be an easy ascent to the bastion, and many men mount a-breast to make a lodgment: but as the lodgments designed on the top of the bastion seldom succeed, and when they do, they are attended with a great loss of men, it is better to make an indifferent breach only to overthrow the wall, to prevent countermines; and then begin another mine on the ruins, to be carried on into the body of the bastion, to take the intended effect.

Many inconveniences attend large breaches, if you fail to lodge yourself upon them: one is the easy descent it gives to the besieged to come down upon the lodgments you are making, or have made, either at the bottom, or half way up the breach, in order to fix the miner. Another is, that the enemy having raised a parapet on the edge of the mine, the larger it is the more it overlooks all the ruins of the said mine. Besides, it must be considered, that to the end the mine may have a great effect, it must be carried far into the earth, which often gives you an opportunity of disappointing the enemy's countermines: I would therefore make the mine in the wall, and after the effect, make a lodgment at one third of the height after this manner. Ten or twelve sturdy soldiers with shovels, shall go as privately as possible, to level the place where the lodgment is to be made, so that three or four gabions may stand on it, in a range; then four ranks of gabions, at about seven or eight feet distance from one another, shall be pushed on covered with wool-packs; and then two or three soldiers shall throw earth on them, to secure the lodgment against every thing that may be thrown from

from above. Thus four ranks of gabions covered, as heretofore described, will make three little lodgments; the middlemost shall serve for the miners, who shall presently fall to work to make a mine in the earth of the bastion; and the lodgments on the right and left, shall each of them contain four or five soldiers well armed, with head-pieces and breast-plates, musket-proof, and with javelins and pistols.

For the greater security, two lines may be made at the same time, one at the angle, and the other towards the orillon, that the second line may ruin the retranchments made within, as those in the bastion ABC, which might be ruined by the effect of the mine, were it not for fear they should be disappointed, and the enemy be in a condition to ruin the lodgment on the top of the breach.

If the retranchment be made as in the bastion C, and its ditch deep, it will be hard to be master of it, unless you lodge yourselves on the top of the bastion, after the first or second mine have taken effect. There if you think you cannot easily begin a mine at the breach of the rampart, you may carry it under the ditch of the retranchment, spring it, and by that means plant cannon at the top of the bastion, and batter the retranchment; or else make a lodgment at the edge of its ditch; then passing it, fix the miner to the retranchment. While the first mines are carrying on, it will be proper to begin other mines in such places where the effect of the first may not ruin them, so that the one may be used if the other be disappointed; or else by that means to carry on mines into the body of the bastion, and under the retranchments, if it should prove more practicable that way, than by the breach the first mines have made.

If there be a gallery in the thickness of the wall, either of the body of the place, or of the detached works, three *furneaux* shall be made at the same time, upon one and the same face, which shall only blow up the thickness of the wall as far as the gallery; and being laid open in three places, the middle may serve to fix the miner again to make a large mine, and the holes on the right and left will prevent the enemy from passing the gallery, to obstruct the work of the mine. But when the out-works are taken, and a breach made in the bastions, the town generally surrenders.

The besiegers encompass their camp, to defend it against any army that may attempt to relieve the place with lines of *circumvallation*, *countervallation*, and *communication*. A line of *circumvallation*, is a line or trench, with a parapet, which must be cannon-shot distant from the place, ordinarily about twelve feet broad, and seven deep; it is bordered with a breast-work, and flanked with

redoubts, or little forts, erected from space to space: It serves both to prevent any succour from being sent into the place, to keep in deserters, and prevent incursions of the enemy's garrison. Care must be taken that the line of *circumvallation* never passes by the foot of an eminence; lest the enemy, seizing on the eminence, lodge there his cannon, and command the line. *Countervallation*, is a counter-line, or ditch, made around a place besieged, to prevent the sallies and excursions of the garrison when it is strong. Along its edge, on the side of the place, runs a parapet, and it is flanked from space to space. It is without musket shot of the town, and sometimes goes quite round it, sometimes not, according as the general finds occasion. The army forming a siege, lies between the lines of *circumvallation*, and *countervallation*. The lines of *communication* are trenches six or seven feet deep, and twelve broad, made between one fort, or work, and another; in order for a safe passage between one quarter and another.

While a place is besieged, the besieged are employed in works for their own defence, and to oppose the besiegers. The works they do, on that occasion, are *counter-approaches*, *retranchments*, *caponieres*, *countermines*, *fougades*, &c.

COUNTER-APPROACHES are lines or trenches made by the besieged, when they come out to attack the lines of the besiegers in form. A line of *counter-approach*, is a trench which the besieged make, from their *covert-way*, to the right and left of the attacks, in order to scour or enfilade the enemy's works. It should commence in the angle of the place of arms of the half moon that is not attacked; above 50 or 60 fathom from the attacks; and continued as far as shall be found necessary, in order to see the enemy in his trenches and parallels. This line must be perfectly enfiladed from the *covert-way*, and the half-moon, that if the enemy get possession of it, it may be of no service to him. In this line the governor must frequently, in the night-time, send small parties of horse and foot, to drive the workmen from their posts; and if possible carry off the engineers, who have the direction of the work.

The CAPONIERE, or *caponniere*, is a covered lodgment, sunk four or five feet into the ground, encompassed with a little parapet two feet high, serving to support several planks covered with earth. The *caponniere* is large enough to contain fifteen or twenty soldiers; and is usually placed in the glacis, on the extremity of the counterscarp, and in dry moats; having little embrasures for the soldiers to fire through.

COUNTER-MINE is a subterraneous vault, running the whole length of a wall, three feet broad, and

and six deep, with several holes and apertures therein, contrived to prevent the effect of mines, in case the enemy should make any, to blow up the wall; but this sort of counter-mine is now little in use. The modern counter-mine is a well, or pit, and a gallery, sunk on purpose till it meets the enemy's mine, and prevent its effect; it being first pretty well known whereabouts it is.

FOUGADE, or *saucisse*, is a little mine in the manner of a well, scarce exceeding ten feet in width, and twelve in depth; dug under some work, or

post, that is like to be lost; and charged with barrels, or sacks of gunpowder, covered with earth: It is set on fire, like other mines, with a *saucisse*, i. e. a long train of powder sewed up in a roll of pitched cloth, about two inches in diameter; the length of the *saucisse* is to extend from the chamber of the mine, to the place where the engineer stands to spring the mine. There are usually two *saucisses* to every mine, that if one should fail, the other may take effect.

## F O U N D E R Y.

**F**OUNDERY (from the latin word *fundo*, I melt) is the art of melting and casting all sorts of metals; particularly brass, iron, bell-metal, &c.

For the exercising of this art in general, the workman must be provided with furnaces, moulds, presses, and other tools proper for particular branches thereof.

The branches, into which we shall divide *foundery*, shall be that of (1.) *small works*, or the art of casting in sand, which is thus performed.

The sand used for casting small works, is, at first, of a pretty soft, yellowish, and clammy nature: but it being necessary to strew charcoal dust in the mould, it at length becomes of a quite black colour. This sand is worked over and over, on a board, with a roller, and a sort of knife; being placed over a trough to receive it, after it is by these means sufficiently prepared.

This done, they take a wooden board of a length and breadth proportional to the things to be cast, and putting a ledge round it, they fill it with sand, a little moistened, to make it duly cohere. Then they take either wood or metal models of what they intend to cast, and apply them so to the mould, and press them into the sand, as to leave their impression there. Along the middle of the mould is laid half a small brass-cylinder, as the chief canal for the metal to run through when melted, into the models, or patterns; and from this chief canal are placed several others, which extend to each model or pattern placed in the frame. After this frame is finished, they take out the patterns, by first loosening them all round, that the sand may not give way.

Then they proceed to work the other half of the mould with the same patterns in just such another frame, only that it has pins, which, entering into holes that correspond to it in the other, make the two cavities of the pattern fall exactly on each.

The frame thus moulded, is carried to the melter, who, after extending the chief canal of the counterpart, and adding the cross canals to the several models in both, and strewing mill dust over them, dries them in a kind of oven for that purpose.

Both parts of the mould being dry, they are joined together by means of the pins; and to prevent their giving way, by reason of the melted metal passing through the chief cylindrical canal, they are screwed or wedged up like a kind of a press.

While the moulds are thus preparing, the metal is fusing in a crucible of a size proportionate to the quantity of metal intended to be cast.

Some of these small work founder's furnaces are like a smith's forge; others stand a few feet under ground for the more easily and safely taking out a weighty pot of metal; which is done by means of a circular pair of tongs that grasps round the top of the crucible. When the metal is melted, the workman pours it through the chief canal, of each mould, which conveys it to every distinct pattern.

When the moulds are coolish, the frames are unscrewed, or unwedged, and the cast work taken out of the sand, which sand is worked over again for other castings.

(2.) OF STATUES. The casting of statues depends on the due preparation of the pit, the core, the wax, the outer mould, the inferior furnace to melt-off the wax, and the upper to fuse the metal.

The pit is a hole dug in a dry place something deeper than the intended figure, and made according to the prominence of certain parts thereof. The inside of the pit is commonly lined with stone, or brick; or when the figure is very large, they sometimes work on the ground, and raise a proper fence to resist the impulsion of the melted metal.

The inner mould, or core, is a rude mass to which is given the intended attitude and contours.

It is raised on an iron-grate, strong enough to sustain it, and is strengthened within by several bars of iron. It is generally made either of potter's clay, mixed with hair, and horse-dung; or of plaster of paris mixed with brick-dust. The use of the core is to support the wax, the shell, and lessen the weight of the metal. The iron-bars, and the core are taken out of the brass figure through an aperture left in it for that purpose, which it foldered up afterwards. It is necessary to leave some of the iron-bars of the core, that contribute to the steadiness of the projecting part, within the brass figure.

The wax is a representation of the intended statue. If it be a piece of sculpture, the wax should be all of the sculpture's own hand, who usually forms it on the core; though it may be wrought separately in cavities, moulded on a model, and afterwards aranged on the ribs of iron over the grate; filling the vacant space in the middle with liquid plaster and brick-dust, whereby the inner core is proportioned as the sculpture carries on the wax.

When the wax, which is the intended thickness of the metal, is finished, they fill small waxen tubes perpendicular to it from top to bottom, to serve both as canals for the conveyance of the metal to all parts of the work; and as vent-holes, to give passage to the air, which would otherwise occasion great disorder, when the hot metal came to encompass it.

The work being brought thus far, must be covered with its shell, which is a kind of crust laid over the wax, and which being of a soft matter, easily receives the impression of every part, which is afterwards communicated to the metal upon its taking the place of the wax, between the shell and the mould. The matter of this outer mould is varied according as different layers are applied. The first is generally a composition of clay, and old white crucibles well ground and sifted, and mixed up with water, to the consistence of a colour fit for painting: accordingly they apply it with a pencil, laying it seven or eight times over, and letting it dry between whites. For the second impression, they add horse-dung, and natural earth to the former composition. The third impression is only horse-dung and earth. Lastly, the shell is finished by laying on several more impressions of this last matter, made very thick with the hand.

The shell, thus finished, is secured by several iron-girts, bound round it, at a about half a foot distance from each other, and fastened at the bottom to the grate under the statue, and at top to a circle of iron where they all terminate.

If the statue be so big that it would not be easy to move the moulds with safety, they must be

wrought on the spot where it is to be cast. This is performed two ways; in the first a square hole is dug under ground, much bigger than the mould to be made therein, and its inside lined with walls of free-stone, or brick. At the bottom is made a hole of the same materials with a kind of furnace, having its aperture outwards: in this is a fire made to dry the mould, and afterwards melt the wax. Over this furnace is placed the grate, and upon this the mould, &c. formed as above. Lastly, at one of the edges of the square pit, is made another large furnace to melt the metal. In the other way, it is sufficient to work the mould above ground, but with the like precaution of a furnace and grate underneath. When finished, four walls are to be run around it, and by the side thereof a massive made for a melting furnace. For the rest, the method is the same in both. The mould being finished, and inclosed as described, whether underground or above it, a moderate fire is lighted in the furnace under it, and the whole covered with planks, that the wax may melt gently down, and run out at pipes contrived for that purpose; at the foot of the mould, which are afterwards exactly closed with earth, so soon as the wax is carried off. This done, the hole is filled up with bricks thrown in at random, and the fire in the furnace augmented, till such time as both the bricks and mould become red hot. After this, the fire being extinguished, and every thing cold again, they take out the bricks and fill up their place with earth, moistened, and a little beaten to the top of the mould, in order to make it the more firm and steady. These preparatory measures being duly taken, there remains nothing but to melt the metal, and run it into the mould. This is the office of the furnace above described, which is commonly made in the form of an oven with three apertures, one to put in the wood, another for a vent, and a third to run the metal out at. From this last aperture, which is kept very close, while the metal is in fusion, a small tube is laid, whereby the melted metal is conveyed into a large earthen basin, over the mould, into the bottom of which all the big branches of the jets, or casts, which are to convey the metal into all the parts of the mould, are inserted.

These casts, or jets, are all terminated with a kind of plugs, which are kept close, that, upon opening the furnace, the brass, which gushes out with violence, may not enter any of them, till the basin be full enough of matter to run into them all at once. Upon which occasion, they pull out the plugs, which are long iron-rods with a head at one end, capable of filling the whole diameter of each tube. The whole of the furnace is opened with

with a long piece of iron fitted at the end of each pole, and the mould filled in an instant. This completes the work in relation to the casting part; the rest being the sculptor's or carver's business, who taking the figure out of the mould and earth, wherewith it is encompassed, saws off the jets with which it appears covered over, and repairs it with chissels, gravers, puncheons, &c.

(3) **FOUNDRY OF BELLS.** The metal, it is to be observed, is different for bells, from what it is for statues; there being no tin in the statue metal: but there is a fifth, and sometimes more, in the bell-metal.

The dimensions of the core, and the wax, for bells, if a ring of bells especially, are not left to chance, but must be measured on a scale, or diapason, which gives the height, aperture, and thickness necessary for the several tones required.

It is on the wax that the several mouldings and other ornaments are formed to be represented in relief, on the outside of the bell.

The business of bell-foundry is reduced to three particulars. 1. The proportion of a bell. 2. The forming of the mould; and, 3. The melting of the metal.

The proportions of our bells differ much from those of the *Chinese*: in ours the modern proportions are to make the diameter fifteen times the thickness of the brim, and twelve times the height.

There are two kinds of preparations, *viz.* the simple and the relative: the former are those proportions only that are between the several parts of a bell, to render it sonorous; the relative proportions establish a requisite harmony between several bells.

The particulars necessary for making the mould of a bell, are, 1. The earth: the most cohesive is the best: it must be well ground and sifted, to prevent any chinks. 2. Brick-stone; which must be used for the mine, mould, or core, and for the furnace. 3. Horse-dung, hair, and hemp, mixed with the earth, to render the cement more binding. 4. The wax for inscriptions, coats of arms, &c. 5. The tallow equally mixed with the wax, in order to put a slight lay of it upon the outer mould, before any letters are applied to it. 6. The coals to dry the mould.

For making the mould, they have a scaffold consisting of four boards, ranged upon tressels. Upon this, they carry the earth, grossly diluted, to mix it with horse-dung, beating the whole with a large spatula.

The compasses of construction is the chief instrument for making the mould, which consist of

two different legs, joined by a third piece. And last of all, the founders shelve, on which are the engravings of the letters, cartridges, coats of arms, &c.

They first dig a hole, of a sufficient depth to contain the mould of the bell, together with the case, or cannon, under ground; and about six inches lower than the terreplain, where the work is performed. The hole must be wide enough for a free passage between the mould and walls of the hole; or between one mould and another, when several bells are to be cast. At the center of the hole is a stake erected, that is strongly fastened in the ground. This supports an iron-peg, on which the pivot of the second branch of the compasses turns. The stake is encompassed with a solid brick-work, perfectly round, about half a foot high, and of the proposed bell's diameter. This they call a mill-stone. The parts of the mould are the core, the model of the bell, and the shell. When the outer surface of the core is formed, they begin to raise the core, which is made of bricks that are laid in courses of equal height upon a lay of plain earth. At the laying each brick, they bring near it the branch of the compasses, on which the curve of the core is shaped, so as that there may remain between it and the curve the distance of a line, to be afterwards filled up with layers of cement. The work is continued to the top, only leaving an opening for the coals to bake the core. This work is covered with a layer of cement, made of earth and horse-dung, on which they move the compasses of construction, to make it of an even smoothness every where.

The first layer being finished, they put the fire to the core, by filling it half with coals, through an opening that is kept shut, during the baking, with a cake of earth, that has been separately baked. The first fire consumes the stake, and the fire is left in the core half, or, sometimes, a whole day: the first layer being thoroughly dry, they cover it with a second, third, and fourth; each being smoothed by the board of the compasses, and thoroughly dried before they proceed to another.

The core being completed, they take the compasses to pieces, with intent to cut off the thickness of the model, and the compasses are immediately put in their place, to begin a second piece of the mould. It consists of a mixture of earth and hair, applied with the hand on the core, in several cakes that close together. This work is finished by several layers of a thinner cement of the same matter, smoothed by the compasses, and thoroughly dried, before another is laid on. The first layer of the model is a mixture of wax and greafe spread over

over the whole. After which are applied the inscriptions, coat of arms, &c. besmeared with a pencil dipped in a vessel of wax in a chaffing-dish: this is done for every letter. Before the shell is begun, the compasses are taken to pieces, to cut off all the wood that fills the place of the thickness to be given to the shell.

The first layer is the same earth with the rest, sifted very fine; whilst it is tempering in water, it is mixed with cow's hair, to make it cohere. The whole being a thin cullis, is gently poured on the model, that fills exactly all the sinuosities of the figures, &c. and this is repeated till the whole is two lines thick over the model. When this layer is thoroughly dried, they cover it with a second of the same matter, but something thicker: when this second layer becomes of some consistence, they apply the compasses again, and light a fire in the core, so as to melt off the wax of the inscriptions, &c.

After this, they go on with other layers of the shell, by means of the compasses. Here they add to the cow's hair a quantity of hemp, spread upon the layers, and afterwards smoothed by the board of the compasses. The thickness of the shell comes to four or five inches lower than the mill-stone before observed, and surrounds it quite close, which prevents the extravasation of the metal. The wax should be taken out before the melting of the metal.

The ear of the bell requires a separate work, which is done during the drying of the several incrustations of the cement. It has seven rings, the seventh is called the bridge, and unites the others, being a perpendicular support to strengthen the curves. It has an aperture at the top, to admit a large iron-peg, bent at the bottom; and this is introduced into two holes in the beam, fastened with two strong iron-keys. There are models made of the rings, with masses of beaten earth, that are dried in the fire, in order to have the hollow of them. These rings are gently pressed upon a layer of earth and cow's hair, one half of its depth; and then taken out, without breaking the mould. This operation is repeated twelve times for twelve half-moulds, that two and two united may make the hollows of the six rings: the same they do for the hollow of the bridge, and bake them all, to unite them together.

Upon the open place left for the coals to be put in, are placed the rings that constitute the ear. They first put into this open place the iron-ring to support the clapper of the bell; then they make a round cake of clay, to fill up the diameter of the thickness of the core. This cake after baking, is clapped upon the opening, and soldered with a thin

mortar spread over it, which binds the cover close to the core.

The hollow of the model is filled with an earth, sufficiently moist, to fix on the place, which is strewed, at several times, upon the cover of the core; and they beat it gently with a pestle, to a proper height; and a workman smooths the earth at top with a wooden trowel dipped in water.

Upon this cover, to be taken off afterwards, they assemble the hollows of the rings. When every thing is in its proper place, they strengthen the outsides of the hollows with mortar, in order to bind them with the bridge, and keep them steady at the bottom, by means of a cake of the same mortar, which fills up the whole aperture of the shell. This they let dry, that it may be removed without breaking. To make room for the metal they pull off the hollows of the rings, through which the metal is to pass, before it enters into the vacuity of the mould. The shell being unloaded of its ear, they range under the mill-stone five or six pieces of wood, about two feet long, and thick enough to reach almost the lower part of the shell; between these and the mould they drive in wooden wedges with a mallet, to shake the shell of the model whereon it rests, so as to be pulled up, and got out of the pit.

When this and the wax are removed, they break the model and the layer of earth, through which the metal must run, from the hollow of the rings, between the shell and the core. They smoke the inside of the shell, by burning straw under it, that helps to smooth the surface of the bell. Then they put the shell in the place, so as to leave the same interval between that and the core; and before the hollows of the rings or the cap are put on again, they add two vents, that are united to the rings, and to each other, by a mass of baked cement. After which they put on this mass of the cap, the rings, and the vent, over the shell, and solder it with thin cement, which is dried gradually by covering it with burning coals. Then they fill up the pit with earth; beating it strongly all the time, round the mould.

The furnace has a place for the fire, and another for the metal. The fire-place has a large chimney with a spacious ash-hole. The furnace which contains the metal, is vaulted, whose bottom is made of earth rammed down; the rest is built with brick. It has four apertures; the first, through which the flame reverberates; the second is closed with a stopple that is opened for the metal to run; the others are to separate the dross, or scoriae, of the metal by wooden rakes: through these last apertures passes the thick smoke. The ground of the furnace is built sloping, for the metal to run down.

(4.) *FOUNDRY of great guns and mortar-pieces.* The method of casting these pieces is little different from that of bells: they are run maffly, without any core, being determined by the hollow of the shell; and they are afterwards bored with a steel trepan, that is worked either by horses, or a water-mill.

The *metal* of which *cannons* are composed, is either iron, or which is more usual, a mixture of copper, tin, and brafs; the tin being added to the copper, to make the metal more dense and compact; so that the better and heavier the copper is, the less tin is required. Some to an hundred pounds of copper add ten of tin, and eight of brafs; others ten of tin, five of brafs, and ten of lead. The *fiour Bereau* pretends, that when old pieces of metal are used, the founder ought to add to one hundred weight of that metal, twenty-five pounds of good copper, and five pounds of tin. *Braudius* describes a method of making cannon of leather: and it is certain the *Swedes* made use of such in the long war of the last century; but these burst too easily to have much effect.

A *cannon* consists of *several members*, the principal of which are as follows, *viz.* The uppermost part round about the piece is the *superficies* of the metal; the substance or whole mass of metal is called the *body* of the cannon; the hollowness is called the *concave cylinder*, or *soul*, the whole length is the *chase*; that part of the bore, which contains the powder and shot, is the *chamber*, or charged cylinder; the remainder is the *vacant cylinder*; the spindles or ears are called *trunnions*, and the space between them the *gravity of her center*; the pumel at her coyl is called the *casabel*, or *deck*; the little hole, the *touch-hole*; the metal behind the touch-hole is called the *breech*, or *coyl*; the greatest ring at the touch-hole, her *base ring*; the next ring, or circle, is the *reinforced ring*; the next to this, the *trunnion ring*; and the foremost circle is the *muzzle ring*; the ring between the trunnions and muzzle ring is called the *cornish ring*; and all the rings, circles, and eminences at her muzzle, are called the *frize*.

*Cannons* are distinguished by the diameters of the balls they carry. The rule for their length is, that it be such as that the whole charge of powder be on fire, before the ball quit the piece. If it be too long, the quantity of air to be drawn out before the ball, will give too much resistance to the impulse; and that impulse ceasing, the friction of the ball against the surface of the piece, will take off from the motion.

In former days, cannon were made much longer than they are now; but experience has taught us, that a ball moves with a greater impetus thro' a less space than a greater: and accordingly it is found, that an iron ball of 48 pound weight, goes farther from a short cannon, than another ball of 96 pound out of a longer piece; whereas, in other respects, it is certain, the larger the bore and ball, the greater the range. It is found too, by experience, that of two cannons of equal bore, but different lengths, the longer requires a greater charge of powder than the shorter. But the ordinary charge of a cannon is, for the weight of its gunpowder to be half that of its ball.

A table exhibiting the names of the several cannon, their length, their weight, and that of their ball, as they obtain among us.

Names of cannon.	wt of weight		length of the cannon.
	an iron ball.	of the cannon.	
	lb. oz.	lb.	ft inch.
Cannon royal	48 0	8000	12 0
Demi-cannon large	36 0	6000	12 0
Demi-cannon ordinary	32 0	5600	12 0
Demi cannon least	30 0	5400	11 0
Culverin largest	20 0	4800	12 0
Culverin ordinary	17 5	4500	12 0
Culverin least	15 0	4000	11 0
Demi-culverin ordinary	10 11	2700	11 0
Demi-culverin least	9 0	2000	10 0
Saker ordinary	6 0	1500	10 0
Saker least	4 12	1400	8 0
Minion largest	3 12	1000	8 0
Minion ordinary	3 4	800	7 0
Falcon	2 8	750	6 0
Falconet	1 5	400	5 6
Rabinet	0 8	300	5 6
Base	0 5	200	4 6

*Cannon* are likewise distinguished according to the diameter of their mouth, or *calibre*. This calibre is divided into thirty-six parts, in order to determine by these parts the dimensions of the different moulds for cannon.

An account of the dimensions of the several parts of cannon of five different calibres, as they are regulated by an order of the king of *France*, on *Oct. 7, 1732*, in the following table.

Pieces of cannon	of 24			of 16			of 12			of 8			of 4		
	feet.	inches.	lines.	feet.	inches.	lines.									
Length of the bore	9	6		9	2		8	8		7	10		6	6	
Depth of the chamber	2	6		1	10										
Thicknefs of metal at breech	5	5		4	9		4	4		3	9		3		
Length of the cascabel	10	11		9	6		8	8		7	7		6		
Diameter of the trunnions	5	5		4	9		4	4		3	10		3		
Projection of the trunnions	5	5		4	9		4	4		3	10		3		
Calibre of the piece	5	8		4	11		4	6		3	11		3	2	
Diameter of the ball	5	6		4	9		4	4		3	9		3		
Length of the whole piece	11			10	6		10			8	10		7	3	
Weight of the piece	5400			4200			3200			2100			1150 lb.		

LETTER-FOUNDERY, or *casting of printing letters*. The first thing requisite is to prepare good steel-punches, on the face of which is drawn the exact shape of the letter with pen and ink, if the letter be large, or with a smooth blunted point of a needle, if small; and then, with proper gravers, the cutter digs deep between the strokes, letting the marks stand on the punch; the work of hollowing being generally regulated by the depth of the counter punch: then he files the outside, till it is fit for the matrix.

They have a mould to justify the matrices by, which consists of an upper and under part, both which are alike, except the stool and spring behind, and a small roundish wire in the upper part, for making the nick in the shank of the letter. These two parts are exactly fitted into each other, being a male and female gage, to slide backwards and forwards.

Then they justify the mould, by casting about twenty samples of letters, which are set in a composing stick, with the nicks towards the right hand; and comparing these every way with the pattern-letters, set up in the same manner, they find the exact measure of the body to be cast.

Next they prepare the matrix, which is of brass or copper, an inch and a half long, and of a proportionable thickness to the size of the letter it is to contain. In this metal is sunk the face of the letter, by striking the letter-punch the depth of an *n*. After this, the sides and face of the matrix are justified and cleared, with files, of all bunchings that have been made by sinking the punch.

Then it is brought to the furnace, which is built upright of brick with four square sides, and a stone at top, in which is a hole for the pan to stand in. They have several of these furnaces.

Printing letters are made of lead, hardened with iron or stub-nails. To make the iron run, they mingle an equal weight of antimony, beaten small in an iron mortar, and stub-nails together. They charge a proper number of earthen pots, that bear the fire, with the two ingredients, as full as they can hold, and melt it in an open furnace built for that purpose.

When it bubbles, the iron is then melted, but it evaporates very much. This melted compost is ladled into an iron pot, wherein is melted lead, that is fixed on a furnace close to the former, 3 lb. of melted iron to 25 lb. of lead; this they incorporate according to art.

The caster taking the pan off the stone, and having kindled a good fire, he sets the pan in again, and metal in it to melt. If it be a small-bodied letter, or a thin letter with great bodies, that he intends to cast, his metal must be very hot, and sometimes red hot, to make the letter come. Then taking a ladle, of which he has several sorts, that will hold as much as will make the letter and break, he lays it at the hole where the flame bursts out; then he ties a thin leather, cut with its narrow end against the face, to the leather groove of the matrix, by whipping a brown thread twice about the leather groove, and fastening the thread with a knot. Then he puts both pieces of the mould together, and the

matrix into the matrix-check ; and places the foot of the matrix on the stool of the mould, and the broad end of the leather on the wood of the upper half of the mould, but not tight up, lest it hinder the foot of the matrix from sinking close down upon the stool, in a train of work. Afterwards laying a little rosin on the upper part of the mould, and having his casting ladle hot, he, with the boiling side, melts the rosin and presses the broad end of the leather hard down on the wood, and so fastens it thereto.

Now he comes to casting, when placing the under half of the mould in his left hand, with the hook or jag forward, he holds the ends of its wood between the lower part of the ball of his thumb and his three hinder fingers ; then he lays the upper half of the mould upon the under half, so as the male gages may fall into the female ; and, at the same time, the foot of the matrix places itself upon the stool, and clasping his left hand thumb strongly over the upper half, he nimbly catches hold of the boy or spring, with his right hand fingers at the top of it, and his thumb under it, and places the point of it against the middle of the notch in the backside of the matrix, pressing it forwards, as well towards the mould, as downwards, by the shoulder of the notch, close upon the stool, while at the same time with his hinder fingers, as aforesaid, he draws the under half of the mould towards the ball of his thumb, and thrusts, by the ball of his thumb, the upper part towards his fingers, that both the registers of the mould may pass against both sides of the matrix, and his thumb and fingers press both sides of the mould close together.

Then he takes the handle of his ladle in his right hand, and with the ball of it gives two or three strokes outwards upon the surface of the melted metal, to clear it of the scum ; then he takes up the ladle full, and having the mould in the left hand, turns his left side a little from the furnace, and brings the beak of his ladle to the mouth of the mould ; and turns the upper part of his right hand towards him, to pour the metal into it, while, at the same instant, he puts the mould in his left hand forwards, to receive the metal with a strong shake, not only into the bodies of the mould, but, while the metal is yet hot, into the very face of the matrix, to receive its perfect form there, as well as in the flank. Then he takes the upper half of the mould off, by placing his right thumb on the end of the wood next his left thumb, and his two middle fingers at the other end of the wood : he tosses the letter, break and all, out upon a sheet of waste paper, laid on a bench, a little beyond his left hand ; and then is ready to cast another letter, as before, and likewise the whole number in that matrix.

Then boys, commonly employed for this pur-

pose, separate the breaks from the shanks, and rub them on a stone, and afterwards a man fixes them in a wooden frame and cuts them all of an even height with a carpenter's plane, which finishes the fount. A workman will ordinarily cast 3000 of these letters in a day.

The perfection of letters thus cast, consists in their being all severally square and strait on every side ; and all generally of the same height, and evenly lined, without slooping one way or other ; neither too big in the foot, nor the head ; well grooved, so as the two extremes of the foot contain half the body of the letter ; and well ground, barbed, and scraped, with a sensible notch, &c.

A set or quantity of letters, and all the appendages belonging thereto, as numeral characters, quadrats, points, &c. cast by a letter-founder, and sorted, is called a *Fount*. Founts are large or small, according to the demand of the printer, who orders them by the hundred weight, or by sheets. When a printer orders a fount of five hundred, he means that the fount, consisting of letters, points, spaces, quadrats, &c. shall weigh 500 lb. When he demands a fount of ten sheets, it is understood, that with that fount he shall be able to compose ten sheets, or twenty forms, without being obliged to distribute. The founder takes his measures accordingly ; he reckons 120 lb. for a sheet, including the quadrats, &c. or 60 lb. for a form, which is only half a sheet : not that the sheet always weighs 120 lb. or the form 60 lb. on the contrary, it varies according to the size of the form ; besides, it is always supposed that there are letters left in the cases. As therefore every sheet does not comprehend the same number of letters, nor the same sort of letters, we must observe, that, as in every language some sounds recur more frequently than others, some letters will be in much more use, and oftener repeated than others : and consequently their cells or cases should be better stored than those of the letters, which do not recur so frequently : thus, a fount does not contain an equal number of *a* and *b*, or of *b* and *c*, &c. the letter-founders have therefore a list or tariff, or, as the *French* call it, a *police*, by which they regulate the proportions between the different sorts of characters that compose a fount ; and it is evident that this tariff will vary in different languages, but will remain the same for all sorts of characters employed in the same language.

The art of casting *statues* in brass is very antient ; inasmuch that its origin was too remote and obscure, even for the research of *Pliny*, an author admirably skilled in discovering the authors of other arts. All we can learn for certain, is, that it was practised in all its perfection, first, among the *Greeks*, and afterwards, among the *Romans* ; and that the number of statues.

statues consecrated to the gods and heroes surpassed all belief. The single cities of *Athens*, *Delfos*, *Rhodes*, &c. had each 3000 statues; and *Marcus Scaurus*, tho' only *Ædile*, adorned the *Circus* with no less than three thousand statues of brass, for the time of the *Circensian* games. This taste for statues was carried to such a pitch, that it became a proverb, that in *Rome* the people of brass were not less numerous than the *Roman* people. Among us the casting of statues was but little known or practised before the seventeenth century.

We find mention made of *bells* in the poets, *Ovid*, *Tibullus*, *Martial*, *Statius*, *Manilius* and the *Greek* authors, under the appellations of *tintinnabula*, and *sounding brass* *Sustonius*, *Dion*, *Strabo*, *Polybius*, *Josaphus*, and others, mention them under the names of *Petasus*, *Tintinnabulum*, *Æraumentum*, *Crotalum*, *Signum*, &c. but these appear to have been no more than baubles, and little like the large bells in use among us. *Hieronymus Magius*, who

has a treatise expressly on *bells* (wrote, when in chains in *Turkey*, and which is accounted very remarkable, purely from his memory without the assistance of any books) makes large *bells* a modern invention. Indeed we do not hear of any before the sixth century: in 610, we are told, *Lupus* bishop of *Orleans*, being at *Sens*, then besieged by the army of *Clotharius*, freighten'd away the besiegers, by ringing the bells of *St. Stephen*. The first large bells in *England* are mentioned by *Bede*, towards the latter end of that century. They seem to have been pretty common in the year 816.

All authors agree, that the first cannon were cast in the fourteenth century; tho' some fix the event to the year 1338, and others to 1380.

Letter-founding was invented by *FAUST*, a *German*, about the year 1450, who was the first printer and founder of separate metal types, in the manner now practised.

## F O W L I N G .

**F**OWLING is the art of catching birds, which is done either by *hawks* or other birds of prey trained up for the game; and then is called *Falconry*, already treated of: or by nets, bird-lime, decoys, and by other devices, which moderns practise; and also how to feed birds. All which shall be the subject of this treatise.

The *Fowler* must provide himself with such implements, as the branch of his art or game requires.

—For SMALL BIRDS, with *bird-lime*, *nets*, and *decoys*.

The *nets* must be proportioned in the size of their meshes to the bigness of the birds sought after: made of the best packthread, about two fathom deep, and six long; verged on each side with strong cord, and extended at each end with poles made on purpose.

The *bird-lime* is a viscid preparation from *holly-bark*; made after this manner. Boil this bark ten or twelve hours, then separate the green coat thereof from the other part, and place it cover'd in a moist place for a fortnight: then pound it into a tough paste, so as no fibres of the wood be left; and wash it in running water till no moats appear: then after it has fermented four or five days more, and skimmed as often as needful, it will be fit for use.

To make the *bird-lime* bear water, a pound of it must be washed in spring-water, till made very pliable; and beaten afterwards, till no water is perceived in it; and after it has been well dried, it is put in an earthen pot, mix'd with as much capon's

grease as will make it run; to which are added, two spoonfuls of strong vinegar, a spoonful of the best salad oil, and a small quantity of turpentine; those ingredients must be increased, or diminished, in proportion to the quantity of *bird-lime*. Being thus mixed together, they must be boiled gently over a slow fire, stirring them continually: then they are taken off the fire and left to cool. This sort of *bird-lime* is the best, especially for *snipes* and *feldfares*.

*Decoys* are pipes, whistles, and calls.

For BIRDS of a LARGER SIZE, fit for food, we must provide not only *nets*, but *decoys* of another sort, *fowling-pieces*, and *dogs* properly trained for the game.

The *nets* must be made stronger and larger, both in the meshes and in their length and breadth, according to the species of birds to be sought.

The *decoys* are either a place made to trap pigeons, or other wild fowl; or, a bird (for example, a *duck*) trained to deceive its own species. Thus a *decoy duck* is one that flies abroad, and lights into a company of wild ones, and being become acquainted with them, by her allurements draws them into the *decoy* place, where they become a prey.

Of *fowling-pieces*, those are reputed the best, which have the longest barrel, viz. from 5½, to 6 feet; with an indifferent bore under the *harquebus*; tho' for different occasions they should be of different sorts and sizes; but it is essential, the barrel be well polished and smooth within, and

the

the bore of a bigness from end to end; which may be proved by thrusting in a piece of wood, cut exactly to the bore of the muzzle, down to the touch-hole.

The powder must not be too old, for keeping weakens it much, especially if it grows damp.

The *dogs* used in this art are of two sorts; such as are trained up for the *water*, and such as are taught to hunt *partridges* and other land birds.

The dog trained for *water-fowling*, is to be well proportioned in his body, and must be well broke to the sport. His hairs must be long, curled, neither loose nor shagged; his head round and curled, his ears broad and hanging, his eye full, lively and quick, his nose very short, his lip hound-like, his chops furnished with a full set of strong teeth, his neck thick and short, his breast sharp, his shoulders broad, his fore-legs strait, his chin square, his buttocks round, his belly gaunt, his thighs brawny, &c.

For the *training* such a dog; as soon as he can lap, he must be taught to lie down, not daring to stir from that posture without leave, neither is he permitted to eat any thing till he deserves it; nor allowed more teachers, feeders, and cherishers than one. That teacher must never alter the word he first used in his lessons; for the *dog* takes notice of the sound, not of the language. When he is acquainted with the word suitable to his lesson, he must next be taught the word of reprehension; which at first should not be used without a jerk. He must also be used to cherishing words, which gives him encouragement when he does well; and which ought to be always the same, and attended with spitting in his mouth, stroking him with the hand under the belly, &c. There is also a word of advice to instruct him when he does amiss.

When the dog understands well these several words, he must be taught next to lead orderly in a string or collar, neither running too forward, nor hanging backward. This instruction is followed by that of coming close at his master's heels, without leading; for he must not range, unless it be to beat the fowl from their covert, or to fetch the wounded.

His next lesson must be to fetch and carry any thing his master throws to him out of his hands. He must be tried first with the glove, shaking it over his head, and making him snap at it; and sometimes suffering him to hold it in his mouth, and striving to pull it from him; and at last throwing it a little way, and letting him worry it on the ground; and so by degrees making him bring it wherever it is thrown. From the glove he must be taught to fetch cudgels, bags, nets, &c. It will not be amiss to use him to carry dead fowls; for by that means he will never tear or bruise what fowl is shot.

The last lesson which must be given, is to drop something which the dog does not see; and being gone a little way from it, send him back to seek it, by saying, *Back, I have lost*. If he appears amazed, he must be urged to seek out till he has found it. Then something must be dropped at a greater distance, and he made to find out that too; till he is brought to go back a mile.

To train him for the gun, he must be made to stalk after the fowler step by step, or else couch and close till he has shot.

The last use of the *water dog* is in moulting-time, when wild fowls cast their feathers and are unable to fly; which is towards the latter end of the summer. At this time the dog must be brought to their coverts, and hunt them out into the stream; and there they will be taken in the nets.

The *setting dog* to hunt *partridges*, &c. is a big *land spaniel*, taught by nature to hunt the *partridge* more than any chace whatever, running the fields over with such alacrity and nimbleness, as if there was no limit to his fury and desire, and yet by art under such excellent command, that in the very height of his career, by a *hem*, or sound of his master's voice, he shall stand, gaze about him, look in his master's face, and observe his directions, whether to proceed, stand still, or retire: nay, when he is even just upon his prey, that he may even take it up with his mouth, yet his obedience is so formed by art, that presently he shall either stand still, or fall down flat on his belly, without daring either to make any noise or motion, till his master comes to him, and then he will proceed in all things to follow his directions.

To train a dog from a whelp till he comes to that perfection, you must choose him a *land spaniel*, of a good and nimble size, rather small than great, and of a courageous mettle, and tho' these good qualities cannot be discerned while young; yet they may be justly guessed at, from a right breed, which have been known to be strong, lusty, and nimble rangers, of active feet, wanton tails and busy nostrils,—whose tail was without weariness, their search without changeableness, and which no delight did transport beyond fear and obedience.

When the fowler has made choice of his dog, he begins to instruct him, while about four or six months old; first by making him loving and familiar with his master, to know him from any other person, and following him wherever he goes: which the better to effect, he must very seldom receive his food from any other hand but his; and when he corrects him, to keep him in awe, he must rather do it with words than blows. A dog thus instructed will follow none but his master, and can distinguish his frown from his smile, and smooth

words from rough. Then he must teach him to lie down close to the ground; first, by laying him often on the ground, and crying, *lie close*: when he has done any thing to his master's mind and pleasure, he must be rewarded with a piece of bread; if otherwise, chastized with words, but few blows. After this, he must be taught to come creeping with his belly and head close on the ground, as far, or as little a way as his master shall think fit; and this the master may do by saying, *come nearer, come nearer*, or the like; and at first, till he understands his meaning, shewing him a piece of bread, or some other food, to entice him. If he offers to raise his body or head, the part thus raised must not only be thrust down, but he must likewise be threatened with an angry voice; which if he seems to slight, two or three jerks, with a whipcord-lash, must be added to the voice. These lessons must be often repeated, till he be very perfect, still encouraging him when he does well. If the fowler walks abroad with his dog, and he takes a fancy to range, even when he is most busy, he must speak to him, and in the height of his pastime made fall upon his belly, and lie close; and afterwards, come creeping. The next which must be given him, is to lead in a string or line, and to follow his master close at his heels, without trouble or straining of his collar. By the time the dog has learned all these lessons, he must be near twelve months old; at which time, the season of the year being proper, he must be taken into the field and permitted to range, but still in obedience to his master's command.

Being brought to good temper, and right obedience; as soon as he comes upon the haunt of any partridge, (which is discover'd at his greater eagerness in hunting, as also at a kind of whimpering and whining in his voice, being very desirous to open, but not daring) his master shall speak to him, bidding him take heed, and the like: but if, notwithstanding, he either rushes in, and springs the partridge, or opens, and so the partridge escapes, he must be corrected severely, cast off again, and made to hunt in some haunts where the fowler knows a covey lies, and sees whether he has mended his fault: and if any partridge be catch'd with the net, the dog must have the head, neck, and pinions, for his future encouragement.

The implements for fowling thus provided, it is necessary to divide the winged game into proper classes; as, *water fowls*, and *land fowls*.

The *water fowls* are so called from their natural delight in a d about water, for their habitation and subsistence in and from that element. This kind of *fowls* are naturally the subtilst, and wisest of all birds, and most careful of their own safety: hence they have been compared to a camp, having scouts

at land afar off, guards, centinels, and all sorts of other watchful officers, surrounding the body, to give an alarm, on any approach or seeming danger. They always fly in company, so that when a single fowl, or a couple fly together, they must have been separated from the rest, either by the approach of men, or the beating of some birds of prey on the river. But though thus separated, they seldom leave wing till they meet together again.

There are two sorts of *water fowls*, viz. those that live of the water, and those that live on the water. The one take their food from the water, by wading and diving for it with their long legs, and without swimming thereon; the others are web-foot, and swim, as the swan, goose, mallard, &c.

The large *water fowls*, or those which divide the foot, frequent most commonly the edge of shallow rivers, brooks, and flashes of water; and never fly in company, but are to be found, here one, there a couple, and the like; which renders it difficult to take them by decoys, nets, or any other implement of that kind. They delight likewise in low and boggy places, dry parts of drown'd fens, overgrown with tall and long rushes, reeds, and hedges; half drown'd moors, or the hollow vales of downs, heaths, or plains, where there is shelter either of hedges, hills, tufts of bushes or trees, where they may lurk obscurely.

To catch them with *nets*, the fowler must know where they feed in the morning and evening; and coming to the place, two hours at least before that time, spreads his *net* smooth and flat upon the ground, staking the two lower ends firm thereon, and leaving the upper ones extended upon the long cord, the further end whereof must be staked fast down to the earth, two or three fathom from the *net*, and the stakes which stake down the cord, stand in a direct and even line with the lower verge of the *net*; then he shall hold in his hand, at the uttermost distance, the other end of the cord, which must be at least ten or twelve fathom long; there he must make some artificial shelter either of grass, sods, earth, or such like matter, where he may lie out of sight of the fowl. He ought also to take care to strew over all his *net*, as it lies upon the ground, some grass, that he may hide it from the fowl. It will not be improper to stake down near the *net* a live hern, or some other fowl formerly taken for a *stake*.

When the fowler sees a sufficient number of fowls to come within the verge of his *net*, he ought then to draw suddenly his cord, and so cast his net over them; continuing to act in that same manner, till the sun be near an hour high, and no longer; for then the fowls feeding is over for that time; but he

he may return in the evening, from about sun-set till twilight. By these means he may not only take great quantities of large wild fowls, but also plovers, which take their food as much from land as water.

The *lesser fowls*, which are web-footed, haunt continually drown'd fens, where they may have plenty of water, and swim undisturbed by man or beast; main streams of rivers, where the current is swiftest and least subject to freeze; and the broader and deeper such rivers are, the greater delight these fowls take therein; the wild-goose and barnzele excepted, which never abide on waters above their founding; for when they cannot reach the *ouze*, they instantly remove thence, seeking out more shallow places. These two last named, are extremely delighted with green winter corn; therefore they are to be search'd after, where such grain is sown; especially if the ends of the lands have much water about them.

These smaller fowls do also much frequent small brooks, rivers, ponds, drown'd meadows, pastures, moors, loughs, and lakes, especially if well stored with islands unfrequented, and well furnished with shrubs, bushes, reeds, &c. They frequent such places winter and summer, and breed there.

To take these smaller fowls with *nets*, they must be pitch'd for the evening flight before sun-set, staking them down on each side of the river, about half a foot within the water, the lower side of the *net* being so plumb'd, that it may sink so far and no farther: its upper side is to be placed slantwise, shoaling against the water, yet not touching it by near two foot. The strings which support this upper side, ought to be fasten'd to small yielding sticks set in the bank, which as the fowl strikes may give liberty to the *net* to rangle and entangle them.

Several of these *nets* may be placed over divers parts of the river, at a competent distance from one another, or as the river or brook shall give leave.

To hasten the fowls to fly to the *nets*, the fowler must fire his gun in the fens and plashes, round about the river where they are placed; for thereby the fowls will be so frightened, that they'll instantly post to the river.

This kind of fowls are also taken with *lime-twigs*, by fitting them in length according to the depth of the river, besmearing them with very strong water-lime, such as no wet or frost can injure; and pricking them in the water, so that as much of the rod as is lim'd, be above water; staking here and there among the rods, a live *stake*, as a mallard, widgeon, or teal.

The fowler needs not to wait continually on his rods, but may come thrice a day to see what is taken,

*viz.* early in the morning, at noon, and late in the evening; and then he must be accompanied with his water-spaniel; for if he perceives any of his rods missing, he may imagine that some fowls are fasten'd to them, which are crept in some hole, bush, or hedge by the river side, which his dog will help him to find.

Small *water fowls* may also be taken by *small*, or *great springs*, which is done in the following manner.

Having took notice where the fowls feed morning and evening, of the furrows and water-tracts where they usually stalk and paddle, to find worms, float-grass roots, and the like; the fowler must mark where many furrows meet in one, and break out, as it were, into one narrow passage, which divides itself afterwards into other parts and branches: then he marks how every furrow breaks and comes into this center or little pit, which is most paddled with the fowl, or which is easiest for fowl to wade in: this being done, he takes small and short sticks, and pricks them cross wise athwart over all the other passages, one stick within half an inch of the other, making, as it were, a kind of fence to guard every way but one, through which he will have the fowl to pass.

Having thus hemmed in all ways but one, he takes a stiff stick cut flat on the one side, and pricks both ends down into the water, making the upper part of the flat side of the stick, to touch the water and no more: this done, he makes a bow of small hazel, or willow, of a foot long, and five or six inches broad, in the form of a pear, broad and round at one end, narrow at the other, making a small nick at the narrow end: then he takes a good stiff grown plant of hazel, free from knots, three or four inches about at the bottom, and an inch at the top, and having sharpened the bottom end, he fastens at the top a very strong loop of about an hundred horse-hairs, plaited very fast together with strong packthread, and made so smooth that it will run and slip at pleasure. Near this loop he fastens a little broad tricker, within an inch and half of the end of the plant, which he makes equally sharp at both ends: he thrusts the bigger sharp end of the plant into the ground, close by the edge of the water; and brings the smaller end with the loop and the tricker down to the first bridge, and then the hoop being laid on the bridge, one end of the tricker is set upon the neck of the hoop, and the other end against a nick made on the small end of the plant, which by the violence and bend of the plant, makes them stick together until the hoop be moved. This done he lays the swickle on the hoop in such a manner as the hoop is proportioned; then from each side of the hoop pricks little sticks, making

ing an impaled path to the hoop; and as he goes farther from the hoop and spring, he makes the way wider; therefore the fowl can enter a good way before he perceives the fence, and thereby will be enticed to wade up to the spring, which will be no sooner touch'd, than the part of the bird which touches it, will be presently catch'd; and thus according to the strength of the plant, a fowler may take a fowl of any bigness.

The spring for lesser fowl, as woodcock, snipe, plover, &c. is made after the same manner, differing only in strength, according to the bigness of the bird we intend to catch.

When the fowler seeks for sport more than profit, he only takes his *piece* and his *dog*; in which case he must observe, in *shooting*, to shoot with the wind if possible, and not against it: and rather sideways, or behind the fowl, than full in their faces. Choosing the most convenient shelter he can find, as either hedge, bank, tree, or any thing else, which may hide him from the view of the fowl.

If he has not shelter enough by reason of the nakedness of the banks and want of trees, he must creep upon his hands and knees under the banks, and laying flat upon his belly, put the nose of his piece over the bank, and so take his level; for a water fowl is so fearful of a man, that though a hawk were soaring over her head, yet at the sight of a man she would betake herself to her wing, and run that danger. But it happens sometimes that the fowls are so shy, there is no getting a shoot at them without a screen, or device to hide the fowler, and amuse the game, while he gets within shot.

This device is called *stalking*; and there is a *stalking hedge*, a *stalking horse*, a *stalking tree*, &c.

A *stalking hedge*, is an artificial hedge, two or three yards long, and a yard and half high, made with small wands, to be light and portable, yet bushed out like a real hedge, with stakes to support it, while the fowler takes his aim.

*Stalking horse*, is an old jade trained up for the purpose, which will gently walk up and down as you would have him in water, &c. beneath whose fore-shoulder the sportsman shelters himself and gun. When thus got within shot, he takes aim from before the fore-part of the horse, which is much better than shooting under his belly. To supply the defect of a real *stalking horse*, an artificial one is frequently made of old canvas, shaped in form of a horse, with his head bent down, as if grazing; stuffed with any light matter, and painted: in the middle it is fixed to a staff shod at the foot, to stick into the ground while aim is taken. For change, when the fowls begin to be used to the *stalking horse*, and to know it, some *stalk* with an ox, cow,

deer, or the like. Others use a *stalking tree*, and others a *stalking bush*.

The LAND FOWLS are so called from their delighting principally in the cover and subsistence they meet with upon the earth. These are of divers sorts, some are either fit for food, as *pigeons* of all sorts, *rook*, *pheasant*, *partridges*, *quails*, *rails*, *feldfares*, &c. or for pleasure only, as all manner of birds of prey, *viz. castres*, *ring-tails*, *buzzards*, &c. or for food and pleasure together, as *black-bird*, *thrush*, *nightingale*, *linnet*, *lark*, and *bull-finch*.

These *land fowls*, of all sorts, are taken either by day or by night. If by day, it is done with the great net, commonly called the *crow-net*, not at all different in length, depth, bigness of mesh, manner of laying, &c. from the *plover-net*; only it will not be amiss if the cords be longer.

This net may be laid before a barn-door, or where corn has been winnowed, or in stubble-fields; and it must be hidden, that the fowls may not discover the snare. When the fowler, who must lie concealed afar off, with the cord in his hand, perceives a quantity of fowls within the net, scraping for food, he must quickly pull the net over them. But to succeed well in this manner of sport, he must carefully observe the morning and evening haunts of the fowl, when they come to feed upon the green-sward, and there lay his net, where he will meet with as good success as any where else; provided he takes care to hide himself, and does not pull his cord too hastily, but wait till he sees a good number of fowls within the net, then pull freely and quickly; for the least deliberation after the net is rais'd, proves the ruin of the sport.

There is another manner of taking *land fowls*, especially *small birds*, with *bird-lime*, particularly in frost and snow; for, as those small birds then assemble in flocks, (as *larks*, *chaffinches*, *linnets*, *goldfinches*, *yellow-hammers*, *buntings*, *sparrows*, &c. they all, but the lark, perch on trees or bushes, as well as feed on the ground) the fowler must go into a field and scatter chaff and thresh'd ears, twenty yards wide, (it is best in snow) and then stick the limed ears up and down, with the ears leaning, or at the end touching the ground: then he retires from the place, and traverses the ground round about; the birds being thereby disturbed in their haunts, fly to the ears, and pecking at them, they stick; which perceiving, they straitways mount up from the earth, and in their flight the bird-limed straws lay under their wings, and falling, are not able to disengage themselves from the straw, and so are certainly taken.

*Land fowls* are taken by night, with the help of a low bell, and of a net, whose mesh is twenty yards deep; and so broad, that it may cover five or

fix lands or more, according to the company the fowler has to carry it: this cannot be used but in plain champain countries, from the end of *October* until the end of *March*.

With these implements the fowler goes into a corn-field; the foremost carries the bell, tolling it as he goes, very mournfully; next follows the net, borne up at each corner and on each side, by several persons; then another carries some iron or earthen vessel, with burning, but not blazing coals in it; at which coals bundles of straw must be lighted, unless one should chuse to carry links. The nets being pitched where the game is supposed to lie, the ground must be beaten, and a noise made, at which the fowls rise, and are entangled in the net.

There is another manner of taking birds by night, which roost in bushes, shrubs, hawthorn-tree, &c. called *BAT-FOWLING*; and which is thus: the fowler must be very silent till his lights are blazing; and may chuse if he will carry nets or not. If he carries none, he must have long poles with great bushy tops fixed to them; and having from a vessel to carry fire in, lighted his straw or other blazing matter, he must beat those bushes where he thinks birds are at roost; which done, if there be any in those bushes or trees, he will instantly see them fly above the flames, so that those who have the bushy poles may beat them down at pleasure, and take them up.

*Larks, buntings, merlins, bobbies*, and any birds which will stoop either to stale, prey, gig, glass, or the like, may be taken from *August* to *September*, with the *day-net*, which must be planted before sun-rising; and the milder the air, the brighter the sun, and the pleasanter the morning, the better will be the sport, and of longer continuance.

The place chosen for this kind of sport must be a plain, either on barley stubble, green lays, and level and flat meadows, remote from villages, but near corn-fields.

These *nets* being staked down with strong stakes, tight on their lines, so as to be cast to and fro at pleasure, with a nimble twirch, a dozen of hand-lines, or drawing cords, a fathom long, must be fastened to the upper end of the foremost staves, and extended of such reasonable straitness, as with little strength they may raise up the nets and cast them over. When the nets are laid, stales, decoys, or playing wantons, must be placed twenty or thirty paces beyond them, upon some perching boughs, which will not only entice birds of their own feathers to stoop, but also hawks, and other birds of prey to swoop into the nets.

A *day-net* must be made of fine pack-thread, the mesh small, and not above half an inch square half-way; three fathom in length, and one in breadth;

like the *crow-net* in shape; verged about in the same manner with a small strong cord, the two ends whereof extended upon two small long poles, suitable to the breadth of the net, with four stakes, tail-strings, and drawing lines, as heretofore mentioned; only whereas that was but one single net, here must be two of one length, breadth, and shape. These *nets* must be placed opposite to each other, yet so close and even together, that when they are drawn and pulled over, the sides may touch one another.

*Particular DIRECTIONS for catching snipes, feld-fares, pigeons, magpies, pheasants, partridges, rails, quails, moor-pots, &c.*

To catch *snipes* with bird-lime, the fowler must know the places they frequent most, which is easily discovered by their dung; and there set two hundred limed twigs, more or less (especially if it be hard, frosty, or snowy weather, where the water lies open; for commonly they lie very thick in such places.) The twigs must be at a yard distant from one another, and sloping, some one way and some another; then the fowler retiring at a convenient distance from the place, must wait the success of the sport, and not be too hasty to stir at the first he sees taken; for the *snipe* will feed with the twig under his wings, and be a means to entice those down, who come over the place. When he sees the coast clear, and but few that are not taken, he must then take up his birds, fastening one or two of them, that the other flying over, may alight at the same place. If there be any other open place near that where the twigs are planted, they ought to be beaten up.

*Feld-fares*, as well as *snipes*, are also winter birds, and are taken by setting a dead one at the top of a great birchen bough, cover'd with small lime twigs, and planing the bough where the *feld-fares* resort in a morning to feed. By this means, others flying but near, will quickly espy the top-bird, and fall in whole flocks to him.

*Pheasants* are taken three several ways, *viz.* by *net, lime-bush, or driver*,

*Nets for pheasants*, must be made of double twined brown thread, dy'd blue or green, the mesh reasonably large and square, almost an inch between knot and knot; its length about three fathoms, and about seven feet broad, verged on each side with strong small cord, and likewise at the ends, that it may lie compass-wise and hollow.

In this kind of sport, the fowler must, as in all others heretofore mentioned, know the haunts of the fowl, which are never in open fields, nor in old high woods, since *pheasants* seldom frequent any other place, but young copses well grown; and of those, none but such as are solitary, and unfrequented

ed by men or cattle. But the most certain way of finding them out, is to have a *pheasant-call*, which he must learn how to use; understand all their notes, and how to apply them: for *pheasants* have several and different notes; one to cluck them together when the hen would feed them, another to chide them when they straggle too far, a third to call them to meat when she has found it, a fourth to make them look out for food themselves, and a fifth to call them about her to sport withal. The call may be used early in the morning, at which time they straggle abroad to find provender; or else in the evening just before sun-setting, which is their time likewise for feeding. Tho' they may be called at any other time of the day, by only changing note; for as before sun-rising, and at its setting, the note must be to call them to feed; in the forenoon, and afternoon, it must be to call them to brood, or chide them for straggling, or give them notice of some approaching danger.

With all these necessary instructions, the Fowler must lodge himself as close as possible, and then call at first very softly, lest the *pheasants* being lodged very near him, should be frightened at a loud note, but if nothing reply, he must raise his note higher and higher, till he extends it to the utmost compass; and if there be a *pheasant* within hearing, she will answer in a note as loud as his own, provided it be not untunable, for that would spoil all. As soon as he hears this answer, if it be from afar, and from a single fowl, he must creep nearer and nearer unto it, so will the *pheasant* to him, and as he alters his note so will she, and in all points he must endeavour to imitate her, whereby he'll get sight of her at last, either on the ground or perch; which got he ceases his calling, and spreads his net between the *pheasant* and himself, in the most convenient place he can find, with much secrecy and silence, making one end of the net fast to the ground, and holding the other end by a long line in his hand, whereby when any thing strains it, he may pull the net close together. This done he calls again, and as soon as he perceives the *pheasant* come underneath the net, he rises up and shews himself, whereby the *pheasant* being frightened, offering to mount, finds herself entangled within the net.

But if it happens that the Fowler hears many answers, and from different parts of the wood, he must not stir, but keep his place, and as he hears them by their sound, to come nearer and nearer unto him, he must make his nets ready, and spread them conveniently about him, one net on the one side, and another on the other; then lie close and apply himself to the call, till he has allured them under his nets, which done, he must stand up and shew himself, to fright them, and make them mount, whereby they are entangled.

*Pheasant-powts*, or young *pheasants*, are driven into nets, with an instrument made of strong white wands, or osiers, set fast in a handle, twisted about in two or three places, and bound with other wands, in the shape of those things cloth-dressers usually dress their cloth withal. With this driver the Fowler must make a gentle noise, raking upon the boughs and bushes round about him, which will make the *powts* run from it a little way, and then stand and listen, keeping all close together, till by another rake of the driver, they are made to run again as before, and by thus raking they will be driven like so many sheep into the nets, which must be placed across the little pads and ways which the fowler sees they have made, which are like sheep-tracks, and as near their ordinary haunt as possible, which may be discovered by the barrenness of the ground, mutings, and loose feathers.

Two things are to be observed in using the *driver*; the first is secrecy in concealing one's self from the sight of the *pheasants*; for if they chance to see the Fowler, they will instantly hide themselves in holes and bottoms of bushes, and will not stir from thence till night. The other is circumspection in the work, for nothing obstructs this pastime more, than too much precipitation or haste, for *pheasants* are fearful creatures, soon startle, and when once alarmed, they all fly in an instant, without staying to behold what they are so much afraid of.

To take *pheasants* with a lime-bush; the Fowler having discovered their haunts, besmears the top branch of a willow, or single rod twelve inches long, with the strongest birdlime. The branch must have a pretty long handle, made sharp at bottom to stick it into the ground, or into shrubs and bushes; which must be done near the branch or tree, where the *pheasant* perches. When the bush or rods are placed, the Fowler, lying close, takes out his call. If the call be good, and he knows how to use it, he will soon have all the *pheasants* within hearing about him, and if one happens to be entangled, she will go near to entangle all the rest, either by her extraordinary fluttering, or their own amazement and confusion; and as they are taken by the rods on the ground, they will likewise be surpris'd with the bushes, for being scared from below, they will mount to the perch or bushes, to see what becomes of their companions, and there be taken themselves.

*Lime* is only for the winter-season, beginning from *November* when the trees have shed their leaves, and ending in *May*. Nets are used from the beginning of *May*, till the latter end of *October*. So that there is no time of the year but their

breeding-time, which may not be employed in this pleasure.

*Partridges* are also taken several ways, either by *net*, *engine*, *driving*, or *setting*. They are naturally so fearful and simple, that they may easily be deceived, without any train, bait, or other device.

The usual haunts of *partridges* are corn-fields, either while the corn grows, or after it is cut down. In winter, when the fields are ploughed up, or over-soiled with cattle, they fly to the upland meadows, and lodge in the dead grass, or fog, under hedges, among mole-hills, or under the roots of trees. Sometimes they fly to copses, and under woods, especially if any corn-fields be near; or where broom, brakes, fern, &c. grows. In the harvest time, when every field is full of men and cattle, they are found in day-time, in the fallow-fields, next to the corn-fields, where they lie lurking till the evening, and then feed among the flocks, or sheaves of corn, which they do likewise in the morning.

When the haunts of *partridges* are known, the Fowler has several ways to find them; either by the eye, for they are a very lazy bird, and so unwilling to take to the wing, that the Fowler may even set his foot upon them before they will stir, provided he do not stand and gaze on them, but be in continual motion, otherwise they will spring up and be gone: Or, by going to their haunts early in the morning, or at the close of the evening, which is called the *jucking-time*, and there listening for the calling of the cock *partridge*, and for the answering of the hen; after which they meet together, which may be discovered at their rejoicing, and chattering; then the Fowler may take his range about them, drawing nearer to the place he hears them *juck* in, and casting his eyes towards the furrows of the land, he will soon find where the covey lies. Or by the *call*, having first learned the true and natural note of the *partridge*, and how to tune it in its proper key. Being perfect herein, he must frequent their haunts morning and evening, and hiding himself in some secret place, where he may see and not be seen, listen if he can hear the *partridges* call; if he hears them, he must answer them in the same notes, and imitate them as near as possible, as they change or double those notes; continuing thus till they draw nearer unto him. Having them in view he lays himself on his back, as if he was dead, without motion, by which means he may count their whole number.

Having proceeded thus far, the next thing he must do is to catch them. If he wants to do it with nets, having found out the covey, he draws forth his nets, and taking a large circumference, walks

a good round pace with a careless eye, rather from them towards the *partridges*, till he has trimmed his nets, and made them ready for the purpose, which done, he must draw his circumference less and less, till he comes within the length of his net, then pricking down a stick about three foot in length, fastens one end of the net to it, and walking about, letting the net slip out of his hands, he spreads it open as he goes, and thus lays it all over the *partridges*. But if they should lay straggling, so that he cannot cover them all with one net, he must draw forth another, and do with that as he has done with the former, which being done, he rushes in upon them, who frightened will fly up, and so be entangled in the nets.

*Partridges* are taken with birdlime, either in stubble fields, from *August* till *Christmas*, or in woods, pastures, or meadows. If in stubble fields, the Fowler must take the largest wheat-straws he can get, and cut them off between knot and knot, and lime them with the strongest lime. Then he goes to the haunts of *partridges*, and calls; if they answer he pricks at some distance from him, his lime-straws in many cross rows and ranks across the lands and furrows, taking in two or three lands at least; then lies close and calls again, not ceasing till he has drawn them towards him, so that they be intercepted by the way by the limed straws, which they shall no sooner touch, but they will be ensnared, and by reason they all run together like a brood of chickens, they will so besmear and daub one another, that very few of them will escape.

But if *partridges* are to be taken in pastures, woods, or meadows, the rods must be limed as for *pheasants*, and stuck in the ground after the same manner.

The most pleasant manner of taking *partridges* is by a *setting-dog*. The Fowler must take him where *partridges* do haunt, cast him off, and by some word of encouragement wherewith he is acquainted, engage him to range, but never too far from his master, who must see that he beats his ground justly and even, without casting about, or flying here and there, which the mettle of some will do if not corrected and reproved. Therefore when the Fowler perceives this fault, he must presently call his dog in with a *hem*, and so check him, that he dare not do the like again for that day; so he will range afterwards with more temperance. If in the dog's ranging he be perceived to stop on a sudden, or stand still, his master must then make in to him (for without doubt he has set the *partridge*) and as soon as he comes to him command him to get nearer, and if he goes not, but either lies still, or stands shaking of his tail, as if he would say, here they are under my nose; and  
withal

withal now and then looks back, then the Fowler must cease urging him further, and take his circumference, walking fast with a careless eye, looking strait before the nose of the dog, and thereby see how the covey lies, whether close or straggling: Then commanding the dog to lie still, he draws forth his net and pricks one end to the ground, and spreads it all open, and thus covers as many of the *partridges* as he can. Which done he makes in with a noise and springs up the *partridges*, which no sooner rise but they are entangled with the net. The Fowler must always let go the old cock and hen.

RAILS, QUAILS; MORE-POOTS, &c. are taken in the same manner as *partridges*, either with nets, limed bushes or rods, engine, or a setting dog. The way of finding them is also the same, by the eye, the ear, and haunt; though the chiefest of all is the *call* or *pipe*; to which they listen with such earnestness, that you can no sooner imitate their notes, but they will answer them, and pursue the *call* with such greediness, that they will play and skip about you, nay, run over you, especially the *quail*. The notes of the male and female differ very much; therefore the Fowler must have them both at his command; and when he hears the male call, he must answer in the female's note; and when the female calls, answer in the male's note; and thus will have them both come to him. Their haunts are also much like those of *partridges*, only the *quail* loves most the wheat fields; the *morepoot* the heath and forest-grounds; and the *rails* the long high grafs, where they may lie obscure.

We'll close this treatise with directions for catching, preserving and keeping SINGING BIRDS; and with remedies for their peculiar distempers.

The *nightingale* claims our first attention. She is the chief songster in the woods, where she appears at the latter end of *March*, or at the beginning of *April*. She builds her nest commonly about two feet above the ground, either in quickset-hedges, or in beds of nettles; hatching her young ones about the beginning of *May*, and naturally delighting in cool places, where small brooks are garnished with pleasant groves, where they sing melodiously till they have hatched, for then they grow mutes.

*Nightingales* must be taken out of their nests; when they are indifferently well fledged; for if well feathered they will be fullen, and if too little, they are so tender the cold will kill them.

The way of taking old and young is thus: for the young, you must take notice where the cock sings; and if he sings long the hen is not far, who often betrays her off-spring by being too careful: for when you come near her nest, she will

*sweet* and *cur*: if notwithstanding this you cannot find her nest, stick a meal-worm or two upon a thorn, and laying down or standing, observe which way it is carried by the old one, and drawing near, you'll hear the young ones while she feeds them. When you have found out the nest touch not the young; for if you do, they will not tarry in the nest.

The *branchers*, or *pushers* (thus called, because when thoroughly fledged, the old ones push them out of the nest) are taken with a bird-trap, or net-trap, made with green silk or thread, about the compass of a yard, and in the shape of a shove-net for fishes; then a large wire bended round, and the two ends joined, must be put into a short stick about an inch and an half long, and a piece of iron, with two checks and a hole on each side, through which must be ran some fine whip-cord three or four times double, that it may hold the piece of wood the faster, into which the ends of the wire are put, and with a button on each side of the iron the whip-cord is twisted; then the net is fastened to the wire, and the two checks of the iron joined at the handle of a board of the compass of the wire; to which is added a piece of stick about two inches long, with a hole at the top of it, which must have a plug to put in, with two wires to stick the meal-worm upon; then a string is tied in the middle of the top of the net, which net is to be drawn up, and having an eye at the end of the handle to put the thread through, it must be pulled till it stands upright. When the net and worms are ready, having first scraped the place, ants must be put into the trap-cage; which cage is to be placed near the place where the *nightingales* are heard calling, and left there.

When the *nightingales* are taken, the ends of their wings must be tied with some thread, to hinder them from beating themselves against the cage, which ought to be above half covered with green bays, and they left for four or five days undisturbed; though they must be fed six times a day with sheep's heart and egg shred very fine, and mingled with some pismires; and if thro' fullness they refuse to eat, their bill must be forced open.

In the summer they must be fed every day with fresh meat; and when they begin to moult, with half an egg hard boiled, and half a sheep's heart, mingled with saffron and water; and sometimes red worms, caterpillars, hog-lice, and meal-worms.

The *nightingales* taken in *July* or *August*, will not sing till the middle of *October*, and then they will hold in song till the middle of *June*; but those taken from the first of *April* to the twentieth, are the

the best birds for song. The *nestlings* and *branchers* (except they have an old bird to sing over them) have not the true song for the first twelve months. When they are so tamed that they begin to *cur* and *sweet*, with cheerfulness, and record softly to themselves, it is a certain sign that they eat, one need not trouble himself with feeding them; but if they sing before they feed, they commonly prove excellent birds: those which are long a feeding, and make no *curring* nor *sweeting*, are not worth the keeping. One which flutters, and bolts up his head in the night against the top of the cage ought not to be kept; for he is not only good for nothing, but his bad example will teach the best of birds to do the like.

The best sort of *nightingales* frequent high-ways, orchards, and sing close by houses: these when taken will feed soonest, being more used to company; and after their feeding will grow familiar, and sing speedily.

To distinguish the cock from the hen; the cock is both longer and bigger: if a *nestling* (before he can feed himself) records a little to himself, and in his recording his throat is perceived to wag, he is a cock; but when they come to feed themselves, the hen will record as well as the cock. *Branchers*, whether cocks or hens, (when taken and do feed themselves) will record; but the cock does it much longer, louder, and oftner.

*Nightingales* are subject to several diseases; for if they are not kept clean, their feet are clogged, their claws rot off; and they are subject to the gout and cramp. To cure them of these diseases, their feet must be anointed four or five days with fresh butter, and they will be well again. They are likewise troubled with imposthumes and breakings out about their eyes and neb, for which capon's grease must be used: if they be melancholy, some liquorice with a little sugar-candy must be put in their drinking pots.

The CANARY-BIRDS are originally from the *Canary-Islands*; from whence they were brought into *Europe*. They are in colour much like our green birds, but differ much in their song, and nature: for as other birds are subject to be fat, the cocks of these are always lean, by reason of the greatness of their mettle, and their lavish singing: the best are long shaped, standing strait and boldly. There are no certain rules to be given for the choice of *Canary-birds*, every one consulting his own fancy.

To discover if a *Canary-bird* be in health, before he is purchased, he must be taken out of the store-cage, and put into a clean one alone; where if he stands boldly without crouching, without shrinking feathers, and his eyes looking brisk and cheerfully,

these are good signs of a healthy bird; but if he bolts his tail like a *nightingale*, after he has dunged, it shews he is not well; though he seems lively for the present, there is some distemper near attending: likewise, if he either dung very thin and watry, or of a slimy white, and no blackness in it; these are dangerous signs of approaching death.

*Canary-Birds* above three years old are called *Runts*; at two years old they are called *Eriffs*; and those of the first year are called *Branchers*; when they are new flown, and cannot feed themselves, they are called *Puffers*; and those that are brought up by hand, *Nestlings*.

The BLACKBIRD builds her nest upon old stumps of trees by ditch-sides, or in thick hedges; they are brought up almost with any meat whatsoever; but above all, they love ground worms, sheep's heart, hard eggs, and white bread and milk mixed together. This bird sings somewhat more than three months in the year; his note is harsh and loud; therefore to add a value to him, he must be taught to whistle.

There are five kinds of thrushes, *viz.* the *missle-thrush*, the *northern-thrush*, or *feldfare*, the *wind-thrush*, the *wood-song-thrush*, and the *beath-thrush*.

The first is the largest of all five, and the most beautiful; but as he sings but little, and his notes are rambling and confused, he is not worth the keeping. The second is the *feldfare*, who comes into *England* before *Michaelmas*, and goes away about the beginning of *March*. They breed upon certain rocks near the *Scotish* shore three or four times a year, and are there in very great numbers: they are not so fit for the cage as for the spit, having a most lamentable untuned chattering tone. The third is the *wind-thrush*, or *whindie*, which travels with the *feldfare* out of the north, and is a smaller bird, with a dark red under his wing. She breeds in woods and shaws as *song-thrushes* do, and has an indifferent song exceeding the two former; but yet is fitter for the pot or spit, than for a cage or a very. The fourth is the *wood-song-thrush*, and sings most incomparably, both lavishly and with variety of notes; and sings at least nine of the twelve months in the year. She builds about the same time, place, and manner the *blackbird* does; the composition of her nest is so marvellous that it cannot be mended by the art of men; besides the curious building, she leaves a little hole in the bottom of her nest, to let out the water, as may be supposed, if a violent shower should come, that so her eggs or young ones may not be drowned. If the weather favours them, they go very soon to nest, and breed three times a year. *viz.* in *March*, *April*, *May* and *June*; but the first birds usually prove the best; which must be taken in the nest when

when fourteen days old, and kept warm and clean, not suffering them to sit on their dung, but must be so contrived that they dung over the nest. They are to be fed with raw meat and some bread chopped together with bruised hempseed, wetting the bread before it is mingled with the meat. Being thoroughly fledged, they must be put in a cage with two or three perches, where they may have room enough, and some moss at the bottom to keep them clean; for otherwise they will be troubled with the cramp, and for want of delighting in themselves their singing will be spoiled. They must also have fresh water twice a week, that they may bathe and plume themselves therein, otherwise they will not thrive. The fifth and last is the *heath-thrush*, which is the least we have in *England*, having a dark breast. Some are of opinion, that this bird exceeds the *song-thrush*, having better notes, and neater plume. The hen builds by the heath-side in a fern-bush, or stump of an old hawthorn, and makes not shaws and woods her haunt as other thrushes do. She begins to breed towards the middle of *April*, and breeds but twice in a year; and if kept clean and well fed, will sing three parts in four of the year. To know the cock from the hen, according to some, is to chuse the top bird of the nest, which commonly is most fledged. Others think that to be the cock which has the largest eyes and most speckles on his breast. Others chuse the cock by the pinion on his wing; but the best marks are a white gullet, with black streaks on each side, the spots on the breast large and black, and the head of a light shining brown, with black streaks under each eye, and upon the pinion of the wing.

THE ROBIN-RED-BREAST, for sweetness of note, is very little inferior to the *nightingale*: He is taken either in a pit-fall, or with a trap-cage and a meal-worm. They breed very early in the spring, and commonly twice a year. When the young ones are about ten days old they must be taken from the old ones, and kept in a little bower-basket. They are fed in all respects like the *nightingale*: when they grow strong they are put in a cage, with moss at the bottom; but as they are very tender birds the cage must be lined, to keep them warm. The cock has his breast of a darker red, and his red goes further up upon the head than the hen.

THE WREN is a little bird, as pleasant to the ear as he is to the eye: he builds twice a year about the latter end of *April*, in shrubs where ivy grows thick, and sometimes in old hovels and barns. They lay a numerous quantity of eggs. Their second time of breeding is in the middle of *June*; of either breed, what you intend to keep must be taken out of the nest at thirteen and fourteen days old;

and fed every day very often, but a little at a time, with sheep's hearts and eggs minced very small; and when they begin to pick their meat of their own accord, off the flick they are fed with, they must be caged, and meat put in a little pan, and about the sides of the cage, to entice them to eat, though they must be fed too, lest they neglect themselves and die. When they can feed themselves very well, a spider or two must be given them once in three days. The brownest and largest of the young *wrens* are the cocks.

THE WOOD-LARK, is by some preferred to the *nightingale*, because he has a great variety of very excellent and pleasant notes. The *wood-lark* breeds the soonest of any bird, by reason of his extraordinary mettle; therefore if they are not taken in the beginning of *February* at least, they grow so rank that they will prove good for nothing. He delights most in gravelly grounds and hills lying towards the orient, and in oat-stubs. Their building is in layers-grounds, where the grass is rank and ruffet, making their nests of ben grass, or dead grass of the field, under some large tufts, to shelter them from the injury of the weather. These birds are never bred from the nest, for they die in a week either of the cramp or scowring. The times of the year to take them is in *June, July, August*, with a hobby, in this manner: go in a dewy morning to the sides of some hills which lie to sun-rising, where they most usually frequent, and having sprung them, observe where they fall, then surround them twice or thrice with your hobby on your fist, causing it to hover when you draw near, by which means they will lie still till you elap a net over them. If three or four go together, take a net made in the same manner as that for *partridges*, when you go with a setting-dog, only the mesh must be smaller, *i. e.* a lark mesh, and then your hobby is to the lark what a setting-dog is to partridges. Those taken in this season are called *young branchers*, because they have not moulted yet; and will sing presently, but will not last long, by reason of their moulting.

*Wood-Larks* taken at the latter end of *September*, having then moulted cannot be distinguished whether old or young. Those taken in *January* and *February* will sing in five or six days, or sooner, and they are the best, being taken in full stomach, and are more perfect in their song than those taken in other seasons.

Upon the first taking of the *wood-lark*, two pans must be put into the cage, one for sheep's heart minced small, and mingled with bread, egg, and hemp-seed; and another for oatmeal and whole hemp-seed. The bottom of the cage ought to be covered with red gravel, which must be shifted

shifted every week at furthest, and the perch lined with green bays; and lest they should not find the pan soon enough, to prevent famine, there must be strewed upon the sand some hemp-seed and oatmeal; and if they grow poor at the beginning of the spring, there must be given to them every two or three days a turf of three leaved grass. The cock is distinguished from the hen, by the largeness and length of his call, by his tall walking, his strong singing, and the doubling of his notes in the evening.

These birds are very subject to the cramp, giddiness in the head, and louzy. The best remedy to prevent the cramp is to shift the cage often with fresh gravel, otherwise the dung will clog to the feet, which causes the cramp. The giddiness of the head proceeds from feeding upon much hemp-seed, and is cured with gentles, or hog-lice, emmets and their eggs, with liquorice, all put into water. Louziness is cured by the smoak of tobacco.

The SKY-LARK is a hardy bird, and will live upon any food, provided he has once a week a turf of three-leaved grass. *Sky-larks* commonly build in corn, or thick high grass meadows, and seldom have more than four young ones, which they hatch towards the middle of *May*. They must be taken when a fortnight old, and fed at first with minced sheep's hearts, mixed with hard eggs; when they can feed alone, they eat hemp-seed and oatmeal; they must have sand in the bottom of their cage, and no perch.

*Sky-Larks* are taken either with a net and hobby, or a trammel, or a pair of day-nets and a glass, or with a low-bell, or with pack-thread.

The *trammel* is only used in dark nights, and is above six and thirty yards long, and six yards over, run thro' with six ribs of pack-thread; which ribs at the ends, are put upon two poles sixteen feet long, made taper at each end, and so is carried between two men half a yard from the ground, to cause the birds to fly up, otherwise the net might be carried over them without disturbing them; when they are heard to fly against the net, it must be clapped down. The *day-nets* are commonly seven feet deep, and fifteen long, knit with *French* mesh, and very fine thread. These *nets* take all sorts of small birds that come within their compass, as *bunting-larks*, and *linnets* in abundance. To take *larks* with the low-bell, the bell and a great light in a tub must be both carried by one man, and the net by another; this bell and light so amazes them, that they lie as dead, and stir not till the net over-cast them. To take them with pack-thread, a hundred, or two hundred yards of packthread must be provided, when there is abundance of snow upon the ground, fastening at every

six inches a noose made with horse-hairs, two hairs are sufficient.

*Larks*, designed to be kept for singing, must be taken in *October* or *November*, chusing the straitest, largest and loftiest bird, and he that has most white on his tail; for these are the marks of the cock.

The LINNET builds his nest in thorn-bushes, and fir-bushes, and some of the hotter sort will breed four times a year. The young ones may be taken at four days old, if you intend to teach them to whistle, or learn the song of other birds, for being so young they know not the tune of the old bird; then they must be kept very warm, and fed often, and a little at a time, with bruised and soaked rape-seeds, mixed with an equal quantity of white bread. The cock is known from the hen by the brownness of his back, and the white of his wing; that is to say, take your young *linnet* when the wing feathers are grown, and stretch out his wing, holding his body fast with the other hand, and then observe the white upon the fourth, fifth, and sixth feather; if it cast a glistering white, and it goes quite to the quill, it is a sure sign of a cock.

This bird is subject to several diseases, as the phtyisick, known by his panting, staring feathers, lean breast, and spilling his seeds up and down the cage. Which disease happens for want of water, or for want of green meat in the spring: he is troubled also with strains, or convulsions of the breast; sometimes with hoarseness, being over-strained in singing; sometimes he is melancholy, at other times afflicted with scouring, of which there are three sorts, the first is thin, or with a black or white substance in the middle, not very dangerous; the second is between a black and white, clammy and sticking, this is bad; but the third and last is most mortal, which is the white clammy scouring.

The GOLD-FINCH breeds commonly in apple trees, and plumb trees, thrice a year. *Gold-finches* are taken in great plenty about *Michaelmas*, and will soon become tame. The young ones are taken with the nest at ten days old, and fed with the best hempseed pounded, sifted, and mixed with the like quantity of white bread, with some flour of canary-seed. They must be kept very warm till they can feed themselves.

The TIT-LARK appears at the same time of the year as the *nightingale* does, which is the beginning of *April*, and leaves us at the beginning of *September*. He breeds about the latter end of *April*, or the beginning of *May*, and builds his nest on the ground by some pond or ditch. The *tit-larks* are fed, when taken, as the *nightingale*. They are easily brought up, being hardy, and are

not subject to colds or cramps, but live long if preserved with care. The song of this bird is short and sweet.

The CHAFFINCH builds his nest in hedges, and trees of all sorts, and has young ones twice or thrice a year, which are seldom bred up from the nest, because they are not apt to take another bird's song, or to whistle. The *chaffinch* has but one short plain song.

The STARLING, to be excellent, must be taken from the old ones at the end of three or four days; for if taken fledged out of the nest, they retain too much of their own natural harsh notes. They learn to whistle, or speak, or an other bird's song, by hanging under him.

The BULLFINCH has no song, nor whistling of

his own, but is very apt to learn any thing, if learned with the mouth.

The GREENFINCH breeds three times a year by the highways, and early before the hedges have leaves upon them. The young ones are very hardy birds to be brought up, and may be fed with white bread and rape-seed bruised and soaked. The *Greenfinch* is a beautiful bird, but very dull.

The HEDGE-SPARROW builds in a white thorn, or private hedge, laying eggs of a fine blue colour. These birds are taken at the latter end of *January*, or beginning of *February*, and will feed almost on any thing. They are very tractable, and will take any bird's song, if taken young out of the nest. Old or young they will become tame very quickly.

## F U L L I N G.

**F**ULLING is the art or act of *scouring* and *pressing* cloths, stuffs, stockings, &c. to cleanse, thicken, and render them more firm and strong, which is done by means of a *water-mill*. See *second* plate of MECHANIC ARTS, Fig. 1. in which, 1. is the track of the wheel, that turns on the outside; 2. a front view of the wheel; 3. the arbour with its leavers, which as they pass, raise the heads of the wooden mallets, and let them fall alternately; 4. the trough, which in the plate is hid behind the timber work, and is only expressed by dots that shew its position: each trough has at least two, and sometimes three mallets; 5. the head of the mallet, with three or four notches, which hinder the stuff from sticking under the hammer; 6. the arm or handle; 7. the end of the mallet fastened by a pin. 8. In the troughs are laid the cloths, stuffs, &c. intended to be full'd: then letting the current of water fall on the wheel, the mallets are successively let fall upon them, when by their weight and velocity they stamp and press the stuffs very strongly, which by this means become thickened and condensed.

In this operation, fuller's earth is used with some proportion of soap; but soap alone would do much better, was it not dearer than fuller's earth.

*Fulling* of stockings, caps, &c. is performed either with the hands or feet, or a kind of wooden machine, either armed with wooden teeth, or those of horses or bullocks. The ingredients generally used on this occasion are fuller's earth, urine, white soap and green soap. But water softened with chalk is far preferable.

The following is M. Colmet's method of *fulling* with soap, grounded on experiments made by order of the Marquis de Louvois. Let a coloured cloth of about 45 ells, be laid in the usual manner in the trough of a fulling-mill, without first soaking it in water, as commonly practised in most places. To full this troughful of cloth, fifteen pounds of soap are required, one half of which is to be melted in two pails of river or spring water, made as hot as the hand can bear. Let this solution be poured by little and little, upon the cloth, in proportion as it is laid in the trough: thus it is to be full'd for at least two hours; after which, let it be taken out and stretched. This done, let the cloth be immediately returned into the same trough, without fresh soap, and there full'd two hours more. Then take it out, wring it well, and express all the grease and filth. After the second fulling, dissolve the remainder of the soap, as the former part, and throw it at four several times on the cloth, not forgetting to take it out every two hours, to undo the plaits and wrinkles it got in the trough. When it is sufficiently full'd, and brought to the requisite quality and thickness, it is scoured out, for good, in hot water, keeping it in the trough till it be thoroughly clean. As white cloths full more easily than coloured ones, a third part of the soap may be spared.

The art of *fulling* was invented, according to *Pliny*, lib. 7. c. 56. by one *Nicias* the son of *Hermias*: and it appears by an inscription quoted by Sir *George Wheeler*, in his travels through *Greece*, that

that this same *Nicias* was a governor in *Greece*, in the time of the *Romans*.

The *fullers*, among the *Romans*, washed, scoured, and fitted up cloaths, and their office was judged of

that importance, that there were several laws prescribed them for the manner of performing it: such was the *lex de fullonibus*, &c.

## G A M I N G.

**G**AMING considered only as an artful contrivance to take advantages over the ignorant and unguarded, has at all times been detested by the wise and virtuous, looked upon as a practice pernicious to society, and in many places severely prohibited by law.

In *England*, the statute 33 *Hen. VIII.* gives justices of peace, and head officers in corporations, a power to enter all houses suspected of unlawful games; and to arrest the gamesters, till they give security not to play for the future.

Persons keeping any unlawful gaming-house, are fined 40*s.* and the gamesters 6*s.* 8*d.* a time.

If any persons by fraud, deceit, or unlawful device, in playing either at cards or dice, tables, bowls, cock-fighting, horse races, foot-races, &c. or bearing a share in the stakes, or betting, shall win any money or valuable thing of another, he shall forfeit treble the value thereof: likewise if any person shall play at any of the said games upon tick, and not for ready money, and lose the sum of 100*l.* on credit, at any one meeting, if the money be not paid down, his security taken for it shall be void, and the winner becomes liable to a forfeiture of treble value of such money won. 16. *Car. II.* c. 7.

Not only all notes, bills, bonds, mortgages, or other securities given for money won at gaming, are declared void; but also where lands are granted, they shall go to the next person intitled, after the decease of the person so incumbering the same: persons losing by gaming at one time 10*l.* may recover the money lost, from the winner, by an action of debt, brought within three months; and on the loser's not prosecuting, any other person may lawfully do it, and recover treble the value, with costs. 9 *Ann. c.* 14.

Those who cheat at cards, dice, &c. besides their forfeitures, have inflicted on them such infamy and corporal punishment, as in cases of perjury; and heating or challenging any other person to fight, on account of money won by gaming, shall forfeit all their goods, and be imprisoned two years: and where persons play that have no visible estates, and do not make it appear that the principal part of their maintenance is got by other means than gaming, they may be bound to their good behaviour by

two justices of the peace, &c. Stat. *ibid.* See 2 *Geo. II. c.* 28.

The ace of hearts, pharaoh, basset, and hazard, are judged to be lotteries by cards or dice; and persons who set up those games, are subject to 200*l.* penalty. And every adventurer, who shall play, stake, or punt at them, forfeits 50*l.* Also any sales of houses, goods, plate, &c. in such a way, are void, and the things forfeited to any who will sue for the same. 12 *Geo. II. c.* 28.

However, considered amongst the recreations of mankind, and serving for amusement in our leisure hours, it is proper to treat of this art in such a manner, as to shew the nature and hazard of gaming; and also to give a few directions towards forming a just idea of certain games, that are most in fashion.

The nature and hazard of gaming appear from the doctrine of chance, whose variety may be understood from what follows.

Suppose *p* the number of cases in which an event may happen, and *q* the number of cases wherein it may not happen, both sides have the degree of probability, which is to each other, as *p* to *q*.

If two gamesters, A and B, engage on this footing, that, if the cases *p* happen, A shall win; but, if *q* happen, B shall win, and the stake be *a*; the chance of A will be  $\frac{p a}{p+q}$  and that of B  $\frac{q a}{p+q}$ ; consequently, if they sell the expectancies, they should have that for them respectively.

If A and B play with a single die, on this condition, that, if A throw two or more aces at eight throws, he shall win; otherwise B shall win, what is the ratio of their chances? Since there is but one case wherein an ace may turn up, and five wherein it may not, let *a*=1, and *b*=5. And again, since there are eight throws of the die, let *n*=8; and you will have  $\frac{a^n}{a+b} - b^n - nab^n - 1$ , to  $b^n + nab^n - 1$ : that is, the chance of A will be to that of B, as 663991 to 10156525, or nearly as 2 to 3.

A and B are engaged at single quoits, and, after playing some time, A wants 4 of being up, and B 6; but B is so much the better gamester, that his chance against A upon a single throw would be as 3 to 2; what is the ratio of their chances

chances? Since A wants 4, and B 6, the game will be ended at nine throws; therefore, raise  $a+b$  to the ninth power, and it will be  $a^9 + 9a^8b + 36a^7bb + 84a^6b^3 + 126a^5b^4 + 126a^4b^5$ , to  $84a^3b^6 + 36aab^7 + 6ab^8 + b^9$ : call  $a$  3, and  $b$  2, and you will have the ratio of chances in numbers, viz. 1759077 to 194048.

A and B play at single quoits, and A is the best gamester, so that he can give B 2 in 3, what is the ratio of their chances at a single throw? Suppose the chances as  $z$  to 1, and raise  $z+1$  to its cube, which will be  $z^3 + 3z^2 + 7z + 1$ . Now since A could give B 2 out of 3, A might undertake to win three throws running; and, consequently, the chances in this case be as  $z^3$  to  $3z^2 + 3z + 1$ . Hence  $z^3 = 3z^2 + 3z + 1$ ; or,  $2z^3 = z^3 + 3z^2 + 3z + 1$ . And, therefore,  $z^3 \sqrt[3]{2} = z + 1$ ; and, consequently,  $z = \frac{1}{\sqrt[3]{2}-1}$ . The chances,

therefore, are  $\frac{1}{\sqrt[3]{2}-1}$ , and 1, respectively.

Again, suppose I have two wagers depending, in the first of which I have 3 to 2 the best of the lay, and in the second 7 to 4; what is the probability I win both wagers?

1. The probability of winning the first is  $\frac{3}{5}$ , that is the number of chances I have to win, divided by the number of all the chances: the probability of winning the second is  $\frac{7}{11}$ : therefore, multiplying these two fractions together, the product will be  $\frac{21}{55}$ , which is the probability of winning both wagers. Now, this fraction being subtracted from 1, the remainder is  $\frac{34}{55}$ , which is the probability I do not win both wagers: therefore the odds against me are 34 to 21.

2. If I would know what the probability is of winning the first, and losing the second, I argue thus: the probability of winning the first is  $\frac{3}{5}$ , the probability of losing the second is  $\frac{4}{11}$ : therefore multiplying  $\frac{3}{5}$  by  $\frac{4}{11}$ , the product  $\frac{12}{55}$  will be the probability of my winning the first, and losing the second; which being subtracted from 1, there will remain  $\frac{43}{55}$ , which is the probability I do not win the first, and at the same time lose the second.

3. If I would know what the probability is of winning the second, and at the same time losing the first, I say thus: the probability of winning the second is  $\frac{7}{11}$ ; the probability of losing the first is  $\frac{2}{5}$ : therefore, multiplying these two fractions together, the product  $\frac{14}{55}$  is the probability I win the second, and also lose the first.

4. If I would know what the probability is of losing both wagers, I say, the probability of losing the first is  $\frac{2}{5}$ , and the probability of losing the second  $\frac{4}{11}$ : therefore, the probability of losing them

both is  $\frac{8}{55}$ ; which being subtracted from 1, there remains  $\frac{47}{55}$ : therefore, the odds of losing both wagers is 47 to 8.

This way of reasoning is applicable to the happening or failing of any events that may fall under consideration. Thus if I would know what the probability is of missing an ace 4 times together with a die, this I consider as the failing of four different events. Now the probability of missing the first is  $\frac{5}{6}$ , the second is also  $\frac{5}{6}$ , the third  $\frac{5}{6}$ , and the fourth  $\frac{5}{6}$ ; therefore the probability of missing it four times together is  $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{625}{1296}$ ; which being subtracted from 1, there will remain  $\frac{671}{1296}$  for the probability of throwing it once or oftner in four times: therefore the odds of throwing an ace in four times is 671 to 625.

But if the flinging an ace was undertaken in three times, the probability of missing it three times would be  $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$ ; which being subtracted from 1, there will remain  $\frac{91}{216}$ , for the probability of throwing it once or oftner in three times: therefore the odds against throwing it in three times are 125 to 91.

Again, suppose we would know the probability of throwing an ace once in four times and no more; since the probability of throwing it the first time is  $\frac{1}{6}$ , and of missing it the other three times is  $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6}$ ; it follows that the probability of throwing it the first time, and missing it the other three successive times, is  $\frac{1}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{1296}$ ; but because it is possible to hit it every throw as well as the first, it follows, that the probability of throwing it once in four throws, and missing the other three, is  $\frac{4 \times 125}{1296} = \frac{500}{1296}$  which

being subtracted from 1, there will remain  $\frac{796}{1296}$  for the probability of throwing it once, and no more, in four times. Therefore, if one undertake to throw an ace once, and no more, in four times, he has 500 to 796 the worst of the lay, or 5 to 8 very near.

Suppose two events are such, that one of them has twice as many chances to come up as the other, what is the probability that the event, which has the greater number of chances to come up, does not happen twice before the other happens once, which is the case of flinging 7 with 2 dice before 4 once? Since the number of chances are as 2 to 1, the probability of the first happening before the second is  $\frac{2}{3}$ , but the probability of happening twice before it, is but  $\frac{2}{3} \times \frac{2}{3}$  or  $\frac{4}{9}$ : therefore it is 5 to 4 seven does not come up twice before 4 once.

But, if it were demanded, what must be the proportion of the facilities of the coming up of two events, to make that which has the most chances come up twice, before the other comes up once? The answer is 12 to 5 very nearly: whence it follows, that the probability of throwing the first be-

fore the second is  $\frac{2}{7}$ , and the probability of throwing it twice is  $\frac{1}{7} \times \frac{1}{7}$ , or  $\frac{1}{49}$ ; therefore, the probability of not doing it is  $\frac{48}{49}$ : therefore the odds against it are as 145 to 144, which comes very near an equality.

Suppose there is a heap of thirteen cards of one colour, and another heap of thirteen cards of another colour, what is the probability that, taking one card at a venture out of each heap, I shall take out the two aces?

The probability of taking the ace out of the first heap is  $\frac{1}{13}$ , the probability of taking the ace out of the second heap is  $\frac{1}{13}$ ; therefore the probability of taking out both aces is  $\frac{1}{13} \times \frac{1}{13} = \frac{1}{169}$ , which being subtracted from 1, there will remain  $\frac{168}{169}$ : therefore the odds against me are 168 to 1.

In cases where the events depend on one another, the manner of arguing is somewhat altered. Thus, suppose that out of one single heap of thirteen cards of one colour I should undertake to take out the first ace; and, secondly, the two: though the probability of taking out the ace be  $\frac{1}{13}$ , and the probability of taking out the two be likewise  $\frac{1}{13}$ ; yet, the ace being supposed as taken out already, there will remain only twelve cards in the heap, which will make the probability of taking out the two to be  $\frac{1}{12}$ ; therefore the probability of taking out the ace, and then the two, will be  $\frac{1}{13} \times \frac{1}{12}$ .

In this last question the two events have a dependence on each other, which consists in this, that one of the events being supposed as having happened, the probability of the others happening is thereby altered. But the case is not so in the two heaps of cards.

If the events in question be  $n$  in number, and be such as have the same number  $a$  of chances by which they may happen, and likewise the same number  $b$  of chances by which they may fail, raise  $a+b$  to the power  $n$ . And if A and B play together, on condition that if either one or more of the events in question happen, A shall win, and B lose, the probability of A's winning will be  $\frac{a^n}{(a+b)^n}$ ; and that of B's winning will be  $\frac{b^n}{(a+b)^n}$ ; for when  $a+b$  is actually raised to the power  $n$ , the only term in which  $a$  does not occur is the last  $b^n$ : therefore all the terms but the last are favourable to A.

Thus if  $n=3$ , raising  $a+b$  to the cube  $a^3 + 3a^2b + 3ab^2 + b^3$ , all the terms but  $b^3$  will be favourable to A; and therefore the probability of A's winning will be  $\frac{a^3 + 3a^2b + 3ab^2}{(a+b)^3}$ , or  $\frac{(a+b)^3 - b^3}{(a+b)^3}$ ;

and the probability of B's winning will be  $\frac{b^3}{(a+b)^3}$ .

But if A and B play on condition, that if either two or more of the events in question happen, A shall win; but in case one only happen, or none, B shall win; the probability of A's winning will be

$$\frac{(a+b)^n - nab^{n-1} - b^n}{(a+b)^n}$$

for the only two terms in which  $a$  does not occur, are the two last, viz.  $nab^{n-1}$  and  $b^n$ .

The games in fashion are divided into *games of exercise*, and *adresse*; and *games of chance*, or *hazard*.

Under the first appellation we reckon *tennis*, *billiards*, *chess*, *bowls*: under the second are numbered *cards*, *dice*, &c.

The game at *tennis* is the most active and genteel. The exercise is most violent; is performed with racquets and hard balls, and requires a good fight and great agility and dexterity in catching and striking the ball.

**BILLIARDS** is a game play'd on an oblong table, covered with green cloth, with ivory balls struck with sticks made on purpose: the whole secret of this game consists in lodging the ball of our antagonist in one of the pockets or holes, of which there are three on each side of the table.

The party that is struck into the pocket, loses two; and he that misses his antagonist's ball, loses, every time he misses, one.

He that would play well at this game, must understand perfectly well how to use his *masse* and also the tail or cue, when his ball is nailed close against the side of the table, or so near that of his adversary, that he cannot use the *masse* without running the risk of touching the ball of his adversary, as well as his own. He must also endeavour, as much as possible, to touch always the ball of his adversary in full, for when he touches it corner-wise, tho' he sometimes *blouzes* his adversary, he seldom misses of *blouzing* himself also. He should besides understand how to draw perpendiculars, diagonals, and equilateral lines with his eyes, either to touch always the ball, or to lodge it in the hazards or pockets. The adversary is distressed in several manners, 1. By pocketing him. 2. By nailing his ball close against the side of the table. 3. By bringing it upon the edge of a hole, that he may run the risk of pocketing himself, or miss touching our ball.

**CHESS** requires both art and adresse, but no strength nor agility.

The theatre upon which this game, is acted, is a chequered board, half black and half white, like a draught-

draught-board; and by two little armies drawn up in order of battle, opposite to each other; each army is commanded by a king and several great officers, who in all (the king included) are eight principal persons.

The *king* is the first in rank and order; next to him stands the *queen*; two *rooks* next; next to the two *rooks*, two *knights*; two *bishops* next; eight *pawns*, who are no other than common soldiers.

The method of drawing up this little army, is to place the principal pieces on the lowest rank of the board next to the gamester, *viz.* the *king* first upon the fourth spot from the corner, which is white; the *queen* on the black spot on his right; the two *bishops*, one next the *king*, and the other next the *queen*; the *knights* on the sides of the *bishops*, and the two *rook*, one in each corner. The *pawns* are placed just in the rank before those illustrious persons, to serve as their rampart. The other army is drawn up on the opposite side in the same manner; and lest they should not be distinguished when they are engaged, one army is always clothed in *black*, the other in *white*.

The *king* never moves but from one chequer to another; forward in a line, or side-ways in a line, or backward in a line. If he meets with any scout of the enemy in his way, he may take him prisoner, and place himself, where he stood; and when it is his turn to move again, he may go backwards, side-ways, or retire. The *king* can also, the first motion, pass over one chequer, but after that he can only move from chequer to chequer.

The *queen*, provided the passage be clear, may pass from one end of the board to the other at one movement, either in a line forwards, or in a line side-ways; and if an enemy stands in her way, she may take him prisoner, and stand in his place.

The *bishop's* motion is oblique; he may either move from chequer to chequer, or run along a whole row, according as he sees an advantage to snap an enemy. One *bishop* stands upon a black chequer, and the other upon a white; but he who stands upon a black chequer must always move upon the black row, without touching the white; as he who stands upon a white, must always move on the white row, without touching the black.

The *knight* jumps from black to white, and from white to black, in the form of a demi-circle; and if one of the enemy should stand next to him, he can jump over his head.

The *knight* is of great use in the beginning of the battle; for very often he makes a passage through the enemy's army, and forces his way up to the king, whom he attacks, and to whom he gives *cheque-mate*.

The motion of the *rooks* is in a direct line every way; they can neither cross the chequer, as the *bishops* do, nor hop like the *knights*: they may either move from chequer to chequer, or else as far as the passage is clear. If any of the enemy stands in their way to interrupt their march, they may take him prisoner, and stand in his place, as all the others must when they take a prisoner, till the next movement.

The eight *pawns*, at the first movement, may, if it be thought necessary, pass over two chequers, reckoning that they come from one; but afterwards they can only move from chequer to chequer in a direct line forwards: but if one of the enemy should stand next to one of them in an oblique manner, they may take him. And if any of them should make his way up to the first rank of the enemy, he is immediately preferred and made an officer; and the *king* may prefer him to the post of any officer he has lost. If the *queen* herself had been taken prisoner, she must be exchanged for this *pawn*.

The general rules to be observed in playing at *chess*, are, 1. To play at the beginning with a great deal of caution, and not too open, as if there was no danger while the enemy is at a distance; since the *queen*, a *bishop*, and a *rook*, can take a prisoner from one end of the board to the other, if he lies uncovered. 2. That, as it is impossible to proceed without exposing the men or officers, a good player will give up an inferior officer to take a superior one from the enemy. For instance, he'll play his *knight* just in the mouth of a *rook*, when he has placed another officer in ambuscade to surprize the *rook*. 3. A good player endeavours always to get behind the enemy, to attack the *king*, and give him *cheque-mate*. 4. The *king* can be chequered two ways; the first is a *simple cheque*, when the king can either retire out of danger, or cover himself with an inferior man, or take that man which chequers him: the second is, when the king is so besieged and over-powered, that he can neither move nor defend himself, nor cover himself with another: this is called *cheque mate*, in which case the game is lost.

There are besides several particular rules given by captain *Joseph Bertin*, as will perfect those, who are somewhat skilled in the game of *chess*; which rules are these: 1. The pawns of the king, bishop, and queen, must move before the knights; for were they to move last, the game would be crowded by useless removes. 2. The *queen* is not to be played till the game be well opened; since otherwise some moves would be lost. 3. For the same reason useless cheques ought not to be given. 4. Upon being well posted, either for attack or defence, no opportunity of taking your adversary's men must tempt you, for this may divert you from gaining the

the main design. 5. Do not castle, but when very necessary; because the move is often lost by it. 6. Never attack or defend the king without a sufficient force; and take care of ambushes and traps. 7. Never crowd your game by too many men in one place. 8. Consider well before you play, what harm your adversary is able to do you, that you may oppose his designs. 9. To free your game, take off some of your adversary's men if possible, for nothing; though to succeed in your design, you must often give away some of your own, as occasion serves. 10. He who plays first, is understood to have the attack. When the game is opened you must endeavour to defend in your turn; for the defence, if well played, is still the best against the gambets, in which you change all your pieces except the gambet that gives three pawns, which will be necessary to keep a rook, to conduct your pawns to the queen. 11. A good player ought to foresee the concealed move, from 3 to 5 and 7 moves. The concealed move is a piece that does not play for a long time, but lies snug in hope of getting an advantage. 12. At the beginning of a game you may play any pawn two moves without danger. 13. The gambet is, when he who first gives the pawn of the king's bishop in the second move, for nothing, the other keeps it, or takes another for it, if he is obliged to lose it. 14. The close game is, when he that plays first, gives no men, unless to make good advantage; but in giving a pawn first, he loses his advantage. 15. He who castles first, the other must advance his three pawns on the side of his adversary's king, and back them with some pieces, in order to force him that way, provided his own king or pieces are not in danger in other places. 16. When your game is opened, to gain the attack, you must present your pieces to change; and if your adversary, who has the attack, refuses to change, he loses a good situation; and either in exchanging or retiring, the defence gets the move: *Ex. gr.* In the beginning of a game, to shew the necessity of playing the pawns before the pieces, if there were but two pawns on each side of the board, *viz.* the pawns of the rooks, the first that should play would soon win the game, by taking the other pieces by cheque; and that situation may come in less number of pieces. 17. To play well the latter end of a game, you must calculate who has the move, on which the game always depends. 18. To learn well and fast, you must be resolute to guard the gambet pawn, or any other advantage against the attack; and when you have the least advantage you must change all, man for man. A draw game shews both players to be good.

The common opinion is, that *chefs* was invented by *Palamedes*, at the siege of *Troy*, to divert tedious

evenings during that long siege. Others attribute the invention to *Diomedes*, who lived in the time of *Alexander*: the *Romance of the Rose* ascribes it to one *Attalus*; but the truth is, the game is so very antient, there is no tracing its author.

In *China* it makes a considerable part of the education of their maids, and seems to take the place of dancing among us. In *Spain* whole cities challenge each other at *chefs*.

*Donatus*, on *Terence's Eunuch*, observes that *Pyrrhus*, the most knowing and expert prince of his age, ranging a battle, made use of the men at *chefs* to form his designs; and to shew the secrets thereof.

BOWLING is a game of recreation, exercise, and address, which consists chiefly in having a kind of compass in the eye, to measure well the distance between the place the gamester lets fall his bowl at, and the *jack*, that it may neither fall short of it, nor run too far from it.

Amongst the games with CARDS, I shall only exemplify the sociable game at *piquet*, much used in the polite world. It is play'd between two persons, with only 32 cards; all the *duces*, *threes*, *fours*, *fives*, and *sixes* being set aside.

In reckoning at this game, every card goes for the number it bears, as ten for ten; all court-cards go for ten, and the ace for eleven; and the usual game is one hundred up. In playing, the ace wins the king, the king the queen, and so down.

Twelve cards are dealt round, usually by two and two, which done, the remainder are laid in the middle; if one of the gamesters finds he has not a court-card in his hand, he is to declare he has *carte blanche*, and tell how many cards he will lay out, and desire the other to discard that he may shew his game, and satisfy his antagonist that the *carte-blanche* is real; for which he reckons ten.

Each person discards, *i. e.* lays aside a certain number of his cards, and takes in a like number from the stock. The eldest hand is allowed to take five, though he can take less; for he must always leave three to his adversary, who may take them all three if he pleases; he can also take more than three, if his adversary leaves more, provided he discards as many as he takes; and see those he leaves; and the eldest hand also, if he declares what card he will lead: both are obliged to discard at least one card, let their game be ever so good.

After discarding the eldest hand examines what suit he has most cards of, and reckons how many points he has in that suit; if the other has not so many in any one suit, he is to tell one for every ten of that suit: an example will make this plain.

If the eldest has *ace, king, queen, and knave*, of any suit; he asks, are 41 good? If the other cannot reckon up as many or more, he shall tell 4 for them; for if he had 50 he should tell 5; if 60, 6, and so on. But suppose 35 in either hand should be good, he who has them is to reckon as much as for 40, that is to say 4; and the same for any number betwixt 35 and 40; but for any number less than 5, nothing is reckoned: and for 41, 42, 43, or 44, you reckon but 4. He who thus reckons most, is said to win the *point*.

The *point* being over, each examines what *sequences* he has of the same suit, *viz.* how many *tierces, quartes, or fours, quintes, or fives, sixiemes, or sixes, &c.* For a *tierce* they reckon three points, for a *quarte* four, for a *quinte* fifteen, and for a *sixieme* sixteen, &c. And the several *sequences* are distinguished in dignity by the cards they begin from: thus, *ace, king, and queen*, are called *tierce major*; *king, queen, and knave, tierce to a king*; *knave, ten, and nine, tierce to a knave*: all which tell three. Likewise *ace, king, queen, and knave*, are called *quarte major*; *king, queen, knave, ten, quarte to a king*, and thus of the *queen and knave*, as in the *tierces*; which *quartes* tell 4. The *ace, king, queen, knave, ten*, are *QUINTE major*; the *king, queen, knave, ten, and nine, QUINTE to a king, &c.* all *quintes* tell 15. The *ace, king, queen, knave, ten, nine*, are a *SIXIEME major*, and this *sequence* follows the same order of the others, and tells 16. The best *tierce, quarte, quinte, or sixieme*, i. e. that which takes its descent from the best card, prevails, so as to make all the others in that hand good, and destroy all those in the other hand. In like manner a *quarte* in one hand sets aside a *tierce* in the other.

The *sequences* over, they proceed to examine how many *aces, kings, queens, knaves, and tens*, each holds; reckoning for every three of any sort, three: but here too, as in *sequences*, he that with the same number of threes has one that is higher than any the other has, *ex. gr.* three *aces*, has all his others hereby made good, and his adversary's all set aside: for example, if I have three *aces*, three *knaves*, and three *tens*, and my adversary three *kings*, my three *aces* sets his three *kings* aside, and make my three *knaves* and three *tens* good; so that I reckon of this article only, nine, while my adversary reckons nothing. Four of any sort, *viz.* four *aces*, or four *kings, queens, knaves, or tens*, are called a *quatorze*, and tell 14. The *quatorze* of *aces*, setting aside that of *kings*; that of *kings*, the *quatorze* of *queens*; and thus of the *knaves* and *tens*, for you are allowed nothing for the nines, eights, and sevens.

All the game in hand being thus reckoned, the eldest proceeds to play, reckoning one for every card

he plays above a nine, and the other follows him in the suit; and the highest card of the suit wins the trick. If two cards of different suits are play'd, that which leads wins the trick, though the first was but a 7 and the last an *ace*.

It is not the person that wins the trick, who always reckons for it, and in some cases both reckon one for the same trick: of which this is an example. If the person who leads plays a tenth card, he reckons one for it as soon as he plays it down; if another plays another card that is higher he wins it, and also reckons one; thus they both reckon for the same trick.

If the leader plays an 8 or 7 he reckons nothing; and if the follower should win it with a nine he reckons nothing; for as it has been observed before, a card under a ten cannot count at this game: nevertheless that trick serves towards winning the cards. It must be observed that the follower, that is, he who plays last, never reckons for his cards unless he wins the trick; and that he who wins the last trick reckons one for it, though it be won by any card under a 10; and if it be won with a 10 or upwards, he reckons 2 for it.

When the cards are played out, each is to count his tricks, and he that has most is to reckon 10 for winning the cards; if they have tricks alike, neither is to reckon any thing.

The first thing that's reckoned at *piquet*, is the *carte-blanche*; if there be no *carte-blanche*, the point is the first thing. The second thing is, the *sequences*, as *tierces, quartes, quintes, &c.* The next are the *threes* or *quatorzes*; as three *aces*, or four *knaves, or tens, queens, or kings*: for instance, if both parties should be 95 of the game, and one has in his hand 45, or 50 for point, which we will suppose to be good; and the other a *quint*, or a *quatorze* of *aces*, he who has the point wins the game, because it is to be reckoned first; and the rest have the same preference according to their ranks. If one be 99 of the game before he plays down the first card, he plays it up if it be a tenth card, tho' he loses the trick. If the parties are 99 each when they are to play down, the leader must win the game if he plays a tenth card; because he tells as soon as he plays down, the other cannot, till after the trick is won. When the *points, tierces, quartes, or quintes*, are equal in both hands, neither is to reckon any thing for them.

He who wins all the tricks, instead of reckoning ten, which is his right for winning the cards, reckons 40: and this is called a *CAPOT*.

He who without playing down, can reckon up 30 in hand, either in *carte-blanche, points, quintes, or quatorzes*, when the other has reckoned nothing, reckons 90 for them; and this is called a *REPICQUE*:  
and

and if he can make up above 30 in hand, he reckons as much above 90; e. g. if he has 32, 33, or 34, he reckons 92, 93, 94, and so on.

He who can make up 30, part in hand and part by play, before the other has told any thing, reckons them for 60; and this is called *PICQUE*.

There is a great number of accidents attending this game, and which are attended with penalties: for,

1. If the dealer by mistake, or otherwise, should give a card too many, or too few, it is at the option of the eldest hand either to play the game, or make him deal again.

2. If the eldest having 13 cards dealt him, will play, he must lay out 5 cards and take in but 4; and if he plays when he has but 11 cards dealt he must lay out a card less than what he takes in. The dealer is to do the same, if 11 or 13 cards fall into his hand; with this difference, that it is the choice of the eldest to play, or make him deal again.

3. If one should have 15 cards, or but 9 dealt him, which may happen when the dealer does not think what he is doing; in this case the cards must be dealt again, and neither have power to hinder it.

4. He that has *carte-blanche*, *point*, *quinte*, or *quatorze* in his hand, and plays down a card before he remembers to name it, loses the benefit thereof; and so he does of every thing that is to be told in hand, if he does not name them before he plays down.

5. If one party names his *point*, and the other allows it to be good, and does not remember to shew it before he plays down a card, he must not reckon it; the same must be said of *tierces*, *quartes*, and *quintes*, if he forgets to shew them before he plays down a card; which gives an opportunity to his antagonist of telling his *points*, *tierces*, *quartes*, or *quintes*, &c. though they are not so good; but the antagonist must likewise shew them before he plays down to the leader's card, otherwise he loses the right of reckoning them as well as the other.

6. He that has *three*, or *quatorzes* of *aces*, *kings*, *queens*, *knaves*, or *tens*, is not obliged to shew them.

7. If one should count a *three* or *quatorze*, which he has not in his hand, though he laid it out by mistake, or otherwise, if the other finds it out at any time, before the cards are cut for the next deal, he cuts him off from all he reckoned, and he is to count nothing that he got by the deal. And if the eldest should count 3 aces when he laid out one of them, and the other three kings, or any thing else, he shall count his three kings, though he does not discover the other's false reckoning till the end of the deal. But it must be observed, that though he who reckons false, can count nothing by the deal, yet what he has in his hand may hinder the other, and save a *picque* or a *repicque*: as for example, he

who counts 3 aces false, and has a *quinte-major* in his hand, though he cannot count for it, yet it cuts the other off from counting one inferior *quinte*, *quarte*, or *tierce*.

8. He that takes in a card more than he lays out, counts nothing; but he that takes in a card less than he lays out, may count his game; and must play card for card with the other as long as his cards last.

9. When one has 12 cards, and the other but 10; if he who has the 12 cards should win 10 tricks successively, then he has 2 cards left in his hand, which we'll suppose to be the king of *spades*, and any small card of another suit; the other has but one card, which we'll suppose to be the ace of *spades*; if the first plays his small card, the other must play the ace of *spades* to it. Thus he suffers a *capot* for want of another card; and this seems just, because it was his own fault that he wanted a card.

10. When a card is once played out of hand, it cannot be taken up again, unless it be the case of a *renounce*; if then by mistake, one should throw down a card of a different suit when he has one of the same in his hand, he may take it up again and play down the other.

11. If the leader should play a king, and the other having the ace of the same suit in his hand, should, in surprize, play a small card of the same sort, he cannot recal it, but must be content to lose the trick.

12. If a player has three *aces* in his hand, and by mistake, should count three *kings* instead of three *aces*, he counts nothing that deal, provided he does not recollect his mistake before he plays down his first card; if he does, he saves the penalty.

13. If when the deal is half played out, one of the parties expecting to win no more tricks, should throw up the cards, and mix them with the rest; if he repents after, and would take his cards up again, he is not allowed: but if they are not mixed with the rest he may take them up again, and play out the deal.

14. When the cards are play'd out, except two or three on one side, and one supposing the other's cards to be better than his own, should throw them down; but finding himself mistaken, he takes up his cards again, he shall be obliged to play what card the other directs him.

15. It is not allowed in any case to discard twice; nor to look before discarding, to examine the cards you are to take in, even on the outside, lest they should be known by their back.

16. He that takes in first, should always tell how many he leaves, if he does not take in all his five; that the other may discard accordingly.

17. He that takes in a card too many, and perceives it before he looks on them, may turn it back again, unless he mixes it with the rest of his game; in which case he loses the whole profit of that deal, and reckons nothing.

18. If any one takes the cards to deal when it is not his turn, and should deal them all out; and if the other examines his cards, provided he that dealt by mistake has not looked on his cards also; he may throw them up to be dealt by the other.

19. If the person who is to speak first, should shew a *point*, or a *tierce*, *quarte*, or *quinte*, &c. or a *three*, or *quatorze* of any thing, which the other two should allow to be good; if, after this, he should find he was mistaken, and that he has a better of that sort than the eldest shew'd, he may count it afterwards: and he suffers nothing by this mistake, provided there be not a card play'd down.

20. He that has nothing in his hand, but the *carte-blanche*, faves a *picque* or a *refique*.

21. If you should have in your hand three aces, three kings, three queens, three knaves, or three tens, and in discarding lay out one, or either of these, you are to count but three: then the other may ask you which *ace*, which *king*, &c. you laid out, and you are obliged to tell him; and if he requires it, you must shew him which you laid out.

22. If it should happen that the pack should be false, (as sometimes there may be two cards of a sort) when it is found out, that deal goes for nothing; but if you have play'd several deals before with the same pack, they are all good. If the pack should be found false, the very first deal you play you must adjust the pack, and begin again; but you are not to cut again for deal, for the first cutting stands good.

23. Every gamester is to lay his discard near himself; which he has the liberty of looking on as often as he pleases.

24. He that cuts the cards is not to look at the bottom; if he should, forgetting what he was about, they must be shuffled, and cut again.

25. Whoever is found taking a card in, that he had laid out before, loses the game.

26. When by mistake one has taken a card in, more than he had laid out before; and to avoid the penalty, which is of reckoning nothing that deal, he should attempt secretly to lay it out again, he is to lose the game.

With DICE the most ingenious and fair game is *back-gammon*. It requires much skill to play it well.

The men, which are 30 in number, are equally divided between you and your adversary, and are

thus placed; 2. on the *ace point*, and 5 on the side of your left-hand table, and 3 on the cinque, and 5 on the *ace-point* of your right-hand table, answered on the like points by your adversary's men with the same number; or thus, 2 of your men on the *ace-point*, 5 on the double *six*, or *six-cinque points*, 3 on the *cinque-point* in your tables, and five on the *six-point* at home, and all these pointed alike by your adversary.

In your play have a care of being too forward; and be not rash in hitting every blot, but with discretion and consideration, move slowly, but securely.

Be sure to make good your *tray-ace-points*; hit boldly, and come away as fast as you can; to which end if your *dice* run high, you will make the quicker dispatch.

When you come to bearing, have a care of making when you need not; and *doublets*, now, will stand you most in stead.

If your table be clear, before your adversary's men be come in, that is a *back-gammon*, which is three, four or the game.

To play this game accurately the gamester must guard himself against disappointment in the *dice*, and not cloud his reason with impatience and passion: and consider well the chance before he moves his man. For which he will do well to calculate upon the doctrine of chances laid down at the beginning of this treatise, and also the following calculation.

To find the number of cases, wherein any given number of points may be thrown with a given number of dice. Let  $p + 1$ , be the given number of points;  $n$  the number of dice; and  $f$  the number of sides or faces of each die; let  $p - f = q$ ,  $q - f = r$ ,  $r - f = s$ ,  $s - f = t$ , &c. the number of cases will be.

$$+ \frac{p}{1} \times \frac{p-1}{2} \times \frac{p-2}{3}, \text{ \&c.}$$

$$- \frac{q}{1} \times \frac{q-1}{2} \times \frac{q-2}{3}, \text{ \&c.} \times \frac{n}{1}.$$

$$+ \frac{r}{1} \times \frac{r-1}{2} \times \frac{r-2}{3}, \text{ \&c.} \times \frac{n}{1} \times \frac{n-1}{2}.$$

$$- \frac{s}{1} \times \frac{s-1}{2} \times \frac{s-2}{3}, \text{ \&c.} \times \frac{n}{1} \times \frac{n-1}{2} \times \frac{n-2}{3}$$

which series is to be continued till some of the factors either become equal to nothing, or negative.

And note, some factors of the several products  $\frac{q}{1} \times \frac{p-1}{2} \times \frac{p-2}{3}$ , &c.  $\frac{r}{1} \times \frac{r-1}{2} \times \frac{r-2}{3}$ , &c.

$\frac{s}{1} \times \frac{s-1}{2}$ , &c. are to be taken as there are units

in  $n - s$ .

Z z z.

G. A. R.

## G A R D E N I N G.

**G**ARDENING is the art of laying out in taste, and cultivating a spot of ground with a variety of *plants, flowers, shrubs, and fruit trees*. Hence

*Gardens* are usually distinguished into *flower-garden, fruit-garden, and kitchen-garden*; the first of which, being designed for pleasure and ornament, is to be placed in the most conspicuous part, that is, next to the back front of the house; and the two latter, being designed for use, should be placed less in sight. But though the *fruit* and *kitchen-gardens* are here mentioned as two distinct gardens, yet they are now usually in one; and that with good reason, since they both require a good soil and exposure, and equally require to be placed out of the view of the house.

In the choice of a place proper for a garden, the most essential points to be considered are the situation, the soil, the exposure, water and prospect.

1<sup>st</sup>, As to the situation, it ought to be such a one as is wholesome, and in a place neither too high nor too low; for if a garden be too high, it will be exposed to the winds, which are very prejudicial to trees; and if it be too low, the dampness, the vermin, and the venomous creatures that breed in ponds and marshy places, add much to their insalubrity. The most happy situation is on the side of a hill, especially if the slope be easy, and in a manner imperceptible; if a good deal of level ground be near the house, and if it abounds with springs of water; for, being sheltered from the fury of the winds, and the violent heat of the sun, a temperate air will be there enjoyed; and the water that descends from the top of the hill, either from springs or rain, will not only supply fountains, canals, and cascades for ornament, but when it has performed its office, will water the adjacent valleys, and, if it be not suffered to stagnate, will render them fertile and wholesome. Indeed if the declivity of the hill be too steep, and the water be too abundant, a garden on the side of it may frequently suffer, by having trees torn up by torrents and floods: and by the tumbling down of the earth above, the walls may be demolished, and the walks spoiled. It cannot, however, be denied, that the situation on a plain or flat, has several advantages which the higher situation has not: for floods and rain commit no damage; there is a continued prospect of champaigns, intersected by rivers, ponds and brooks, meadows and hills covered with

woods or buildings; besides, the level surface is less tiresome to walk on, and less chargeable, than that on the side of an hill, since terrace walks and steps are not there necessary: but the greatest disadvantage of flat gardens, is the want of those extensive prospects which rising grounds afford.

2<sup>dly</sup>. A good earth, or soil, is next to be considered; for it is scarce possible to make a fine garden in a bad soil; there are indeed ways to meliorate ground, but they are very expensive; and sometimes when the expence has been bestowed of laying good earth three feet deep over the whole surface, a whole garden has been ruined, when the roots of the trees have come to reach the natural bottom. To judge of the quality of the soil, observe whether there be any heath, thistles, or such-like weeds growing spontaneously in it; for they are certain signs that the ground is poor. Or if there be large trees growing thereabouts, observe whether they grow crooked, ill-shaped, and grubby, and whether they are of a faded green, and full of moss, or infested with vermin; if this be the case, the place is to be rejected: but, on the contrary, if it be covered with good grass fit for pasture, you may then be encouraged to try the depth of the soil. To know this, dig holes in several places, six feet wide, and four feet deep; and if you find three feet of good earth, it will do very well; but less than two, will not be sufficient. The quality of good ground is neither to be stony, nor too hard to work; neither too dry, too moist, nor too sandy and light; nor too strong and clayey, which is the worst of all for gardens.

3<sup>dly</sup>, The next requisite is water, the want of which is one of the greatest inconveniences that can attend a garden, and will bring a certain mortality upon whatever is planted in it, especially in the greater droughts that often happen in a hot and dry situation in summer; besides its usefulness in fine gardens for making fountains, canals, cascades, &c. which are the greatest ornaments of a garden.

4<sup>thly</sup>, The last thing to be considered, is the prospect of a fine country; and though this is not so absolutely necessary as water, yet it is one of the most agreeable beauties of a fine garden: besides, if a garden be planted in a low place that has no kind of prospect, it will not only be disagreeable, but unwholesome.

In the laying out and planting of gardens the beauties of nature should always be studied; for the

the nearer a garden approaches to nature, the longer it will please. The area of a handsome garden, may take up thirty or forty acres, but not more; and the following rules should be observed in the disposition of it. There ought always to be a descent of at least three steps from the house to the garden; this will render the house more dry and wholesome, and the prospect on entering the garden more extensive. The first thing that should present itself to view, should be an open lawn of grass, which ought to be considerably broader than the front of the building; and if the depth be one half more than the width, it will have a better effect: if on the sides of the lawn there are trees planted irregularly, by way of open groves, the regularity of the lawn will be broken, and the whole rendered more like nature. For the convenience of walking in damp weather, this lawn should be surrounded with a gravel walk, on the outside of which should be borders three or four feet wide, for flowers: and from the back of these, the prospect will be agreeably terminated by a slope of ever-green shrubs, which, however, should never be suffered to exclude agreeable prospects, or the view of handsome buildings. These walks may lead through the different plantations, gently winding about in an easy natural manner, which will be more agreeable than either those long strait walks, too frequently seen in gardens, or those serpentine windings, that are twisted about into so many short turns, as to render it difficult to walk in them: and as no garden can be pleasing where there is a want of shade and shelter, these walks should lead as soon as possible into plantations, where persons may walk in private, and be sheltered from the wind. Where the borders of the gardens are fenced with walls or pales, they should be concealed with plantations of flowering shrubs intermixed with laurels, and other ever-greens, which will have a good effect, and at the same time conceal the fences, which are disagreeable, when left naked and exposed to the sight. Groves are the most agreeable parts of a garden, so that there cannot be too many of them; only that they must not be too near the house, nor be suffered to block up agreeable prospects. To accompany parterres, groves opened in compartments, quincunxes, and arbour-work with fountains, &c. are very agreeable. Some groves of ever-greens should be planted in proper places, and some squares of trees of this kind may also be planted among the other wood.

Narrow rivulets, if they have a constant stream, and are judiciously led about a garden, have a better effect than many of the large stagnating ponds or canals, so frequently made in large gardens.

When wildernesses are intended, they should not be cut into stars and other ridiculous figures, nor formed into mazes or labyrinths, which in a great design appear trifling. Buildings, statues, and vases, appear very beautiful; but they should never be placed too near each other: magnificent fountains are also very ornamental; but they ought never to be introduced, except there be water to keep them constantly running. The same may also be observed of cascades and other falls of water.

In short, the several parts of a garden should be diversified; but in places where the eye takes in the whole at once, the two sides should be always the same. In the business of designs, the aim should be always at what is natural, great and noble. The general disposition of a garden, and of its parts, ought to be accommodated to the different situations of the ground, to humour its inequalities to proportion the number and sorts of trees and shrubs to each part, and to shut out from the view of the garden no objects that may become ornamental. And before a garden is planned out, it ought ever to be considered, what it will be when the trees have had twenty years growth.

The art of gardening affords a variety of delights. It teaches how to dispose fruit trees, flowers, and herbs to the best advantage, whether for profit or pleasure; and shews how to prepare the soil for sowing the different kinds of seeds, as well as how to treat the plants when grown up.

So much for GARDENS in general. But to descend to particulars.

THE KITCHEN GARDEN, or a commodious piece of ground laid out by art for the cultivation of fruit, herbs, pulse, and other vegetables, for the use of the kitchen, ought to be situated on one side of the house, near the stables, from whence the dung may be easily conveyed into it; and after having built the wall, borders should be made under them, which, according to *Miller*, ought to be eight or ten feet broad: upon those borders exposed to the south, many sorts of early plants may be sown; and upon those exposed to the north, you may have some late crops, taking care not to plant any sort of deep-rooting plants, especially beans and peas, too near the fruit trees. You should next proceed to divide the ground into quarters; the best figures for these is a square, or an oblong, if the ground will admit of it; otherwise they may be of that shape which will be most advantageous to the ground: the size of these quarters should be proportioned to that of the garden: if they are too small, your ground will be lost in walks, and the quarters being enclosed by espaliers of fruit-fruits, the plants will draw up

slender, for want of a more open exposure. The walks should also be proportioned to the size of the ground; these in a small garden should be six feet broad, but in a larger one ten; and on each side of the walk there should be allowed a border three or four feet wide, between it and the espalier, and in these borders may be sown some small fallads, or any other herbs that do not take deep root, or continue long: but these quarters should not be sown or planted with the same crop two years together. In one of these quarters, situated nearest to the stables, and best defended from the cold winds, should be the hot-beds, for early cucumbers, melons, &c. and to these there should be a passage from the stables, and a gate through which a small cart may enter. The most important points of general culture consist in well digging and manuring the soil, giving a proper distance to each plant, according to their different growths, as also in keeping them clear from weeds; for this purpose you should always observe to keep your dung-hills clear from them; if this is not done, their seeds will be constantly brought in, and spread with the dung.

THE FLOWER-GARDEN, which also is called the *pleasure garden*, is composed of, or laid out in *parterres*, *vista's*, *glades*, *groves*, *compartments*, *quincunxes*, *verdant walls*, *arbour work*, *mazes*, *labyrinths*, *fountains*, *cabinets*, *cascades*, *canals*, *terraces*, &c.

THE PARTERRE, is a level division of ground, which, for the most part, faces the south, and best front of the house, and is generally furnished with greens, flowers, &c.

There are *parterres* of embroidery; *parterres* cut in shell-work, in scroll-work, &c. with sand alleys between.

An oblong, or long square, is accounted the most proper figure for a *parterre*, the sides whereof, to be as two, or two and a half to one.

FLOWERS make the greatest ornament of a *parterre*; these flowers are distinguished into early or *spring flowers*, which flourish in the months of *March*, *April*, and *May*.

Such are the anemones, daffodils, hyacinths, tulips, jonquils, cowslips, primroses, &c.

Summer FLOWERS, which open in *June*, *July*, and *August*, as pinks, gilliflowers, lilies, daisies, campanulas, poppies, sun-flowers, &c.

Autumnal, or late FLOWERS, denote those of *September* and *October*; as indian pinks, roses, pansy, flower-gentle, &c.

Of these FLOWERS, those which subsist all the year, we mean in the stem, or root, at least, are called *perennials*,

And those which are to be planted, or sowed afresh every year, according to the season, are called *annuals*.

VISTA is an open and light passage made through a thick wood, grove, or the like, by lopping off the branches of trees, along the way.

GROVE, in large and magnificent gardens, is usually a plot of trees, inclosed with *palisades*, consisting of tall trees, as elms, horse chestnuts, &c. the tops whereof make a tuft, or plump, and shade the ground below.

COMPARTMENT is a design composed of several different figures, disposed with symmetry, to adorn a *partorre*.

ALLEY, in gardening, is a strait, parallel walk, bordered or bounded on each hand with trees, shrubs, or the like.

*Alleys* are usually laid either with grass or gravel.

An *alley* is distinguished from a *path* in this; that in an *alley* there must always be room enough for two persons, at least, to walk a-breast.

In the planting of fruit-trees, if the soil be a hungry gravel, or sand, Mr. *Switzer* directs where the trees are to be planted, to be dug two feet deep, and three or four over, and filled with rotten horses or cows dung, mixed with rich mould: if it be marle or stiff clay, a compost of rubbish, lime, pieces of brick, ashes, sand, &c. will be the best to mix with dung and mould; though he is of opinion, that untried earth, dug from a waste or common where cattle have been fed, would prove the best soil for young trees.

The trees being now taken out of the nursery, the biggest roots are to be shortened to about six inches; all the small fibres taken off; and the head to be pruned, so as not to leave above two branches; and those not above six inches long.

The wall-trees to be placed as far from the wall as possible; that there may be the more room for the roots to spread, Then filling up the hole with mould, there remains nothing but to secure the roots from the winter's frost, by covering the spot with straw, fern, dung, &c. And in summer, from the sun; by sand, and pebble stones.

For trees planted in borders, the common practice is to make a trench by the wall side, two feet broad, and as many deep. This trench they fill with old dung, mixed with earth, lightly laid, near as high as the borders are intended to be; and then trodden down to half the height in the places where the trees are intended to be. It is prudent to plant the trees shallow, and to raise the earth about them; especially in a wet, clayey soil.

The places near the walls are most advantageously filled with dwarfs; they seldom grow above four or five feet high, and the fruit they yield is usually the finest and best.

There are divers ways of producing *dwarfs*.—*dwarf-pears* are usually had by inoculating on quince-stocks, which grow the *dwarfs* height.

As for *dwarf-apples*, the stocks they chuse to graft on are those raised of the cuttings of the apple-tree.—In order to provide stocks of each kind, they chuse such stems, and branches, as grow straightest, in the month of *October*, from trees whose cuttings will grow, or which in the places they are to be grafted in are at least an inch thick: These they cut off an hand's breadth below the knots or burs, which are the places where they usually put forth their roots; and cut off the top that they may not be above a yard long. If they cannot be got so long of quinces, shorter must do. Cut off all side-branches close to the body, except one small twig near the top for the sap to vent itself at. Set them in beds, as seed plants are: and keep them a foot above ground.

Such trees alone as are apt to put forth roots, are proper for *dwarf* stocks; as the Kentish codlin, genneting, some sorts of sweet apples, bitter-sweets, the quince-tree, mulberry-tree, paradise apple-tree.

As for *dwarf* pear-trees, stocks may be raised for them from the suckers of old pear-trees: Else cut off the top of some old ill pear-tree, and the roots will cast forth suckers.

For *dwarf* cherries and plumbs, suckers of the common red cherry, and ordinary plumb-tree are the best.

As to the grafting or inoculating of *dwarf* stocks, it must be done as low as may be, with two cyons, and those longer than in grafting for long standards that they may spread from the ground.

As to the planting of *dwarf*-trees it is best in a light, hot earth, from the beginning of *October*, to the end of *November*. In cold, wet soil, it is best in *March* and *April*. The stem of the tree to be cut off seven or eight inches above the graft; and remember to cut off half the length of the roots and hairy fibres; to turn the cut of the tree towards the north; to let the graft always be two or three inches above the ground, lest it take root; to plant them shallow, as being apt of themselves, in light ground to sink a foot deep, which is sufficient; and to cover the ground, when they are planted with horse-litter.

With regard to *fruit-trees*, *Monf. Quintine* observes, 1. That the cutting and trimming of young trees, hinders them from quick bearing; though

it contributes both to the beauty of the tree, and the richness and flavour of the fruit.

2. That *kernel fruit-trees*, come later to bear than *stone fruit-trees*; the time required by the first before they arrive at a fit age for bearing, being, one with another, about four or five years: but that when they do begin, they bear in greater plenty than *stone-fruit*.

3. That *stone-fruit*, figs, and grapes, commonly bear considerably in three or four years; and bear full crops the fifth and sixth years; and hold it for many years, if well ordered.

4. That *fruits* in the same neighbourhood will ripen a fortnight sooner in some grounds, than in others of a different temperature.

5. That in the same spot, hot or cold summers set considerably forward, or put backwards the same *fruit*.

6. That the *fruits* of wall-trees generally ripen before those on standards; and those on standards before those on *dwarfs*.

7. That the *fruits* of wall-trees planted in the south and east-quarters commonly ripen about the same time; only those in the south rather earlier than those in the east; those in the west are later by eight or ten days, and those in the north by fifteen or twenty.

*Monsieur de Reffons*, in the *memoires de l'academie Royale des Sciences*, anno 1716, gives a method of grafting *stone fruit-trees* without losing of time; so that a tree which bore sorry fruit the preceding year, shall bear the choicest the year following.

In order to this, it is to be observed; that there are three kinds of branches: Wood-branches growing immediately from the stem or stock of the tree: *fruit* branches; and branches half wood half *fruit*; being such as arising from the largest wood branches preserve the character thereof, but which in two yearstime will produce fruit branches. Now, it is these intermediate kind of branches, that we are to chuse for scutcheons or grafts. They are readily known by being bigger than the fruit branches, and less than the wood-branches: they have each of them two, three, four, or even five leaves to each eye, and the eyes are further distant from each other than those of the fruit-branches, but closer than those of the wood branches. It must be added, that the eyes on such branches are three; one intended for a wood branch, being situate between the two leaves, and advancing further than the other two, which are intended for *fruit*, and are placed without side the leaves. These last are the precise subjects to be chosen for the grafting withal. Twelve of these branches, more or less, according to the strength of the tree to be grafted

grafted on, being duly applied, we may depend on a crop of good *fruit* the very next year, on the same tree, which last year produced the worst.

ENGRAFTING, GRAFTING, or GRAFFING, in *agriculture* and *gardening*, is the art, or act, of inserting, or fixing a cyon, shoot, or bud of one tree, in the stock of another; in order to correct and improve its fruit.

*Engrafting* is the art of applying a graft, or shoot of one plant, to the stock of another; in such manner, as that the sap passing freely through both, the tree *grafted* on may produce the same kind of fruit with that whence the graft is taken.

*Engrafting* only differs from *inoculation*, in that the latter is performed when the sap is at the highest in summer: and the former ere it rises, at least, in any quantity.

INOCULATION, in *Agriculture* and *gardening*, is a kind of grafting, or an artificial operation, by which the bud of one fruit-tree is set into the branch or stock of another, so as sometimes to make different sorts of fruit grow on the same tree.

There are various ways of performing this: the ancient method was, by making a shallow incision in the bark, where the knot, or a shoot or eye, *oculus*, (whence the operation takes its name) begins to bud forth, into which a promising shoot of another kind was inserted, and the incision closed up with fat earth or clay.

The method of *inoculation* now in the best repute, as delivered by Mr. *Lawrence*, is as follows: they cut off a vigorous shoot, from the tree that is to be propagated, a month before, or after, midsummer; then chuse out a smooth place in the stock (which should not be above three or four years growth) making a perpendicular slit in the bark a little above an inch long, and another at right angles to it, at the lower end, to give way to the opening of the bark. This done, the bark is gently loosened from the wood on both sides with a pen-knife beginning at the bottom.

They then prepare the bud, cutting it off from the aforesaid vigorous shoot, and taking with it as much of the wood above as below it, and as near as may be to the length of the slit in the stock. When the bud is thus cut off, they take out the woody part of the bud, and put the bud itself in between the bark and the wood of the stock, at the cross slit before opened, leading it upwards by the stalk, where the leaf grew, till it exactly closes. They then bind it about with woollen yarn, the better to make all parts of it close exactly, that the bud may embody itself with the stock, which it will do in three weeks time.

This operation is said to best performed in a cloudy day, or in an evening; and it is observed, that the quicker it is done, the better it succeeds.

This practice has the advantage of engrafting in many respects, both as it is more secure, it seldom failing of having effect, especially if two or three buds are put into the same stock; and as its success is more readily discovered. Indeed when large stocks are to be pruned on, *inoculation* is not proper, and they are obliged to have recourse to grafting.

This one rule is observed to hold universally, *viz.* That no success is to be expected in *inoculation*, if the sap does not run well; that is, if the bark will not part readily from the wood of the stock.

ENGRAFTING is one of the principal operations in gardening, and that whereon the goodness of our fruit greatly depends.

It is very extraordinary that the seeds, or kernels, or stones of a fruit, as an apple, pear, peach, plumb, cherry, &c. being sown, degenerate in the ground; so that the tree arising from it is of another kind, a sort of wilding, harsher, sourer, and coarser than that of the parent tree. To correct this, trees thus reared, must be *grafted* from other better kinds.

Apples are commonly raised by *engrafting* the intended kinds on crab-stocks, procured by sowing the kernels: so are pears procured by *grafting* on the wild pear-stock: tho' for dwarf or wall-trees, they generally chuse to *engraft* on the quince-stock.

They will do also if *grafted* on the white-thorn. Peaches are produced on an almond or plumb-stock. Indeed in this fruit, it sometimes happens that the stone sown produces better fruit than that from which it was taken: but this is not common; beside, that the tree in such case, is long ere it comes to bear. Plumbs are raised by *engrafting* on a damson, or wild plumb-stock: and cherries on the black cherry, or merry-stock, raised from stones.

Our best gardeners likewise, *engraft* their less kindly trees from other better of the same sort, to mend them; as also the smaller and single flowers, gilliflowers, &c. from the larger and finer.

To produce stocks for ENGRAFTING on. The curious furnish us with other extraordinary and anomalous instances of *engrafting*: as of apples on plane, elder, thorn, cabbage-stalk, &c. and the like of pears, &c. Pears on apple-trees, on elms, &c. Cherries on the lawrel; coral berries on the plumb: beech on the chestnut, oak on the elm, gooseberry on the currant, the vine on the cherry-tree, &c.

The methods, or kinds of *engrafting* are various; as *grafting* in the cleft, *grafting* in the rind, *whip grafting*, *grafting* by approach, *scutcheon grafting*, *root grafting*, reiterated *grafting*, *grafting* on branches, &c.

The apparatus, or instrument used therein, are saws to cut off the heads of stocks; knives to make clefts; a chissel to pare away the wood; clay, mixed with horse-dung, to prevent freezing, and with tanners hair to prevent cracking; balsstrings, or woollen-yarn, to tie the *grafts* with, and *grafting* wax.

*GRAFTING in the cleft, or stock*, called also SLIT *GRAFTING*, is the most antient, and ordinary way; we have a very beautiful description of it in *Virgil, Geor. II. v. 78*. It is chiefly used for middle-sized stocks, from one to two inches diameter. Its season is the months of *January, February, and March*.—The method as now practised is thus.

The head of the stock being fawn, or cut off smooth and clean, a perpendicular cleft is made therein, nearly two inches deep, with a strong knife, or chissel, as near the pith as may be to miss it. In this cleft, the *grafting* chissel, or wedge, is put to keep it open. The *graft*, or cyon, is prepared by cutting it aslope, in form of a wedge, to suit the cleft; only leaving a small shoulder on each side: and, when cut, is to be placed exactly in the cleft, so, as that the inner bark of the cyon may aptly and closely join in the inner part of the bark or rind of the stock; in the dexterous performance of which, the chief secret consists, if the cleft pinch too tight, a small wedge may be left in it to bear the stress. And lastly, the cleft is covered over with clay; or rather, as Mr. *Gentil* advises, with moss, or the fresh bark of a tree bound on with osier.

*GRAFTING in the rind, or shoulder grafting*, called also *slicing*, and *packing*, is practised in the latter end of *April*, or the beginning of *May*. The method is as follows.

The top of the stock is cut off in a smooth, strait place: then the cyon, or *graft* is prepared by cutting on one side from the joint, or seam down sloopewise, making the slope about an inch long; and observing its bent, that so when the cyon is fixed to the stock, it may stand nearly upright. At the top of the slope they make a shoulder, whereby it is to rest on the slope of the stock. The whole slope to be plain and smooth, that it may lie even to the side of the stock. As to the length of the cyon, for a standard-tree, it may lie about four inches from the shoulder; but for a dwarf or wall-tree, six inches.

The cyon prepared; the out side is applied to the west, or south-west side of the stock, and its

length and breadth measured thereon; which done, the bark of the stock is cut away to those dimensions, that the cut part of the cyon may fit it. Wherein, regard is to be had to the bigness of the stock, and the thickness of the bark, to proportion the length and breadth of the chip thereto; otherwise the passages of the juice in the stock and cyon will not meet. Lastly, laying the cut-part of the cyon on that of the stock, they bind them together with woollen-yarn, and cover the whole with clay an inch above, and as far below, the stock's head; working it round the cyon till it become sharp at top, that the rain may run down it.

*GRAFTING, in the bark*, is performed thus. Prepare the stock and cyon, as in *grafting in the rind*; but instead of cutting the bark of the stock, slit the same on the south-west side from the top, almost as long as the sloped part of the cyon, and at the top of the slit loosen the bark, with the top of your knife. Thrust your instrument, made of ivory, silver or the like, and formed at the end like the slope end of the cyon, but much less, down, between the bark and wood, to make room for the cyon; which being put in the bark is to be so managed, as that it may fall close to the stock and edges of the cyon.

*GRAFTING by approach*, called also *inarching*, and *ablation*.

*Whip GRAFTING, or Tongue-GRAFTING*, is a sort of *grafting* in the rind, proper for small stocks, from an inch diameter to a quarter of an inch. Mr. *London* speaks of it as the most effectual way of any, and that most in use.

In this, the stock and cyon are to be of the same bigness. The cyon to be sloped off a full inch, or more; and the like to be done to the stock; and so the one to be tied to the other. Otherwise the top of the stock being cut off, a shoulder is to be made in the *graft*: and the rest to be performed as already shewn under *grafting in the rind*.

This method is also improved by what they call *tipping* or *tonguing*; which is the making a slit with a knife in the bare part of the stock downwards; and the like in the sloped face of the cyon, upwards; and then joining them, by thrusting one slice into the other, till the bare place of the cyon cover that of the stock.

*Side GRAFTING*. In this the cyon is prepared as in *whip-grafting*, but the head of the stock is not cut off, only from a smooth part on the west side, so much of the bark is pared off as the cyon will cover; then slitting both cyon and stock, as in the last article, they bind the two together, and close them up with clay. At the years end the top of the stock is cut off at the grafted place, sloopewise, and the place covered with clay.

*Scutcheon GRAFTING* is another method of grafting, in the rind, practised in *June, July,* and *August*; when the bark will not part from the stock. It is performed, by slitting the bark of the stock in form of the capital letter T, loosening it with the point of a knife, and clapping in a cyon, prepared as above.

*Crown GRAFTING* is when four or more grafts are placed round the stock, between the bark and the rind, somewhat in the manner of a crown. — This is only practised in the larger trees, which are capable of receiving a number of grafts, and are too big to be cloven. The method is in all respects the same as that already delivered for grafting in the rind.

*Root GRAFTING* is a modern invention, treated of at large by *Agricola*: Its intention is somewhat different from the former, being for the propagation, or multiplication of plants.

To perform this, take a graft, or sprig of a young tree, which you intend to propagate; and a small piece of the root of another tree of the same kind, or very like it; or else pieces of roots cut off of other trees, in transplanting; and whip-graft them together, observing that the two but-ends of the graft and root be united, and that the rind of the root join that of the graft. These may, afterwards, be planted out at pleasure, and the piece of root will draw the sap, and feed the graft, as the stock does the other way.

This way of propagation is very easy and expeditious; roots being more plentiful than stocks: by this method the pieces of roots of one crab stock, or apple-stock, will serve for twenty or thirty apple grafts, and the like of other trees. The same is an excellent way for raising of tender trees, that will hardly bear, being grafted in the stock. Add, that trees thus grafted, bear sooner, and are more easily dwarfed than those done any other way.

*Reiterated GRAFTING*, or grafting by a double, or triple incision, is another method mentioned by *Agricola*: To perform which, first graft a good cyon on a stock, and cut it away to one half, or a third part; then fix another graft to it, of a better kind; and a third to that: for still the oftner a tree is engrafted, the finer fruit it produces.

By this method, that author assures us, he produced muscat pears that were admirable; making, at first, use of a stock grafted with a pound pear, on which he grafted a summer *bon chretien*; and when the branch of this latter had shot, he grafted on it a cyon of bergamot, which he also cut, and grafted on it a cyon of muscat pear.

*ENGRAFTING of branches*, *Agricola* mentions as a very certain and profitable operation best practised on large full grown, and even old trees.

To do this, half or more of the branches must be lopped off, and grafts of three or four years old be applied to them; taking care to have stakes or other things to support them against the wind, &c.

He adds, that by this method, you will have, perhaps, the same year, at least, the second or third, such a quantity of fruit, as the youngest and foundest tree would hardly produce.

All sorts of trees are raised in a nursery, which is a *seminary* or seed-plot.

Some authors make a difference between *nursery*, and *seminary*, holding the former not to be a place wherein plants are sown; but a place for the reception and rearing of young plants, which are removed, or transplanted hither from the *seminary*, &c.

Mr. *Lawrence* recommends the having several nurseries, for the several kinds of trees: one for tall standards; viz. apples, alders, elms, limes, oaks, pears, sycamores, &c. Another for dwarfs; viz. such as are intended for apricots, cherries, peaches, plumbs, &c. And a third for ever-greens.

The nursery for standards should be in a rich, light soil, sown with the proper seeds, in *October* or *November*. For apples, and pears, crab and wild pear kernels, are to be preferred for stocks: elms and lime are to be raised from planted suckers: walnuts to be sown with the green shell upon them, to preserve them from mice. This nursery, if it be well managed and weeded for two years, the crabs and pears will be fit for grafting and inoculating the third year.

Firs and pines are to be raised from those little seeds taken out of their large apples.

The nursery for dwarfs does best by itself, that it may not be over-topped by taller trees. Stones of apricots and peaches are not proper to raise those trees; but in lieu thereof, sow the stones of pear-plumbs, muscel, or *bonum magnum* plumb; which prove better and more lasting than the former. For stocks of all sorts of cherries, black cherry, stones do best.

Mr. *Mortimer* directs all stone-fruit to be sown quickly after gathering; for that if they be kept, they will be two years e'er they come up. Add, that if they have not all the moisture of the winter to rot the shells, the kernel will scarce come up at all.

To furnish the nursery of ever-greens, the several sorts of seeds or berries, as yew, holly, juniper, &c. are to be put in so many distinct pots or boxes, with fine mould over them, and thus buried for a year; after which, they are to be taken out and sown.

EVER-GREENS are a species of perennials, which continue their verdure, leaves, &c. all the year.

Of these, our gardeners reckon twelve, fit for *English* air, viz. the alternus, arbutus, bay tree, box-tree, holley, juniper, laurustinus, phyllirea, pyracantha, or ever green thorn, *Italian* green privet, and the yew tree. If they were to be sown when gathered, like other seeds, they would not come up the first year, nor grow so kindly.

ORCHARDS are stocked by transplantation; seldom by femination.

The season for transplanting apple-trees into orchards, is in the months of *October* and *November*.

If the leaves be not all off at the time they are removed, they must be pulled off. They are likewise to be pruned. Trees may be transplanted into orchards, after three years grafting; and ought not to be set at a less distance than eight yards, nor greater than fourteen: and the richer the land, the greater the distance.

The trees are transplanted to best purpose, when young: for trees ten or twelve years old, a narrow trench must be dug the *November* before, deep enough to meet the spreading roots, at such a distance all around the tree, as the roots are to be cut off at; in making the trench, the roots to be cut off clean, and without splitting or bruising the bark, and the trench filled up again. This will enable the tree, upon removal, to draw more nourishment than otherwise it would; and so thrive better in its new mansion.

The side branches of all tall orchard fruit-trees, are to be cut off, till the tree be arrived at the height desired.

If the tree be to spread low, some are to be left on each side; so as to form a kind of ballance. For the first three years, at least, they must not grow thick and bushy headed: this must be prevented by cutting off some of the inside shoots, and such as grow cross each other, or pendant.

The soil, if not rich enough, is to be amended in two or three years; by opening it around the tree, and on the outside of the ground first dug, when the tree was set; and in a month's time filling it up again with a proper compost or manure.

TRANSPLANTING of fruit-trees. — After a summer's growth of fruit seedlings in the seminary, such are pulled up as are above a foot high, and transplanted into a nursery; the rest to be left in the seed-plot till another year.

When drawn up, the sprigs are to be cut off from about the top, the strings from the roots, and the extremities both of the top, that it may

not run too fast upwards, and of the tap or heart-root, that it may not pass directly downwards; lest it go beyond the good soil. The holes or pits to be so deep, as that the plants may stand somewhat deeper in the ground, than when in the seed-plot; close the mould about them, and if it be a dry time, water them the first day, and cover the soil with old fern.

Mr. *Bradley* gives us a new method of transplanting trees of all kinds and ages with safety, either while they are in the blossom, or with fruit upon them, thus: the holes to receive the trees are to be prepared before the trees are taken up, and the earth which comes out of the holes to be made very fine and put into large tubs, and mixed with water, till it be about the consistence of thin batter. Then the holes wherein the trees are to be planted, are to be filled with this thus-tempered earth, before the earthy parts have time to settle.

The advantage hereof is, that the trees thus planted have their roots immediately inclosed and guarded from the air; and the warm season of the year disposing every part of the tree for growth and shooting, it will lose very little of its vigour. In winter it does not succeed.

The same author adds, that in consideration of the circulation of the sap, it is as necessary to preserve the vessels of the trees entire, as those in animal bodies, and therefore in transplanting trees in the summer seasons, it is not proper to cut off any of the branches, or wound any of the vessels, till they have renewed their roots, which it is of absolute necessity to wound in transplanting them. For the wounded roots he has provided a plaister of a mixture of gums, to prevent the canker and rot, and promote their healing.

PRUNING in gardening and agriculture, is the operation of lopping or cutting off the superfluous branches of trees; either to dispose them to bear better, to grow higher, or appear more regular.

Pruning is one of the most important branches of the gardener's province; and that whereon the weal or woe of his fruit-trees, as well as the form and regularity of his garden, in great measure depends.

Pruning is an annual operation; the amputation is usually made sloping, sometimes stump-wise. Its best season is about the end of *February*, though it may be begun as soon as the leaves are off, viz. in *November*; and continued to the time fresh leaves comes on, viz. in *April*.

As the Gardener has usually three kinds of trees to manage, viz. Some too weak, others too strong, and others in a just plight; he will find pruning-work enough through all that space; it being proper to prune some sooner and some later. The

weaker and more languishing a tree is, the sooner it ought to be *pruned*, to ease it of its offensive branches: and the more vigorous the tree is, the longer may the *pruning* be deferred.

For *PRUNING* a tree of the first year, *i. e.* a tree planted the year before: if it have only shot one fine branch from the middle of the stem, it must be cut to that branch, and the branch shortened to four or five eyes or buds: the effect of which is, that the next year there will be, at least, two fine branches opposite to each other.

If the tree produce two fine branches, well placed, with weak ones among them, all required is to shorten them equally, to the compass of five or six inches in length; care, however, being taken, that the two last eyes or buds, of the extremes of the branches thus shortened, look on the right and left, to the two bare sides, that each may bring forth, at least, two new ones, and the four being so well placed, that they may be all preserved. If one of the two branches be much lower than the other, or both on one side, or the like, only one is to be preserved, and that the fittest to begin a fine figure; the other to be cut off so close, as that it never may be able to produce thick ones in the same place. If a tree have put forth three or four branches, all in the extremity, or a little beneath, they must be all *pruned* by the same laws as the two above-mentioned: if they be equally thick they are to be used alike; if some of them be smaller than the rest, they must only be *pruned*, with a prospect of getting a single branch each, taking care to have it on that side which shall be found empty; in order to which, they should be shortened to an eye or bud, that looks on that side; and the same care to be taken in the larger, in order to begin to fill up the better: if these fine branches shoot a little below the extremity, it is but shortening the stem to them: on the contrary, if the branches be most of them ill ones, two at least, if possible, are to be preserved, and *pruned* in the same manner as the two fine ones above. Good weak branches are to be carefully preserved for fruit, only cutting them a little at the extremity. when they appear too weak for their length, not failing to take away all the sapless branches. If the tree have produced five, six, or seven branches, it is sufficient to preserve three or four of the best; the rest to be cut quite off, at least if they be thick; but if they be weak, *i. e.* fit for fruit branches, they should be kept till they have performed what they are capable of doing; and if among the great ones, there happen to be many small ones, two or three of the best only to be preserved, pinching off the ends of the longest.

*PRUNING* of a tree the second year. — If having

put out two fine wood branches, and one or two small ones, for fruit the first year, the sap have altered its course in the second year, from the thick branches to the small ones, so that the small become wood, and the large, fruit branches. If a tree from the first year's *pruning*, have produced four or five branches, or more, it must needs be very vigorous: for which reason it may be sometimes adviseable to preserve those branches; even though it be not necessary to the figure of the tree, but even to consume part of the sap, which might otherwise be prejudicial to the fruit branches; these superfluous branches may be left long, without any ill consequence; but those essential to the beauty of the tree, must be all *pruned*, a little longer than those of the preceding year, *i. e.* about two, or at most three eyes, or a good foot. This is making an advantage of the figure of the tree, which without this would not yield fruit in a long time; the redundant sap converting all the sap in wood-branches. In these vigorous trees, some branches cut stumpwise are to be left on, and even some thick ones, though of false wood, especially where they are necessary to the form of the tree, or employ the excess of sap, and prevent its doing mischief. Still more to assuage its violence, it may be necessary to preserve many long, good, weak branches, when placed so as to occasion no confusion, and even on the thick branches, a good number of out-lets for the sap to range in. Be it a general rule, rather to spare the lower branches, and cut off the higher, than the contrary: by this means the tree spreads more easily to the bottom of the wall.

*PRUNING* of a tree of the third year. In a tree that has been planted three years, and *pruned* twice, if it be vigorous, as many old branches as possible, are to be preserved, especially for fruit: if it be weak, it must be eased of the burden of old branches, as well those for fruit, as wood; it must be cut short, to enable it to shoot out new ones; which if it cannot do with vigour, let it be pulled up, and a new one, with fresh earth, planted in its place.

In all *pruning*, provision is to be made for branches to proceed from those now under the *pruning* knife, to prepare such as may be proper for the form; with this assurance, that when the high branch is taken down from over the lower, this latter being reinforced with the sap that would have gone to the former, will certainly produce more branches, than it would have done without such reinforcement.

*General rules* of *PRUNING* fruit trees, 1. The more the branches shoot horizontally, the apter and better disposed the tree is to bear fruit; consequently

frequently the more upright the branches, the more inclined is the tree to increase in wood, and the less in fruit.

Hence, ever take care to keep the middle of a tree from great wood, or thick branches; and as those increase and grow upon you, you cut them out entirely; for the place will be soon filled with better and more fruitful wood.

In dwarfs, you are to prune all open, and clear of wood, leaving none but horizontal branches; and in wall trees, if you do but furnish your walls with horizontal branches, nature will provide for the middle. Chuse therefore such shoots as are not vigorous, to furnish bearing branches.

2. Take care the tree be not left over full of wood; nor even of bearing branches; as it is frequently seen in the management of peaches, nectarines, and cherries.

Nature cannot supply them all with juice enough; whence none will be supplied well: the consequence of which is, that either the blossoms will fall off, or the fruit dwindle. It is certain, a multitude of branches crowding on one another, produces neither so good, nor so much fruit, as where there is a convenient space; beside the disagreeable effect of crossing one another.

3. All strong and vigorous branches are to be left longer on the same tree, than weak and feeble ones; consequently, the branches of a sickly tree, must be *pruned* shorter, and fewer in number than those of a strong healthful tree.

4. All branches shooting directly forward from trees that grow against a wall, are to be *pruned* close to the branch whence they spring, &c.

5. When a branch, well placed either against a wall, or in a dwarf, has shot some false wood, neither fit for the figure nor the fruit, prune it off within the thickness of a crown piece, or slopingly; though this is best *pinched* off in the beginning of summer.

6. Cut off all branches arising from hard knobs whereon pear-stalks grew; or from short branches, like spurs.

7. If a tree, in its years, have produced branches of moderate vigour, and afterwards puts forth strong ones, well placed, though of false wood; the latter may be used as the foundation of the figure, and the other kept a time for bearing fruit.

8. When an old tree shoots stronger branches towards the bottom than the top, and the top is in ill case, cut it off, and form a new figure from the lower ones. If the top be vigorous, cut off the lower ones, unless well placed.

9. The order of nature, in the production of roots and branches, is, that branch is always less than that out of which it shoots: if this order be inverted, use them as false wood.

10. Regard to be always had to the effects of former *pruning*, in order to correct its defects, or continue its beauties.

11. In vigorous trees, the weaker branches are the fruit bearers; in weaker trees, the stronger chiefly: therefore in the latter, *prune* off the feeble and small.

12. In vigorous trees, three good branches may put forth at one eye or bud; in which case, the two side branches are generally to be preserved, and the middlemost cut off in *May* or *June*.

13. It is difficult to strengthen a weak branch, without cutting off others above it; sometimes it can scarce be done, without cutting off the end of the branch it shoots out of.

14. The *pruning* of vigorous peach trees, to be deferred till they are ready to blossom, the better to know which are likely to bear fruit.

15. Fruit-buds, next the ends of branches, are commonly thick and better fed than others. In weak trees, therefore, it may be best to *prune* them early, that the sap may not waste itself in such parts as are to be retrenched.

16. The farther a weak branch is from the trunk, the less nourishment it receives, and therefore, the more it is to be shortened; but thick branches, the more distant they are from the heart, the more they receive; and are therefore to be removed, that the vigour may extend itself to the middle, or lower part.

17. A branch for wood must never be *pruned*, without especial occasion; as where it annoys others.

18. If an old well-liking tree be disordered with false wood, through ill *pruning*, or want of *pruning*; take it lower, by cutting off a branch or two yearly, till it be sufficiently reduced. Some trees put forth so vigorously, that they cannot be reduced to compass, in one year; but must be allowed to extend themselves, otherwise they will produce false wood.

19. All trees have a predominant branch or two, if not more; yet the more equally the vigour is divided, the better; where it runs much on one side, it is faulty.

20. The buds of all stone-fruit, frequently form themselves the same year, in which the branch they grow on was formed: the same holds of pears and apples; tho' it is, generally, at least two or three years, ere the latter come to perfection.

21. All shoots, put forth in autumn, are to be *pruned* off as naught: the same may be said of all sapless branches.

22. When a tree puts forth much stronger shoots on one side, than the other, a great part of the strong ones must be cut off close to the body, or some of them stump-wise.

23. In all trees, less length to be allowed the weak, than strong branches.

24. Upper branches to be cut off close to others, that they may heal over: lower branches are to be cut sloping, or at a little distance, that new ones may grow out of them.

25. If a young crooked tree produce a fine branch beneath the crook, cut the head off close to the branch.

26. Though five, six, or seven inches, be the ordinary lengths, wood-branches are left at; yet must this be varied on occasion of the vigour or weakness of the tree, thickness, or smallness of the branch, the fulness or vacuity of the place, &c.

27. Be careful not to *prune* many thick branches standing over weak ones; lest the sap, which fed the larger, flow so plentifully into the less, as to occasion them to put forth ill wood and suckers.

28. Branches shot from the ends of others are usually good wood; sometimes it happens otherwise, and then they must be *pruned*.

As to the grand *yearly prunings*:—Fruit branches being of short continuance, and perishing the first year, wherein they produce fruit, are to be cut off, unless they put forth shoots, for blossoms the succeeding year. In the second *pruning*, about the middle of *May*, where the fruit is so close as to be like to obstruct each other, some of them, and their branches are to be taken off, as must also the multitude of young shoots, that cause confusion. Branches more luxurious than others, to be cut clear off.

To preserve old trees, they must be disburdened, by leaving few branches, for wood on them, and those to be shortened to five or six inches; and very few weak ones, and none dry, and nigh wasted.

## G A U G I N G.

**G**AUGING is the art or act of measuring the capacities or contents of all kinds of vessels, and determining the quantities of fluids or other matters contained therein.

The art of *gauging* is that branch of the *mathematics* called *stereometry*, or the measuring of solids; because the capacity of all sorts of vessels used for liquors, as *cubical, parallelopipedal, cylindrical, spheroidal, conical, &c.* are computed as though they were really solid bodies, and reduced thereby to some known cubic measure, as *gallons, quarts, pints, &c.* The principal vessels that come under its operation are *pipes, barrels, rundlets*, and other *casks*; also *backs, coolers, vats, &c.*

The solid content of cubical, parallelopipedal, and prismatical vessels is easily found in cubic inches, or the like, by multiplying the area of the base by the perpendicular height. And for cylindrical vessels, the same is found by multiplying the area of the base by the perpendicular altitude as before.

Casks of the usual form of hogheads, kilderkins, &c. may be considered as segments of a spheroid cut off by two planes, perpendicular to the axis; which brings them to *Oughtred's* theorem for measuring ale and wine-casks, which is thus:

Add twice the area of the circle at the bung, to the area of the circle of the head; multiply the sum by one third of the length of the cask, the product is the content of the vessel in cubic inches.

But for accuracy, *Dr. Wallis, Mr. Caswell*, and others, think that most of our casks had better be considered as *frustums* of parabolic spindles, which

are less than the *frustums* of spheroids of the same base and height, and give the capacity of vessels nearer the truth than either *Oughtred's* method, which supposes them spheroids; or than that of multiplying the circles of the bung and head, into half the length of the cask, which supposes them parabolic conoids; or than that of *Clavius, &c.* who takes them for two truncated cones, which is farthest off of all.

The common rule for all wine or ale-casks, is to take the diameters at the bung and at the head, by which you may find the area of the circle there; then taking two thirds of the area of the circle at the bung, and one third of the area of the circle at the head, and adding them together into one sum; this sum multiplied by the internal length of the cask, gives the content in solid inches; which are converted into gallons by dividing by 282 for ale, and 231 for wine-gallons.

*Gauging*, as now practised, is chiefly done by means of *instruments* called *gauging-rods* or *rules*, which do the business at once, and answers the question without so much calculation: which is no inconsiderable addition both to the ease and dispatch of the work, though it is not so much to be depended on.

The methods of *gauging* which are mostly used, is by the *four-foot gauging-rod*, and *Everard's sliding rule*: the description and uses of both are as follows:

The *four-foot GAUGING-ROD* (See the figure on the plate of SURVEYING) is usually made of box, and consists of four rules, each a foot long, and about

about three eights of an inch square, joined together by three brass-joints; by which means the rod is rendered four feet long when the four rules are opened, and but one foot when all are folded together.

On the first face of this rod, marked 4, are placed two diagonal lines, one for beer and the other for wine; by means of which the content of any common vessel in beer or wine-gallons, may be readily found, by putting the brafed end of the gauging-rod into the bung-hole of the cask, with the diagonal lines upwards, and thrust this brafed end to the meeting of the head and staves; then with chalk make a mark at the middle of the bung-hole of the vessel, and also on the diagonal lines of the rod, right against or over one another, when the brafed end is thrust home to the head and staves; then turn the gauging-rod to the other end of the vessel, and thrust the brafed end home to the end as before. Lastly, see if the mark made on the gauging-rod, come even with the mark made on the bung-hole, when the rod was thrust to the other end; which if it be, the mark made on the diagonal lines will, on the same lines, shew the whole content of the cask in beer or wine-gallons. If the mark made on the bung hole be not right against that made on the rod, when you put it the other way, then right against the mark made on the bung-hole, make another on the diagonal lines; and the division on the diagonal line, between the two chalks, will shew the whole content of the vessel in beer or wine-gallons.

Thus, *ex. gr.* if the diagonal line of a vessel be  $28\frac{1}{8}$  inches, its content in beer-gallons will be nearly 51, and in wine gallons 62.

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

If you have a large vessel, as a tun or copper, and the diagonal line taken by a long rule be 70 inches; then every inch at the beginning-end of the diagonal line call 10 inches: thus 10 inches become 100 inches; and every tenth of a gallon call 100 gallons; and every whole gallon call 1000 gallons.

On the second face, 5, are a line of inches and the gauge line, which is a line expressing the areas of circles (whose diameters are the correspondent inches) in ale-gallons: at the beginning is wrote *ale-area*. Thus, to find the content of any cylindrical vessel in ale-gallons: seek the diameter of the vessel in inches, and just against it, on the gauge-line, is the quantity of ale-gallons contained at one

inch deep; this multiplied by the length of the cylinder, will give its contents in ale-gallons.

On the third face, 6, are three scales of lines; the first, at the end of which is written *hoghead*, is for finding how many gallons there are in a hoghead, when it is not full, lying with its axis parallel to the horizon. The second line, at the end of which is written *B. L.* is for the same purpose. The third is to find how much liquor is wanting to fill up a butt, when it is standing; at the end of it is wrote *B. S.* signifying, *butt standing*.

Half way the fourth face of the gauging-rod, 7, there are three scales of lines, to find the wants in a firkin, kilderkin, and barrel, lying with their areas parallel to the horizon. They are distinguished by the letters *F. K. B.* signifying a firkin, kilderkin, and barrel.

The use of the lines on the two last faces is very easy; you have only to put it downright into the bung-hole to the opposite staves, if the vessel, you want to know the quantity of ale-gallons contained therein, be lying: and then where the surface of the liquor cuts any one of the lines appropriated to that vessel, will be the number required.

EVERARD'S *sliding-rule* is principally used in gauging, being ordinarily made of box, a foot long, an inch broad, and  $1\frac{1}{16}$  inch thick, with two small scales to slide in it, which may be drawn out, one towards the right hand, and the other towards the left, till the whole be three feet long. See the figure thereof, *ibid.*

On the first broad face of the instrument are four lines of numbers; the first marked *A*, consisting of two radius's, numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, 10; and then 2, 3, 4, 5, &c. to 10. On this line are four brass center-pins, two in each radius; one in each whereof is marked *M B*, to signify that the number it is set against, 2150.42, is the cubic inches in a malt bushel; the other two are marked with *A*, to signify that the numbers they are set against, *viz.* 282, are the cubic inches in an ale-gallon. The second and third lines of numbers are on the sliding-pieces, and are exactly the same with the first. Close to the figure 7, in the first radius, is a dot marked *S i*, set exactly over 707, denoting .707 to be the side of a square inscribed in a circle, whose diameter is unity. Close to 9, is another dot, mark'd *S e*, set over .886, which is the side of a square, equal to the area of a circle whose diameter is unity. Another dot, nigh *W*, is set over 231, the number of cubic inches in a wine gallon, and another near *C*, is set over 3.14, the circumference of a circle, whose diameter is unity. The fourth line of numbers marked *M D*, to signify *malt depth*, is a broken line

line of two radius's, numbered 2, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 9, 8, 7, &c. the number 1 being directly set against M B on the first radius.

On the second broad face, marked *cd*, are, 1. A line of numbers of one radius, numbered 1, 2, 3, &c. to 10, noted by the Letter D, on this are four center-pins; the first marked W G, is the *gauge-point* for a wine-gallon, *i. e.* the diameter of a cylinder, whose height is an inch, and contents 231 cubic inches, or a wine-gallon, which is 17.15 inches; the second center-pin A G, stands at the *gauge-point* for an ale-gallon, which is 18.95 inches; the third M S, stands at 46.3, the side of a square, whose content is equal to the inches in a solid bushel; the fourth M R, is the *gauging-point* for a malt bushel, which is 52.32 inches.

—2. Two lines of numbers on the sliding piece, which are exactly as those on the sliding piece on the other side. Close to the division 8 is a dot marked *c*, which is set to .795, the area of a circle whose diameter is unity; and another marked *d*, stands at .785, the area of a circle whose diameter is unity. —3. Two lines of segments, each numbered 1, 2, 3, &c. to 100; the first for finding the ullage of a cask, taken as the middle frustum of a spheroid, lying with its axis parallel to the horizon; and the other for finding the ullage of a cask standing—Again, on one of the narrow sides, noted *e*, are 1. A line of inches, numbered 1, 2, 3, &c. to 12; each subdivided into ten equal parts. 2. A line by which, with that of inches, we find a mean diameter for a cask, in the figure of a middle frustum of a spheroid; it is numbered 1, 2, 3, &c. to 7, and marked *spheroid*. 3. A line for finding the mean diameter of a cask, in the figure of a middle frustum of a parabolic spindle, which *gaugers* call the second variety of casks; it is numbered 1, 2, 3, 4, &c. and noted *second variety*. 4. A line by which we find the mean diameter of a cask of the third variety, *i. e.* of a cask in the figure of two parabolic conoids, abutting on a common base; it is numbered 1, 2, 3, and noted *third variety*.—On the other narrow face, marked *f*, are, 1. A foot divided into 100 equal parts, marked *fM*. 2. A line of inches, like that before-mentioned, noted *IM*. 3. A line for finding the mean diameter for the fourth variety of casks, which is the middle frustum of two cones, abutting on a common base; it is numbered 1, 2, 3, &c. and noted *fC*, signifying *frustum of a cone*.—On the backside of the two *sliding* pieces, are a line of inches, from 13 to 36, when the two pieces are put endwise; and against that the correspondent gallons, or hundred parts, that any small tub, as the like open vessel from 13 to 36 inches diameter, will contain at one inch deep.

After this description of *Everard's sliding rule*, we must apply it to the use we intend to make of it in this place, *viz.* *gauging*. Beginning, by finding the area in inches, or in wine, or ale-gallons, of the diameter of a circle given; and supposing that diameter 20 inches, we will set 1 upon D, to .785 (noted *d*) on C, then against 20 on D is 314.159 the area required. Now to find that circle's area in ale-gallons, we will set 18.95 (marked A G) upon D, to 1 on C; then against the diameter 20 upon D, is the number of ale gallons on C, *viz.* 1.11. The same may serve for wine-gallons, having only regard to the proper *gauge-point*.

The two diameters of an ellipsis being given, to find the area in ale-gallons. Suppose the transverse diameter 72 inches, and the conjugate 50; we will set 359.05, the square of the *gauge point* on B, to one of the diameters (suppose 50) on A; then against the other diameter 72 on B, we will have the area on A, *viz.* 10.02 gallons, the content of this ellipsis at one inch deep: the like may be done for wine-gallons, if instead of 359.05 we use 249.11 the square of the *gauge-point* for wine-gallons.

To find the area of a *triangular surface*, in ale-gallons: suppose the base of the triangle 260 inches, and the perpendicular let fall from the opposite angle 110 inches; we will set 282 (marked A) upon B to 130, half the base on A; then against 110 on B is 50.7 gallons on A.

To find the content of an *oblong* in ale-gallons: suppose one side 130 inches, and the other 180; we will set 282 on B, to 180 on A; then against 130 upon B is 82.97 ale-gallons, the area required.

To find the content of a *regular polygon*, in ale-gallons, one of the sides being given: we find the length of the perpendicular let fall from the center to one of the sides; this multiplied by half the sum of the sides, gives the area. For instance: suppose a pentagon, whose side is 1 inch; here the perpendicular will be found .837, by saying as the sine of half the angle at the center, which in this polygon is  $36^\circ$ , is to half the given side .5, so is the sine of the complement of  $36^\circ$ , *viz.*  $54^\circ$  to the perpendicular aforesaid: whence the area of a pentagon, whose side is unity, will be found 1.72 inches; which divided by 282, give .0061 the ale-gallons in that polygon.

To find the content of a cylinder in ale-gallons: suppose the diameter of the base of the cylinder 120 inches, the perpendicular height 36 inches; we will set, therefore, the *gauging-point* (A G) to the height 36 on C; then against 120, the diameter on D, is found 1443.6, the content in ale-gallons.

The bung and head diameters of any cask, together with its length, being given; to find its content in ale or wine-gallons: 1. Suppose the length of a cask taken (as the middle frustum of a spheroid, which is the first case or variety) be 40 inches, its head-diameter 24 inches, and bung-diameter 32 inches; we will subtract the head-diameter from that of the bung, the difference is 8. Then we look for 8 inches on the line of inches, on the first narrow face of the rule; and against it, on the line spheroid, stands 56 inches, which added to the head-diameter 24, gives 29.6 inches for that cask's mean diameter; we set therefore the gauge-point for ale (marked A G) on D, to 40 on C; and against 29.6 on D, is 97.45, the content of the cask in ale-gallons. If the gauge-point for wine (marked W G) be used instead of that for ale, we will have the vessel's content in wine-gallons. 2. If a cask of the same dimensions as the former be taken (as the middle frustum of a parabolic spindle, which is the second variety) we will see what inches, and parts, on the line marked *second variety*, stand against the difference of the bung and head-diameters, which in this example is 8; and we will find 5.1 inches, which added to 24, the head diameter, makes 29.1 inches, the mean diameter of the cask, we will therefore set the rule as before, and against 29.1 inches, we will have 94.12 ale-gallons for the content of the cask. 3. If the cask taken be the middle frustum of two parabolic conoids, which is the *third variety*; against 8 inches, the difference of the head and bung-diameter, on the line of inches, we will find 4.57 inches on the line called *third variety*; this added, as before, to 24, gives 28.57 for the cask's mean diameter: proceeding as before, we will find the content 90.8 gallons. 4. If the cask taken be the frustums of

two cones, which is the *fourth variety*, against 8 inches, on the line of inches, we will find on the line marked *fC* 4.1 inches, to be added to 24 inches: the rest carried on as before, gives the content of the cask 87.93 ale-gallons.

A cask partly empty, lying with its axis parallel to the horizon, to find the quantity of liquor therein, we find its whole content as above; which suppose 97.455 gallons, and suppose the inches left dry 8, and the bung-diameter 32: then as the bung-diameter on C is to 100 on the line of segments L, so are the dry inches on C to a fourth number on the line of segments: and as 100 upon B is to the cask's whole content on A, so is that fourth number to the liquor wanting to fill up the cask; which subtracted from the whole content of the cask, gives the liquor remaining therein. *ex. gr.* Set 32, the bung-diameter on C, to 100 on the segment line L; then against 8, the dry inches on C, stands 17.6 on the segment line: set therefore 100 on B, to the cask's whole content on A; and against 17.6 on B, you have 16.5 gallons on A; subtracting therefore the said gallons from 97.45, the vessel's whole content, the liquor in the cask will be 8.95 gallons.

To find the liquor in a cask standing upright, or with its axis perpendicular to the horizon; suppose the length of the cask 40 inches, and 10 of them dry; we will set 40 inches on the line C, to 100 on the segment line S; and against 10, the dry inches on the line C, stand 24.2 on S, the segment line. Then we set 100 on B, to 97.455, the cask's whole content on A; against 24.2 on B, we will have 23.5 gallons, which is what is wanting to fill up the cask; this therefore subtracted from the whole content 97.455 gives 73.955 gallons, for the quantity of liquor remaining in the cask.

## G E O G R A P H Y.

**T**HE science of GEOGRAPHY. (from *γῆ*, earth, and *γράφω*, I write) chiefly consists in a description of the surface of the *terrestrial* or *terracuous globe*; so called, because it is composed of *land* and *water*: so that it differs from *chorography*, and *topography*, as the whole from a part; and from *cosmography*, as a part from the whole.

COSMOGRAPHY describes the whole visible world, both the heavens and the earth.

CHOROGRAPHY describes some principal part of the earth, as *England*, *France*, &c.

TOPOGRAPHY only describes some particular district, city, &c. in that principal part.

The best *Geographers* divide GEOGRAPHY into *general* and *special*, or *universal* and *particular*.

By *universal geography*, is understood that part of the science which considers the whole earth in general, and explains its properties without regard to particular countries. This division is distinguished into three parts, *absolute*, *relative*, and *comparative*. The *absolute* part respects the body of the earth itself, its parts and peculiar properties, as its *figure*, *magnitude*, and *motion*; its *lands*, *seas*, and *ivers*, &c. The *relative* part accounts for the appearances and accidents that happen to it from celestial causes; and, lastly, the *comparative* contains an explanation of those properties which arise from comparing different parts of the earth together.

*Special or particular geography*, is that division of the science which describes the constitution and situation of each single country by itself; and is twofold, *viz. chorographical or topographical*.

Hence the object or subject of *geography* is the earth, especially its superficies and exterior parts.

The properties of *geography*, are of three kinds, *viz. celestial, terrestrial, and human*. The *celestial* properties are such as affect us by reason of the apparent motion of the sun and stars. These are eight in number. 1. The elevation of the pole, or the distance of a place from the equator. 2. The obliquity of the diurnal motion of the stars above the horizon of the place. 3. The time of the longest and shortest day. 4. The climate and zone. 5. Heat, cold, and the seasons of the year; with rain, snow, wind, and other meteors. 6. The rising, appearance and continuance of the stars above the horizon. 7. The stars that pass through the zenith of a place. 8. The celerity of the motion with which, according to the *Copernican hypothesis*, every place constantly revolves.

The *terrestrial* properties are those observed in the face of each country, and are ten in number. 1. The limits and bounds of each country. 2. Its figure. 3. Its magnitude. 4. Its mountains. 5. Its waters, *viz.* springs, rivers, lakes, and bays. 6. Its woods and deserts. 7. The fruitfulness and barrenness of the country, with its various kinds of fruits. 8. The minerals and fossils. 9. The living creatures there. 10. The longitude and latitude of the place.

The third kind of observations to be made in every country is called *human*; because they chiefly regard the inhabitants of the place, and these are also ten in number. 1. Their stature, shape, colour, and the length of their lives; their origin, meat, and drink. 2. Their arts, and the profits which arise from them, with the merchandize and wares they barter one with another. 3. Their virtues and vices, learning, capacities, and schools. 4. Their ceremonies at births, marriages and funerals. 5. The language which the inhabitants use. 6. Their political government. 7. Their religion and church government. 8. Their cities and famous places. 9. Their remarkable histories. 10. Their famous men, artificers, and inventions of the natives.

These are the three kinds of occurrences to be explained in *special geography*.

In *Universal Geography*, the absolute division of the earth, and the constitution of its parts, are examined; and the celestial phenomena in general are to be applied to their respective countries in *special geography*.

*Geography* is very antient, at least the *special* part thereof; for the antients scarce went beyond the description of the countries. It was a constant custom among the *Romans*, after they had conquered and subdued any province, to have a map or printed representation thereof, carried in triumph, and exposed to the view of the spectators. Historians relate, that the *Roman* senate, about an hundred years before *CHRIST* sent *geographers* into divers parts to make an accurate survey and mensuration of the whole globe, but they scarce ever saw the twentieth part of it.

Before them, *Neco* king of *Egypt*, ordered the *Phœnicians* to make a survey of the whole coast of *Africa*, which they accomplished in three years. *Darius* procured the *Ethiopic* sea, and the mouth of the *Indus* to be surveyed; and *Pliny* relates, that *Alexander*, in his expedition into *Asia*, took two *geographers* to measure and describe the roads; and that from their *itineraries*, the writers of the following ages took many particulars. Indeed this may be observed, that whereas most other arts and sciences are sufferers by war, *geography* and *fortification* alone have been improved thereby.

*Geography*, however, must have been exceedingly defective, as a great part of the globe was then unknown, particularly all *America*, the northern parts of *Europe* and *Asia*, with the *Terra Australis*, and *Mazellanica*; and as they were ignorant of the earth's being capable to be said round, and of the torrid zone's being habitable, &c.

The honour of reducing *geography* to art and system was reserved for *Ptolemy*, who, by adding mathematical advantages to the historical method in which it had been treated off before, has described the world in a much more intelligible manner: he has delineated it under more certain rules, and by fixing the bounds of places from longitude and latitude, hath discovered others mistakes, and has left us a method of discovering his own.

We will begin with *general or Universal Geography*.

This division of the science considers the earth as a *spherical globe*, or nearly so; whose circumference is 360 degrees, of 60 geographical miles each; so that the whole circuit is 21600 such miles, and if the diameter was a third part of the circumference, the diameter would be 7200 miles; but the diameter is as 7 to 22, which makes it something less than a third part of the circumference. If we reduce the geographical miles to *English* miles the circumference of the earth will be about 24,000 miles, and the diameter 8000.

This globe rests upon nothing, but appears equally surrounded by the heavens on every side,  
for

for the better understanding whereof, it will be necessary to observe the several imaginary circles described on the artificial globe, *viz.* 1. The equator and the circles parallel to it. 2. The first meridian, and the rest of the meridional lines. 3. The zodiac, which includes the ecliptic. 4. The horizon. 5. The two tropics. 6. The arctic and antarctic circles. It is supposed also, that a line passes through the center of the globe, called its axis, round which it moves every 24 hours, the ends of which axis are called the poles of the earth; that in the north called the *arctic* or north pole, from a star in the heavens opposite to it, which forms part of the constellation called the *little bear*, and that in the south called the *antarctic* or south pole, as diametrically opposite to the other.

By the *equator* the globe is divided into two equal parts or hemispheres, and on this circle are marked the degrees of longitude, from the first meridian, either east or west. The *parallel circles* are so called from their running parallel to the *equator*, of which there are *nine* in number inclusive, between the equator and either pole, ten degrees distant from each other, every degree of latitude being 60 geographical miles, and every ten degrees 600 such miles. Consequently it is 5400 miles from the equator to either pole, which is one quarter of the circumference of the globe.

The *first meridian* is represented by the brazen circle in which the globe moves, dividing it into the eastern and western hemispheres, on which circle are marked the degrees of latitude, which are counted northward from the equator to the north pole, and southward from the equator to the south pole.

Where the meridional lines are 24 in number, they are 15 degrees, or one hour asunder; those who live under the meridian line on the right hand, that is, to the eastward of the first meridian, have the sun one hour before us; and those who live under the meridional line on the left hand, that is, west of us, have the sun an hour after us; and this shews what is meant by the eastern and western longitude. And as *longitude* is nothing more than the distance any place is east or west of the first meridian, so latitude is the distance a place is from the equator, north or south. If it be north of the equator, it is called *north latitude*; and if it be south of the equator, it is called *south latitude*.

The *first meridian* in the old maps was placed either at *Teneriff*, one of the *Canary isles*, 17 degrees west of *London*, or at *Ferro*, another of the *Canary isles*, 19 degrees west of *London*. But, every nation almost at this day places the *first meridian* at their respective capital cities in their several maps. In *Moll's* maps, *London* is made the first meridian at one end of the map, and *Ferro*

at the other; *Ferro* being 19 degrees west of *London*. And in these maps the upper end is always the north, the lower end the south; the right hand east, and the left hand west, the degrees of longitude being marked at the top and bottom of each map, and the degrees of latitude on the sides of the map.

The *zodiac* is that circle, which cuts the equator obliquely, and is divided into *twelve signs*, through which the sun seems to pass within the space of 12 months, each sign containing 30 degrees of longitude.

The *ecliptic* is a line passing through the middle of the *zodiac*, and shews the sun's, or rather the earth's path or orbit, in which it moves annually.

The *horizon* is the broad circle in which the globe stands, dividing it into the upper and lower hemispheres; the place where any one stands, is the center of the *horizon* and hemisphere; the sensible *horizon* seems to touch the surface of the earth, and is the utmost limits of our sight upon an extensive plain. The rational *horizon* is supposed parallel to this, and to be extended to the heavens.

The poles of our *horizon* are two imaginary points in the heavens, called the *zenith* and *nadir*; the *zenith* being the vertical point directly over our heads, and the *nadir* that point of the heavens under our feet, diametrically opposite to the *zenith*.

The *tropics* shew how far the sun or rather the earth proceeds north or south of the equator every year. The *tropic of Cancer* surrounds the globe  $23\frac{1}{2}$  degrees north of the equator, and the *tropic of Capricorn*  $23\frac{1}{2}$  south of the equator.

The *polar circles* are drawn  $23\frac{1}{2}$  degrees distant from each pole, and  $66\frac{1}{2}$  distant from the equator.

The earth is divided into five zones, *viz.* The torrid zone, the two frigid zones, and the two temperate zones: and they are denominated zones; because they encompass the earth like a girdle.

The *torrid zone* lies between the two *tropics*, and is so denominated from the excessive heat of the climate, the sun passing over it twice every year.

The two *frigid zones* lie within the polar circles, and are so called from the excessive cold within those circles.

The *northern temperate zone* lies between the *tropic of Cancer* and the *arctic* circle, and the *southern temperate zone* between the *tropic of Capricorn* and the *antarctic* circle.

Hence the inhabitants of the earth are distinguished into *Periæci*, *Antæci*, or *Antipodes*: according to their situations.

The *Periæci* are situate under the same parallel, but opposite meridians: it is midnight with one when it is noon with the other, but the length of their days and their seasons are the same; these are found by turning the horary index 12 hours, or turning the globe half round.

The *Antæci* are situate under the same meridian, but opposite parallels; these have the seasons opposite to ours, and the same length of days; but when their days are longest, ours are shortest. These are found by numbering as many degrees on the opposite side of the equator as we are on this.

The *Antipodes* lie under opposite meridians, and opposite parallels; these have different seasons, and their noon-day is our midnight, and their longest day our shortest: These are found by turning the horary index 12 hours from the given place, or turning the globe half round, and then counting as many degrees on the opposite side of the equator, as the given place is on this.

The inhabitants of the earth are distinguished by their different shadows at noon-day, and are denominated either *Amphiscii*, *Ascii*, *Heteroscii*, or *Periscii*.

The *Amphiscii* inhabit the torrid zone, and have their noon day shadows both north and south: When the sun is south of them, then their shadows are north, and when the sun is north of them their shadows are south: these are also called *Ascii*, because the sun is vertical twice every year at noon-day, and then they have no shadow.

The *Heteroscii*, who inhabit the temperate zones, have their shadows always one way at noon-day. In the northern temperate zone their shadows are always north; and in the southern temperate zone, their shadows are always south at noon-day.

The *Periscii* inhabit within the polar circles, and have their shadows every way, the sun being above their horizon all the 24 hours, several months in the year, viz. when it is on the same side of the equator they are of: and if there were any inhabitants at either of the poles, they would have but one day of 6 months, and one night of the same length.

The ancients not being acquainted with the manner of discovering the situation of places by the height of the pole and latitude, or distance of the equator, they sought the situation by the difference in the length of the days: And therefore they divided the surface of the terrestrial globe, by means of circles parallel to the equator, into certain parts or small *zones*, each of which to contain the same length of days, and called them by the name of *climates*, (from *επιμειν*, inclination) and these were subdivided by a circle, or parallel line, into two *demi-climates*, to which they gave the name of *parallel*; so that each *climate* contains two *parallels*, or *demi-climates*.

There are two sorts of *climates*. Those which are between the equator, and the polar circles, where the artificial days increase insensibly, are regulated by half hours; and those, who live between the polar circles and the poles, which con-

tain continual days, are regulated by months, or 30 continual days.

The *parallels* are likewise of two sorts, the one divides the *climates* of half hours into quarters, and the other divides the days of a month into 15 days.

Therefore *climate* is a space of the surface of the terrestrial globe contained between two parallel circles, or lines, between which there is a variation of an half hour, or of 30 days in the longest days of the year.

Likewise the *parallel* is a space of the earth contained between two lines, or parallel circles, between which there is a difference, either of a quarter of an hour, or of 15 days in the longest days of the year.

The *climates* and *parallels* are, between them, very unequal; in those of artificial days, the more they approach the equator, the broader they are, and diminish in proportion as they depart from the equator and approach the poles.

The *climates* of continual days, on the contrary, are broader in proportion they are nearer the poles; and diminish as they depart from them, and advance towards the tropicks.

The inequality of the latitude of the *climates*, as well of artificial as of continual days, proceeds from the different obliquities of the horizons, with regard to the course of the sun, when it is in the tropick; where it determines the length of the longest days, for all the inhabitants of the same hemisphere.

There are sixty *climates*, thirty between the equator and the arctic pole, for the northern hemisphere, and thirty between the equator and the antarctic pole for the opposite hemisphere, which we commonly call southern.

The thirty *climates* of each hemisphere are divided into *climates* of half hours, or artificial days, and *climates* of continual days.

The *climates* of half hours are reckoned between the equator and the polar circles, to the number of 24. Because the artificial day being always of 12 hours under the equator, and of 24 hours, in the longest day of the year under the polar circles, the increase is of 12 hours, which make up 24 half hours, and consequently 24 *climates*.

The *climates* of continual days are reckoned between the polar circle and the pole, to the number of six, and by months; because the longest day under the polar circle, is of a natural day, i. e. of 24 hours, and of six months under the poles; which make up six months of increase, which are distributed by months, each whereof makes a *climate*.

The sixty *climates* making up 120 *demi-climates*, or *parallels*, i. e. 60 *parallels* for each hemisphere, there

there will be 48 by quarters of an hour, for the 24 climates of half hours, and 12 for the climates of months, which together make up the 120 parallels.

The people under the equator have no climate; those whose longest day is of 12 hours and an half have one climate; or are towards the end of the first climate: Those whose longest day is of 11 hours, have two climates, and thus in order to 66 degrees 31 minutes, where there are, as I have observed already, 24 climates, i. e. that they are at the end of the last climate of an hour, because their longest day lasts 24 hours; and as from the end of the twenty-fourth climate, every quarter of a league towards the pole, the day increases 24 hours at once, afterwards a week, a month, &c. the six last climates have been determined by the difference of a month of continual day more at their end than at their beginning.

These particulars well considered, we proceed to the description of the artificial globe.

The ARTIFICIAL GLOBE of the earth is a sphere on whose surface are delineated the principal parts of the earth in their proper situations, distances, &c. and also the imaginary circles already described.

This globe is by its position sometimes called a right sphere, at other times a parallel sphere, and an oblique sphere. And by the various position of the horizon the inhabitants of the earth are sometimes distinguished.

In a right sphere the equator passes through the zenith and nadir, and the parallel circles fall perpendicularly on the horizon, which is the case of those people who live under the equinoctial line.

In a parallel sphere, the poles are in the zenith and nadir; the equator is parallel to, and coincides with the horizon, and the parallel circles are parallel to the horizon, which can only be said of people under either pole.

In an oblique sphere, the inhabitants have one of the poles above, and the other under the horizon, and the equator and parallel circles cutting the horizon obliquely, as is the case of all people that do not live under the equinoctial or the poles.

In order to find the true situation of a place upon the globe; let it be set upon a level table, and the brazen meridian stand due north and south; then bring the given place to the brazen meridian, and let there be 90 degrees between that place and the horizon, both north and south, and the given place will be in the zenith; the globe being thus rectified, you may proceed to solve any problem.

As the longitude of a place will be found by numbering on the equator so many degrees as the place lies east or west of the first meridian: And the latitude will be found by counting so many degrees on the brazen meridian, as the place lies

north or south of the equator: You must turn the globe therefore either east or west, till the given place is brought to the brazen meridian, and you will see the degree of longitude marked on the equator; and the latitude is found at the same time, only by numbering the degrees on the brazen meridian either north or south of the equator, till you come to the given place.

To find what places are under the same meridian with a given place; bring the given place to the brazen meridian, and observe what places lie under that meridian, either north or south of the equator.

To find what places have the same latitude; turn the globe round, and observing on the brazen meridian what places come under the same degree of latitude, as the given place is.

To find the sun's place in the ecliptic at any time of the year. Having found the month, and day of the month, you will find, upon the wooden horizon, the sign in which the sun is opposite to the day of the month; which is the sun's place in the ecliptic at that time.

To know the length of the days at any time and at any place, bring the given place to the zenith; then bring the sun's place in the ecliptic to the east side of the horizon, and set the index of the hour circle to 12 at noon, or the upper figure of 12, and turn the globe till the said place in the ecliptic touch the western side of the horizon, and the number of hours between the upper figure of 12, and the hour the index points to, shews how many hours the day is long, and consequently the length of the nights; because so many hours as the day falls short of 24, must be the length of the night; as when the day is 16 hours long, the night must of course be 8 hours long.

To find those places on the globe where the sun is in the meridian at any time. The globe being rectified, and the place where you are brought to the brazen meridian, set the index of the horary circle at the hour of the day at that place, then turn the globe till the index points to the upper 12, and you will see all those places where the sun is in the meridian; as for example, if it be 11 in the morning at London, and you set the index at 11, turn the Globe till the index points at the upper 12, and you will find Naples, which is an hour or 15 degrees east of London. And in all places under the same meridian as Naples is, it must consequently be 12 at noon at that time.

In like manner if it be 4 in the afternoon at London, and you set the index at 4, and turn the Globe till the index points at the upper 12, you will find Barbadoes, which is four hours or 60 degrees west of London, and at all places under the same meridian

dian as *Barbados* is, it must consequently be 12 at noon at that time.

To discover where the *sun* is *vertical* at any time of the year, (as the *sun* can only be *vertical* in such places as lie between the tropics) to know this, you are only to find what place the *sun* is in the *ecliptic*, and bringing that place to the brazen meridian, observe what degree of *latitude* it has, for in all places in that *latitude* the *sun* will be *vertical* that day, and you will find all those places, only by turning the *globe* round, and observing them as they come to the brazen meridian.

To find where the *sun* is *above* the horizon, or shines *without setting* all the 24 hours in the northern hemisphere. The day given must be when the *sun* is in the northern signs, and having found the *sun's* place in the *ecliptic*, you must bring that place to the brazen meridian, then count the same number of degrees from the north pole towards the equator, as there is between the equator and the *sun's* place in the *ecliptic*; then turn the *globe* round, and in all the places passing under the last degree counted from the north pole, the *sun* begins to shine constantly without setting on the given day: and the rule will serve *vice versa* for any place set in the southern hemisphere, when the *sun* is in the southern signs.

To discover the *length* of the longest and shortest days and nights at any place in our northern hemisphere; rectify the *globe* according to the *latitude* of the given place, or which is the same thing, bring the given to the *zenith*, then bring the first degree of *Cancer* to the east side of the horizon, and setting the index of the hour circle to the upper figure of 12, turn the *globe* till the sign of *Cancer* touch the west side of the horizon, and observe the number of hours between the upper figure of 12, and the hour the index points to, and that is the length of the longest day, and the shortest night, consequently consists of so many hours as the day falls short of 24; and as for the length of the days and nights in southern *latitude*, they are just the reverse of those in northern *latitude*, and the table of the *climates* shews both the one and the other.

To find in what places the *sun* is *rising* or *setting*, or in its meridian: or what parts of the earth are enlightened at any particular time: First find where the *sun* is *vertical* at the given hour, and bring that place to the *zenith*, under the brazen meridian; then observe what places are in the eastern semi-circle of the horizon, for there the *sun* is *setting*, and in those places in the western semi-circle of the horizon the *sun* is *rising*, and in all places under the brazen meridian it is noon-day: all those places in the upper hemisphere of the *globe* are enlightened, and those in the lower hemisphere are in darkness.

To find the *distance* of one place from another upon the *globe*: If both places lie under the same meridian, bring them to the brazen meridian, and count thereon how many degrees of *latitude* the two places are from each other, which being reduced to units is the true *distance*. Every degree of *latitude* containing 60 geographical miles, as has been observed already; and 60 geographical miles make near 70 *English* miles. If the two places lie under the same parallel of *latitude*, then observe on the equator how many degrees of longitude they are asunder, and observe in the table A, how many miles a degree of longitude makes in that *latitude*, and then numbering the degrees of longitude on the equator, reduce them to miles, and that will give the distance of the two places. For instance, suppose *Rotterdam* lies in 52 degrees of north latitude, and 4 degrees of eastern longitude, and *Pymont* lies under the same parallel 5 degrees east of *Rotterdam*, and I find that every degree of longitude in this *latitude* makes 37 miles, then I multiply 37 by 5, which makes 185 being the number of miles between *Rotterdam* and *Pymont*.

Where the two places differ both in longitude and *latitude*, the distance may be found by measuring the number of degrees they are asunder by the quadrant of altitude, and reducing those degrees to miles. For example, if I find the two places are the length of 10 degrees asunder by the quadrant, they must necessarily be 600 miles distant from each other; because 60 miles which is the extent of one degree of *latitude*, multiplied by 10, makes 600 miles on the *globe*, in whatever direction one place lies from another, as north, east, south, west, &c.

To find how one place *bears* of another, that is, whether it lies north-east, south-west, or on any other point of the compass from another place: Bring one of the places to the *zenith*, and fix the quadrant of altitude there; then extend it to the other place whose bearing you would know, and the lower part of the quadrant will intersect the wooden horizon at the point of the compass inscribed on the wooden horizon, which is the true bearing of the given place.

To find on what point of the compass the *sun* rises or sets at any place: Bring the given place to the *zenith*, and having found the *sun's* place in the *ecliptic*, bring the same to the eastern side of the horizon, and it will shew on what point of the compass the *sun* rises. On the other hand, if you bring the *sun's* place in the *ecliptic* to the west side of the horizon, it will shew on what point of the compass the *sun* sets.

The contents of this GLOBE are divided first into land and water.

The land on the earthy part is again divided into continents, islands, peninsulas, isthmus's, promontories or capes.

A continent is a large portion of land, containing several countries, so united together as not to be separated by seas: As *Europe*, *Asia* and *Africa*, form but one continent in the east; and *America* another in the west.

An island is a portion of land surrounded by water, as *Great-Britain* is from all the world.

A peninsula is a portion of the earth surrounded by water, except on one part, where it is joined to some other land by a narrow neck, or isthmus. As *Africa* is joined to *Asia* by the isthmus of *Suez*; and the *Morca* is joined to *Achaia* by the isthmus of *Corinth*.

An isthmus is that neck of land, which joins two countries together; as the isthmus of *Darien* joins north and south *America*, and the isthmus of *Corinth*, *Achaia* and the *Morca*.

A promontory or cape is a point of land which extends itself into the sea; as the cape of *Good-Hope* in *Africa*, and cape *Comorin* in the *East-Indies*.

The waters are divided into oceans, seas, straights, bays or gulphs, lakes and rivers.

Oceans are vast seas which divide one part of the earth from another; as the *Atlantic ocean*, which divides *Europe* and *Africa* from *America*, and the *pacific ocean* or *south-sea*, which divides *America* from *Asia*.

Seas are less bodies of waters which divide one country from another; as the *Mediterranean*, which divides *Europe* from *Africa*; and the *Baltic*, which divides *Sweden* from *Germany*.

A bay or gulph is a sea encompassed with land, except on one part whereby ships enter it; as the gulph of *Mexico* in *America*, and the gulph of *Finland* in the *Baltic*. And the lesser bays are frequently called creeks or sounds, as *Plymouth sound*.

A straight is a narrow passage into some sea, as the straight of *Gibraltar*, and this is also sometimes called a sound; as the straight by which we enter the *Baltic sea* is.

A lake is properly a great water surrounded by land, which has no visible communication with any sea, as the *Caspian sea* in *Asia*; but many other waters, which have a communication with the sea, are denominated lakes also; as the *Onega lake* in *Russia*, and the lake of *Nicaragua* in *America*.

A river is a stream issuing from some fountain, which after it has run a considerable course, discharges itself usually into some sea; as the *Danube*, which rising in the mountains of the *Alps*, after it has run a course of many hundred miles from west to east, through great part of *Germany*, *Hungary*,

and *Turkey*, discharges itself into the *Euxine sea* by several channels.

From the *Globe* let us proceed to the description of geographical Maps.

A MAP is a plain figure representing the surface of the earth, or a part thereof, according to the laws of perspective.

In maps these three things are essentially requisite. 1. That all places have the same situation and distance from the great circles therein, as on the globe, to shew their parallels, longitudes, zones, climates, and other celestial appearances, 2. That their magnitudes be proportionable to their real magnitudes on the globe. 3. That all places have the same situation, bearing and distance, as on the earth itself.

The true chart performs the first and last of these very exactly, but fails extravagantly in the second; and, indeed, no kind of projection yet found can exhibit more than two of them at once, by reason of the great difference between a plane and convex superficies.

Maps are not always to be used as they lie before us, for sometimes any part is uppermost; but, generally, the top is the north part, the bottom the south, the right hand the east, and the left hand the west, and marked with these words, or latin ones of the same import.

There is also inscribed a compass, pointing to all the quarters of the world, the north one being marked with a flower de luce.

The degrees of longitude are always numbered at top and bottom, and the degrees of latitude on the east and west sides. In all right-lined, and general circular maps, except those of *Wright's* projection, the degrees of latitude on the sides are of an equal breadth; and in all circular and right-lined maps, except the said *Wright's*, and the plain charts, the degrees of longitude are unequal.

In general maps, the circles corresponding to those in the heavens are inscribed, viz. the equator is expressed by a straight east and west line; and the first meridian, the polar circles, the tropics, and the other meridians and parallels, which are drawn at every five or ten degrees, intersect each other at right angles.

In several maps there are three sorts of scales of miles, according to the various computations in different parts of the same country, viz. greater, lesser, and mean; besides which, there are often affixed scales of other country-measures, as *Dutch*, *French*, *Italian*, &c.

As for other matters, regarding maps in general, the characters used to denote cities, rivers, roads, boundaries, and the like, they are usually explained.

in the maps themselves. We shall therefore proceed to shew the several methods of constructing the *geographical maps* in order : and first of

The *Stereographic projection* of MAPS upon the plane of the equator, the eye being supposed placed in one of the poles. To do this proceed thus : from P, the pole. (See the *second plate of Geography*, Fig. 1. N<sup>o</sup> 1.) draw a circle A B C D, of what circumference you please, to represent the equator, which cross with two diameters A C, B D, dividing it into four quadrants, then subdivide each of these into nine, and these again into ten more, if the largeness will admit ; and from D, the point of intersection of the first meridian B D, number every tenth degree with figures, both on the right hand and on the left, till they meet in the opposite point B 180 ; so will the *map* be divided into east and west longitude. Then from the pole draw right lines to every such tenth degree in the equator, as is done in the quadrant D C ; and these will represent the meridians, and the figures will shew the longitude.

To delineate the parallels of latitude, from B draw lines to every tenth degree in the quadrant A D ; and where they intersect the diameter P A, through those points must circles be described from the center P, and then numbered from the equator towards the pole with 10, 20, 30, &c. Thus you have the meridians and parallels projected ; and since the polar circles and tropics are only parallels, at a certain distance from the pole and equator, *viz.* 23° 30' ; therefore set off 23° 30', on the equator from D to E, as also from C to F ; then through the points H and I, where the points B E and B F intersect A C, describe double circles to distinguish them from other parallels. So shall P H represent the arctic circle, and P I the tropic of *Cancer*. The lineaments of your *map* being thus projected, places may be inserted by help of a table of latitudes and longitudes, as represented (*ibid.* N<sup>o</sup> 2.) But in these maps, the mutual bearings and distances of places cannot be determined ; also countries near the equator take up more room than proportionably they should.

*Orthographic projection* of MAPS upon the plane of the equator, wherein the eye is supposed to be at an infinite distance in the axis, two hundred semi-diameters at least ; by which means the places about the pole, which may be discerned at any distance, will have a larger projection than those nearer the equator ; just the reverse of what happened in the former projection.

In this projection, the equator must be drawn and divided, and meridians delineated in the same manner as taught above ; then to describe the parallels proceed thus : from either side of the first

meridian A P (*ibid.* Fig. 2. N<sup>o</sup> 1.) draw right lines through the corresponding degrees, or every tenth degree of the quadrants A B, A D, parallel to the diameter B D ; and through the points where these cut the meridian A P, draw circles representing the parallels, numbering them with 10, 20, 30, &c. from A to the pole P, to shew the degrees of latitude. To delineate the polar circles and tropics, set off from B to G, and from D to H 23° 30' ; as also from A to I, and from A to K ; and drawing lines between each, through the points of intersection of the first meridian A P, draw circles : thus P L will represent the polar circle, and P M the tropic of the *Cancer*. The ecliptic may be projected, and places laid down in the same manner as above ; *ibid.* N<sup>o</sup> 2.

This kind of the equatorial projection, shews the true decrease of the degrees of the equinoctial, or of longitude, in every parallel of latitude : the circumpolar regions may be delineated better in this than in the former projection ; and so may *Tartary*, and the north parts of *Europe*, as *Sweden*, *Norway* and *Muscovy*.

But besides the inconveniencies already mentioned, attending these two kinds of projection, there is no bringing all the places in the eastern or western hemisphere into less than two hemispheres, so as to express *Europe*, *Asia* and *Africa*, or *America* by itself, in one map ; Geographers have therefore invented another way, somewhat more difficult indeed, but much more natural and useful, *viz.*

The *stereographic projection* of maps upon the plane of the first meridian, wherein you must conceive the eye to be situated in that point of the equator, which is cut by the meridian 90° distant from the first meridian. In this projection the equator is a right line, as is also the meridian 90° distant from the prime one, and cutting it in the point of the eye's position : but the other meridians, and all the parallels, are arches of circles, and the ecliptic an ellipsis.

The method is this : describe the circle NESW, (*ibid.* Fig. 3.) representing the first meridian ; cross it with two diameters at right angles, and W C E shall represent the equator, W the west part, and E the east ; and the other diameter N C S will be the meridian, 90° distant from the first, N representing the north and S the south pole, and C the point where the eye is supposed to be.

To delineate the meridians, proceed thus : from N draw lines through each tenth degree, or each degree, if you think fit, of the quadrants WS or S E, which shall cut the quadrant of the equator W C in F, G, H, I, K, L, O, P ; or, to avoid scores in your paper, make a point in the line where the side of the ruler cuts it. You need only divide  
one

one quadrant, because the divisions in it may be transferred into the lines CN, CE and CS, which will save the trouble of their particular divisions. Thus are the points in the equator, through which the meridians are to pass; as, also, those points in the perpendicular meridian, determining the ambit of the parallels found out. The centers of all those meridians, whose distance from the first meridian, N W S E, does not exceed  $45^{\circ}$ , may be found out in the line CE, reckoning every second degree from the point C, for the centers of each degree from the point W. By the same proportion, we must take every twentieth degree, or point, from C, in the line CE, for centers to each tenth degree or point, from W, in the line WC: therefore Q will be the center of F, R of G, T of H, and V of I. But because the centers of the meridians, exceeding  $45^{\circ}$ , lie without the circumference of the first meridian, in the line CE extended; therefore, laying the ruler upon N, and every second degree, or, according to the projection upon every twentieth degree of the quadrant NE, make points in the extended line CE, which shall be the centers of all the other meridians where the edge of the ruler cuts it. Thus X will be the center of K, the meridian  $50^{\circ}$  distant from the primitive, and so on. And, in the like manner, may the meridians be described through the points in the line CE, by transferring the center-points of CE to CW continued.

The points for the projection of the parallels being already marked in the lines CN and CS, to find the centers of these points, erect a perpendicular at E, as *ab*; and from C, through each tenth degree of the quadrant NE, draw secant lines to cut the said perpendicular in *c, d, e, f, &c.* Then take the distance *Cc* in your compasses, and transfer it upon the line CN, continued, from C to *1*, which will be the center to the parallel *b 80 b*; *Cd* transferred to *C 2* will give the center of the parallel *i 70 i*; *C 3 = Ce* will be the center of *k 60 k*; and so on for the rest of the parallels.

To project the tropics and polar circles, set off, on each side the equator and poles,  $23^{\circ} 30'$ ; then draw a secant from C, through these points, and transfer the point of intersection with the tangent line, as before, for the centers of those circles.

The construction of the parallels of the other hemisphere is performed in the same manner, viz. by transferring the centers found by the intersection of the secants with the tangents, to the line CS, continued.

There are two ways of projecting the ecliptic; for supposing C to be the first point of Aries, and the eye to be in the vertical colure, it will be represented by a right line, drawn from the beginning

of Cancer B, through the beginning of Aries C, to the beginning of Capricorn M; which being graduated like the equator, the degrees of each sign are to be marked upon it. To do this, cross the ecliptic BM with a line at right angles, drawn from the opposite points of the polar circles in the meridian, Z, D; divide the quadrant BD into nine equal parts, each containing  $10^{\circ}$ ; and laying a ruler upon Z, and upon each division of the quadrant BD, cut the line BM as you did the equator. But all this trouble may be spared, by transferring the divisions of the equator upon the ecliptic BM.

The other way of projecting the ecliptic, where the eye is supposed to be in the solstitial colure, is the same as in all maps of the hemispheres, where it cuts the points of the intersection of the first meridian and equator, at W and E; and the third point is that wherein the tropic BAY cuts the meridian NCS at A.

The construction is now ready for inserting the places in the maps, which may be done by the help of a table of longitudes and latitudes, as in the former methods.

The advantages of this projection are these: 1. It very agreeably represents the hemisphere intercepted between the two poles, with all the parts entire. 2. It shews the longitudes, latitudes, and distances of places from all the great circles, exactly as on the globe itself.

Its defects are also two. 1. That the degrees of the equator, meridians, and parallels, are unequal, except those of the first meridian, increasing gradually the nearer they approach to the first or prime meridian; and consequently the parts about C are less, and those about A and B greater than they ought: and, in the same manner, the places about the poles bear an unequal proportion to those nearer the equator. 2. The course and distance between places, are neither with ease or exactness found in their projection.

If you would project a map of any particular portion of the earth, less than an hemisphere, you must make the projection proportionable to the extent of the map you intend to draw, and then cut out so much of it as is terminated by the greatest degree of longitude and latitude of the country to be projected. For example, suppose you would draw a map of *Europe* according to this construction, which being laid down as directed above, through the points where the parallels of the greater and lesser latitude of *Europe*, viz.  $72^{\circ}$  and  $34^{\circ}$ , cut NC, draw lines parallel to the equator: and because, in the common maps, *Europe* includes  $93^{\circ}$  of longitude, therefore set off, viz.  $46^{\circ} 30'$  from *n* to *g* and from *n* to *p*, and draw *gp = 93^{\circ}*, the extent of *Europe* in longitude; then erect perpendiculars

diculars on the points *g* and *p*, to square your map ; or, to save this trouble, set off *ng* from *q* to *r*, and from *q* to *t*, and cut out your map accordingly. However, it is best to allow a little more room in separating your map from the rest of the projection to express the situation thereof in respect of other countries.

The *orthographic projection of Maps* on the plane of the meridian, in which the parallels of latitude are all right lines, and all the meridians, except the first, semi-ellipses, is in construction formed by supposing perpendiculars to fall from all points of each hemisphere on the plane of the first meridian.

Thus let *N E S W*, (*ibid* fig. 4.) the meridian, be divided, as in the former method, into four quadrants, and each quadrant into 9 or 90 equal parts or degrees ; from each tenth degree of the quadrants *N W* and *W S*, draw lines to each corresponding tenth degree in the quadrants *N E* and *E S*, parallel to the equator *W E*, and these will be the parallels of latitude : and having numbered each parallel on the first meridian, and in *C N* and *C S*, transfer the intersections of these parallels with *C N* or *C S* into *C W* and *C E*, which will give the points in the equator through which the meridians must pass ; and number these from *W* towards *E*, for degrees of longitude.

Then, since the meridians are semi-ellipses, you may describe them through the given points, *viz.* the two poles and the divisions of the equator *W E*, with elliptical compasses ; or, by help of a sector, you may find the points in each parallel of latitude, through which the ellipses may be formed. The ecliptic, in this projection, will be represented by an elliptical or straight line, in the same manner as in the former method.

The maps of this construction have this advantage above the preceding methods, that they exhibit the true proportional decrease of the degrees of the equator in each parallel ; but this advantage is counter-balanced by a great inconvenience, *viz.* the too great contraction of the meridians the nearer they lie to the first, which makes this projection unfit for general maps ; *Africa* being the only quarter of the globe that would nearly retain its due figure and dimensions.

The *stereographic projection of Maps* upon the plane of the horizon, the eye being supposed in the zenith for the upper hemisphere, and in the nadir for the lower one.

The common method of construction is this : suppose it were required to describe an horizontal projection for the city of *London*, in latitude  $50^{\circ} 32'$  ; from *L* or *Z*, (*Plate* *ibid* fig. 5.) the zenith and *London* being here the same, describe the circle

*N E S W* of what extent you please ; to represent the horizon, quarter it, and divide each quarter into  $90^{\circ}$  ; or, to avoid confusion, divide only one quadrant *N W* or *W S* ; draw the diameter *N S*, which let be the first meridian, then will *W E* be the prime vertical, or azimuth of east and west. Next take  $51^{\circ} 32'$  from the divided quadrant *N W*, and set it off from *N* to *A* ; then draw a line from *W* to *A*, and where the ruler cuts *N S* make a point, which shall represent the arctic pole *P*. Thirdly, take the distance of the arch of any of the quadrants, as *N E*, and set it off from *A* to *B* ; and where the line *W B* cuts the diameter *N S*, that point *Q* will be the point of the intersection of the meridian with the equator. Fourthly, divide the semicircle *N A E B S*, from *B*, into degrees, the same in proportion to those of the quadrant *N W* ; and from *W* to each, or each tenth degree, lay a ruler, and mark where it cuts the line *N S*, for there will be the points of the intersection of the parallels with the first meridian, which fall within the periphery of the projection. But if you would find the opposite point of each parallel, in order to delineate them easily on the projection, continue the division of the periphery from the equatorial point *B*, upon the quadrant *N W*, and draw lines as before through each point to cut the diameter *N S* continued ; then describe circles through the points of equal degrees from the pole *P*, through 80, 70, 60, &c. in the line *P S*, and 80, 70, 60, &c. in the line *P N* extended. Thus may all the parallels, tropics, and polar circles be projected.

In the construction of the meridians proceed thus : first, through the points *W*, *P*, *E*, draw a circle, the half of which is *CPD*, and delineate thereon the meridian projection, by dividing it into  $360^{\circ}$  ; then drawing lines from *P* to every degree, or tenth degree : and, lastly, describing circles from the centers found in the line *C D*, continued at both ends, through the division in the diameter *W E*, and the poles, in the same manner as directed in the stereographic projection upon the meridian, the parallels excepted, which must not be drawn. In describing the meridians, observe to draw each thro' the pole to touch the horizon, which will be the meridians north of the pole. Thus, when you describe the meridian *F P*, describe at the same time *F P G* ; and the same holds of all the rest.

When you have proceeded thus far, describe a circle round the horizon pretty close, to contain the degrees of graduation, which must be made between the meridians, and not the parallels, each into ten parts or degrees, to shew the longitudes of places. The latitude must be graduated on the first meridian *N S*, and numbered from the equator towards either pole, and from the pole backward,

backward, towards N. This done, draw a circle with this again, wide enough to hold the figures belonging to the numbered degrees. Lastly, describe two more circles, the first near the former, and divide the quadrants into eight equal parts each, or thirty-two in all, to represent the points of the compass, and shew the bearings of places in respect of *London* the center. The outward graduated circles supply the place of azimuths, to draw which would occasion confusion in the scheme; for if a central rule be fixed upon a pivot in the center, or place representing *London*, and graduated with the same divisions as ZN, by moving it about to any place, we may easily discover not only the bearing, but the distance of that place from *London*.

All these circles are expressed in the lower figure, in which so much of the earth is described as is contained within the horizon of *London*, as a specimen of the nature and use of this projection. Thus your projection being completed, it is easy to insert the places, according to their latitudes and longitudes.

The *horizontal projection of Maps*, with azimuth lines. Those who are unwilling to take the trouble of laying down the former projection, and are content to know the bearings and distances of places from the center, without the longitude or latitude, may divide the circle NESW (*ibid* Fig. 6.) into degrees and points of the compass; where NS represents the meridian, WE the east and west line, and Z the zenith, or place in the center. This done, you may put *London*, or any other place in the center; and by the help of the scale of equal parts ZA, fixed in the center, the bearings and distances of places may be laid down from the globe or maps.

A new, easy, and exact method of projecting particular Maps. Suppose you would draw a map of some part of the earth, containing 6° of latitude, viz. from 39° to 45°, let the longitude be what it will. 1. Draw the line EF, (*ibid.*) and in its middle raise the perpendicular DC, which divide into six equal parts, or degrees of latitude; and through C, draw a line parallel to EF. 2. Divide a degree into ten, or if large enough to admit it, into sixty equal parts; and in the table for decreasing longitude, find the content of a degree of longitude in the latitude of 39°, viz. 46.62 miles. 3. From the degree so divided, take the parts 46.62; divide that distance, and from D set off one half to E, and the other half to F. 4. Find the content of a degree in latitude 45°, viz. 42.43 miles; take that distance from the scale of the degree; divide it, and from the point Clay one half to I, and the other half to K. 5. Draw straight lines from I to E, and from K to F; divide them

in like parts with CD, and through those marks draw parallel lines.

Thus IKFE is a projection for one degree of longitude, including six degrees of latitude; which may be transferred upon the paper, as often as there is occasion, by the following method.

1. If the compasses be large enough, or the projection will admit it, take the distance from E to K, or from F to I, and setting one foot first in E and then in F, describe the arches L and M. In like manner set one foot first in I and then in K, and with the same extent draw the arches N and O: take the distance with another pair of compasses, between E and F, and set it off from E to N, and from F to O: likewise set the distance between I and K, from I to L, and from K to M; draw lines between L and N, and M and O; divide them into degrees, and draw parallels from those points to the corresponding points in the meridians IE and KF. And, after the same manner, may meridians and parallels be drawn, to as many degrees of longitude as your map contains.

2. If the map be very large, so that the compasses cannot extend to the farthest degree, or from F to I, then you may draw one or more diagonals, as you can conveniently, at once; and then proceed to draw the rest. Thus, when you have laid down the squares PGEN (*ibid.*) and HQOF, in the same manner as directed above; go on to draw LIGP and KMQH, by the same method.

In this projection, the diagonals being all equal, places lying in the remotest longitudes or diagonals, are as truly exhibited as those near the middle, and consequently their distances conformable to one common measure; so that the compasses, extended between any two places, and applied to the scale, gives the distance without more ado. The bearings too will be very conspicuous by means of a compass drawn on a corner or side of the map.

The scale on the sides is that by which the distances are measured; but it must be graduated on one of the meridians, and not on the out-lines of the map, as is commonly done.

N.B. Printed maps, on being imported from abroad, pay a duty of 15 s.  $4\frac{80}{100}$  d. per ream; and draw back, on exportation, 13 s. 6 d. and, if in frames, for each map 1 s.  $2\frac{36\frac{1}{4}}{100}$  d. the drawback being 1 s.  $\frac{93\frac{3}{4}}{100}$  d.

Thus far of *general or universal geography*, we now enter upon that part of the division called *special or particular GEOGRAPHY*, which represents the earth, first to be two great continents, viz. the

new and old world; or, the eastern and western continents: the eastern continent comprehending Europe, Asia, and Africa; Europe in the north west division; Asia in the north east division; and Africa in its south division: and the western continent all that vast region on the left hand of a map of the world, called America.

We now descend to particulars; and first begin with EUROPE.

EUROPE is situate between 36 and 72 degrees of north latitude, and between 10 degrees of west, and 65 degrees of eastern longitude, bounded by the frozen ocean on the north, by Asia on the east, (from which it is separated by the Archipelago, the Hellespont or strait of the Dardanells, the Propontis or sea of Morea, the Bosphorus or strait of Constantinople, the Euxine sea, the Palus Meotis, the river Don or Tanais, and a line drawn from that river to the rivers Irtis and Oby, which being united, run into the frozen ocean.) The Mediterranean sea divides Europe from Africa on the south, and the Atlantic ocean divides it from America in the west. The greatest length of Europe, viz. from cape St. Vincent in the west, to the mouth of the river Oby in the north east, being about three thousand miles; and the breadth from north to south, viz. from the north cape in Norway, to cape Cagha, or Matapar in the Morea, the most southern promontory in Europe, being about two thousand five hundred miles.

Europe is usually thrown into three grand divisions, viz. the north, the middle, and the southern division.

The northern division comprehends, 1. Russia, or Moscovy. 2. Sweden. 3. Denmark, and Norway. And 4. the islands of Britain, Iceland, Greenland, and the islands of the Baltic.

The middle division comprehends, 1. Poland. 2. Germany, and the Austrian dominions contiguous thereto. 3. The Netherlands. And 4. France, and its conquests on the Rhine.

The south division contains Turkey in Europe, (the ancient Greece) Romania, Servia, Bulgaria, Bosnia and Dalmatia, with the tributary provinces of Walachia and Moldavia, Crim, Little Tartary, Budziac Tartary and Bessarabia, 2. Switzerland, with the Grisons, and the rest of their allies. 3. Italy. 4. Spain and Portugal. And 5. the islands of the Mediterranean, viz. those of the Archipelago, Sicily, Sardinia, Corsica, Majorca, and Ivica.

Russia in Europe lies between 46 and 72 degrees of north latitude, and between 21 and 65 degrees of eastern longitude, bounded by the frozen ocean on the north, by Moscovy in Asia on the east, by the Palus Meotis, and Little Tartary on the south,

and by Poland, the Baltic sea, Finland, and Swedish and Norwegian Lapland on the west.

The chief towns are Petersburg, Mosco, and Riga.

The principal rivers of European Russia, are the Wolga, the Don, the Borysthenes, and the two Dwina's.

The constitution of the Russian empire is an absolute monarchy, and the crown hereditary; but different branches of the royal family have of late been advanced to the crown, and the military men seem to dispose of it as they see fit.

Sweden is situate between 55 and 69 degrees of north latitude, and between 10 and 30 degrees of E. longitude, bounded by Norwegian Lapland on the north; by Russia and Russian Lapland on the east; the Baltic sea, which separates it from Germany and Livonia on the south, and by Denmark and Norway on the west, from which it is separated by the strait called the Sound, and the Dofrine mountains.

The chief towns in Sweden, are Stockholm and Gottenburg. This is a mixed monarchy, and the king has very little power.

Denmark is situate between 54 and 58 degrees of north latitude, and between 8 and 13 degrees of eastern longitude; being bounded by the Categat sea, which divides it from Norway on the north. By the same sea and the Sound which separates it from Sweden on the east, by the Baltic Sea and part of Germany on the south, and the German ocean on the west.

This is an absolute monarchy, and the crown hereditary. The capital city is Copenhagen. Norway is situate between 58 and 72 degrees of north latitude, and between 4 and 30 degrees of eastern longitude, bounded by the Atlantic ocean on the north and west. By the Dofrine mountains, which divide it from Sweden, on the east; by the Categats sea on the south, and the German ocean on the west. The chief town is Bergen.

This kingdom is now a province to Denmark.

The islands of Great Britain and Ireland, the Orcades, Hebrides, the Isle of Man, and the rest of the islands subject to Great Britain; including Shetland, are situated in the Atlantic ocean, between 50 and 62 degrees of north latitude, and between ten degrees west, and 3 degrees of eastern longitude, bounded by the northern or Caledonian ocean on the north, by the German sea, which separates them from Denmark, Germany, and the Netherlands on the east, by the English channel and the Atlantic ocean on the south, and by another part of the Atlantic ocean on the west.

England, the south division of Great Britain, is situate between 50 and 56 degrees of north latitude,

and between 6 degrees west, and 2 degrees east longitude, bounded by *Scotland* on the north, the *German sea* on the east, the *English channel* on the south, and the *Irish* or *St. George's channel* on the west, about 400 miles long from north to south, and 300 broad from east to west. The capital, *London*; where we place the first meridian, [situate on the river *Thames* in the county of *Middlesex*;] the latitude whereof is 51 degree 30 minutes, being 200 miles north west of *Paris*, 180 west of *Amsterdam*, 600 north west of *Vienna*, and 800 north east of *Madrid*. The chief rivers are the *Thames*, the *Severn*, the *Trent* or *Humber*, and the *Medway*. *England* is a limited monarchy, and the crown hereditary.

*Scotland*, the north division of *Great Britain*, is situate between 54 and 60 degrees of north latitude, and between 1 and 6 degrees of west longitude; bounded by the *Caledonian ocean* on the north, the *German sea* on the east, by *Eng'land* and *Solway Frith* on the south, and by the *Irish sea* and *Atlantic ocean* on the west, being about 300 miles long from north to south, and from 50 to 150 miles in breadth from east to west. The capital city *Edinburgh*, in the shire of *Lothian*, two miles south distant of the *Frith of Forth*, and 400 miles north-west of *London*. The chief rivers are the *Tay*, the *Olyde*, the *Spey*, the *Dee*, and the *Don*. *Scotland* is united to *England* and subject to the same sovereign.

*Ireland* is situate between 51 and 56 degrees north latitude, and between 6 and 10 degrees of western longitude; bounded by the northern ocean on the north, by *St. George's channel*, which separates it from *Great Britain* on the east, and by the *Atlantic* and western ocean on the south and west, being about 250 miles long from north to south, and generally 150 miles broad from east to west. The capital city, *Dublin*. The chief rivers are, the *Shannon*, *Boyne*, *Liffy*, *Lee*, *Blackwater*, and *Barrow*. *Ireland* is a province to *England*, and many of the *English* laws are introduced there; but they have a distinct parliament, and some laws peculiar to that kingdom; however, no law can be enacted till approved by the privy-council of *Great Britain*, and the subject may appeal from the courts of *Ireland* to those in *Great Britain*. An act of parliament of *Great Britain*, will bind *Ireland* where that kingdom is expressly named.

*Iceland* is an island situate in the *Atlantic ocean* between 64 and 67 degrees of north latitude, 500 miles off the coast of *Norway*, and almost as many north of *Scotland*, being about 300 miles in length, and 150 in breadth. The capital town is *Besfede*, in the south-west part of the island, subject to *Denmark*.

*West Greenland* extends from the first meridian to 50 degrees of west longitude, and from 60 to upwards of 80 degrees of north latitude, and in a cold

barren country with few inhabitants, but subject to the *Danes*, who have some colonies here; and claim the sole right of fishing on the coast, which the *Dutch* dispute with them.

*East Greenland*, or *Spitsberg*, lies between 10 and 30 degrees of eastern longitude, and between 77 and 82 degrees of north latitude, so cold and barren a country that there are no inhabitants, and few animals or vegetables; the very fish and fowl forsake the coast in winter. There is a night of four months and upwards, the seas, as well as other waters, are frozen up in winter. But here is the best whale-fishery in the world, whither the *Dutch* resort about *Midsummer*, and kill whales sufficient to supply all *Europe* with whale-bone. The *English* began this fishery, but were beaten out of it by the *Dutch* for some time; but they now have recovered it again, and improved it greatly. This country is supposed to be contiguous to *West Greenland* by some, and to extend as far as the north pole, though it is generally taken to be an island.

The chief islands in the *Baltic sea*, are *Zealand*, *Funen*, and *Lafland*; which belong to *Denmark*, and are situate at the entrance of the *Baltic sea*.

The islands of *Aland*, *Gotland*, *Oeland*, *Bornholm*, and *Rugen*, which belong to *Sweden*.

The islands of *Dagoe* and *Osel*, on the coast of *Livonia*, which are subject to *Russia*.

The middle division of *Europe* contains *Poland*, *Germany*, the *Austrian dominions* in and contiguous to *Germany*, the *Netherlands*, and *France*.

*Poland* is situate between 46 degrees 30 minutes, and 57 degrees 30 minutes north latitude, and between 16 and 34 degrees of east longitude, being bounded by the *Baltic sea*, *Livonia*, and *Russia* on the north; by *Russia* and *Budziac Tartary* on the east; by *Bessarabia*, *Moldavia*, *Transylvania*, and *Hungary*, (from which it is separated by the *Carpathian mountains*) on the south, and by *Silesia* and *Brandenburgh* on the west; being 660 miles in length from north to south, and 560 in breadth from east to west. The chief towns are *Warsaw*, *Cracow*, and *Dantzick*.

The chief rivers in *Poland* are the *Vistula*, the *Memel*, the *Dwina*, the *Nieper* or *Borysthene*, the *Niefter*, and the *Bog*. The most considerable hills are the *Carpathian mountains*, which divide *Poland* from *Hungary* and *Transylvania*.

*Poland* is a republic, with a king at the head of it, who is elected by the gentlemen of the country when the throne is vacant; but both the legislative and executive power is lodged chiefly in the senate, and diet or parliament; the king however has the nomination of officers, but can displace none without the concurrence of the diet.

The *Austrian* dominions contiguous to *Germany* are the kingdoms of *Bohemia* and *Hungary*, *Transylvania*, *Scalvania*, and *Croatia*.

The kingdom of *Bohemia* comprehends *Bohemia Proper*, part of *Silesia* and *Moravia*, and is situated between 48 and 52 degrees of north latitude, and between 12 and 19 degrees of east longitude, extending near 300 miles in length, and 250 in breadth. The chief towns *Prague*, *Breslaw*, and *Olmuts*.

*Hungary* is situate between 45 and 49 degrees of north latitude, and between 16 and 23 degrees of eastern longitude, being bounded by the *Carpathian* mountains which divide it from *Poland* on the north; by *Transylvania* and *Walachia* on the east; by the river *Drave*, which divides it from *Servia* and *Scalvania* on the south; and by *Austria* and *Moravia* on the west: and is 300 miles in length from east to west, and 240 in breadth from north to south.

The chief towns are *Presburg* and *Buda*.

*Transylvania* is situate between 45 and 48 degrees of north latitude, and between 22 and 26 degrees of east longitude, being bounded by *Poland* on the north, by *Moldavia* and *Walachia* on the east, by *Bulgaria* on the south, and by *Hungary* on the west, being 200 miles in length from north to south, and 120 miles in breadth from east to west.

The chief rivers are the *Atlanta*, and *Merish*: the chief mountains the *Carpathian*, which divide it from *Hungary*, and the *Irongate* mountains, which divide it from *Turky*: and the chief town is *Hermanstat*.

*Transylvan* was heretofore a distinct principality, but is now annexed to *Hungary*, as well as the bannat of *Temeswaer*, and subject to the crown of *Hungary*.

*Scalvania* is situate between 45 and 47 degrees of north latitude, and between 16 and 21 degrees of eastern longitude, bounded by the rivers *Drave* and *Danube*, which divide it from *Hungary* on the north-east, and by the river *Save*, which separates it from *Bosnia* and *Servia* on the south-west, being 200 miles and more in length, and 60 in breadth. The chief town is *Pofega*. The chief rivers are the *Danube*, the *Drave*, and the *Save*. This country also is subject to the *Austrian* family, who are as absolute here, as in *Hungary*.

*Croatia* is situate between 45 degrees 30 minutes, and 46 degrees 20 minutes north latitude, and between 16 and 18 degrees of east longitude, bounded by *Scalvania* on the north and east, by the river *Unna* which divides it from *Bosnia* on the south, and by *Carniola* on the west, being about 70 miles long and 60 broad. The chief town is *Carlsat*. The chief rivers are the *Save*, the *Culp*, and the *Unna*. This country is also subject to the house of *Austria*.

*Germany Proper* is situated between 45 and 55 degrees of north latitude, and between 5 and 19 degrees of east longitude, bounded by the *German* ocean, *Denmark* and the *Baltic* sea on the north, by *Poland* and *Hungary* (if we include *Bohemia*) on the east, by *Switzerland* and the *Alps*, which separate it from *Italy* on the south, and by the dominions of *France* and the *Netherlands* on the west: being divided into ten circles, viz. 1. three circles in the north of *Germany*, i. e. the circle of *Upper Saxony*, the circle of *Lower Saxony*, and the circle of *Westphalia*.

2. Three circles about the middle of *Germany*, viz. the circle of *Franconia*, the circle of the *Upper Rhine*, and the circle of the *Lower Rhine*.

3. Three circles in the south of *Germany*, viz. the circle of *Austria*, the circle of *Bavaria*, and the circle of *Swabia*.

In the circle of *Upper Saxony* is, 1. The marquisate of *Brandenburg*, subject to the elector of *Brandenburg* (king of *Prussia*). 2. The duchy of *Pomerania*, subject to the same prince, and the king of *Sweden*. 3. The duchy of *Saxony*, *Misnia*, *Lusatia*, and *Thuringia*, the greatest part whereof is subject to the elector of *Saxony* (king of *Poland*).

The chief towns in the circle of *Upper Saxony* are, 1. *Berlin*, the capital of *Brandenburg*. Note, The elector of *Brandenburg*, has at present the largest territories of all the sovereigns of *Germany*, except the king of *Bohemia*; for besides his marquisate, he is possessed in *Westphalia* of the principality of *Minden*, of the duchy of *Cleves*, of the counties of *La Mark*, of *Revensperg*, and of the lordship of *Revenstein* in *Brabant*. He holds in *Lower Saxony*, the principalities of *Magdeburg*, and of *Alberstadt*: the ulterior *Pomerania*, and the ducal *Prussia*; also was declar'd legitimate heir of *Neuchatell*, and *Velangin*, to the exclusion of the other pretenders; and, lastly, he has almost all *Silesia*.

2. *Stetin*, the capital of *Brandenburg Pomerania*.

3. *Stralsund*, the capital of *Swedish Pomerania*.

4. *Dresden*, the capital of *Misnia*, and of all the elector of *Saxony's* German dominions.

The countries comprehended in the circle of *Lower Saxony* are the duchies of *Hanover*, *Zell*, *Lunenbourg*, *Bremen*, and *Verden*, subject to the elector of *Hanover*, king of *Great Britain*. The duchies of *Brunswick* and *Wolfembuttel*, subject to the duke of *Brunswick* and *Wolfembuttel*. The hishoprick of *Hildesheim*, subject to the elector of *Cologn*. The duchies of *Magdeburg*, and *Halberstat*, subject to the elector of *Brandenburg*. The duchy of *Holslein*, subject to the king of *Denmark*, and the duke of *Holslein*. The duchy of *Mecklenburg*, subject to the duke; and the duchy of *Lawenburg*, subject to the elector of *Hanover*.

The

The chief towns in the circle of *Lower Saxony* are, 1. *Hanover*, the capital of the king of *Great Britain's German dominions*.

2. *Brunswick*, the capital of the duke of *Brunswick Wolfenbüttele's* territories.

3. *Magdeburg*, the capital of the elector of *Brandenburg's* dominions in this circle.

4. *Gustraw*, the capital of the duke of *Mecklenburg's* dominions.

5. *Hamburg*, an imperial city and port town, situate on the river *Elbe*.

6. *Lubeck*, an imperial city and port town, situate on the river *Trave*, near the *Baltic sea*.

7. *Altena*, the capital of the king of *Denmark's* territories in *Holstein*.

8. *Lawenburg*, the capital of the dutchy of *Lawenburg*.

9. *Bremen*, the capital of the dutchy of *Bremen*, an *Imperial city*, situated on the river *Weser*.

The countries comprehended in the circle of *Westphalia* are the dutchies of *Munster* and *Westphalia*, the bishopricks of *Osnaburg* and *Paderborn*, subject to the elector of *Cologne*; the dutchies of *Juliers* and *Bergue*, subject to the elector *Palatine*; the dutchy of *Cleve*, and the counties of *Mork Ravensburg* and *Bentheim*, subject to the elector of *Brandenburg*; the bishoprick of *Liege*, subject to its bishop; the counties of *Lippe*, *Scharwenburg*, *Hoye*, *Diepholt*, *Oldenburg*, *Delmonburst*, *Embden*, *Tecklenburg*, *Pyrmont*, *Lingen*, *Steinfort*, *Corbey*, *Abbey*, and several towns and small territories, subject to their respective sovereigns.

The chief towns in *Westphalia* circle are, 1. *Munster*, the capital of *Westphalia*.

2. *Dusseldorp*, capital of the dutchy of *Berg*, and of the elector *Palatine's* dominions in *Westphalia*.

3. *Aix la Chapelle*, or *Aken*, an imperial city in the dutchy of *Juliers*, celebrated for its baths.

4. *Liege*, capital of the bishoprick of *Liege*, situate on the river *Maes*.

The countries comprehended in the circle of *Franconia* are the territory of *Nuremburg*, the bishopricks of *Bamberg* and *Wurtsburg*, the marquise of *Anspach* or *Onspach*, the counties of *Holach*, *Archstet*, and *Wertheim*, and the territories of the grand master of the *Teutonic* order.

The considerable towns in the circle of *Franconia* are, 1. *Nuremburg*, the capital of the territory of *Nuremburg* and of all *Franconia*, an imperial city.

2. *Bamberg*, capital of the bishoprick of *Bamberg*.

3. *Wurtsburg*, capital of the bishoprick of *Wurtsburg*.

The countries comprehended in the circle of the *Upper Rhine* are the dutchy of *Deux Ponts*, the landgravates of *Hesse-Cassel* and *Hesse-Darmstai*,

and formerly the landgravate of *Alsatia*, but that is now a province of *France*.

The chief towns in the circle of the *Upper Rhine* are, 1. *Heidelberg*, the capital of the *Palatinate*.

2. *Hesse Cassel*, the capital of that landgravate.

3. *Hesse Darmstai*, capital of that landgravate.

4. *Worms*, an imperial city, situate on the *Rhine*.

The countries comprehended in the circle of the *Lower Rhine*, are the three spiritual electorates of *Mentz*, *Triers*, and *Cologne*, and most part of the *Palatinate* of the *Rhine*, with the territory of *Francfort*.

The considerable towns in this electorate are,

1. *Mentz*, capital of the electorate of *Mentz*.

2. *Francfort*, situate on the river *Maine*, a free imperial city, sometimes placed in the circle of the *Lower Rhine*, and at other times in *Franconia*.

3. *Triers* or *Treves*, situate on the river *Moselle*, capital of the electorate of *Triers*.

4. *Cologne*, capital of the electorate of *Cologne*, and of all the circle of the *Lower Rhine*.

The countries contained in the circle of *Swabia* are the dutchy of *Wirtemberg*, the marquise of *Baden*, the *Burgaw*, the bishopricks of *Sasburg* and *Constance*, the territories of *Ulm*, the *Brisgaw*, and several imperial cities and forest towns. Whereof the dutchy of *Wirtemberg* is subject to the duke of *Wirtemberg*, and the territories of *Baden* to the prince of *Baden*; the *Burgaw*, *Brisgaw*, *Forest Towns*, and several principalities of *Swabia*, are subject to the house of *Austria*.

The chief towns in *Swabia* are, 1. *Augsburg*, an imperial city, capital of the *Burgaw*.

2. *Ulm*, an imperial city, situate at the confluence of the rivers *Danube* and *Iller*.

3. *Stuttgart*, capital of the duke of *Wirtemberg's* dominions, situate on the river *Neckar*.

4. *Constance*, situate on the lake of *Constance*, and subject to the house of *Austria*.

5. *Baden*, capital of the marquise of *Baden*.

6. *Friburgh*, capital of the *Brisgaw*.

The countries contained in the circle of *Bavaria* are the dutchy of *Bavaria*, the palatinate of *Bavaria*, the dutchy of *Newburg*, the territory of *Saltsbach*, the archbishoprick of *Saltsburg*, and the bishopricks of *Passau*, and *Freisingen*.

The chief towns in *Bavaria* are, 1. The city of *Munich*, capital of the dutchy and electorate of *Bavaria*.

2. *Ratisbon*, an imperial city where the diet of the empire is used to be held.

3. *Amberg*, capital of the palatinate of *Bavaria*.

4. *Saltsburg*, the capital of the archbishoprick of *Saltsburg*.

5. *Newburg*, the capital of the dutchy of *Newburg*.

6. *Passau*, the capital of the bishoprick of *Passau*.

The Countries within the circle of *Austria* are the archduchy of *Austria*, the dutchies of *Stiria*, *Carinthia*, and *Carniola*, the country of *Tyrol*, and the bishopricks of *Trent* and *Brixen*.

The chief towns in the circle of *Austria* are, 1. *Vienna*, the capital of the archduchy of *Austria*, and of the *German* empire.

2. *Gratz*, the capital of the dutchy of *Stiria*.

3. *Clagenfurt*, the capital of the dutchy of *Carinthia*.

4. *Landbach*, the capital of the dutchy of *Carinthia*.

5. *Inspruck*, the capital of the county of *Tyrol*, situate on the river *Inn*.

6. *Trent*, the capital of the bishoprick of *Trent*, situate on the river *Adige*.

The considerable rivers in *Germany* are the *Danube*, the *Rhine*, the *Elbe*, the *Weser*, the *Oder*, the *Maes*, the *Inn*, the *Moselle*, and the *Havel*.

The *Germans* are not supposed to be furnished with a vast deal of wit, but they are very good artists, liberal, noble, brave, good, sincere, and very sociable; they are for the generality very handsome, and of a strong constitution. They love naturally war, and good cheer; but they are not esteemed the best civilized people in *Europe*.

Note also, that the empire of *Germany* is composed of five sorts of powers, viz. the emperor, who is chief, but not master, since he can dispose of nothing but his own: the electors to the number of nine, viz. the archbishop of *Mentz*, high chancellor of the empire in *Germany*: the archbishop of *Triers*, high chancellor of the empire in *Gaul*: the archbishop of *Cologne*, high chancellor of the empire in *Italy*: the king of *Bohemia*, great cup-bearer: the duke of *Bavaria*, high steward: the duke of *Saxony*, grand marshal: the marquis of *Brandenburg*, grand chamberlain: the count *Palatine* of the *Rhine*, high treasurer: the duke of *Hanover*, called likewise high treasurer: the ecclesiastick princes; the secular princes; the free-towns, which are as many republicks; some of those towns, or cities, are called imperial, and appear at the assemblies, or diets, on the benches of *Swabia* and of the *Rhine*: others are called *Hanse* towns, and appear under four colleges, whose seats are *Lubeck*, *Cologne*, *Brunswick*, and *Danzick*: these towns have received the name *Hanse*, from the *German* words *An zee Stette*, i. e. cities situated on the sea; because the first which began the confederacy were all situated on the sea, or at least on some considerable rivers: they formed this confederacy, to maintain themselves mutually in trade; and they had once counting-houses in common, viz. one at *London*, in *England*; one at *Bruges*, in *Flanders*, and

afterwards at *Antwerp*; one at *Novogrod*, in *Muscovy*, then at *Revel*, in *Livonia*, and afterwards at *Narva*; and the other at *Bergen*, in *Norway*.

The *German* powers depend no otherwise on the emperor, than by doing homage to him; otherwise, they can make war, alliances, and confederacies with foreign princes, provided they do not prove prejudicial to the empire.

The *NETHERLANDS* are situate between 50 and 53 degrees north latitude, and between 2 and 7 degrees of east longitude, bounded by the *German* sea on the north, by *Germany* on the east, by *Lorraine* and *France* on the south, and by another part of *France* and the *British* seas on the west, extending near 300 miles in length, and 200 in breadth.

These provinces are 17 in number, whereof 7, which are under the dominion of the *Dutch*, are called the *United Provinces*, the other ten are called the *Austrian* and *French Netherlands*, being most of them subject to those powers.

The names of the *United Provinces* are, 1. *Holland*. 2. *Zealand*. 3. *Friesland*. 4. *Groningen*. 5. *Overissel*. 6. *Gelderland* with *Zutphen*, and 7. *Utrecht*.

The chief towns in the *United Provinces* are, 1. *Amsterdam*, the capital of the province of *Holland*, and of all the *United Provinces*.

2. *Rotterdam*, situate on the river *Maes*.

3. *Middleburg*, the capital of the province of *Zealand*, situate in the island of *Walcheren*.

4. *Nimeguen*, situate on the river *Waal*, in the province of *Gelderland*.

5. *Utrecht*, the capital of the province *Utrecht*, situate on the channel of the *Old Rhine*.

6. *Lewarden*, the capital of the province of *Friesland*.

The chief rivers in the *United Provinces* are the *Rhine*, the *Lech*, the *Waal*, the *Maes*, and the *Scheld*.

The names of the other ten provinces are, 1. *Brabant*. 2. *Flanders*. 3. *Hainault*. 4. *Limburg*.

5. *Luxemburg*. 6. *Namur*. 7. *Artois*. 8. The *Cambresis*. 9. The marquisate of *Antwerp*. And

10. The lordship of *Malines*, or *Melkin*: Of these the *French* possess the entire provinces of *Artois* and *Cambray*, part of *Flanders*, *Hainault* and *Luxemburg*; and the *Dutch* possess the north of *Brabant* and *Flanders*; all the rest are subject to the house of *Austria*.

The chief towns in the *Austrian* and *French Netherlands* are, 1. *Brussels*, the capital of *Brabant*, and of all the *Austrian Netherlands*, situate on the river *Senne*.

2. *Ghent*, or *Gau t*, the capital of *Austrian Flanders*, situate on the four rivers of the *Scheld*, *Lys*, *Lieue*, and *Mourwater*.

3. *Lisse*, the capital of the *French Netherlands*, situate in the province of *Flanders*, on the river *Deule*.

4. *Mons*, the capital of *Hainault*, situate near the banks of the rivers *Haine* and *Trouille*.

5. *Namur*, the capital of the province of *Namur*, situate at the confluence of the rivers *Sambre* and *Maes*.

6. *Antwerp*, the capital of the marquisate of *Antwerp*, situate on the river *Scheld*.

7. *Malines*, or *Mechlin*, the capital of the lordship of *Mechlin*.

8. *Luxemburg*, the capital of the dutchy of *Luxemburg*, situate on the river *Else*.

9. *Limburg*, the capital of the dutchy of *Limburg*, situate on the river *Vese*.

The principal rivers in *Flanders* are the *Maes*, the *Sambre*, the *Scheld*, the *Lys*, the *Scarpe*, the *Senne*, the *Mebain*, the *Deule*, the *Dyle*, and the *Demer*.

*France* is situate between 5 degrees west and 7 degrees east longitude, and between 43 and 51 degrees of north latitude, being bounded by the *English* channel, and the *Netherlands* on the north, by *Germany*, *Switzerland*, *Savoy*, and *Piedmont* on the east, by the *Mediterranean* sea and the *Pyrenean* mountains on the south, and by the bay of *Biscay* on the west, being almost square, and upwards of 500 miles over either way.

The provinces or governments in *France* are, 1. *Picardy*. 2. *Normandy*. 3. *Brittany*; and 4. the isle of *France*, on the north.—5. *Orleans*, and 6. *Linois*, in the middle.—7. *Guienne*, and *Gascony*. 8. *Languedoc*. 9. *Provence*; and 10. *Dauphine*, on the south.—11. *Burgundy*. 12. *Champagne*. 13. The *French Netherlands*. 14. *Lorraine*; and 15. *Alsace*, on the east.

The chief towns are, 1. *Paris*, the capital of the isle of *France*, and of the whole kingdom, situate on the river *Seine*, in 48 degrees 50 minutes north latitude, and two degrees 25 minutes east longitude.

2. *Rouen*; capital of the province of *Normandy*, situate on the *Seyne*.

3. *Orleans*, capital of the government of *Orleans*, situate on the river *Loyre*.

4. *Lions*, the capital city of the government of *Lionois*, situate at the confluence of the rivers *Rhine* and *Soane*.

5. *Thoulon*, or *Toulon*, the best port-town in *France*, is situate in *Provence*, on a bay of the *Mediterranean* opposite to the islands of *Hieres*.

6. *Touluse*, the capital of the province of *Languedoc*, is situate on the river *Garonne*.

7. *Bordeaux* the capital of the province of *Bour-*

*deois*, and of the government of *Guienne* and *Gascony*, situate on the river *Garonne*.

8. *Nants*, a great port-town in the province of *Brittany*, situate on the river *Loyre*.

9. *Brest*, the most considerable port-town of *France* upon the ocean, situate on the coast of *Brittany*.

The chief rivers in *France* are the *Rhone*, the *Soane*, the *Garonne*, the *Loyre*, the *Seyne*, the *Dordonne*, the *Oyse*, the *Marne*, the *Aube*, the *Ijere*, and the *Durance*.

The chief mountains are the *Alps*, which separates *France* from *Italy*; the mountains of the *Cevennes* and *Auverne*; the mountains of *Vauze*, which divide *Franche Comte* from *Alsace* and *Lorraine*; and the *Pyrennes*, which divide it from *Spain*.

The king of *France* in his dominions (the conquests excluded) promotes to eighteen archbishoprics, a hundred and ten bishoprics, to seven hundred and fifty abbeys of monks, without reckoning those who have been re-united to other commonalties or benefices; and to more than two hundred abbeys of nuns.

The eighteen ARCHBISHOPRICKS, are, *Aix*, *Aiby*, *Ambrun*, *Aries*, *Auch*, *Besaneon*, *Bordeaux*, *Bourges*, *Cambray*, *Lyons*, *Narbonne*, *Paris*, *Rheims*, *Rouen*, *Sens*, *Touluse*, *Tours*, *Vienne*.

The hundred and ten BISHOPRICKS, are, *AGDE*, *Agen*, *Air*, *Alet*, *Amiens*, *Angiers*, *Angoulême*, *Apt*, *Arvas*, *Auranche*, *Autun*, *Auxerre*; *BAYEUX*, *Bayonne*, *Bazas*, *Beauvois*, *Bellay*, *Bethléem*, *Beziers*, *Blois*, *Boulogne*, *St. Brieu*; *CAHORS*, *Carcassone*, *Castres*, *Châlons*, *Chalons*, *Chartres*, *Cisteron*, *Clermont*, *Cominges*, *Condom*, *Cornouaille*, *Conserans*, *Coutance*; *DAX*, *Die*, *Digne*, *Dole*; *EVREUX*; *S. FLOUR*, *Frejus*; *GAP*, *Geneve*, *Glandève*, *Grace*, *Grenoble*; *KEBEO LAITOUR*, *Langres*, *Lâon*, *Lavaur*, *Leon*, *Lescor*, *Limoges*, *Lisieux*, *Lodève*, *Lombes*, *Lucon*; *MAACON*, *S. Malo*, *Mande*, *Mans*, *Marseille*, *Meaux*, *Metz*, *Mirepoix*, *Montauban*, *Montpellier*; *NANTES*, *Nevers*, *Nice*, *Nimes*, *Noyon*; *OLERON*, *S. Omer*, *Orange*, *Orleans*; *PAMIERS*, *S. Papoul*, *S. Paul trois Chateaux*, *Perigueux*, *Perpignan*, *Poitiers*, *S. Pol de Leon*, *S. Pons de Tanieres*, *Puy*; *RENNES*, *Rieux*, *Riez*, *Rochelle*, *Rodez*; *SAINTE*, *Sais*, *Sarlat*, *Senes*, *Sentis*, *Soissons*, *Straßbourg*; *TARBES*, *Toul*, *Toulon*, *Tournay*, *Trequier*, *Troyes*, *Tulles*; *VABRES*, *Valence*, *Vannes*, *Vence*, *Verdun*, *Viviers*, *Usaiz*.

*Turkey* in *Europe*, is the south-east part of *Europe*, and comprehends all those countries, enumerated already in the general division of *Europe*, which lie between 36 and 44 degrees of north lat. and between 17 and 40 degrees of eastern long. extending 1000 miles and upwards in length from

from east to west, and 500 miles in breadth from north to south.

The chief towns of *Turkey in Europe*, are

1. *Constantinople*, situate on the *Bosphorus* or *Straight*, which separates *Europe* from *Asia*, being the capital of the province of *Romania*, and of the whole *Turkish* empire.

2. *Adrianople*, situate in the province of *Romania*.

3. *Belgrade*, the capital of the province of *Servia*, situate on the river *Danube*.

4. *Salonichi* or *Theffalonica*, a port-town of *Macedonia*, situate on the *Archipelago*, or *Egean sea*.

5. *Athens* or *Settines*, the capital of *Achaia* or *Livadia*.

6. *Napoli de Romania*, a port-town, the capital of the *Morea*.

7. *Lepanto*, situate on the gulph of *Lepanto* in the province of *Achaia*.

8. *Negropont* or *Egripos*, the capital of the island of *Negropont*, the largest island in the *Egean sea* or *Archipelago*.

The chief rivers of *Turkey in Europe*, are the *Danube*, the *Save*, the *Alauta*, the *Niesler*, and the *Pruth*.

The chief mountains are those of *Rhodope* or *Argentum*, which divide *Romania* and *Macedon* from *Bulgaria* and *Servia*, and the mountain *Parnassus* in *Greece*.

The principal *Turkish* islands in *Europe* are the numerous islands in the *Archipelago* or *Egean sea*, are all subject to the *Turks*, whereof part lies in *Europe*, and part in *Asia*, of which the largest *European* island is that of *Negropont* already mentioned, anciently called *Eubœa*, situate north east of the coast of *Achaia* or *Livadia*, by which it is separated by the narrow sea called the *Euripus*, remarkable for its irregular tides, which flow sometimes 13 or 14 times in 24 hours. The islands of *Lemnos*, *Sciros*, *Andros*, and *Melos*, are of a considerable extent. These and the rest, are inhabited chiefly by *Grecian* christians.

*Italy* is situate between 38 and 46 degrees of north latitude, and between 7 and 19 degrees of eastern longitude, being about 600 miles long, and from 80 to 400 broad. It is bounded by *Switzerland*, and the *Alps*, which separate it from *Germany* on the north, by the gulph of *Venice* on the east, by the *Mediterranean sea* on the south, and by the same sea and the *Alps*, which separate it from *France*, on the west; and comprehends the following countries: viz. 1. The principality of *Piedmont*, the dutchy of *Savoy*, and the dutchy of *Monferrat*, subject to the king of *Sardinia*. 2. The dutchies of *Milan*, *Parua*, and *Parma*, subject to the house of *Austria*. 3. The dutchy of *Modena*,

subject to its own duke. 4. The large dominions of the republick of *Venice*; all which lie in the north of *Italy*. 5. The dutchy of *Tuscany*, subject to the grand duke, the present emperor of *Germany*. 6. The little republic of *Lucca*. 7. The pope's extensive territories, which last three lie in the middle of *Italy*. 8. The kingdom of *Naples*, which takes up the south of *Italy*, and is subject to the king of the two *Sicilies*.

The chief towns in *Italy* are. 1. *Turin*, the capital of *Piedmont*, and of the king of *Sardinia's* dominions, situate on the river *Po*.

2. *Chamberry*, the capital of *Savoy*.

3. *Genoa*, the capital of the republick of *Genoa*.

4. *Milan*, the capital of the dutchy of *Milan* and of the *Austrian* dominions in *Italy*.

5. *Mantua*, the capital of *Mantua*, situate in the middle of a lake.

6. *Parma*, the capital of the dutchy of *Parma*.

7. *Venice*, the capital of the *Venetian* dominions, situate on several islands at the bottom of the gulph of *Venice*, five miles from the continent.

8. *Florence*, the capital of the dutchy of *Tuscany*, situate on the river *Arno*.

9. *Leghorn*, or *Livorno*, the most considerable port town in all *Italy*, situate on the *Tuscan sea*.

10. *Modena*, the capital of the dutchy of *Modena*.

11. *Lucca*, the capital of the republick of *Lucca*.

12. *Rome*, the capital of the *Campania*, and of all the pope's dominions, situate on the river *Tiber*, once the seat of universal empire.

13. *Naples*, the capital of the kingdom of *Naples*, situate on a bay of the *Tuscan sea*.

The most considerable rivers of *Italy* are the *Po*, the *Adige*, the *Stura*, the *Arno*, the *Tiber*, and the *Volturno*.

The highest mountains are the *Alps* which divide *Italy* from *Germany*, and *France*; and the *Appenine*, which run the whole length of *Italy*; and mount *Vesuvius* in *Naples*, remarkable for its volcano.

The most considerable *Italian* islands are *Sicily*, *Sardinia*, *Corfica*, the *Lipari* islands, and that of *Elba*.

*Sicily*, is situate in the *Mediterranean sea*, between 37 and 38 degrees 30 minutes north latitude, and between 12 and 15 degrees of east longitude, being about 160 miles long, and 100 broad, separated from the kingdom of *Naples* in *Italy*, by the narrow strait of *Messina*.

The principal towns are 1. *Palermo*, the capital of *Sicily*.

2. *Messina*, a great port town, situate at the east end of the island, opposite to *Regio* in *Naples*. This island with the kingdom of *Naples*, is sub-

ject

ject to *Don Carlos*, who styles himself king of the *Two Sicilies*.

In the island of *Sicily*, is *Mount Etna*, the most terrible volcano in *Europe*, which has by its eruptions and earthquakes, destroyed some of the best towns in the island.

*Sardinia* is situate in the *Mediterranean* sea, between 39 and 41 degrees of north latitude, and between 8 and 10 degrees of eastern longitude, being 140 miles in length from north to south, and 70 in breadth from east to west; the capital town *Cagliari*, situate on a bay of the sea, at the south end of the island in 39 degrees of north latitude, and 9 degrees of eastern longitude, subject to the king of *Sardinia*.

*Corfica* is situate between 41 and 43 degrees of north latitude, and between 9 and 10 degrees of east longitude, in the *Mediterranean* sea, separated from the island of *Sardinia*, on the south by the strait of *Bonifacio*; the chief town, *Bastia*, is situate on the east side of the island, in 42 degrees 40 minutes north latitude, and 9 degrees 50 minutes east longitude. The island is subject to the republic of *Genoa*.

*Switzerland* is situate between 45 and 48 degrees of north latitude, and between 6 and 10 degrees of east longitude, bounded by *Germany* on the north and east, by the territories of *Venice*, *Piedmont*, and *Savoy* in *Italy*, on the south, and by *France* on the west, being 180 miles in length from east to west, and 140 in breadth from north to south, consisting of a great many independent cantons, or republics, of which those of *Bern*, *Zurich*, and the *Grisons*, are the chief.

The chief towns in *Switzerland* are 1. *Bern*, the capital of the canton of *Bern*, and of all *Switzerland*, situate on the river *Aar*.

2. *Coire*, the capital of the *Grisons*, situate on the river *Rhine*.

3. *Zurich*, the capital of the canton of *Zurich*, situate at the north end of the lake of *Zurich*.

4. *Geneva*, situate on the river *Rhone*, at the west end of the lake *Lemân* or *Geneva*.

5. *Basil*, the capital of the canton of *Basil*, situate on the river *Rhine*, near the confines of *Alsace*.

6. *Baden*, the capital of the territory of *Baden*, where the states or representatives of the cantons assemble.

*Switzerland* is the most mountainous country in *Europe*, being situate on the *Alps*.

Several of the largest rivers also, have their sources here: viz. the *Danube*, the *Rhine*, the *Rhone*, and innumerable torrents, which fall precipitately from the mountains on the melting of the snow: and there are lakes on the tops of their highest mountains.

*Spain* is a peninsula, surrounded by the *Atlantic* ocean and the *Mediterranean* sea, except on the north east where it is joined to *France*, by the *Pyrenean* mountains, and is situate between 36 and 44 degrees of north latitude, and between 10 degrees west, and 3 degrees eastern longitude, being bounded by the bay of *Biscay*, part of the *Atlantic* ocean and *France* on the north, by the *Mediterranean* and the strait of *Gibraltar* and the *Atlantic* ocean on the south, and by the same *Atlantic* ocean on the west, being upwards of 600 miles in length from east to west, and almost as many in breadth; but in this description *Portugal* is included, which was once a province of *Spain*.

The provinces comprehended in the kingdom of *Spain* are, 1. *Galicia*. 2. *Asturia*. 3. *Biscay* on the north. 4. *Navarre*. 5. *Aragon*. 6. *Catalonia*. 7. *Valencia* on the east. 8. *Murcia*. 9. *Granada*. 10. *Andalusia* on the south. 11. *Old Castile*. 12. *New Castile*. 13. *Leon*, and 14. *Estremadura* in the middle of *Spain*.

The chief towns in *Spain* are 1. *Madrid*, the capital of the kingdom, situate in the province of *New Castile*.

2. *Toledo*, heretofore the capital of the kingdom, situate in the province of *New Castile*, on the river *Tagus*.

3. *Compostella*, the capital of *Galicia*.

4. *Bilboa*, the capital of the province of *Biscay*.

5. *Saragossa*, the capital of the province of *Aragon*.

6. *Barcelona*, the capital of the province of *Catalonia*.

7. *Valencia*, the capital of the province of *Valencia*.

8. *Carthagena*, in the province of *Mercia*, situate on a bay of the *Mediterranean*, one of the best harbours in *Spain*.

9. *Granada*, the capital of the province of *Granada*.

10. *Gibraltar*, a strong fortified port-town in *Andalusia*, situate on the strait, between the ocean and the *Mediterranean*, which separates *Europe* from *Africa*.

11. *Cadiz*, the most considerable port-town in *Spain*, chief station of the *Spanish* men of war and galleons, situate on the island of *Leon*, in the province of *Andalusia*.

12. *Seville*, the capital of the province of *Andalusia*, situate on the river *Guadalquivir*.

The most considerable rivers and mountains in *Spain* are the *Ebro*, the *Guadalquivir*, the *Guadiana*, the *Tagus*, the *Douro*, and the *Minho*.

The most considerable mountains are those of the *Pyrenees*, which separate *France* and *Spain*, and branches of those, under several names, run through

Spain from east to west; it being generally a very mountainous country. *Mount Calpe* which covers the town of *Gibraltar* is one of the pillars of *Hercules*; that of *Mount Abile* in *Africa* on the opposite side of the straight of *Gibraltar* being the other.

The chief *Spanish* islands are those anciently called the *Balears*: viz. *Majorca*, *Minorca*, and *Ivica*.

*Majorca* the largest, is situate between 2 and 3 degrees of eastern longitude, and between 39 and 40 degrees of north latitude; the chief town *Majorca*.

*Minorca*, the least of these islands, is situate in 40 degrees north latitude, and 4 degrees of east longitude; the chief town *Port mahone*, lately taken by *France* from *Great Britain*.

*Ivica*, is situate in 39 degrees of north latitude, and 1 degree of east longitude.

*Portugal* is situate between 37 and 42 degrees of north latitude, and between 7 and 10 degrees of west longitude, being upwards of 300 miles in length from north to south, and 100 in breadth; bounded by the *Spanish* province of *Galicia* on the north, by other parts of *Spain* on the east, and by the *Atlantic* ocean on the south and west.

The provinces comprehended in *Portugal* are 1. *Entre and Minho Douro*. 2. *Tralos Montes* on the north 3. *Beia*, and 4. *Estremadura* in the middle. 5. *Alentio*, and 6. *Algarves* in the south,

The chief towns are 1. *Lisbon*, the capital of the province of *Estremadura* and of the whole kingdom, situate near the mouth of the river *Tagus*, and the *Atlantic* ocean, in 38 degrees, 45 minutes north latitude, and 9 degrees west longitude. It was almost totally destroyed by an earthquake on Nov. 1, 1755, and is now rebuilding in a more magnificent taste.

2. *St. Ubes*, situate on a bay of the *Atlantic* ocean.

3. *Porto*, situate near the mouth of the river *Douro*, and the ocean; in the province of *Entre Minho and Douro*.

The chief rivers in *Portugal*, are the *Tagus*, the *Guadiana*, the *Minho*, and the *Douro*.

There are several sorts of governments in *Europe*, viz. The *monarchical*; as in *France*, *Spain*, &c. The *despotick*, as in *Turky*, and *Muscovy*; the *aristocratical*, as the republick of *Venice* in *Italy*; the *democratical*, as that of *Switzerland*, and of the *united provinces*. Others, which are a mixture of *monarchy*, *aristocracy*, and *democracy*; as, in *England*, *Germany*, and *Poland*.

The *monarchical state*, is that governed by a sole sovereign.

The *despotick*, is that where a sovereign has power of life and death over his subjects, without any other formality than his own will.

The *aristocracy*, is that which is governed by the nobles.

The *democratick*, is that where the governors are chosen among the people.

There are several sorts of *religions* professed in *Europe*; though among so many there are but five principal, the others being only branches, or sects of those five.

1. The most general of the five is the *ROMAN CATHOLICK RELIGION*; which is the reigning one in *France*, *Spain*, *Portugal*, *Italy*, part of *Germany*, *Poland*, &c. and in all places, that belong in *America*, *Asia* and *Africa*, to the crowns of *France*, *Spain*, *Portugal*, &c.

2. *LUTHERANISM*, professed in *Germany*, in *Sweden*, *Denmark*, &c.

3. *CALVINISM*, professed in *Scotland*, in some parts of *Germany*, *Poland*, &c.

4. The *ESTABLISHED CHURCH OF ENGLAND*, professed in most of the *BRITISH* dominions.

5. The *GREEK RELIGION*, professed in the dominions of the grand seignior, in *Muscovy*, and in some parts of *Poland*.

*EUROPE* has five general *LANGUAGES*, four of which are natural to its inhabitants, viz. the *Latin*, *Greek*, *Teutnick*, *Esclavonic*, and a foreign one which they have received from *Asia*, and which is the *Tartarian*, under which is comprised the *Turkish* tongue.

*Europe* has one prince ecclesiastick, three emperors, ten kings, six republicks, and more than three hundred sovereign princes; whose estates are as fiefs or tributaries of superior powers.

The ecclesiastick prince is the *POPE*, who styles himself *Servus Servorum Dei*.

The three emperors are, the *EMPEROR of Germany*, called emperor of the holy *Roman* empire.

The *EMPEROR of the Turks*, who calls himself sultan of the *Ottomans*, or grand seignior of the *Turks*.

The *EMPEROR of Muscovy*, who assumes the title of emperor, of the *Two Russias*; vulgarly called *Czar of Muscovy*.

The ten kings are;

The most *CHRISTIAN KING*, or king of *France*; who notwithstanding the vast extent of his dominions, composed of several sovereignties, viz. *Brittanny*, *Normandy*, *Burgundy*, *Provence*, *Languedoc*, &c. takes no other title than that of king of *France* and *Navarre*.

The *CATHOLICK KING*, or king of *Spain*.

The *KING OF GREAT BRITAIN*, and defender of the *faith*.

The KING of *Portugal*.

The KING of *Sweden*.

The KING of *Denmark*.

The KING of *Poland*.

The KING of *Prussia*.

The KING of *Naples* and *Sicily*.

And the KING of *Sardinia*.

The six republicks, are 1. *Venice*. 2. *Genoa*.  
3. *Lucca* in *Italy*. 4. The *United Provinces*. 5. The  
*Switzers*. 6. The *Grisons*, in *Germany*.

The 300 subaltern sovereign Princes, are of  
two sorts, viz. *Ecclesiasticks* and *Laicks*.

Among the *Ecclesiasticks* are two *Grand Masters*.

1. The GRAND MASTER of the *Knights of  
Malta*.

2. The GRAND MASTER of the *Teutonic  
Order*.

Four *Archbishops*, and the three first *Electors* of  
the empire.

1. The ARCHBISHOP and ELECTOR of *Mentz*.

2. The ARCHBISHOP and ELECTOR of *Treves*.

3. The ARCHBISHOP and ELECTOR of *Cologne*.

4. The ARCHBISHOP of *Saltzbourg*.

Twenty-two *Bishops*, who are, 1. *Münster*.

2. *Paderborn*. 3. *Liege*. 4. *Worms*. 5. *Spire*.

6. *Straßbourg*. 7. *Eafil*. 8. *Syon*. 9. *Coire*. 10.

*Briscen*. 11. *Trente*. 12. *Constance*. 13. *Augsbourg*.

14. *Frisingue*. 15. *Passau*. 16. *Ratisbon*. 17. *Rich-*

*stott*. 18. *Wurtzbourg*. 19. *Bamberg*. 20. *Hidel-*

*sheim*. 21. *Osnabrug*. 22. *Lubeck*.

A GRAND PRIOR of *Malta*, who calls himself  
*Grand Prior of Germany*.

Several ABBOTS, that of *Fulde*, who has a  
greater extent of lands than any of the others.

Several PREVOSTIES, the most considerable of  
which is that of *Berechtsgaden*.

Among the *Laick SOVEREIGNS*, are five *Elec-*  
*tors*.

1. The ELECTOR and DUKE of *Bavaria*.

2. The ELECTOR and DUKE of *Saxony*.

3. The ELECTOR and MARQUIS of *Branden-*  
*burg*.

4. The ELECTOR and COUNT *Palatine*.

5. The ELECTOR and DUKE of *Hanover*.

An ARCHDUKE of *Austria*.

A GREAT DUKE of *Tuscany*.

The several *Dukes* are those of *Newbourg*  
*Weimar*, *Lunenbourg*, *Brunswick*, *Werttemberg*,  
*Mecklenbourg*, *Lawenbourg*, *Helflein*, &c. and all  
in *Germany*.

Those of *Savoy*, *Mantua*, *Modena*, *Parma*, and  
several others whose territories are of a lesser extent,  
are in *Italy*.

That of *Bouillou* is between *France* and the  
*Low-Countries*.

And that of *Courland* in *Poland*.

Among the *Marquises*, the most considerable  
are, those of *Baden*, and *Durlach*, of *Anspach*,  
and of *Culmbach* in *Germany*.

And several in *Italy*, but whose territories are of  
a little extent.

Several LANDGRAVES, some of whom are  
Princes, viz.

The LANDGRAVE of *Hesse-Cassel*, and of *Hesse-*  
*Darmstad*.

Several Princes, and the most considerable among  
them are,

The PRINCE of *Anbalt* in *Germany*.

The PRINCES of *Monaco*, of *Solfarini*, and of  
*Castillione* in *Italy*.

Several Counts or Earls, among whom are the  
Princes, of *Nassau*, *Furstemberg*, *West-Friseland*,  
*Höbenzollern*, *Amberg*.

Besides whom are,

The CHAM of the *Little Tartary*.

The *Vaivodes* of *Transilvania*, *Walachia*, *Mol-*  
*davia*, and of *Ukrania*.

And the republick of *RAGUSA*.—This repub-  
lick, and the five last Princes, are tributaries of the  
*Ottoman* empire.

From *Europe*, we will pass into *Asia*, which  
is the most eastern, and the most extended of the  
parts, the antient world, or our continent, is com-  
posed of; chosen by a special favour, by the author  
of nature, for the creation of the first man. It  
has been the laboratory (if I may use that ex-  
pression) where he has formed all his other works:  
It has the advantage of having served as a sacred  
temple, where the almighty has pronounced his  
oracles: It has furnished the matter on which he  
himself printed the sacred characters of his divine  
commandments, to give them to *Moses*: And it  
had the glory to witness the birth of the saviour  
of the world; to have possessed his divine presence  
during the whole course of his mortal life; having  
been as a new temple, where he has accomplished  
the mysteries of our redemption.

I will say more, that it is from *Asia* all the colo-  
nies which have peopled the other parts of the  
world have been taken; that it has been the seat of  
the most antient and most powerful monarchies of  
the earth: For after the deluge, it saw the begin-  
ning of the empire of the *Assyrians* by *Belus*, or  
*Ninus*, which continued as far as *Sardanapalus*: It  
passed afterwards to the *Medes* by *Arbaces*, as far  
as *Ashyages*; to the *Persians* by *Cyrus*, as far as  
*Darius*; and to the *Greeks* by *Alexander the Great*.  
The *Partians* established there likewise a very  
flourishing empire, which ended under *Alexander*  
*Severus*, and passed to the *Persians*, till it was  
swallowed up by the *Turks* and *Saracens*.

*Christianity, Mahometanism, and Paganism*, are the three reigning religions in *Asia*.—*Christianity*, is divided into eleven sects, *viz* 1. Of the *Greeks*; 2. Of the *Russians*; 3. Of the *Georgians*; 4. Of the *Syrians*; 5. Of the *Jacobites*; 6. Of the *Armenians*; 7. Of the *Nestorians*; 8. Of the *Cophts*, or *Egyptians*; 9. Of the *Abyssines*, or *Abyssinians*; 10. Of the *Maronites*; and 11. Of *St. Thomas*: These two last acknowledge, at present, the *Roman church*.—The *Greek* is the religion of the natives of part of *Turky in Asia*, whose patriarch is that of *Constantinople*.—The *Russian* is professed in the dependencies of that empire, whose patriarch resides at *Moscow*.—The *Georgian* is the religion of the people of *Mingrelia*, who have their own patriarch.—The *Syrian*, extends in *Syria*, or *Seristan*, which is a province of *Turky in Asia*, whose patriarch is that of *Antioch*, residing at *Damascus*.—That of the *Jacobites* is in the *Diarbeck*, or *Mesopotamia*, and in the *Holy Land*, under two patriarchs; one residing at *Caracnid*, who styles himself patriarch of *Antioch*; and the other at *Jerusalem*, for the *Holy Land*.—That of the *Armenians*, is professed in both *Armenia's*, under two patriarchs, one for the *great*, and the other for the *little Armenia*.—That of the *Cophts*, is in *Egypt*, whose patriarch is that of *Alexandria*, residing at *Cairo*.—That of the *Abyssines*, is that of the dependencies of the empire of the same name.—That of the *Nestorians*, extends in the *Erzerum*, or *Assyria*, in the *Diarbeck*, the *Gerack*, or ancient *Chaldæa*, and in some provinces of *Persia*, under the patriarch of *Mosul*, which is the ancient *Niniveb*; this sect was once the most extended. Among all these schismatical sects, there are but the *Russian*, *Abyssinian*, and *Georgian*, which are professed by sovereign princes; the others being most of them subject to the *Mahometan* princes, in whose dominions they are professed.

The *Mahometanism* in *Asia*, is almost the sole religion of *Arabia*; and is the reigning one of *Turky in Asia*, of *Persia*, of the *Mogul*, of the western parts of the *great Tartary*, of the northern part of the peninsula of *India*, this side the river *Ganges*, of the *Maldivia Islands*, and of most of the *Isles of Sunda*, and of the *Molucca's*.

Among the *Pagan* sects, that of the *Parfis*; was antiently the reigning religion of *Persia*; but ever since *Mahometanism* has gained the ascendancy, there are but few of the natives who profess it, some of whom have settled on the coasts of the *Mogul*, near *Persia*, and in some places of the peninsula of *India*, this side the river *Ganges*.—The religion of the *Bruchmans*, was once the only one of all *Indostan*, and of the peninsula, this side

the river *Ganges*; and since *Mahometanism* has been established in those countries, it is yet the most followed religion, and most general of the natives of the dominions of the *Mogul*, and of the *Mahometan* states of the peninsula of *India*, this side the *Ganges*; is the reigning one in other dominions of the same peninsula, and those of the *Rajas* of *Indostan*, who have maintained themselves against the *Mogul*.—The religion of *Jukiao*, is the particular religion of men of letters in *China*, and that of the court.—The religion of the *Lama*, is also professed no where but in *China*.—That of the *Lamas*, which has some remains of christianity, is the religion of all the regions of *Tartary*, near *China*, as of the *Tibet*, of *Tangu*, *Kin*, and has been introduced in *China* by the conquest the *Tartars* have made of that country.—*Judaism* is also professed throughout all *Asia*, but is subject to the three others above-mentioned.

*ASIA* has six general languages, and five particular ones.

Among the general languages, three are natural to it, *viz* the *Arabic*, *Tartarian*, and *Chinese*; and three foreign, which it borrows from *Europe*, *viz* the *Greek*, *Latin*, and *Teutonic*.

The five particular languages are the *Japanese*, the *Armenian*, the *Guzarate*, *Malabar*, and *Malayan*.—The *Japanese* is the only one of the inhabitants of *Japan*, without any mixture of foreign languages.—The *Armenian* is very much in use for the commerce in *Turky*, and *Persia*.—The *Guzarate*, *Malabar*, and *Malayan*, have their course on the coasts of *India*, and in the neighbouring islands; particularly the *Malayan*, which is esteemed the most beautiful and elegant of the *East-India*.

*Asia* is situate between the equator and 72 degrees north latitude, and between 25 and 148 degrees of east longitude, being 4800 miles in length from east to west, and 4300 in breadth, from north to south, comprehending,

1. The empire of *China*, and *Chinese Tartary*, *Tibet*, and independent *Tartary*, with *Japan* and the other oriental islands in the east. 2. *India*, *Uzbek Tartary*, *Calmuck Tartary*, and *Siberia* in the middle. 3. The kingdom of *Persia*, *Arabia*, *Astracan*, *Circassian Tartary*, and *Turky in Asia* on the west; and is bounded by the frozen ocean on the north, by the pacific ocean on the east, by the *Indian Ocean* on the south, by the *Red sea*, which separates it from *Africa*, on the south-west, and by *Europe* on the north-west.

*China*, comprehending *Chinese Tartary*, is situate between 95 and 139 degrees of eastern longitude, and between 21 and 25 degrees north latitude,

tude, being about 2000 miles in length from north to south, and 1000 miles in breadth, from east to west; bounded by *Russian Tartary* on the north, by the Pacific ocean on the east and south, and by *Tonquin Tibet*, and the territories of *Russia* on the west.

The chief towns in *China* are.

1. *Peking*, the capital of the province of *Peking*, and of the whole empire.

2. *Nanking*, the capital of the province of *Nanking*, situate near the mouth of the river *Kiam* and the *Keng* sea.

3. *Canton*, the capital of the province of *Canton*, situate on the river *Ta*.

The chief rivers are the *Croccus* or *Hoombo*, and the *Kiam*; and there are two considerable islands on the coast of *China*, subject to that empire, viz. *Hainan*, in the south of *China*, and *Formosa*, on the south-west of *China*.

*Tibet* and independent *Tartary* lie between 30 and 35 degrees of north latitude, and between 75 and 85 degrees of eastern longitude, having *Siberia* on the north, *China* on the east, *India* on the south, and the *Usbeck* and *Calmuck Tartars*, and another part of *Siberia* on the west.

The islands of *Japan* are situated between 30 and 40 degrees north latitude, and between 130 and 140 degrees of east longitude, of which there are great numbers, but the three chief are those of 1. *Japan Proper* or *Nippon*. 2. *Sacock*, and 3. *Tonsa*.

1. *Japan Proper*, the most northerly of these islands, is about 600 miles in length from north to south, and from 100 to 150 miles broad.

2. *Sacock*, is about 500 miles in circumference.

3. *Tonsa*, is 400 miles in circumference.

The chief towns are, 1. *Jeddo* or *Yedo*, the capital of the empire.

2. *Saccai*, *Bongo*, and *Nangasague*.

The other islands comprehended under the name of the oriental islands, are all the islands south of *China*, and the farther *India* may properly be called the oriental islands, particularly, 1. The *Phillippine* islands. 2. *Gilolo* with the *Moluccas* or clove islands. 3. *Ceram* with *Amboyna*, *Banda*, and the rest of the nutmeg islands. 4. *Celebes* or *Macassar*. 5. *Borneo*. 6. *Java*, with the islands of *Bally* and *Florin*, and the rest of the islands east of *Java*. And 7. The island of *Sumatra*.

The *Phillippine* islands are very numerous, and lie between 5 and 19 degrees north latitude, and between 114 and 127 degrees of east longitude, whereof the islands of *Manilla* or *Luconia*, and *Mindanao* are the chief.

1. That of *Manilla* or *Luconia* is 400 miles long and 200 broad. The chief town *Manilla*.

The island of *Mindanao*, is situate between 5 and 10 degrees of north latitude, and between 120 and 126 degrees of east longitude. The chief town *Mindanao*.

2. *Gilolo* with the *Molucca* or clove islands, are situate between 1 degree of south latitude, and 2 degrees north latitude. The chief of the clove islands is *Ternate*, situate in 1 degree 15 minutes north latitude, and 12 degrees of east longitude; scarce 30 miles in circumference. This with the rest of the clove islands was usurped by the *Dutch* in the reign of king *James I.* and the cloves are now eradicated and planted only in the island of *Amboyna*, which is situate in 3 degrees 40 minutes south latitude, and 126 degrees of east longitude. It was here that the *Dutch* tortured and massacred several of the *English* factors and merchants, and then drove the rest out of the clove islands.

3. *Ceram* and the islands of *Banda*, which only produce nutmegs, are situate between 3 and 4 degrees of south latitude, and between 125 and 129 degrees of east longitude. Here the *Dutch* destroyed both the *English* and the natives in the reign of king *James I.* usurped the dominion of these islands also, and have kept possession of them ever since.

4. The island of *Celebes* or *Macassar*, is situate between 2 degrees north, and 6 degrees south latitude, and between 116 and 124 degrees of east longitude, being 500 miles long, and 200 broad. The chief town *Macassar*.

5. *Borneo*, the largest island in the known world, situate between 7 degrees 30 minutes north latitude, and 4 degrees of south latitude, and between 107 and 117 degrees of eastern longitude. It is fruitful in the best pepper. The chief town *Borneo*.

6. The island of *Java*, situate between 5 and 8 degrees of south latitude, and between 102 and 113 degrees of east longitude. The capital city *Batavia*. The capital of all the *Dutch* settlements in *Asia*, and the east coast of *Africa*.

7. The island of *Sumatra*, situate between 5 degrees south, and 5 degrees north latitude, and between 91 and 105 degrees of east longitude. The capital city *Achen*, situate at the north end of the island.

The two last are usually called the *Sunda* islands, from the straits of *Sunda*, which lie near them between *Java* and *Sumatra*.

*India* is usually divided into two parts, the one beyond the river *Gange*, contiguous to *China*, and the other on this side the *Ganges*, next to *Persia*.

*India* beyond the *Ganges* comprehends, 1. *Tonquin*. 2. *Cochin China*. 3. *Laos*. 4. *Cambodia*. 5. *Siam* and *Malacca*. 6. *Pegu*, *Ava*, and *Acham*.

1. *Tonquin* is situate between 17 and 26 degrees of north latitude, and between 101 and 108 degrees of east longitude, bounded by *China* on the north and east, by *Cochin China* on the south, and by the kingdom of *Lao* on the west. The capital city *Cochin* or *Keccio*.

2. *Cochin China*, situate between 104 and 109 degrees of east longitude, and between 10 and 17 degrees of north latitude, bounded by *Tonquin* on the north, by the *Indian* ocean on the east and south, and by *Cambodia* on the west.

3. *Laos* is bounded by *China* on the north, by *Tonquin* on the east, by *Siam* and *Cambodia* on the south, and by *Ava* and *Pegu* on the west.

4. *Cambodia*, situate between 8 and 13 degrees of north latitude, bounded by *Laos* on the north, by *Cochin China* on the east, by the *Indian* ocean on the south, and by the bay of *Siam* on the west. The chief town *Cambodia*.

5. *Siam* including *Malacca*, is situate between the equator and 18 degrees of north latitude, and between 92 and 102 degrees of east longitude. The chief towns *Siam* and *Malacca*.

*Malacca*, the capital of the territory of *Malacca*, is situate on the straight between *Malacca* and *Sumatra*, to which it gives name, and with the adjacent country is subject to the *Dutch*, who being masters of this straight, and that of *Sunda*, have it in their power to exclude all nations from trading to *China* and the oriental islands on the east.

6. *Pegu*, including *Ava* and *Acham*. These countries are situate on the east side of the bay of *Bengal*, between 15 and 25 degrees of north latitude, and between 91 and 100 degrees of eastern longitude. The capital city is *Pegu*.

Besides the islands already mentioned, are those of the *Ladrones*, situate in the pacific ocean, in 140 degrees of east longitude, and between 12 and 28 degrees of north latitude. Also the *Andamen* and *Nicobar* islands, near the coast of *Siam*, on the east side of the bay of *Bengal*.

*India* on this side the *Ganges*, or the hither *India*, most properly called *India*, or *Indostan*, is situate between 7 and 40 degrees of north latitude, and between 66 and 92 degrees of east longitude, being about 2000 miles in length from north to south, and from 300 to 1500 in breadth from east to west, bounded by *Usbeck Tartary* and *Tibet* on the north, by another part of *Tibet*, the kingdoms of *Acham*, *Ava*, and *Pegu* on the east, by the bay of *Bengal*, and the *Indian* ocean on the south, and by the same ocean and the kingdom of *Persia* on the west. The chief towns *Agra*, *Delly*, *Lahor*, and *Surat*.

The chief rivers are those of *Ganges*, *Indus*, and *Attock*.

The chief mountains are those of *Balegate*,

which run through the middle of *India* from north to south, and those which divide *India* from *Tartary* called *Balch* and *Bember*, said to be branches of *Mount Caucasus*.

*Usbeck Tartary*, and *Mogul* or *Mogul Tartary* are the same; this being the country of *Tamerlane*, the first great *Mogul*, who was not only sovereign of these countries, but of *Persia* and *India*, and from whom the *Moguls* of *India* are descended.

The present country denominated *Usbeck Tartary* is situate between 35 and 45 degrees of north latitude, and between 64 and 77 degrees of east longitude, having the *Calmuck Tartars* on the north, independent *Tartary* on the east, *India* and *Persia* on the south, and a desert which lies between this country and the *Caspian* sea on the west.

Their chief towns are *Bochera* and *Samarcand*.

The *Calmuck Tartars* lie north of *Usbeck Tartary*, and the *Caspian* sea, and have no towns or settled habitation, but have lately put themselves under the protection of *Russia*, and therefore may now well be esteemed a part of *Siberia*.

*Siberia*, if we include *Calmuck Tartary*, is situate between 44 and 72 degrees north latitude, and between 60 and 100 degrees of east longitude, bounded by the frozen ocean on the north, by the pacific ocean, *China*, and independent *Tartary* on the east, by another part of independent *Tartary* and *Usbeck Tartary* on the south, and *European Russia*, and *Astracan* on the west. The chief town *Tobolski*.

*Persia* is situate between 25 and 45 degrees of north latitude, and between 45 and 67 degrees of east longitude, being 1200 miles long, and almost as many broad, bounded by *Circassian Tartary*, the *Caspian* sea and the river *Oxus*, which separates it from *Usbeck Tartary* on the north; by *India* on the east, by the *Indian* ocean, the gulphs of *Ormuz* and *Bossora* on the south, and by the *Turkish* empire on the west. The chief towns are, *Ispahan*, *Schiras*, *Gombron*, *Mesched*, *Asterabat*, and *Tauris*.

The chief rivers in *Persia*, are the *Kur* or *Cyrus*, *Arras* or *Araxes*, *Oxus*, and *Herat*.

The chief mountains, *Caucasus*; of which *Ararat* is a part, situate between the *Euxine* and *Peisian* seas; and mount *Taurus*, which runs cross *Persia* from *Turky* to *India*; the branches whereof very much incumber this kingdom, it being one of the mountainous countries in *Asia*, and has at the same time scarce one navigable river.

*Arabia* is situate between 11 and 30 degrees of north latitude, and between 35 and 60 degrees of east longitude, being upwards of 1200 miles in length and 900 in breadth, bounded by *Turky* on the north, the kingdom and gulph of *Persia* or *Bossora* on the east, the *Indian* ocean on the south, and

and the *Red-sea* which separates it from *Africa* on the west: the north-west part of it, between *Egypt* and *Palestine*, is denominated *Arabia Petraea*, the middle of it *Arabia Deserta*, and the south *Arabia Felix*; but the limits of any of them have never been exactly described

The chief towns are *Medina*, *Mecca*, *Mocho*, *Aden*, *Muscat*, and *Bossora*.

*Medina* is remarkable for *Mahomet's* tomb, situate in 24 degrees.

*Mecca* is celebrated for the *Kaaba* or *Holy-House* to which the *Mahometan* nations go in pilgrimage, and for being the place of *Mahomet's* nativity.

There are no navigable rivers in *Arabia* but the *Euphrates* and *Tigris*, which unite their streams in the province of *Iraca Arabia*, and fall into the gulph of *Persia*, or *Bossora*, a little below the City of *Bossora* in 30 degrees north latitude.

There are several mountains, among which those of *Mount Sinai* and *Mount Horeb* in *Arabia Petraea*, are the most remarkable.

*Turkey* in *Asia* is situate between 30 and 44 degrees of north latitude, and between 26 and 45 degrees of east longitude, comprehending the counties of 1. *Diarbeck*, the ancient *Mesopotamia*. 2. *Curdistan*, part of the ancient *Assyria*. 3. *Turcomania*, the ancient *Armenia*. 4. Part of *Georgia*, *Mengrelia*, and *Circassia*. 5. *Syria* and *Palestine*; and 6. *Natolia* or *Asia Minor*.

The chief towns of *Turkey* in *Asia* are,

1. *Erzerum*, the capital of the province of *Turcomania* or *Armenia*.
2. *Diarbec*, the capital of the province of *Diarbec* or *Mesopotamia*.
3. *Aleppo*, the capital of the *Beglerbelic* of *Aleppo*.
4. *Jerusalem*, the capital of *Palestine*.
5. *Damascus* or *Scham*, the capital of *Syria*.
6. *Smyrna*, a port town in the lesser *Asia*, situate on a bay of the *Archipelago*.
7. *Bursa* or *Prusa*, the capital of *Bythinia*.
8. *Tocat*, the capital of the province of *Amasia* in the lesser *Asia*.

9. *Trepisond* or *Trapezond*, a port town of *Amasia* in the lesser *Asia*, situate in the *Euxine* sea.

The chief rivers and mountains of *Turkey* in *Asia* are the *Tigris* and *Euphrates*.

The mountains are *Taurus*, *Anti-taurus*, *Caucasus*, *Arrarat*, *Libanus*, mount *Zion*, the mountains about *Jerusalem*, and mount *Olympus* in *Bythinia*.

The kingdom of *Astracan* is part of the *Russian* dominions in *Asia*, and situate on the north side of the *Caspian* sea, between 45 and 50 degrees of north latitude, and between 51 and 57 degrees of east longitude.

*Astracan* city, the capital of the kingdom, is situ-

ate on the river *Volga*, in 47 degrees north latitude, and 52 degrees of east longitude.

**AFRICA.** This part of the antient world is the most southern, and the greatest peninsula of the universe. *Josephus* assures us, that the word *Africa* comes from *Afer*, *Abraham's* grandson.

It extends from 35 degrees of northern latitude, to 35 of southern latitude; and from 3 degrees of longitude, to 83; so that it may have 1600 leagues in length, at the altitude of the river *Niger*, about half under the equator, and always diminishing as one goes southward: it has very near 1400 leagues in breadth, towards the lake *Zaire*, and about 600 in *Guinea*: therefore it is believed to have more than 5000 leagues of coasts.

It confines northward with the *Mediterranean*; eastward with the isthmus of *Suæus*, the *Red Sea*, and the eastern ocean; southward with the sea of *Ethiopia*; and westward with the *Atlantick*.

Its situation shews us, that the equator passes justly in the middle, and that two thirds thereof are in the torrid zone, which renders the climate extremely hot: add to this, that the middle of the country is full of shining sand, which reflects the rays of the sun with a burning and insupportable heat. All this sandy land is uncultivated, very little inhabited, and abounds with ferocious beasts: among which are found the lion, the leopard, the panther, the elephant, the monkey, the wild horse and ass, the sea-ox and horse, the camel, &c. the sheep, oxen, &c. are very good, and extraordinary large and fat. The soil produces delicious fruit, and medicinal plants: it has in several places mines of gold and silver, and some of salt.

Its most considerable rivers are the *Nile* and the *Niger*; the first springs from the lake *Zaire*, or from a small river which enters into it in *Abyssinia*, which it traverses from south to north by east; as it does *Nubia* and *Egypt* from south to north. It disembogues into the *Mediterranean* through several mouths, after it has divided itself into several branches, which form a triangle, called the *Delta* of *Egypt*, because it has very near the form of that *Greek* letter. The *Niger* takes its source from a lake of the same name in *Abyssinia*, runs from south to north between that empire and the kingdom of *Congo*: then entering the kingdom of *Borno*, loses itself in the mountains; then appears again near the lake *Borno*, thro' which it passes, and traverses afterwards all *Nigritia* from east to west, forming the island which the *Arabs* call *Nub*, between *Gangara* and *Zanfara*, and the lake *Guarda*, in the kingdom of the *Agades*; then, before it disembogues into the ocean; it divides itself into several branches, the most considerable whereof are *Rio Grande* southward, *Gambia* in the middle, and *Senegal* northward: the most

southern

southern point of the island, formed by these two last, is what we call the *Cape Verd*.

AFRICA may be divided into eight principal parts, which are *Egypt*, *Barbary*, the *Bildulgerid*, *Zaara*, or the *Desart*, *Nigritia*, *Guinea*, *Ethiopia*, and *Nubia*; to which may be added, for a ninth part, the isles depending thereon.

The *Africans* were always idolaters, and adored the stars, the fire, &c. The queen of *Sheba*, who visited *Solomon*, instructed them in the *Jewish* religion; and they received afterward the light of the gospel from the eunuch of queen *Candace*, who was baptized by the apostle *St. Philip*. At present there are found in it Mahometans, Idolaters, Castes, *Jews*, and three sorts of Christians, viz. the *Abyssinians* of the *Greek Church*; the subjects of the kings of *Spain* and *Portugal*, who are of the *Roman church*; and the subjects of *Great-Britain*, &c. who are of the *reformed church*.

*Egypt*. This kingdom extends from 60 degrees of longitude to 67, and from the 22 of latitude to 31, 30 min. so that it may have near 100 leagues of extent from east to west, and 180 from south to north.

It confines eastward with the *Red Sea*, and the isthmus of *Suæ*, northward with the *Mediterranean*; westward with *Barbary* and the desert of *Barca*; and southward with *Nubia* and the *Abyssinians*.

The climate of *Egypt* is unwholsome, because of the excessive heats, and the waters of the *Nile*; for the water which remains on the earth after the overflowing of that river, generates a prodigious quantity of insects of different species, which infect the air.

The isthmus of *Suæ*, which parts the *Red Sea* from the *Mediterranean*, is 30 or 35 leagues broad. Several kings of *Egypt* have attempted in vain to cut it, to join the two seas together.

Four leagues off *Cairo*, are seen the three famous pyramids, which have passed for one of the seven wonders of the world: the greatest of these pyramids has 86 fathoms, 4 feet in length; each side of its base has 113 fathoms, 4 feet; and each face of its pedestal is 270 fathoms, 5 feet long.

*Egypt* is divided into *higher*, *middle*, and *lower*, and more particularly into twelve *Calliwicks* or prefectures, which are found situated in the following manner.—First, between the *Nile* and the *Red Sea*, are inclosed the government of *Cairo*, and the *Calliwicks* of *Cossir* and *Cherestfle*, the country called *Saids* extends southward, and contains westward the *Calliwick* of *Girgio*, and eastward that of *Minio*, those of *Monfelont*, *Benchies*, *Fium*, and *Geza*, which are also westward of it. The government of *Alexandria*, the *Calliwicks*, of *Calliconbieb*, of

*Menoufa*, and of *Garbia*, are on the *Mediterranean*, taking up the whole extent of the *Delta*: lastly, that of *Mansoura* is on the isthmus of *Suæ*.

The city of *Alexandria* was the ancient capital of *Egypt*; but *Cairo* possesses at present that advantage. This city is situated on the border of the *Nile*, over-against the ruins of the ancient *Memphis*.

*Barbary*. It extends along the *Mediterranean*, from 9 degrees 30 minutes of longitude, to 60; and from 27 of latitude, to the 35, 30 minutes so that it may have very near 900 leagues in length, and only 80 in its greatest breadth.

It confines eastward with *Egypt*, northward with the *Mediterranean*, westward with the *Atlantick* ocean, and southward with the *Bildulgerid*.

The climate is temperate enough: the soil produces cotton, maiz, and excellent fruit. It feeds beautiful horses and cattle, whose leather is much esteemed; and a great quantity of coral is fished on the coasts.

It is divided at present into six kingdoms, called of *Barca*, of *Tripoli*, of *Tunis*, of *Algier*, of *Fez*, and of *Morocco*; which are found in this order going from east to west, on the coast of the *Mediterranean* except the last which is on the ocean, at the south by west of that of *Fez*.

The kingdom or country of *Barca*, is situated between *Egypt* and the great *Syrtes*, called *Seiches* of *Barbary*, and contains about 30 leagues of coasts, and 30 or 40 in breadth.

This country is very sterile and full of rocks: it is watered by the rivers *Nachel*, *Doera*, and *Melela*, which spring from the mount *Mæyes* in the desert.

This kingdom depends on the grand seignor, who keeps a sangiack at *Barca*. The inhabitants are *Mahometans*.

The kingdom of *Tripoli* is situated between that of *Tunis*, and the country of *Barca*, extending about 250 leagues on the coast, from the mouth of the small river of the *Salins*, in the great *Syrtes*, or gulph of *Sydra*, as far as to that of the *Capes*, or little *Syrtes*: its breadth is very irregular, of 15, of 25, and of 40 leagues.

This country is divided in two by the river of *Tripoli*, on which is the city of the same name, which is the capital.

In the eastern part, which is almost deserted, except the coasts, are found these four rivers, viz. the *Tessura*, *Macer*, *Mistrata*, and that of *Salins*. In the western part, besides the of river *Tripoli*, are found those of *Rasamalbasa*, of *Portera*, and of *Casa-*

*Casarnacara*. These, as well as the first, spring from mount *Atlas*.

The kingdom of *Tunis*, is situated between that of *Algier* and the *little Syrtis*. Its greatest length from east to west is of about 70 leagues, and its greatest breadth 90.

The *Gualdabarbar* waters its most western part, springing from the *Biledulgerid*; after it has divided itself into two arms, the most western thereof runs so serpent-like, that in the extent of a strait line of about 25 leagues, one could make more than 90, if one would follow its shore. The other arm is called *Magrida*. The other rivers are *Magerada*, *Capallia*, &c. which spring from it.

The city of *Tunis*, capital of this kingdom, is a port advantageously situated, at the bottom of a gulph. Its entrance, which is narrow, is defended by the fort *La Goulette*. It is also governed in form of a republic, under the protection of the grand seignior,

The isles *Galata*, *Pantbalarea*, *Lampedusa*, *Limosa*, *Cheerchara*, *Gamelera*, and some others, are dependencies of this kingdom.

The kingdom of *ALGIER* is situated between that of *Tunis*, and that of *Fez*. Its greatest length is of about 220 leagues, and its breadth of 80 or 90.

This country is full of high mountains, particularly southward, where it is confined by a part of mount *Atlas*.

Among its rivers are found the great one, which springs from the lake *Mezzal*, and traverses mount *Atlas*; the others which comes from that mount, are the *Titnes*, *Sestisas*, *Mironus*, *Sefay*, &c.

This kingdom is divided into five provinces: first, that of *Algier* is in the middle; that of *Bugiek* eastward of it; that of *Constantine* is likewise eastward of this; that of *Tenese* is westward of *Algier*; and that of *Tremesin*, or *Tellenfin*, is the most eastern.

The city of *Algier*, which is the capital, is also governed in form of a republic, under the protection of the grand seignior, who has not the least authority in it. It serves for a retreat to pyrates, among whom the famous *Barbaroussa* alarmed the *Mediterranean* during the reign of the emperor *Charles V.*

The other cities are situated on the coasts, except *Tremesin*, which is 6 or 7 leagues more advanced in the country, and *Constantine*, which is an island made by a river towards the middle of its province. The king of *Spain* keeps *Marsalquivir*, and *Oran* on this coast.

The kingdom of *FEZ*, which is part of the ancient *Tingitana Mauritania*, is situated between that of *Algier* and the ocean. Its greatest length is of

about 120 leagues, and its breadth, as far as to the strait of *Gibraltar*, of 90.

It is separated from the kingdom of *Algier*, eastward, by the river *Mulvia*; at south by west the *Ommirabi* parts it from *Morocco*; and southward, mount *Atlas* divides it from the *Segelakeffe*.

This country is the best cultivated, and most inhabited of all *Barbary*; and though it be full of mountains, several pretty large cities are found in it towards the middle.

This kingdom is divided into seven provinces, situated thus, first *Fez*, *Afgar*, and *Temesne*, are on the ocean; *Habat* on the strait; *Errif* and *Garet*, on the *Mediterranean*; and *Chaus*, which contains almost half the country, is farther in the land.

*Fez* is the capital, and is situated in the middle of the kingdom, on the small river *Union*, between *Suba*, and *Bunafar*. This city passes for one of the fairest of the whole world, and for the ornament of all *Africa*.

This kingdom is governed by a prince, who styles himself emperor of *Africa*, king of *Morocco*, *Fez*, *Sus*, and *Tafilet*, lord of *Gage*, *Dare* and *Guinea*, grand xerif of *Mahomet*, &c.

The king of *Spain* keeps some places on this coasts; as *Ceuta*, *Pennon de Velez*. The *Portuguese* are masters of *Cazar*, *Ezagbir*.

The kingdom of *Morocco*, which is the other part of the *Tangitana Mauritania*, is situated at the south by west of that of *Fez*, between *Segelwelse* and the *Atlantiek ocean*.

Its greatest length is of about 120 leagues, from cape *Non* to the mountains, which part it from the *Segelmeke*; and its greatest breadth is of about 110, along the coasts of the ocean, from the same cape to the mouth of the *Ommirabi*.

Its rivers are the *Ommirabi*, *Tensif*, *Sus*, *Cuadelbabi*, which disembogue into the *Ommirabi*, and the *Affimeal*, which runs to the *Tensif*.

The soil is fertile in corn, fruit, oil, and sugar; delicious grapes, each of which is as big as a pigeon's egg, are found in some of its mountains; and it has mines of gold, silver, and copper.

This kingdom is divided into seven principal provinces, which are *Morocco*, *Hascora*, *Tedles*, *Ducalia*, *Hea*, *Sus*, and *Guzalu*.

The city of *Morocco*, situated near the river *Tensif*, is the capital of this kingdom.

The kings, princes, and people of *Barbary*, are all *Mahometans*.

The *Biledulgerid*. This country, which contains very near the ancient *Numidia*, is called *Biledulgerid* by the *Arabs*, because of the great number of dates it produces.

If the desert of *Barca* be included in it, it extends from the 5 degree of longitude to the 60, and from the 22 of latitude to the 32, so that its greatest extent is about 1000 leagues; and its breadth, which is very irregular, is from 30 to 160 in some places.

It confines eastward with *Egypt*, northward with *Barbary*, westward with the ocean, and southward with the *Zaara*, or desert.

The climate is very hot, and notwithstanding very wholesome. The soil is sandy, uncultivated, and very little inhabited in several places: in other places it produces barley and anis-feed, and a little wheat; but its fertility consists in the great quantity of dates it produces, and in its camels.

Among the rivers, which run through it, the most remarkable are the great river, that of *Salina*, the *Quadilbarbar*, the *Tegorarain*, *Ghiz*, *Ziz*, and others: which all spring from some lake or fountain.

It is divided into eight principal provinces, reckoning the desert of *Barca*.

This country is inhabited by the natives, and the *Arabs*: the first are brutish, lascivious, and very great thieves; the others have more humanity: but in general all these people are violent, and it is dangerous falling into their hands.

It is in part governed by some petty kings or lords, who are most of them tributary to the *Turks* of *Al-ier*, of *Tenis*, or of *Tripoli*; in part by some republics; and in some places those people live without laws or policy; as some bands of *Arabs*, who live in the deserts, and put several cities under contribution.

All these princes and the people are *Mahometans*. The rest follow the *Jewish* religion, and have their synagogues in most of the greatest cities, where they are all merchants.

The *Zaara*, or *Desart*. This country is called *Zaara* by the *Arabs*, i. e. *Desart*, because so little inhabited.

It is situated under the tropic of Cancer, between the 12 and 27 degree of latitude, and extends from the 4 of longitude to the 56; so that it may have more than 950 leagues in length, and 40, 60, 100, even as far as 250 in breadth, according to the different places.

It confines northward with the *Biledulgerid*, eastward with *Nubia*, southward with *Nigritia*, and westward with the ocean.

It enjoys a very wholesome climate, though very hot. All its riches consist in camels.

There are but three considerable rivers found in it, viz. that of *Nubia*, which after it has passed the deserts of *Lempta*, and *Borno*, hides itself under

ground, for the space of seven or eight leagues, then appears anew in *Nubia*; that of *Ghir*, and that of the *Horfes*.

This country is divided into several principal provinces or deserts, which bear the name of some of their most considerable cities. *Borno*, *Garga*, *Berdoa*, *Lempta*, *Targa*, *Zuenziga*, and *Zanbaga*.

The inhabitants are brutish, wild, and great thieves. Part of them live in cities with a little more humanity; but the others are vagabonds in the fields, where they keep their flocks or seek fortunes; and those have neither laws nor policy.

They have kings, or particular lords, whom they call *Zeques*.

Several follow the doctrine of *Mahomet*; the others have neither faith nor religion.

*Nigritia*. This part of *Africa*, borrowed its name from the river *Niger*, receives its name from the country; and that of the country comes from the colour or hue of its inhabitants.

It extends between the 8 and 23 degree of latitude, from the 3 degree of longitude to the 44; and may have 800 leagues in length, near 300 in its greatest breadth, and 140 in its lesser.

It confines northward and eastward with the *Zaara*; southward with *Guinea*; and westward with the *Atlantic ocean*.

The climate is very hot, but so wholesome, that of itself it cures maladies. The soil produces rice, flax, and cotton. It has mines of gold, and copper; ambergrease, and some fruit-trees. The soil in this country is more fertile than in any other part of *Africa*.

The principal rivers are the *Niger*, and its branches, which all have different names, as *Senegal*, *Gambia*, *Rio San Domingo*, and *Rio Grande*.

This country is divided into sixteen principal kingdoms, found along the *Niger*, re ascending towards its source in the following order. First, northward of this river, *Genchoa*, and *Galate*, which are on the ocean; then *Tanbut*, *Agades*, *Cano*, *Casseua*, and *Gangara*, in which the *Niger* forms an island, 100 leagues long, and 50 broad. Between the rivers *Senegal* and *Gambia*, are included the kingdoms of the same name, the people whereof are called *Jaloffi*; between *Gambia* and *Rio San Domingo*, are the kingdoms of the *Cassan-gas*; between *San Domingo* and *Rio Grande*, those of the *Bijagos*; southward of the great river, are found following one another, the kingdoms of the *Biaffari*, *Mili*, *Soufos*, *Mandiga*, *Guber*, *Gago*, *Zegazeg*, and *Zanfara*, which ends at the lake *Borno*. Most of these kingdoms are subdivided into several others lesser, which have all their capital cities of the same name; that of *Tanbut* being  
more

more considerable and larger, than those of *Mandigues* and *Cano*.

The negroes are less wild than the people of *Barbary*, and of the *Biledulgerid*; but they are not less brutish in their amours. Most of them carry on the commerce of slaves, whom they take from their neighbours, and even sell their wives, children, fathers, and mothers to the *Europeans*.

The kings of this country are very absolute in their respective dominions.

They are all *Mahometans*, or idolaters, and great enemies of the *Jews*. Those of the desarts live without religion.

**GUINEA.** It extends between the 4 and 12 degree of latitude, from the 9 of longitude, to the 38; so that it may have 550 leagues in length, 140 in its greatest breadth, and about 60 in its lesser, at the mouth of the river *Benin*.

It confines eastward with the kingdom of *Biafara*; northward with *Nigritia*; westward with *Sierra Leona*; and southward with the sea of the same name.

The climate is excessively hot. The land is low, fat, and very fertile, watered by several small brooks, and frequent rains. The soil produces pepper, sugar-canes, cotton, rice, millet, barley, and several other sorts of corn, and fruit. It has several golden mines, and feeds a vast number of elephants, peacocks, monkeys, tygers, leopards, &c. and the inhabitants carry on a great commerce of ivory. A great quantity of excellent fish is taken on the coasts, among which are the *Dorado*, the *Bonite*, &c.

The most remarkable of its rivers are the *Sweira da Costa*, those of *Da volta*, *Lago*, *Calabri*, *Del Rey*, *Benin*, and *Dos Camarones*, which parts it from *Biafara*.

*Guinea* is divided into three principal parts: which are the particular kingdom of *Guinea*, situated in the middle; eastward of this, the kingdom of *Benin*; and the province of *Malaguette*, or *Maniguete*, westward. These kingdoms, and this province, is again subdivided into several others very considerable, as *Sabou*, *Fatu*, *Accaria*, *Arda*, &c. but as we have very little knowledge of them, I will content myself with saying that the particular coast of *Guinea* is distinguished by three different names.

The most extended and most eastern, is called the *Golden Coast*; because of the quantity of gold carried away from thence: The most western is called the *Ivory Coast*, for the same reason: and this is again subdivided into two parts, the most eastern whereof is called the coasts of *Good People*; and the most western the coast of *Bad People*.

The people of *Guinea* are witty, dextrous, and understand commerce very well.

*Guinea* is governed by several kings, among whom that called emperor of *Guinea* is most powerful, having several other kings and princes for tributaries, and subjects. That of *Benin* is likewise very powerful, having several kingdoms in his dominions. The province of *Malaguette* is possessed by a great number of princes and people towards the mountains. Some place it in the kingdom of *Sierra Leona*: The *English*, *Dutch*, *Portuguese*, &c. have each their factories on the coasts of *Guinea*.

The people are still idolaters.

**ETHIOPIA.** All the rest of the continent of *Africa*, is commonly known under the name of *Ethiopia*, which is divided into *inward* and *outward*.

The *inward Ethiopia*, contains *Abyssinia*, or the empire of the *Abyssinians*, and *Nubia*, northward of it.

The *outward*, or *exterior Ethiopia*, contains the kingdoms of *Biafara*, and of *Congo*; the coasts or country of the *Cafres*; the empire of *Monomotapa*, and of *Moncemogi*; the coasts of *Zanguebar*, *Ajan*, and *Abex*, which are properly of *Abyssinia*, though they be at present in the power of the *Turks*.

*Abyssinia* extends from 48 degree of longitude to about the 74; and from the 20 degree of northern latitude, to the 14 of southern latitude; so that it may have very near 700 leagues in its greatest extent from north to south, and about 500 from east to west.

It confines northward with *Nubia*; eastward with the coasts of *Abex*, *Ajan* and *Zanguebar*; southward with the empire of *Moncemogi*; and westward with the people subjects of *Congo*, and of *Biafara*, and the *Gales*, who are very powerful.

The climate is very temperate, with regard to its situation, particularly on the mountains, and in the flat country, but in the valleys, it is excessively hot. It is very fertile in barley, millet, maiz, and several other sorts of corn unknown to us, as the *Tiset*, or *Taso*, *Agousta*, and *Machella*, of which they make bread and beer. It produces all sorts of gums, ginger, sugar, honey, and wax, which serves to make candles, cotton, &c. Mines of gold, silver, tin, copper, iron, and sulphur are found in that empire almost every where. There are seen in it elephants, tygers, lions, panthers, rhinoceros, giraff, monkeys, wild-bears, harts, deers, hares, civets, goats, wild oxen, camels, horses, asses, cows and sheep; in a word, all sorts of game and fowls we have in *Europe*, and several others unknown to us. There are also found in the rivers, crocodiles, and wild horses.

The most considerable rivers, which water this vast country are, the *Nile*, the rivers *Abanbi*, and *Tacassi*, the river *Niger*, with its lake, the lakes *Zaire* from south to north, about 80 leagues in breadth,

and more than 350 in circuit. The lake *Zaflan* has more than 300 leagues in circuit. There are in this lake several isles of 30, 40, and 50 leagues round. The lake *Niger* is about 160 leagues in circuit.

*Abyssinia* is governed by a prince called *Artalabassi* by the *Arabs*, and *Negus* by the *Abyssinians*; we call him *Prefter John*: this emperor pretends to be descended from the race of *David*. The greatest part of the coast of *Abex* are in the power of the grand seignior.

The *Abyssinians* pretend to be descended from the first christians, and to have been first instructed in the *Jewish* religion by the queen of *Sheba*, who went to visit king *Solomon*; by whom, they say, she had a son called *Melilech*, who governed them after his mother's death, and that they received the light of the gospel by means of queen *Candace*, whose eunuch was baptized by *St. Philip*, and afterwards by *St. Thomas*, *St. Matthew*, and *St. Bartholomew*. Ever since that time they have preserved the name of *Christians*, but they have been corrupted by the errors of *Eutyches* and *Dioscorus*: They have a patriarch whom they call *Abuna*, inferior to that of the *Copti*, who resides at *Alexandria* in *Egypt*, by whom he must be confirmed. They circumcise their children, afterwards baptize them, viz. the males forty days after their birth, and the females sixty; which is always done on *Saturday* and *Sunday*.

*Nubia*. It is situated in such a manner between the 10 and 23 degree of latitude, and extending from the 48 of longitude, to the 65 degree 30 minutes, that it may have about 370 leagues in its greatest extent from south by west to north by east, and 190 in its greatest breadth.

It confines northward with the desert of *Barca*, and *Egypt*; eastward with the kingdom of *Barnagas*, and the island *Guegere*; southward with the *Deserts*, which are of the empire of the *Abyssinians*; and westward with the deserts of *Borno* and *Gaoga*.

The climate is excessive hot every where; the soil produces a great quantity of sugar-canes, but the inhabitants have not the secret of purifying it, who leave the sugar in its blackness: It has besides mines of gold, sanders-wood, civet, and abundance of ivory: Eastward the land is uncultivated, and desert.

The natives are courageous and cunning; they supply themselves to commerce and husbandry: They are extremely black, and cloath themselves with cotton cloth.

Some authors pretend, that the *Nubians* are neither *Christians*, *Jews*, *Mahometans*, nor idolaters; and say, that having wanted bishops and

priests, the religion is almost entirely destroyed, with their churches, which they have neglected.

This country is situated between the 24 and 48 degree of longitude, and extends from the 13 degree of northern latitude, to the 2 of the southern: So that it takes up near 300 leagues in its greatest extent, from north to south, and 280 from east to west.

It confines eastward with the river and lake *Niger*, and some mountains which part it from *Abyssinia*, and the *Glaqui*, people of *Congo*; northward with the kingdoms of *Congo*, and *Zanfara*; westward with that of *Benin*, and the ocean; and southward with the territories of *Congo*.

The climate is extremely hot at all times: winter is not distinguished but by long and violent rains, which fall from the month of *April* to that of *August*; their summer begins in *September*.

The inhabitants are wild, cheats, and thieves: They are guilty of the most infamous actions, laying together without distinction, the father and the daughter, the mother and the son, brothers and sisters, all things being in common among them; they paint their bodies with various colours, and adorn it with small toys, as rings, little shells, &c. The kings rub their faces and hands with chalk to appear more beautiful.

They are all idolaters, adore the devil, sun, moon, the trees, and the earth, for which they have so great a respect, that they will not permit one should spit upon it, because it produces the things necessary for their subsistence.

*Congo*. This country is situated on the western coast of *Ethiopia*, between 10 and 20 degrees of longitude east, and between the equator and 18 degrees of south latitude, so that it has very near 300 leagues in its greatest extent from north to south, and 260 in breadth.

It confines northward with the kingdoms of *Gabon* and *Macoco*, whose king is called by some, prince or king of the *Anzicans*, eastward with the kingdom of *Danut*, and the lake *Zair*; southward with the kingdoms of *Malemba* and *Mataman*, and westward with the ocean, called the sea of *Congo*.

The climate is excessive hot, the great rains which fall during the months of *April*, *May*, *June*, *July*, *August*, and make their winter, cause the inundations of the *Nile*, of the *Niger*, of the *Zair*, and of other rivers, which water the soil, and render it fertile in all things necessary for life. It produces abundance of rice, maize, white millet, and another small sort of corn, called *Luco* by the inhabitants, and of which they make very good bread: There are seen in it fruit-trees of several species, as orange-trees, lemon-trees, and palm-trees of

three forts. It feeds oxen, cows, hogs, goats, and sheep, which bear three or four times a year; and also elephants, tygers, monkeys, civets, and other animals unknown to us, as the *zebra*, which resembles a mule; the *daut*, and the *empalariga* which have almost the figure of a heifer. Pelicans, peacocks, pheasants, partridges, and several other species of volatiles: There are found in it large serpents, and very venomous vipers. It has mines of silver, copper, and crystal.

Besides the river *Zair*, which flows from the lake of the same name, and traverses the whole country, are found in it the *Loango*, *Lelunda*, *Loanza*, and several others, which flow from the lake *Aquilanda*.

This country is divided into several kingdoms, and different people, the most remarkable of which are the kingdom of *Congo* in the middle; that of *Loango*, with the people of *Anzican*, northward; that of *Angola*, southward; and eastward the people called *Giaqui*, who inhabit the mountains of the sun towards the dominions of the *Grand Negus*.

The city of *Congo* was once called *Baza* by the natives; at present the *Portuguese* call it *St. Salvador*.

The capital of *Loango* bears the same name.

The capital of *Angola* is *Lougo*, or *Engaze*.

The king of *Congo* is the most powerful; and his people have so great a veneration for him, that they never speak to him but kneeling. The kingdom is hereditary in his family, and only the male children can pretend to the crown, with the exclusion of the female. The governor of *Batta* is the most considerable of the kingdom, and his court is very little less numerous than that of the king.

The king of *Loango* is also very much respected by his subjects: That of *Angola* is almost as powerful as that of *Congo*, though he pays a sort of tribute to him; the governors he keeps in each province are called *Sobas*.

Empire of *Monomotapa*. This country called by some the empire of *Monomotapa*, by others *Benomotapa*, and *Benomotaxa*, extends from the 13th degree 30 minutes of northern latitude to the 31st; and from the 43 degree 30 minutes of longitude, to 57 degree 30 minutes, so that it must have 350 leagues in its greatest extent from north to south, and 150 in its greatest breadth.

It confines northward with the *mountains of the moon*, which part it from the empire of the *Monemugi*, and from the kingdom of *Malemba*; on the three other sides it is environed with the *Casrery*.

The climate is temperate; the soil very fat, and fertile in rice, sugar-canes, fruit-trees, and mea-

dows. A great quantity of gold is found in it; in which metal, and ivory, consists the commerce of the country.

The most considerable of its rivers are the *Zair*, the *Rio de Spiritu Santo*, and the river *Cumissa*.

The people are witty enough, and very courageous, but inconstant, and subject to revolts:

This country is under the dominion of an emperor, commonly called *Monomotapa*, to whom all the other kings or princes are subject or tributary.

Empire of the *Monemugi*. This empire confines northward with *Abyssinia*, eastward with the coasts of *Zanguebar*, southward with *Monomotapa*, and westward with the kingdom of *Malemba*, and the lake *Zambre*.

It has very near the qualities of the empire of *Monomotapa*, except that it is fuller of *mountains*, including those of the *moon*: The river *Cuana*, of *Zambre*, traverses it from east to west; by means whereof a commerce is carried on with those of *Quiloa*.

The country is in the power of a king, called *Monvemugi*, to whom all the other petty kings are subject, or tributary: Part of the *Giaqui* are under his dominion. And idolatry still reigns in this empire.

The countries, or coasts of the *Casres*, extends along the coast from *Angra de Negro*, on the western shore of *Ethiopia*, under the 14 degree 30 minutes of southern latitude, to *Punto do Sal*, on the eastern shore, about the 18 degree of the same latitude, including the famous cape of *Good Hope*: So that its coast tread more than 1000 leagues: Its breadth is very irregular; in some places it is more than 100 leagues broad, and in others not 50.

It confines, outward with the ocean; and inward with the *mountains of the moon*; and with *Montes Fragosos*, which part it from *Monomotapa*.

Cattle are numerous but lean, and the sheep are clothed with hairs instead of wool.

The most considerable rivers are the *Zambre*, *de Spiritu Santo*, *Cumissa*, *St. Blaise*, *St. Ambrose*, the *Green River*, and *St. Mary's*.

The city of *Sophala* is very advantageously situated in an island, which is in the middle of a little gulph, into which falls a little river called *Sophala*; it is situated on the eastern coast, about the 20 degree of latitude, near the coast of *Zanguebar*.

The *Casres*, are wild, brutish and cruel; they live in mountains and caves like beasts; those who inhabit the temperate zone are less black than the others; they eat rice, flesh and fish. There is very little commerce carried on in this country,

except

except at *Sophola*, where the people are more tractable. This commerce consists in gold and ivory, which the natives change for stuffs, &c.

As to the government: this country is in part subject to *Monomotapa*, and in part to the king of *Mataman*, the third part is under the dominion of the king of *Sophola*, tributary of the *Portuguese*, who are masters of the capital.

Coasts of *Zanguebar*, called by the antients *Barbaria Regia*; contain the kingdoms of *Mongalle* or *Angoche*, of *Mozambick*, of *Quiloa*, of *Mombaze*, of *Melinda*, and the territories of some petty kings, as *Lamun*, *Putu*, &c. situated in this order ascending from south to north.

This country extends from the equator, to the 18 degree of southern latitude, may have 450 leagues of coasts, and 60, 80, or 100 in breadth: And confines northward with the coasts of *Agan*; eastward with the ocean; southward with the *Casrery*; westward with the territories of *Prester John*.

The climate in general is unwholesome, and particularly in the kingdom of *Quiloa*. The land is low and marshy, and does not produce sufficiently what is necessary for life; it produces millet, rice, pulses, oranges, and lemons: It feeds oxen, goats, and sheep, which are so big and so fat, that one of their tails weighs full thirty pounds: there are found in it wild beasts, fowls, and a vast number of elephants; and it has mines of gold, silver, and other metals. There is a great commerce of gold and silver.

The river *Quilmanca* is the most considerable; the others are those of *Melind*, of *Mombaze*, of *Quiloa*, *Del Gado*, of *Mozambick*, and of *Cuani*.

The people of this country are much more tractable than the *Casres*, they are black, and feed themselves with the flesh of wild beasts, milk, pulses, and wild fruits.

The natives are either *Idolaters* or *Mahometans*, according to the doctrine of a certain zaid, *Haly's* nephew; so that the *Turks* believe them hereticks in their faith.

The king of *Angosia*, or *Mongalle*, is supposed tributary of the *Monamagi* and a *Mahometan*. He resides in the city of *Angai*, capital of his dominions.

The king of *Mozambick* is also a *Mahometan*; but several petty kings and lords live in that kingdom without religion, The *Portuguese* are masters of the capital, and of the island in which it is built.

The king of *Mombaze* is extremely dreaded, and respected by his subjects.

The king of *Melinde* is so much respected by his subjects, that when he appears in public, the

ladies sing his praises before him, and make a kind of simphony in striking brass basons with ivory sticks. He is a very great friend of the *Portuguese*, with whom his subjects trade in all liberty, and with a great deal of honesty. He resides at *Melinde*, capital of his kingdom, and situated on the sea shore, with a very fine port, where the *Portuguese* have built a fortress which commands it entirely; and eighteen or twenty churches in the city.

Coasts of *Ajan* extend from the equator to the 12 degrees of latitude, between the 63 and 70 of longitude; so that it may have 300 leagues of coasts on the ocean, as far as cape *Gardafuy*; and 140 from that cape to the streight of *Bebelmandel*. Its greatest breadth is of about 150 leagues, and its lesser of 60.

It confines northward with the kingdom of *Dancali*, and the streight of *Bebelmandel*; eastward with the ocean; southward with the river *Quilmanca*, which parts it from *Zanguebar*; and westward with the dominions of *Prester John*.

It is fertile in wheat, millet, barley, and various sorts of fruits, and pastures; and therefore feeds a great quantity of cattle, as horses, cows, goats, and sheep. It also produces honey, wax, gold, and ivory.

Among its rivers the most remarkable are the *Quilmanca*, *Magadoxo*, and *Zeila*: westward of the city *Magadoxo* is found the lake of the monks, with an island, and a city in the middle of it, which bears the same name.

This country is divided into four principal states, viz. the kingdom of *Edel*, which is the largest, and the most northern; that of *Adea*, which is in the middle; and that of *Magadoxo*, with the republick of *Brava*, which is the most southern.

The inhabitants of this country are of three sorts: Some are white towards the coasts: some black towards *Abyssinia*; and others called *Beduini*, of *Arabian* extraction, who are vagabonds, live without laws, without care, and are all thieves.

The republick of *Brava* is the only one known in *Africa*. The city which is situated on the coast, between *Barabza* and *Magadoxo*, is governed by twelve Xcqui, chosen among the most antient of the families of the seven brothers, by whom it was founded. It is tributary to the *Portuguese*, and the inhabitants carry on a great commerce of gold, silver, ivory, ambergrease, wax, &c.

Coasts of *Abex*. This country extends from the streight of *Bebelmandel* to the mountains, which part it from *Egypt*, about the 22 degree of latitude; so that it takes up more than 350 leagues of coasts on the Red sea; and has not 50 in its greatest breadth, and

and 20 in its lesser. It is almost all desert and uncultivated, because of its excessive heat and want of water. The climate is burning and unwholesome; the soil sandy, and sterile, particularly northward.

The northern part is in the power of the grand seignior, who keeps a Beglierbeg in the city of *Suaquen*, situated on the coast of the Red sea; he is called at the porte, the *Beglierbeg Bashaw of Abassia*.

The city of *Ercoco*, on the same coast, and the island *Mafua* over-against it, are of this government. All the inhabitants follow the doctrine of *Mahomet*.

Eastward of cape *Gard-fay*, is found, under the 86 degree of longitude, the island *Zocotra*, which may have 45, or 50 leagues of circuit.

The climate is very hot, the soil dry and pretty sterile, having nothing recommendable but aloes, called of its name *Zocotrina*, and *Sanguis Draconis*, which it produces in abundance.

This island is in the power of the king of *Partak*, in *Arabia*, who keeps in it a *Xequi*, or governor. The inhabitants are idolaters, and adore the moon.

The island *Madagascar*. This island is one of the greatest and richest of the whole world. The natives give it the name *Madagascar*, i. e. the *Island of the Moon*. That of *St. Laurence* was given to it, because discovered on that saint's day; and the *French* call it *Ile Dauphine*.

It is situated eastward of the coasts of *Zanguebar*, and of the *Casfrery*, between the 12 and 26 degree of southern latitude; and extends from the 43 degree of east longitude, to the 51: so that it may have about 350 leagues in its greatest extent from north to south, i. e. from cape *Natal*, to cape *St. Mary*; 100 in its greatest breadth; and 900 of circuit.

The climate is wholesome enough and temperate: The soil very fertile in fruits, as oranges, lemons, &c. and in pulses. It produces rice, cotton, sugar, ginger, saffron, the igname, and other very good roots; and also wax and honey. It has mines of gold and silver; and several trees grow there which are very rare among us, as ebony, brazil-wood, red, yellow, and white sanders. Lions, elephants, camels, and several other animals are so common in it, that sometimes a sheep has been given for a sheet of paper, and four cows for a poor jacket.

The middle of this island is full of forests and mountains, from which flow several rivers, the

greatest of which are, *Janibarou*, *Marsucou*, and *Macabarou*.

It has several very commodious ports, viz. *Antongil*, *Vingagora*, *St. Andrew*, *St. Augustin*, *Antipera*, the port of the galleons, &c.

Those who inhabit the middle of the island are brutish, wild, and without faith, like the *Casres*; they go quite naked, and dwell in very low huts. Those towards the coasts are a little more tractable, and all love pleasure to excess: They are witty enough, strong and courageous.

Some are idolaters, or without the least shadow of religion, and those towards the coasts *Mahometans*.

Between the western coast of *Madagascar*, and those of *Zanguebar*, are found the isles of *Comorra*. and several others less considerable, as those of *Querimba*, *Anisa*, *Jan*, *Nueva*, which will be found in my particular description.

The isles of *Comorra* are situated between the 11 and 13 degree of latitude, towards the 72 and 73 of longitude.

They produce rice, banana's, cocoa-nuts, oranges, lemons; and feed cows, goats, sheep, pigeons, hens, &c.

The inhabitants of these isles are tractable enough, and trade freely with the *Portuguese* of *Mosambique*.

They have each a king, which every ship at its arrival, is obliged to acknowledge with a present. And none but the king wears cloaths and shoes, all his subjects going naked, except that they hide what modesty forbids to expose to publick view.

Towards the coasts of *Zanguebar*, is found under the 6 degree of southern latitude, the island *Zanzibar*, from which the whole country has borrowed its name. It may have about 90 leagues of circuit. The island *Pemba*, situated under the 4 degree, has more than 110 leagues of circuit; that of *Monfia* has 50.

These isles produce rice, millet, lemons, oranges, and sugar-canes, but the inhabitants have not the wit to purify the sugar. They feed a great quantity of cattle, in which consists their commerce with those of the main land.

Each of these isles has its particular king, who are made tributary to the king of *Portugal*. These kings, and their subjects, are all *Mahome'ans*.

The natives of these isles are lean, puny, enemies of war, applying themselves to agriculture and commerce. Their women love to be adorned with chains, bracelets, ear-rings, and other jewels.

At 50 leagues distance from the main land of the kingdom of *Biafara*, is found the island *St. Thomas* which has given name to the gulph in which it is situated under the equator.

Its figure is almost round, and some say that it may have 45, and others 60 leagues of circuit.

The climate is unwholsome for foreigners, but not for the natives: The soil produces all that is necessary for the life of the negroes, but not of the Europeans; for it has neither corn nor wine, but maize, palm-trees, potatoes, and a great quantity of sugar.

The Dutch conquered this island from the Portuguese, who retook it afterwards, and keep a governor in the city *Pavaosan*, which is the capital. The inhabitants are most of them catholicks, and there is even a bishop in the capital city.

The *Island of the Prince*, was thus called by the Portuguese, because the prince of Portugal had the revenue thereof.

It is situated at the north by east of that of *St. Thomas*, under the 2 degree of latitude, and the 32° 30 minutes of longitude; and has about 25 leagues of circuit.

The climate is wholsome, and the soil very near like that of the island *St. Thomas*. It is in the power of the Portuguese, and the inhabitants are christians.

The *island of Fernando Poo*, is situated still further into the gulph of *St. Thomas*, between that of the *Prince*, and the mouth of the *Rio des Camarones*, in the main land, it is very near as big as that of *St. Thomas*.

Its climate and soil is like that of the *island of the Prince*, and its government and religion likewise the same.

The *island Annobon*, was thus called because discovered the first day of the year.

It is situated under the 28 degree of longitude; and 2° 30 minutes of southern latitude.

Its extent, soil, government, and religion, is very little different from that of *Fernando Poo*.

Isles of CAPE-VERD. Some authors pretend that there are twenty of them, but we reckon but ten principal; *St. Anthony*, *St. Vincent*, *St. Lucia*, *St. Nicolas*, the *island of Salt*, of *Eona vista*, of *May*, *St. James*, *Del Fuego*, and *Bravo*.

They are situated westward of *Nigritia*, between the 353 and the 357 degree of longitude, extending from the 13 degree 30 minutes of latitude, to the 19.

The *Island St. James*, is the greatest of them all, and may have 45 leagues in its greatest length from south by east, to north by west, 10 in its greatest breadth, and 95 of circuit.

The climate of these isles is generally hot, and unwholsome. The soil is stony yet they produce rice, maize, ignana's, banana's, lemons, oranges, cocoa-nuts, pomegranates, wine, and cotton: And

these fruits are gathered twice a year. They feed a great number of cattle and fowls.

These isles were discovered by a *Genoese*; they are now subject to the king of Portugal who keeps a governor in the city of *St. James*, situate in the island of the same name. This city is not only capital of the isles, but likewise of all the places, which the Portuguese possess on the coast of the *Higher Guinea*. It is an episcopal see, suffragan of *Lisbon*.

The CANARY isles are ten or twelve in number, among which there are seven principal, viz. the *Lancelotte*, *Porteventura*, *Canary*, *Teneriff*, *Gomer*, the island *Del Ferro*, and that of *Palma*.

They extend from the first degree of longitude, to beyond the 28 or 29, if we will speak of the four small ones, which are northward of *Lancelotte*.

The climate of these isles is very good, though a little hot. The soil is very fertile in all things, and produces wheat, barley, millet, and delicious wines, which are exported throughout all Europe; and likewise all sorts of excellent fruits, as figs, oranges, lemons, pomegranates, sugar, &c. It feeds a great quantity of goats and wild asses.

In the island *Teneriff*, there is towards the middle a high mountain, by the Spaniards called *El Pico*, which rises like a sugar loaf, and passes for the highest of the whole world.

The inhabitants of these isles are almost all Spaniards. The natives are great epicures.

They are subjects of the king of Spain, who keeps a viceroy, or governor, in the city of *Canary*, situated in the island of the same name. There is in that capital a royal audience, a bishop, and an inquisition.

The island MADERA, is situated under the first degree 30 minutes of longitude, and under the 32 degree 30 minutes of latitude: 20 leagues in length, 8 in its greatest breadth, and 40 of circumference.

The climate is much more temperate than in the *Canaries*, and the soil still more fertile in corn, wine, sugar, and fruits: it is watered with five or six rivers. When it was discovered by the Portuguese in 1420, it was all covered with wood; whence it takes its name: for *Madera* in Portuguese signifies timber or wood.

The king of Portugal's governor resides at *Fonzal*, the capital of *Madera*, an episcopal see, suffragan of *Lisbon*.

The isles AZORES may be ranked among those *Africa*, though very distant from it.

They are found between the 36 and 40 degree of latitude, and between the 346 and the 354

of our longitude: but the *Dutch* make their first meridian to pass at the island *Terceira*, which is the most considerable of all.

The climate is very wholesome, and the soil very fertile in corn, wine, and fruits.

These isles are nine in number, and the most considerable of all is the island *Terceira*, it having 15 or 16 leagues of circumference; and its capital is *Augere*, which is an episcopal see.

These isles began to be inhabited by the *Portuguese* about the year 1449; and ever since that time they have remained in their power, except during the usurpation of the kings of *Spain*.

Having travelled through the different parts, which compose the antient world, I will pass to the *other continent*; so called, because on the surface of the globe it is separated from our continent by the sea; *new*, because it was not known 300 years ago; *inferior*, because in the vulgar's opinion it should be under ours; *western*, because it is described westward of the first meridian, in the map of the terrestrial globe; *America*, from the name of one of the first navigators who discovered it; and lastly, the vulgar gives it the name of *West-Indies*, *Indies*, because its riches equal those of the true *Indies*; and *west*, because they are westward of *Europe*.

AMERICA, extends from the 63 degree of northern latitude, at the straight of *Hudson*, to that of *Magellan*, under the 54 of the southern; and from *Agubeza del Gato*, below the island of *California*, under the 240 degree of longitude, to the most advanced point of the *Brazil*, under the 348.

Northward it confines with the sea, which parts it from *Greenland*, by the *Straight of Hudson*, &c. Eastward with the *Atlantick Ocean*; southward with the *Straight of Magellan*, which parts it from *Terra del Fuego*; and westward with the *Pacific Ocean*, or *South-Sea*.

This quarter of the world consists of *continent* or main land, and of a number of islands; and is divided amongst various proprietors or states in *Europe*; whose claim to their respective provinces and islands is founded upon pre-occupancy or their first discovery and possession: or upon conquest. Therefore we shall divide our survey thereof,

First, into north and south AMERICA.

Secondly, into continent and islands.

Thirdly, into their respective governments or connections with the powers in *Europe*.

First, SOUTH AMERICA is a great peninsula, which extends between 292 and the 348 degree of

longitude; from cape *Coguibocoa*, under the 12 degree 30 minutes of northern latitude, to the straight of *Magellan*, under 54 of the southern: so that it may have 1330 leagues in its greatest extent from north to south, and 1140 in its greatest breadth from east to west, and very near 5000 of circuit.

It is chiefly under the dominion of *Spain*, and contains *Terra Firma*, *Peru*, *Chili*, *La Plata*, or *Paraguay*.

TERRA FIRMA, formerly known by the name of *Castilla de Oro*, is the northernmost province of *South America*, and extends between the 12 degree 30 minutes of northern latitude, from the isthmus of *Panama*, under the 293 of longitude, to the 328 degree 30 minutes, having southward the country of the *Amazons*, with *Peru*; and northward, the *northern sea*.

The climate is extremely hot, and, notwithstanding, very wholesome, except towards the isthmus of *Panama*, where the land is very marshy, and the heat would be insupportable, if not a little tempered by the northern winds. The soil produces but little corn, but a great quantity of maize, except in the places where it is traversed with marshes and mountains; it is fertile enough in pasture, and abounds in cattle, as cows, sheep, hogs, and others. It produces several fruits unknown to us, as ananas, *Indian figs*, &c. but not equally every where. There is found in it a great quantity of gold, silver, copper, and azure; rocks of emeralds, and some other precious stones.

The most remarkable of its rivers are that of *Oronoque*, which springs from it, and traverses it through all its course; those of the *Magdalen*, *Rio Grande*, and *St. Martha*, which join together between the governments of *Carthagea* and of *St. Martha*: it has likewise the lake *Parime* under the equator, at 319 degree of longitude, all environed with mountains, 129 leagues long, 40 or 50 broad, and which may have 300 of circuit. A little higher the lake *Cassipal*, under the 4 degree of latitude, and which is more than 100 leagues round; and another 30 leagues distant from the lake *Parime*, eastward, and which may have 90 of circuit.

This province is divided into eleven governments; seven of which are on the northern sea, going from east to west, viz. *Castilla de Oro*, or *Terra Firma*, *Carthagea*, *Santa Martha*, *Rio de la Hacha*, *Venezuela*, *Neuva Andalusia*, and *Caribana*. The four others are found southward of these, returning from east to west, in this order. *Guiana*, *Paria*, *Neuva Granada*, and *Papayava*, in part; the other part is in the government of *Peru*.

The capital city is *Santa Fe de Bogotta*, situated in the province of *Neuva Granada*; it is an archi-

epi-

episcopal see, the seat of a governor, and of the royal audience of all the *Terra Firma*.

The natives are well shaped, and of a brass colour; they go naked to the waist.

PERU is situated between the 292 and 316 degree of longitude; extending on the *South-Sea*, from the 5 degree of northern latitude, including the country of *Popayana*, to the 26 degree of the southern; so that it may have 660 leagues of coasts, 260 in its greatest breadth from east to west, and 140 in its lesser.

It confines eastward with *Paraguay*, and the country of the *Amazons*, from which it is separated by its river, and that of *Maragnan*, which springs from it; northward with the *main-land*; southward with *Paraguay*, *Tucumano*, and *Chili*.

The climate is various. It is very hot at all times in the vallies, because it never rains there, and a very great cold is sometimes felt on the mountains, because of the frequent and violent winds: there are very few rivers in it, and it has neither fountains nor wells.

The soil, though very dry, is fertile enough, particularly towards the rivers, where grows wheat, maize, sugar-canes, cotton, and excellent wine in some places. In the valleys is found a plant of singular virtue, called cocoa, whose leaf being put into the mouth, nourishes and is a preservative against hunger and thirst.

*Peru* is divided into three principal governments, or provinces, which are *Peru*, *Los Charcas*, and *Quito*: the first is in the middle, the second is southward, where is found the rich mine of *Potosi*; and the third is northward, subdivided into three small provinces, which are *Quito*, westward; *Los Quixos*, and *Pacamores*, eastward; one at the north, the other at the south.

*Lima*, or *Los Reyes*, situated on the coast, is the capital of the whole province, and the residence of the viceroy of *South America*: it is honoured with an archiepiscopal see, a royal audience, and an university; but cursed with an inquisition.

*Cusco*, was antiently the place where the *Incas*, or kings of *Peru* kept their court; and is, at present, an episcopal see. *Plata*, in the province of *Los Charcas*, is adorned with an archiepiscopal see.

The natives of *Peru* are inconstant and without faith; those who inhabit the mountains, and near the equator, are more ingenious: these people are whiter than the *Spaniards*, though they inhabit the torrid zone.

TUCUMANO. It extends between the 303 and 317 degree of longitude, from the 23 to 37 of latitude: so that it has about 280 leagues in its

greatest extent from south to north; and more than 200 from east to west.

It confines eastward with *Paraguay*, southward with the *Patagons*, westward with *Chili* and *Peru*, and northward with the same province, &c.

The climate is temperate; the soil fertile in pasture, produces very fine cotton, and feeds a vast number of sheep; but it has no mines of metals.

The most remarkable of its rivers are those of *Plata*, *Desaguadero*, *Barbaranna*, and *Rio Vermejo*, or *Salado*.

The people are not so wild here, as in the other provinces; they love working; they are vindictive when they have been offended.

Part of this province is yet in the possession of the natives, who chuse from among themselves *Caciques*, or commanders to govern them, and lead them to war. The other part which the *Spaniards* have conquered, is in the power of the catholic king, who keeps a governor in the city of *Yago del S. Estero*. This city, which was called *Varco*, is situated on the river *Plata*, is the capital of the province, and the seat of a governor, and of a bishop.

CHILI. This country is called *Chili* by the natives, *i. e. cold*, in their language, because the climate is extremely cold by its situation, which is between the 296 and 308 degree of longitude, extending along the coasts from the 26 of latitude to the 47: so that it has about 420 leagues in length from north to south, 150 in its greatest breadth, and 90 in its lesser.

It confines northward with *Peru*; eastward with, *Tucumano*, and *Magellanick land*, from which it is separated by a long ridge of mountains, called by the *Spaniards*, *Sierra Nuevada de los Andes*; southward with the *Patagons*.

The climate is very near the same as in *Spain*; except in the winter, which is sometimes so excessively cold, that it kills men and beasts, particularly on the mountains; which, notwithstanding, the soil is fertile enough in corn and maize. It produces wine like that of *France*, and a great quantity of all sorts of *European* and *American* fruits. It has mines of gold, and the meadows are covered with a great number of sheep, almost as big as camels.

It has several rivers which freeze during the night, and thaw in the day time, but they are not considerable.

This province is divided into three other small ones, which are *Chili*, *Imperial*, and *Chicuito*. The two first are on the coasts, one northward, the other southward; and the last is eastward, separated

rated from the two others by a ridge of mountains, called *Cordeleras*.

The city of *Conception*, was once the capital of *Chili*, and the seat of a royal audience, which was afterwards transferred to *Peru*; but at present *St. Jago* has that advantage, being the seat of a governor, and of a bishop.

The *Chilians* are ambitious, impatient, bold, and very brave. They bear easily all sorts of incommodities, are strong, tall, and well proportioned. They exercise their children to run, hunt, and to use arms, the most considerable among them are those of the valleys of *Arauco*, *Tucapel*, and *Puren*, which the *Spaniards* could never conquer. They are commonly covered with skins of beasts.

The province of *Chili* depends in part on the viceroyalty of *Peru*, under the direction of a governor, sent thither by the king of *Spain*, and in part is in the power of the savages, who chuse from among them caciques, or captains to lead them to war, to administer justice, and the public affairs.

The greatest part of the natives are yet idolaters, and adore the devil, whom they call *Eponamon*, i. e. powerful.

MAGELLANICK LAND OR PATAGONIA. This province, which the natives call *Chiffa*, is called *Magellanick Land*, from the name of the person, who discovered it. Some call it, *Country of the Patagons*, from the name of its inhabitants.

It is more advanced towards the south, than all the other provinces of *America*, and extends like a point into the sea, called also *Magellanick*, between the 296 and 322 degrees 30 minutes from the 36 degree of southern latitude, to the *Streight of Magellan*, under the 54; so that it may have about 400 leagues in its greatest extent from east to west, and 360 from north to south.

The *Paraguay*, *Tucumano*, and *Chili*, confine it northward; and the streight southward.

The climate of this country is very cold, and the soil not very fertile, except in pastures and forests.

Its rivers are the *Desaguadero*, which comes from *Chili*, and passes in the *Tucumano*, and the *Rio de les Camarones*, which are pretty considerable.

The *Patagons* are strong, bold, and very swift, love hunting, and dancing, live without care, paint their faces, cut their hair short, and cover themselves with skins of beasts.

We know nothing of their government, nor of their religion. They only say that they fear a great horned devil, which they call *etebos*.

PARAGUAY. This province, which the mo-

derns call *Paraguay*, from the name of a river, which waters it, is called by *Herrera*, *Rio de la Plata*, from the name of another river more considerable than the first.

It extends between the 309 and the 338 degree of longitude, from the 21 of southern latitude, to the 37; so that it may have about 500 leagues in length and breadth.

It confines eastward with the northern sea; northward with *Brazil*, and the country of the *Amazons*; westward with *Peru*, *Tucumao*, and the *Magellanick Lands* and southward with the ocean.

The climate is very temperate and wholesome. The soil very fertile in corn, fruits, and cotton; has beautiful meadows round its rivers, which are in great number, and marshes full of sugar-canes. A great quantity of silver is found at the bottom of *Rio de la Plata*, from which its name has been formed.

In the great number of its rivers, there are six principal ones, viz. *Rio de la Plata*, *Paraguay*, *Parana*, *Uruguay*, *Rio Bianco*, and *Rio Vermejo*; the first receive the waters of five others.

The *Spaniards* divide this whole country into six principal parts or provinces, three of which are southward, viz. *Rio de la Plata*, *Parana*, and *Uruguay*. The three others, *Paraguay*, *Chaco*, and *Guayra*, are northward.

The king of *Spain* is almost entire master of the whole country; and there are but very few people who are not subject or tributary to him. He keeps a governor there, who answers to the viceroy of *Peru*, and resides in the *City of the Assumption*, capital of the whole country, situated on the river *Paraguay*; this city is adorned with a royal audience, and is an episcopal see, as well as *Buenos Ayres*, and *Paraguay*, whose bishops are suffragan of the archbishop of *La Plata*.

The *Jesuits* claim the sovereignty of the whole country between the river *Paraguay* and *Brazil*; a most desirable situation both for the climate and soil, it being allowed to be one of the most fruitful countries in the world.

The *Portuguese* have very extensive dominions on this continent of *South America*, and have given them the name of BRAZIL.

BRAZIL. This country was discovered in 1501, by *Alvarez Cabral*, a *Portuguese*, and is the most eastern of all *America*, extending between the 322, and the 349 degree of longitude, from the first degree of southern latitude, to the tropick of Capricorn, being 2500 miles in length and 700 miles broad.

It confines northward and eastward with the northern sea; southward with the *Paraguay*; and

westward with the same country, and that of the *Amazons*.

The climate is hot, but very wholesome, and agreeable; the soil is very fertile in pastures: It bears several sorts of fruits, as oranges, and lemons, anana's, acajou's, araticou's, potatoes, and several others unknown to us, as the *aypi*, and *mainoc*, of which they make bread and pap. Its greatest fertility is in sugar; it produces also tobacco, and trees, commonly called brazil-wood, of which there are whole forests. It abounds with gold and diamonds.

The most remarkable among the rivers which all spring from, and roll their waters in that country, are the *Miary*, *Pinara*, *Tabouourou*, *Siope*, that of *S. Francis*, and several others,

The *Brazilians* are cruel, vindictive, and very violent; but they are very patient and abstemious. They are bold, and even rash on occasions.

The middle of the country is inhabited by several different people, among which the *Topinambas*, the *Marjagas*, the *Ouitafe*, the *Paraibas*, and the *Tapouyis*, are the most considerable. The one are governed by a chief, whom they chuse among the most notable: the others, *viz.* the *Maramouins*, *Coriges*, &c. live without law, and without conductor.

The *Portuguese* are masters of all the coasts; and of about 150 or 160 leagues further into the inland. This part is divided into fourteen *Capitaneries*, eleven of which are found on the eastern coast, ascending from south to north in the following order: first, *San Vincente*, *Rio Janairo*, *Spiritu Santo*, *Port Seguro*, *Itheos*, *Balria*, *Seregippe*, *Pernambuco*, *Tamaraca*, *Paraiba*, and *Rio Grande*. The three others are situated on the northern coast, also in order, going from east to west, and are *Siara*, *Maragnan*, and *Para*. There is a governor in each capitanate, all of them under the direction of the viceroy of the whole country, who resides at *St. Salvador*, capital of the whole province, and situated in the *Bay of all Saints*, on the eastern coast; it is also an episcopal see.

*Country of the AMAZONS.* I call by this name, not only the *Guiana* of the antients, but likewise, the whole extent of the country which is in the neighbourhood of the great river of the *Amazons*, between the 300 and the 328 degree of longitude, and extending from the second of northern latitude to the 16 of the southern; so that it may have near 560 leagues in length, and near 300 in breadth.

This country confines eastward with *Brazil*; northward with *Terra Firma*, westward with *Peru*; and southward with the *Paraguay*.

The climate is hotter here than in any other part of *America*. The soil is fertile in meadows, but we know very little else of the country, except that it must have mines of gold, because the natives change that metal for *European* commodities.

The river of *Amazons* traverses all this vast country, from west to east, rolling its waters in an extent of more than 700 leagues, forming several isles in its course, as towards *Peru*, that inhabited by the *Homagui*; the island of the *Tapinabous*, and several others at its mouth, which is 50 or 60 leagues broad. This river receives several other great rivers, southward, as *Maragnon*, *Amarumaye*, *Tapy Catua*, *Cusignares*, *Cayana*, and *Topaysa*, the lesser whereof is more than 200 leagues long; and northward the *Rio Negro* which is a branch of *Oronoque*.

Several different people inhabit this country, the principal provinces whereof are *Caribana*, *Aparia*, *Apanta*, and *Coropos*, northward of the great river; *Cayana*, *Mataya*, *Paranayba*, &c. southward of it.

These people are wild, cruel, and go quite naked, men and women without shame. They have always their bodies painted of different colours, and covered with several little stones, thrust into the skin from their infancy.

Every one lives as he pleases, for they have neither chief, nor conductor; doing themselves justice for the wrongs they have received.

**NORTH-AMERICA.** The northern continent of the new world is divided amongst other sovereigns.

This second part of the NEW WORLD is, in the opinion of some, a great peninsula, whose extent and limits, westward and northward, are not certainly known, towards which, some *Geographers* imagine, that it is joined to the *Arctick land*.

The *Dutch* make it to extend from the *Straits of Anian*, under the 195 degree of longitude of the first meridian of the *Azores*, i. e. about the 187 of the island *Del Ferro*, to the 330; and from the *Isthmus of Panama*, under the 7 degree and 50 minutes of latitude, to beyond the 63.

**GREAT BRITAIN** claims all that tract of land, which is bounded by the *Frozen ocean*, on the north; by the *Atlantic ocean*, on the east: by *Florida*, on the south, and by unknown lands on the west.

Within these bounds are situate *New Britain* or *Eskimaux*, *British Canada*, *Nova Scotia*, *New England*, *New York*, the *Ferseys*, *Pensilvania*, *Maryland*, *Virginia*, *North* and *South Carolina* and *Georgia*.

**NEW-BRITAIN.** This country called also *Eskimaux*, including *British Canada*, and *Hudson's bay*,

bay, contains 1600 miles in length, and 1200 miles in breadth; bounded by unknown lands, about the pole on the north; by the *Atlantic* and *Baffin's* bay on the east; by the bay and river of *St. Laurence*, and *French Canada* on the south; and by unknown lands on the west.

It is watered with the *Black* river, *Rupert* river, *Albany* or *Chickervan* river, *Moose* river, *Severn* river, *Nelson* river, *Berray* river, *Mercour* river, and *Merrick's* river.

Within this region we have divers seas, bays, straights and capes, which take their names from the discoverers.

The SEAS that border on these countries are the *Atlantic* ocean and the extensive sea, called *Hudson's* bay; in which are many lesser bays, as *James's* bay, *Buttons's* bay, *Baffin's* bay, *Sir Thomas Roe's* welcome, *Brig's* bay, *Cumberland's* bay; and the ports or bays of *Rupert*, *Allany*, *Nelson*, and *Churchill*.

The BAYS in *New-Britain* are *Eskimaux*, *Holdwith-Hope*, and *Phillipeaux*.

The STRAITS are *Hudson*, *Davis*, and *Bellisle*.

The CAPES are *Cape Charles* on the straights of *Bellisle*; *Cape Desire* at the entrance of *Hudson's* straight, *Cape Henry*, *Cape James*, and *Cape Worfenham* near the entrance of *Hudson's* bay; *Cape Henrietta* and *Maria* on the south west part of the bay, and *Cape Comfort*, and *Cape Assumption* on the north part of the bay.

This country is full of lakes, bogs, morasses, which being covered with ice and snow great part of the year, makes the air excessive cold.

The natives are savage heathens: but the *English* have settlements on the west side of *Hudson's* bay, called *fort Churchill*, *Nelson*, *New Severn*, and *fort Albany*, subject to the direction of the *Hudson* bay company, who claim by charter an exclusive right, to the trade and country within the limits of the northernmost seas and continent; on condition of their making a search for, and attempting to discover a passage through those seas to the *East-Indies* and *China*. But how far their diligence in this grand attempt is to be commended, is too well known by their discouragement of every project for carrying it into execution, and by their abandoning *Fort Charles* and *Fort Rupert*, and several more situate at the bottom of the bay, to the *French*, rather than be at the charge of maintaining them against those competitors for trade.

The north part of the *Eskimaux* is generally known by the name of *Terra de Labrador*.

Their animals are the mouffe deer or elk, stags, rein deer, bears, tygers, buffaloes, wolves, foxes, beavers, otters, lynk's, martins, squirrels, ermins, wild cats, and hares.

Of the feathered kind they have geese, bustards, ducks, partridges, and all manner of wild fowl.

Of fish, there are whales, morfes, seals, cod fish, and a white fish preferable to herrings; and in their rivers and fresh waters, pike, perch, carp, and trout. Their foxes, hares, and partridges turn white in the winter; their partridges are as large as hens. There have been taken at port *Nelson*, in one season, 90,000 partridges, and 25,000 hares.

The food of the *Indians* is chiefly what they take in hunting or fishing.

The *English* kill beef, pork, mutton, and venison, at the beginning of the winter. These are preserved by the frost six or seven months free from putrefaction: also geese, partridges, and other fowls, killed at the same time, are hung up with their feathers on, and their guts in, and hold good all the winter. In lakes and standing waters, which are not ten feet deep, the water is frozen to the bottom, and the fish killed; but in waters of greater depth, and rivers near the sea, the fish are caught all the winter, by cutting holes in the ice, to which they come for air.

As soon as they are taken out of the water, they are immediately frozen and stiff, but may be thaw'd again by being immerfed in cold water.

And thus it is that people thaw and freshen their salt provision here: they let down the meat through a hole in the ice into the water, and in a little time it becomes soft and pliable, as if it never was frozen, and eats very well; whereas, if you roast or boil it while it is frozen, it will be spoiled, and eat as if it was rotten.

There is no want of food in *Hudson's* bay, at any time of the year. In *April* come the geese, bustards, and ducks, of which they kill as many as they please. About the same time they take great numbers of rein deer, and those do not return to the north till *July* or *August*. In the summer also they take pike, trout and carp, and a white fish like a herring; and, in the beginning of winter, all manner of wild fowl return again.

There come down usually to port *Nelson*, every season to trade with the *English*, a thousand men, and some *Indian* women in about 600 canoes. They come from far distant countries, and are much delayed in their voyages, by being obliged to go on shore every day to hunt for provisions; for their canoes are so small holding only two men and a pack of a hundred beaver skins, that they cannot carry much provision with them; and they are so discouraged by the high price the company sets upon the *European* goods, that if it were not for the necessity they are under of having guns, powder, and shot, hatchets, and other iron tools for hunting,

hunting, with tobacco, brandy, and paint, they would not go down to the factory at all.

When the *Indians* came to the factory in *June* 1742, they could get but a pound of gunpowder for four beaver skins, a pound of shot for one beaver, an ell of coarse cloth for fifteen, a blanket for twelve, two fish-hooks or three flints for one, a gun for 25 skins, a pistol for ten, a hat with a white lace for seven, an ax for four, a hedging bill for one, a gallon of brandy for four, a check'd shirt for seven: all which were sold at that monstrous profit of 2000 per cent. Notwithstanding which discouragement, the *Indians* brought down to port *Nelson* that season 50,000 beaver skins, and 9000 martins, these beaver skins being worth 5 or 6s. a pound; whereas those the *English* purchase at *New York* are not worth above 3s. and 6d. a pound.

Besides these skins, the *Indians*, the same year 1742, brought to the factory at *Churchill* 20,000 beaver skins.

As to the trade on the eastern and southern shores, the company have in a manner abandoned it, and suffer the *French* to run away with it, though this country was confirmed to *Great-Britain* by the peace of *Utrecht*, Anno 1714. If the trade was laid open, and the southern and eastern countries settled, we might regain that trade, and vastly increase it, by furnishing the natives with woollen goods, iron tools, guns, &c. at reasonable rates. The number of hunters would increase, and we should bring home four times as many furs, and other valuable skins, as we do now. By increasing our settlements to the southward, in the bottom of the bay, we should make the natives our friends; being able to afford our goods cheaper than the *French* can, we might force the *French* out of the trade upon the east main, and the countries north of the *Huron* lake, and the other lakes of *Canada*. The company have no other place of strength than *York* fort, with 25 men, and the prince of *Wales's* fort at *Churchill*, in which they keep but 28 men, though there are 40 guns mounted.

This company which does not consist of above nine or ten merchants, exclude all the rest of the *British* subjects from this trade, by virtue of a patent, extremely to the prejudice of their native country; for if the rest of the king's subjects had been suffered to send colonies thither, and traffic with the *Indians*, they would have underfold the *French*, and consequently beat them out of that trade, and out of those countries which were yielded to *Britain* by the peace of *Utrecht*.

The eastern shores of this country were first discovered by *Sebastian Cabot* for *Henry VII.* king of *England*, in the year 1498: they were afterwards visited by *Davis* and other *British* mariners. Mr.

*Hudson* made four voyages thither, between the years 1607 and 1611; in the last of which his men forced him and eight more of their officers into a boat, and left them to starve in the bottom of the bay, and they were never heard of more; but the ship and the rest of the men returned home.

Sir *Thomas Button* pursued the discovery in 1612, and Capt. *James* in 1631, in hopes of finding a north-west passage to *China*: Capt. *Gilham* failed to the bottom of the bay in 1667, and at his return his owners procured a patent for planting this country, Anno 1670. The first *English* governor, who went thither, was *Charles Batley*, Esq; who built a fort on *Rupert* river, calling it *Charles* fort, and soon after settled another factory at *Nelson*. In the Year 1684, the chief *English* factory was at *Albany*, and a fort erected for its defence,

The *French* invaded our settlements, and took fort *Rupert* and *Albany* in *July* 1686, though we were then at peace with *France*. In king *William's* war, Anno 1693, the *English* recovered their settlements again.

During the war in queen *Ann's* reign, the *French* reduced all our settlements except *Albany*, but were obliged to restore them at the peace of *Utrecht*, Anno 1714, when the *French* king having seized some *English* settlements in these countries, he was obliged by the treaty of *Utrecht* in the year 1713, to restore to *Great Britain* the bay and straits of *Hudson*, with all the lands, seas, sea-coasts, rivers, and places, situate on the said bay and straits, (which comprehend all *New-Britain* and *British* *Canada*, or *Nova-Scotia*) and it was agreed, that commissioners, on the part of *Great-Britain* and *France*, should determine, within the space of a year, the limits between the dominions of *Gr. at-Britain* and *France* on that side; which limits the subjects of *Great-Britain* and *France*, were not to pass over to each other by sea or land; but these limits were never settled, which delay brought on at last the present war.

By the 12th article of the same treaty, *Nova Scotia*, with the fortrefs of *Annapolis*, and all the lands and dependencies thereunto belonging, were yielded to *Great-Britain*; and the subjects of *France* were entirely excluded from all kinds of fisheries in the seas of *Nova Scotia*, especially those which lie towards the east, and within thirty leagues thereof, beginning at the island of *Cape Sable*, and extending from thence to the north east.

*NOVA SCOTIA* is bounded by the river of *St. Lawrence*, on the north; by the bay of *St. Lawrence*, and the *Atlantic* ocean, east; by the same ocean and *New England*, south; and by *French* *Canada*, west; extending 500 miles in length, and 400 in breadth.

The chief towns are, 1. *Annapolis Royal*, 2. *Halifax*. 3. *Minnes*. 4. *Chenigto*, all in the southern peninsula; 5. *Canseau*, upon an island at the east end of the peninsula, near the straight which divides *Nova Scotia* from *Cape Breton*.

Here are several good rivers. The river of *St. Lawrence*, which forms the northern boundary. The rivers *Risgonche* and *Nipisiguit* run from west to east, and fall into the bay of *St. Lawrence*. The rivers of *St. John*, *Passamagnadi Penobscot*, and *St. Croix*, which run from north to south, fall into *Fundi* bay, or the sea a little to the eastward of it.

The seas adjoining to it are, the bay of *St. Lawrence*; the *Atlantic* ocean, and *Fundi* bay. The lesser bays are, *Chenigto*, and *Green* bay upon the isthmus, which joins the north part of *Nova Scotia* to the south; the bays of *Cappe* and *Chaleurs* on the north east; the bay of *Chebuëto* on the south east; the bay of the *Islands*. The ports of *Bart*, *Chebuëto*, *Prosper*, *St. Margaret*, *La Heve*, port *Maltois*, port *Resignol*, port *Vert* and port *Joly*, on the south; port *La Tour* on the south east; port *St. Mary Annapolis*, and *Minnes* on the south side of *Fundi* bay.

The chief capes are, *Rosser* and *Gaspé* on the north east. The capes *Portage*, *Ecaumenac*, *Tourmentin*, cape *Port* and *Epis*, on the east. Cape *Fogeri*, and cape *Canseau*, on the south east. Cape *Bianco*, cape *Vert*, cape *Theodore*, cape *Dore*, cape *Le Heve*, and cape *Negro*, on the south. Cape *Sable* and cape *Fourche*, on the south west.

This country is a great forest: where it has been cleared and cultivated, it affords good corn and pasture. The timber is fit for building, and will produce pitch and tar; and the soil is proper for hemp and flax; so that all manner of naval stores might be had there.

It abounds in deer, wild fowl, and all manner of game; and there is one of the finest cod-fisheries in the world on the coast.

No provision was made to plant the rest of *Nova Scotia*, until the year 1749, when about three thousand *English* families, under the command of governor *Cornwallis*, were sent thither, and erected the town of *Halifax* in *Chebuëto* bay.

The dispute between *Great-Britain* and *France*, is not whether *Nova Scotia* was yielded to *Great-Britain* by the treaty of *Utrecht*, but what were the *Bounds* of *Nova Scotia*: which the *British* commissaries demonstrated extended to the river of *St. Lawrence*, on the north, by several treaties between the two nations; whereas the *French* insisted that only a small part of the peninsula was ceded to *Britain*.

The *French* also encroached upon *Virginia* on the side of the *Ohio*, near the lake of *Erie*; made several of the subjects of *Great-Britain* prisoners,

and erected forts on the lake and on the river *Ohio*, to defend their encroachments on that side. Whereupon some forces under the command of general *Bradock* were sent to dislodge them, who fell into an ambuscade, near fort *Duquesne*, and were defeated, and the general, and many of the officers were killed.

In the mean time general *Johnson* marched with a body of troops from *Albany* in *New-York*, and obtained a victory over the *French*, near the lake of *Champlain*, and erected some forts to restrain the incursions of the enemy from fort *Frederic* or *Crown Point*; other detachments of the *English* keep possession of the forts on the isthmus, which unite the peninsula to the continent of *Nova Scotia*; and of those the *French* had erected on the north side of the bay of *Fundi*, since the treaty of *Aix-la-Chapelle*. Since then we have reduced *Cape Breton*, and the island of *St. John*, fort *Duquesne*, and fort *Frontenac*, &c. and are upon an expedition against *Crown Point* and *Quebec*.

The island of *Cape-Breton*, called by the *French* *Isle Royal*, is situated between the 45th and 47th degree of north latitude, and forms, together with the island of *Newfoundland*, from which it is distant only 15 or 16 leagues, the entry of the gulph of *St. Lawrence*. The streight, which separates it from *Acadia* or *Nova Scotia*, is only five leagues in length, and one in breadth. The *French* call it the passage of *Fronsaë*; but the *English* the streight of *Canso*.

The length of the island, from north-east to south-west, is not quite 50 leagues; and its greatest breadth, from east to west, is not above 33. It is of a very irregular figure, and almost interected by lakes and rivers, so that the two principal parts join together only by an isthmus of about an hundred paces over, which separates the bottom of port *Toulouse* from several lakes, which are called *Labrador*. These lakes discharge themselves eastwards into the sea, by two channels, of unequal breadth, formed by the island *Verderonne*, or *la Boularderie*, which is seven leagues in length.

The climate of this island is nearly the same as that of *Quebec*; and, though fogs are here more frequent, the people do not complain of an unhealthy air. All the lands are not good, yet they produce trees of all sorts. Here are oaks of a prodigious magnitude, pines proper for masts, and all kinds of timber for carpenters work. The most common sorts, besides the oak, are the cedar, the ash, the maple, the plane, and aspin-tree. Fruits, especially apples; pulse, corn, and other grains necessary for life, as also hemp and flax, are in less abundance, but as good, in quality, as those of *Canada*. It has been observed, that the mountains here will bear cultivation up to the top, and that the

the best lands are upon their southern declivities, which are defended from the north and north-west winds, by the hills which bound them on the side of *St. Lawrence's* river.

All domestic animals, as horses, black cattle, hogs, sheep, goats, and poultry, find here provisions in abundance. The chase and the fishery are sufficient to nourish the inhabitants a good part of the year. Here are a great plenty of excellent mines of pit-coal. As these mines are in the mountains, there is no occasion for digging deep under ground, or to be at the expence of making drains to carry off the water, as in some other countries. Limestone is also found here. The cod fishery is here carried on with perhaps, better success than in any other part of the world; nor can greater conveniences be found for drying fish. Formerly this island was full of wild beasts, but at present they are very rare, especially elks. The partridges here are almost as large as pheasants, and feathered very much like them. In short, fisheries of seals, porpoises, and sea cows, or grampuses, might be conveniently carried on for the benefit of their oil, there being great plenty of them.

All the ports on the east side round to the south are open, for the space of fifty-five leagues, beginning with port *Dauphin*, and proceeding to port *Toulouse*, which is almost at the entry of the strait of *Canso*, or passage of *Froufac*. Every where else it is difficult to find anchorage, even for small vessels, either in the bays or between the isles. All the north coast is very high, and almost inaccessible; nor is it more easy to go on shore on the west, till you come to the strait of *Canso*; upon leaving which, you fall again upon port *Toulouse*, formerly called *St. Peter's*.

This port lies properly between a kind of gulph, called *Little St. Peter's*, and the isle of *St. Peter*, over-against the isles of *Madame* or *Maurepas*. From thence advancing to the south-east, and passing several other bays, you come to that of *Gaborus*, or *Gaboron*, the entrance of which, about 20 leagues from the islands of *St. Peter*, is a league broad between isles and rocks. This bay is two leagues deep, and affords very good anchorage. Here Admiral *Boscawen* landed the forces that took *Louisbourg*, &c. in 1758:

The haven of *Louisbourg*, formerly called *English Haven*, is a league distant from the above bay. It is one of the finest of all *America*; it is near four leagues in circumference, and every where there are six or seven fathoms water. The anchorage is good, and you may, without danger, run a ship ashore on the mud. The entrance is not above two hundred fathoms wide, and lies between two small islands; and it may be known twelve leagues

off at sea, by the cape of *Lorembec*, which lies but a small distance from it to the north east.

Two leagues higher is *Port de la Baleine*, or *Whale Port*, the entry of which is difficult, because of several rocks, which the sea covers when it runs high. Ships of above 300 tons cannot enter here, but then they are quite safe when they are got in. From hence it is but two leagues to the bay of *Panadou*, or *Menadou*, the entrance of which is about a league broad, from whence it runs in about two leagues. Almost over-against it is the isle of *Scatari*, formerly called *Little Cape Breton*, which is about two leagues long. The bay of *Mire* is separated from it only by a very narrow neck of land. The entrance of this bay is two leagues over, and runs eight leagues into the country. It grows narrow the farther you go into it, and receives a great many rivulets and small streams. Large ships may run up it six leagues, and find very good anchorage, and be sheltered from the winds by the hills.

Besides the island of *Scatari* there are many other small ones, and rocks, which the sea never covers, and may be seen at a great distance. The largest of the rocks is called the *Forillon*.

The bay of *Morienne* is higher still, and separated from the bay of *Mire* by *Cape Bru'e* or *Cape Burnet*. A little higher is *Flat Isle*, or *Gunfwint Isle*, lying in 46 degrees 8 minutes of north latitude. There are good openings between all these islands and rocks, and they may be approached without danger.

Advancing from thence to the north west, we come to *Indiana*, which is a good haven for small vessels, but has not water enough for large. From *Indiana* to *Spaniards Bay* is two leagues, and the latter a very fine haven. The entrance is not a mile over, but enlarges, as we advance inwards, and at the distance of a league divides into two branches, which may be sailed up for two leagues. They are both very good ports, and might be made better at a small expence. From this bay to the lesser entrance of *Labrador* is two leagues, and the island which separates the lesser entrance from the greater, is about the same breadth.

*Labrador* is a gulph, about twenty leagues long, and three or four over, where broadest. It is reckoned only a league and a half from the large entrance of this gulph to port *Dauphin* or *St. Anne's* port, and you may anchor with safety, almost any where among the islands of *Cibou*. A slip of lard, or kind of natural mole, almost entirely shuts up this port, and leaves room for the passage of only one ship at a time. The port is about two leagues in circumference, and ships hardly feel the wind there, by reason of the height of the mountains that surround

it. The shore is every where so bold, that you may ride as near to it, as you please.

NEW ENGLAND is bounded by *New Scotland*, on the north; by the *Atlantic* ocean, on the east and south; and by *New York*, on the west, and is 300 miles long, and 200 broad, divided into four governments, viz. 1. *New Hampshire*, or *Piscataway*. 2. The *Massachusetts* colony. 3. The colony of *Rhode island*, *Providence* plantation; and 4. *Connecticut* colony.

It is divided into four provinces, viz. 1. *New-Hampshire*. 2. *Massachusetts* colony. 3. *Rhode island*. 4. *Connecticut*. Whose chief towns are *Portsmouth*, *Boston*, W. long. 71. N. lat. 42. *Newport*, *London*, and *Hertford*.

Here are the rivers, 1. *Connecticut*; 2. *Thames*; 3. *Patuxent*; 4. *Merimac*; 5. *Piscataway*; 6. *Saco*; 7. *Casco*; 8. *Kinebeque*; and, 9. *Penobscot*, or *Pentagonet*.

The most remarkable bays and harbours are those form'd by *Plymouth*, *Rhode island*, and *Providence* plantation; *Monument bay*; *West* harbour, form'd by the bending of cape *Cod*; *Boston* harbour; *Piscataway*; and *Casco bay*.

The chief capes are, cape *Cod*, *Marble Head*, cape *Anne*, cape *Entick*, cape *Porpus*, cape *Elizabeth*, and cape *Small Point*.

The climate is generally healthful, and agreeable to *English* constitutions.

The fruits of *Old England* come to great perfection here, and particularly peaches, which are all standard-trees.

*English* wheat does not thrive here. They eat maize or *Indian* corn chiefly: one grain whereof frequently produces twelve hundred grains, and sometimes two thousand. Besides the forest-trees of *Old England*, they have cedar, cypress, pine, and fir-trees. Their fir-trees are of a prodigious bulk, and furnish the royal navy of *England* with masts and yards, and they draw from these, and other trees, pitch, tar and rosin, turpentine, gums, and balm; and the soil is proper for hemp and flax. A ship may be built and rigged out with the produce of the soil; so that ship-building is a considerable employment in this country.

The animals, which seem almost peculiar to *New England*, and the rest of *North America*, are the moose deer and the beaver.

The spermaceti whale also is found upon this coast: of which, and other whales, the *New England* people take great numbers, and send some ships every year to fish for whales in *Greenland*. Besides the whale-fishery, there is a very fine cod-fishery on the coast of *Nova Scotia*.

The *New-England* people have a great trade by sea to the *British* sugar colonies, and with the *Dutch* at *Surinam* and *Curoffoa* near *Terra-Firma*: whither they send horses, salt provisions and lumber, that is deal-boards, pipe-staves, hoops, and shingles.

The appointment of a governor, lieutenant governor, secretary, and all the offices of the admiralty, is vested in the crown. The power of the militia is wholly in the hands of the governor, as captain general. All judges, justices, and sheriffs, to whom the execution of the law is intrusted, are nominated by the governor, with the advice of the council; and the governor has a negative on the choice of councillors, peremptory and unlimited. All laws enacted by the general assembly are to be sent to the court of *England*, for the royal approbation; and no laws, ordinances, elections (of magistrates, I presume,) or acts of government whatsoever, are valid, without the governor's consent in writing.

In one of the representations of the board of trade, they inform the privy-council, that in the colony of the *Massachusetts* only, there were upwards of ninety-four thousand souls: and that their militia consisted of six regiments of foot, and fifteen troops of horse, of an hundred men in each troop. The same representation shews, that they employed near five hundred sail of ships, and four thousand seamen, annually in their trade; and if this calculation be right, it must be allowed, that the rest of the colonies north of *Virginia* and *Maryland*, viz. *Connecticut*, *Rhode Island*, *New York*, the  *Jerseys*, and *Pennsylvania*, can raise at least as many more. All that seems wanting, in order to render these forces useful and capable of opposing an invasion, is a generalissimo, impowered, on any exigencies, to oblige every colony to raise their respective quotas of supplies and troops, and to command them when assembled in the field; for these are particulars, which it is never to be expected the colonies should agree on among themselves, or at least time enough to prevent the ravages of a potent enemy, as some late proceedings have convinced us.

*New England* was planted by the *Independents* a little before the commencement of the civil wars in *England*. These people transported themselves thither, rather than conform to the established church. Though they complained of the government here, for not allowing a toleration, they permitted no other sect or denomination of christians, but themselves, to have any share in the governments they erected there, and were so far from allowing a toleration to those that differed from them, that they hanged several quakers. It is but very lately they have suffered any member of the church of *England* to have a share in the magistracy, or to be elected a member of the commons, or

house

house of representatives; and there are not more than two or three admitted at this day into their councils.

**NEW-YORK** with the **JERSEYS**. These are bounded by *Canada*, on the north; by *New-England* east; by the *American* sea south; and by *De la War* river, which divides it from *Pennsylvania*, on the west: 200 miles long and 100 broad. It is divided into three provinces, viz. 1. *New-York*, 2. *The Jerseys*, 3. *Long-Island*, and the rest of the islands near *Hudson's* river; whose chief towns are, *New-York*, W. lon. 72--30. N. lat. 41. *Albany*; *Burlington*; *Elizabeth*; *Southampton*.

The chief RIVERS, besides those of *Hudson* and *De la War*, are the *Mohawk* river; *Onandaga*, *Raritan*, and *Maurice* rivers.

The CAPES are *Cape Mory*, on the east entrance of *De la War* river; *Sandy point*, near the entrance of *Raritan* river; and *Montang Point*, at the east end of *Long-Island*.

There are very extensive LAKES on the north-west, viz. the lakes of *Champlain*, *Ontario*, and *Erie*. The *Iroquois*, or five nations, lie upon the lakes of *Ontario* and *Erie*.

*New York* and the *Jerseys* abound in cattle and a good breed of horses, and have plenty of wheat and other grain, as well as fish. They supply the sugar colonies with flour, salt beef, pork, and salt fish; and with timber, plank, and pipe-staves; and as they are much employed in the fishery, they export a great deal of dried and salted fish to *Spain*, *Portugal*, *Italy*, and other countries of *Europe*. They traffick also with the logwood cutters in the bay of *Honduras*, and with the *Spanish* settlements, exchanging the manufactures of *Europe* for treasure, which they send to *England* as merchandize. They bring over also whale oil and bone, and return with the manufactures of *Great Britain*.

The people of *New-England*, *New-York*, and our other northern colonies, of late, export a great deal of timber to *Portugal*, and other countries in *Europe*.

Every nation of the *Iroquois* is a distinct republic, governed by their sachems or civil magistrates in time of peace, and by their warriors or captains in their wars; but their chiefs neither resolve, nor execute any thing of importance, without consulting the heads of their tribes.

The church of *England* is established in this and all the royal governments in *British America*.

**PENNSYLVANIA**, is bounded by the country of the *Iroquois*, or five nations, on the north; by *De la War* river, which divides it from the *Jerseys*, on the east; and by *Maryland* on the south and west, 200 miles long and 200 broad. It is di-

vided into north and south, and those divisions subdivided into six counties, viz. *Buckingham*, *Philadelphia*, *Cheshire*, *Newcastle*, *Kent*, *Suffex*, whose chief towns are *Bristol*, *Philadelphia*, W. long. 740. N. lat. 40. 50. *Chester*, *Newcastle*, *Dover*, and *Lewes*.

The coast near the sea is flat, but rises gradually, having the *Apalachian* mountains on the west.

The RIVERS are, 1. The *De la War*. 2. *Sasquahanna*; and, 3. *Skooskil*.

The merchandize consists of horses, pipe-staves, pork, beef, and fish, salted and barreled up; skins and furs; all sorts of grain, viz. wheat, rye, pease, oats, barley, buck-wheat, *Indian* corn, *Indian* pease, and beans, pot-ashes, wax, &c.

They have some rice; and a little tobacco of the worst sort. The colonies of *Pennsylvania*, the *Jerseys* and *New-York*, appear extremely proper to produce hemp and flax where they are cultivated. Their trade with the *Indians* consists but in few articles; they receive of the natives chiefly skins and furs of their wild beasts, for which they give them cloathing, arms, ammunition, rum, and other spirits, in return.

**MARYLAND**, is bounded by *Pennsylvania*, on the north, by another part of *Pennsylvania*, and the *Atlantic* ocean, east; by *Virginia*, south; and by the *Apalachian* mountains west, extends 140 miles in length and 135 in breadth: and is divided into two parts by the bay of *Cheesepcak*, viz. 1. The eastern; and, 2. The western division.

The east division contains four counties, 1. *Somerset*, 2. *Dorchester*, 3. *Talbot*, county, 4. *Cecil* county. The west division contains six counties, 1. *St. Mary's* county, 2. *Charles* county, 3. *Prince George* county, 4. *Calvert* county, 5. *Anne Arundel* county, 6. *Baltimore* county; whose chief towns are *Somerset*, *Dorchester*, *Oxford*, *St. Mary's*, *Bristol*, *Masterkout*, *Abingdon*, *Annapolis*, W. lon. 78. N. lat. 39-25. and *Baltimore*.

This country is watered with innumerable springs, which form a great many fine rivers, of which the chief are 1. *Potomack*. 2. The *Pocomoac*. 3. The *Patuxent*. 4. *Severn*. 5. *Cheptonk*. 6. *Sassafras*. 7. *Wicomoca*; and, 8. The river of *St. George*.

It is separated from *Virginia*, on the south, by the river *Patomack*.

The air of this country is excessive hot some part of the summer, and equally cold in winter, when the north-west wind blows.

Tobacco is planted and cultivated here with much application, and their principal traffick with *England* is in this article; though the country produces most of the grain and fruits of *Europe* and *America*.

They are governed by the same laws as in *England*, only some acts of assembly they have relating to particular cases, not under the verge of the *English* laws, or where the laws of *England* do not aptly provide for some circumstances, under which their way of living hath put them. The church of *England* is established here; churches are built, and there is an annual stipend allowed for every minister by a perpetual law; every christian male sixteen years old, and negroes, male and female, above that age, pay 40<sup>lb</sup>. of tobacco to the minister, which is levied by the sheriff among other publick levies; which make the revenues of the ministers, one with another, about twenty thousand pounds of tobacco, or one hundred pounds sterling *per annum*.

*VIRGINIA* is bounded by the river *Patowmack*, which divides it from *Maryland*, on the north-east; by the *Atlantic* ocean, on the east; by *Carolina*, on the south; and by the *Apalachian* mountains, on the west: extending 240 miles in length and 200 miles in breadth; and may be divided into four parts. *viz.* 1. The north division. 2. The middle division. 3. The south division. And, 4. The east division.

The north division contains five counties; 1. *Northumberland*. 2. *Lancashire*. 3. *Westmoreland*. 4. *Richmond*. 5. *Stafford*. The middle division contains ten counties; 6. *Essex*. 7. *Middlesex*. 8. *Gloucester*. 9. *King* and *Queen* county. 10. *King William* county. 11. *New Kent*. 12. *Elizabeth*. 13. *Warwick* county. 14. *York* county. 15. *Princess Anne* county. The south division contains eight counties. 16. *Norfolk* county. 17. *Nansamund* county. 18. *Isle of Wight* county. 19. *Surrey* county. 20. *Prince George* county. 21. *Charles* county. 22. *Henrico* county. 23. *James* county. The eastern division between *Cheesepeak* bay and the ocean is only one county. 24. *Acomac* county. These counties are divided into parishes, *viz.* *Wincomoca* parish, *Christ-Church*, *St. Paul's*, *Farnham*, *Christ-Church*, *Abington*, *Stratton*, *St. John's*, *St. Peter's*, *Elizabeth*, *Denby*, *York*, *Lynhaven*, *Elizabeth*, *Chukatuk*, *Newport*, *Southwark*, *Wyanoke*, *Westover*, *Bristol*, *James Town*, *Williamsburg* and *Acomac*.

Into the west side of *Cheesepeak* bay fall four great rivers, which rise in the *Apalachian* mountains, running from the north-west to the south-east; the most southerly of these is *James* river, the *Indian* name whereof was *Powhatan*, being generally about two miles over, and navigable at least fourscore miles. *York* river, whose *Indian* name was *Paamunky*, is a little to the northward of *James* river. North of *York* river is the river *Rappahanock*; north of *Rappahanock*, is the great

river of *Patowmack*, which is navigable near two hundred miles; being nine miles broad in some places, but generally about seven.

The great bay of *Cheesepeak* runs up through *Virginia* and *Maryland*, almost due north, three hundred miles and upwards, being navigable most part of the way for large ships. We enter this bay between two promontories called *Cape Charles* and *Cape Henry*.

As we approach *Virginia* from the Ocean, it appears to be low land; and for an hundred miles up into the country, there is a scarce a hill or a stone to be met with. People travel with ease through these forests on horseback, and never want a fine shade to defend them from the summer heats.

Snow falls sometimes in pretty great quantities, but rarely continues there above a day or two; their spring is about a month earlier than in *England*; in *April* they have frequent rains; *May* and *June* the heat increases, and it is much like our summer, being mitigated with gentle breezes; that rise about nine of the clock, and decrease and increase as the sun rises and falls. *July* and *August* those breezes cease, and the air becomes stagnant; then the heat is violent and troublesome. In *September* the weather usually breaks suddenly, and there falls very considerable rains, when many fall sick, this being the time for cachexies, fluxes, scorbutic dropsies, gripes, or the like.

It is computed there are in *Virginia* upwards of an hundred thousand souls, besides servants and slaves, which are above twice that number.

No country produces greater quantities of excellent tobacco.

Of spontaneous flowers there are great variety; the finest crown-imperial in the world, the cardinal flower, so much extolled for its scarlet colour; and almost all the year round the plains and vallies are adorned with flowers of one kind or other.

There is also found the fine tulip-bearing laurel-tree, which has the pleasantest smell in the world, and keeps blossoming and seeding several months together.

The woods produce great variety of incense and sweet gums, which distil from several trees.

All sorts of naval stores may be produced there, as pitch, tar, rosin, turpentine, plank-timber, masts and yards, besides sails, cordage, and iron.

Horses, cows, sheep and hogs, run wild in their forests. Beef and pork are sold from one penny to two pence a pound. Their fattest pullets are sixpence a piece; chickens at three or four shillings a dozen; Geese at ten pence a-piece; a turkey for eighteen pence. Fish, oysters, and

wild fowl, are the cheapest food in this country in the season. And deer are sold from five shillings to ten shillings a-piece.

The government of the *English* is formed upon the *English* model; the governor acts as king; the council supplies the place of a house of lords, and the house of representatives the commons.

There are no other forces in *Virginia* but militia. Every freeman, (that is, all that are not servants) from sixteen to sixty years of age, are listed in the militia, and are mustered once a year at a general muster, and four times a year by troops and companies in their respective counties; and they are reckoned to be about twenty thousand men; the whole inhabitants, men, women and children, amounting to upwards of one hundred thousand, and slaves and servants to twice that number.

There is a college at *Williamsburgh*, situate between *James* and *York* rivers. King *William* and queen *Mary* gave two thousand pounds in 1692, towards its foundation, endowed it with twenty thousand acres of land, and a revenue of one penny in the pound on all tobacco exported. Hence this college is called *William and Mary* College, for a resident, six professors, and a hundred students. This college has acquired a very considerable donation also from the Hon. Mr. *Boyle*, for the education of *Indian* children.

**CAROLINA**, comprehending *North Carolina*, *South Carolina*, and *Georgia*, is situated between 75 and 86 degrees west longitude, and between 33 and 36 degrees north latitude.

If we were to extend *Carolina* to the westward, as far as their charters would justify them, or as far as the country of the *Cherokee Indians* our allies extends, we might make the river *Mississippi* the western boundary, which falls into the gulf of *Mexico*, in 95 degrees of western longitude; but if we take in no more than is actually planted by the *English*, we must not extend it above two hundred miles west of the *Atlantick* ocean. As to the *French* settlements on the river *Mississippi*, they are but late intruders there, since the year 1720, for all to the east of that river properly belongs to the *English*; and all towards the west to the *Spaniards*; and the *Spaniards* actually destroyed some of the forts the *French* had erected on the west side of that river; though since the strict Union between the two kingdoms of *France* and *Spain*, the *Spaniards* wink at the *French* Incroachments.

I shall take the liberty, however, to give *Carolina* the bounds it ought to have, both against *French* and *Spanish Florida*, and bound *Carolina* by *Virginia* on the north; by the *Atlantick* ocean

on the east; by the river of *St. John* on the south; and the river *Mississippi* on the west; and throw it into three divisions, viz. 1. *North Carolina*, 2. *South Carolina*, and 3. *Georgia*; extending five hundred miles in length, with an uncertain breadth.

*North Carolina* contains three counties, viz. *Albemarle*, *Bath* county, and *Clarendon* in part, which are divided into parishes, but have no towns.

The middle division, or *South Carolina*, contains five counties, viz. *Clarendon* in part, *Craven* county, *Berkeley* county, *Colleton* county, and *Granville* county; whose chief towns are *St. James*, *Christ-Church*, *Charles-Town*, west long. 79, north latitude 32. 30. and *Port-Royal*.

The South division contains only *Georgia*, whose chief towns are *Savannah*, *Frederica*, and *Purisburgh*.

The chief rivers are, 1. *Albemarle*. 2. *Pentague*. 3. *Neuse*. 4. *Cape Fear*, or *Clarendon* river. 5. *Waterce*. 6. *Santee*. 7. *Ashley*. 8. *Cooper*. 9. *Colleton*. 10. *Cambahce*. 11. *Savannah*. 12. *Alatamaha*; and 13. That noble river *St. John's*, which divides *Georgia* from *Spanish Florida*; all which rivers rise in the *Apalachian* mountains, and, running east, fall into the *Atlantic* ocean.

There has not yet been found one good harbour in *North Carolina*; the best are those of *Roanok*, at the mouth of *Albemarle* river, and *Pinlico*. In *South Carolina* there are the harbours of *Winyaw*, or *George-town*, *Charles-town*, and *Port-Royal*. In *Georgia*, the mouths of the rivers *Savannah*, and *Alatamaha*, form good harbours.

The most remarkable promontaries are *Cape Hatteras*, in 35° odd min. north latitude; *Cape Fear* to the south of it, and *Cape Carteret* still further South.

It has a low level coast; not a hill to be seen from *St. Augustin* to *Virginia*, and a great way beyond. The country rises into hills about 100 miles west of the coast, and continues to rise gradually to the *Apalachian* mountains, which are about 150 miles distant from the ocean.

*Carolina* is situate between the extremes of heat and cold; but the heat is more troublesome in summer, than the cold in winter.

The vegetables are innumerable, for all that grow in *Europe*, grow there, and many that cannot stand our winters thrive there.

This country hath produced, and would still produce, silk, wine, and oil, if it was properly cultivated; mulberry-trees and grapes grow spontaneously.

They ship off yearly from *Carolina* about 60,000 barrels of rice, each barrel containing 400 weight, and export 70,000 deer skins per annum at a medium, for ten years successively; also 20,000 barrels of pitch; and they have sent home 70,000 barrels of tar

tar in a year: whereby they reduced the price of *Norway* tar, from 50s. a barrel, to 12 s. and 15 s.

The *English* traffick with the natives for deer-skins, bear and buffaloe skins, for which they give them guns, powder, knives, scissars, looking-glasses, beads, and some coarse-cloth, and Juffs. The *English* chapmen carry these on pack horses 5 or 600 miles into the country, west of *Charles Town*; but most of the trade is confined within the limits of the *Creek* and *Cherokee* nations, which do not lie above 300 miles from the coast.

*Georgia*, the most southern province, is not a fruitful country; but having several fine rivers running through it, the banks of them are fortified, and make a very good barrier for the *Carolinas*, which were before exposed to the incurfions and ravages of the *Spaniards* and their *Indian* allies.

On this same continent our most inveterate and natural enemies the *French* have got a strong footing, and were contriving means to ruin the *British* empire and trade in these parts, till by their encroachments we were provoked to maintain our right by the present war.

Their claim is to one tract of land measuring 1800 miles in length and 1260 in breadth, which they call *FRENCH CANADA* or *NEW FRANCE*; and to which they set the bounds of *New-Britain* and *British Canada* on the north; *New Scotland*, *New England* and *New York* on the east, and unknown lands on the west. To another tract, which they call *LOUISIANA*, extending 1400 miles in length and 900 in breadth, and bounding on the river and lake of *Illinois* on the north; by *Carolina* on the east; by the gulph of *Mexico* on the south, and by *New Mexico* on the west, and to a third province, which they name *CAEN* or *EQUINOCTIAL FRANCE*, bounded by *Surinam* on the north; by the *Atlantic* ocean, on the east; by the *Amazons* on the south, and by *Guiana* on the west, which extends 300 miles in length, and 240 miles in breadth.

But, we say that *FRENCH CANADA* or *NEW FRANCE*, stripped of the encroachments made upon the *British* discoveries and settlements, is but a small province, confined to the coast of the south and east sides of the river of *St. Lawrence*. Its chief town is *Quebec*, about 110 leagues from the sea. It is an episcopal see, and adorned with several convents and churches for *Jesuits*, religious of both sexes, and parochial. The whole extent of the place is covered by a regular fortification with a citadel and several redoubts, well furnished with artillery. This is the largest and strongest town in *New France*, and generally maintains a strong army, to over awe both their *Indian* and

*British* neighbours: so that the reduction thereof must entirely destroy the power and interest of *France* on that continent.

Though *Canada* is situated in the midst of the temperate zone, yet the air of it is prodigiously sharp: so that their winter, which sets in about the middle of *November*, and lasts to the middle of *May*, is excessively severe, the greatest rivers being frozen over, and the snow two or three feet deep on the ground. But, notwithstanding this, the *French* boast very much of the fertility of this country; and, indeed, where it is cultivated, it yields *Indian* and other sorts of corn, peas, beans, and, in short, all kinds of herbs and vegetables in great plenty. There is likewise plenty of stags, elks, bears, foxes, martins, and other wild creatures in the woods, besides wild fowl and other game. The southern parts, in particular, breed great numbers of wild bulls, deer of a small size, divers sorts of roebucks, goats, wolves, and a great variety of other animals, both wild and tame.

The meadow grounds, which are all well watered, yield excellent grass, and breed great quantities of large and small cattle; and, where the arable land is well manured, it produces large and rich crops. The mountains abound with coal mines, and some, we are told, with silver, and other metals; though we do not learn that any great advantage is made thereof. The marshy grounds, which are likewise very extensive, swarm with otters and beavers, and the rivers and lakes with fish of all sorts.

With regard to the product of this colony, it consists of furs, especially castors, which they purchase from the *Indians*; several kinds of hides or skins, which they likewise purchase from the natives; fish, and what we call lumber. that is, planks, pipe staves, and other things of that nature. The greatest part of the commerce of the country is carried on in light canoes, made of bark, proper for the navigating their lakes and rivers, incumbered with water falls, which render them unfit for other kinds of vessels. In winter they make use of a kind of sledges, which are drawn either by horses or by dogs, and are very proper for passing over vast tracts of snow and ice, and enable them to continue their commerce with the *Indians* all the winter: which, however, the *French* tell us, is attended with one great inconveniency.

The persons, who carry on this trade, must have licences granted by the governors, which are confined to a certain number every year; and, though this brings them in large sums, yet by hindering the resort of *Indians* to their fairs in summer, when every man is at liberty to make the most

most of his goods, this prejudiced the colony in general.

As for their modern claim to the vast tract of lands, to which the *French Geographers* give the pompous name of *LOUISIANA*, nothing can be more chimerical. The whole is an encroachment upon *British* property; whose prior discoveries give the *English* a right to the whole continent, that lies east of the river *Mississippi*.

The *French* in 1687, formed schemes to conquer *New York*, which twice miscarried, as did their design on *Boston* in 1697.

The *Ohio* country was known early to the *English*, and thoroughly discovered beyond the *Mississippi* by colonel *Wood*, from 1654 to 1664, as also by captain *Bott* in 1670. In 1698 two ships sent by Dr. *Cox* of *New Jersey*, discovered the mouth of that river, and sailing up 100 miles, took possession, and called it *Carolana*. Next year the *French* first found and settled on it. From thence to *Illinois* river, in 40° latitude they call it *Louisiana*, (the trade of which was granted to M. *Crofat* in 1712.)

Since the peace of *Utrecht* they have daily encroached. In 1719, they began to dispute our title to *Nova Scotia*. In 1726 they repossessed fort *Denonville*, near the falls of *Niaguara*, bordering west on the *Six Nations*. In 1731 they built fort *Frederick* at *Crown Point*, 120 miles south of *St Laurence* river. In 1750 they seized two parts in three of *Nova Scotia*, by erecting forts at *Sbegnikto*, *Bay Verte*, and at the mouth of *St. John's* river in 1752 and 54; two more on lake *Érie*, in 1752 and 53.

In 1754, they, by force, took our two forts on the *Ohio* and in the *Great Meadows*; drove our people out of their back settlements; and, as it were, kept *Virginia* besieged; all this they have done in time of peace. About 1716, they built a fort on the *Alabama* river, in the country of the *Creek Indians*, to curb and straiten *South Carolina*; thus they hemm'd in our colonies with forts, and cut off our trade and alliance with the *Indians*.

To the two *French* colonies there are only two inlets, the rivers *St. Laurence* and *Mississippi*, whose mouths are above 1000 leagues asunder, and both their entrances of difficult access; the first being full of rocks; the second shoaly.

*Canada* in 1753 had not more than 45000 inhabitants, of which 15000 were fighting men; *Quebec* had 15000 inhabitants and 500 soldiers, or more than at both *Trois Rivières* and *Montreal*, their other two settlements. *Louisiana* has not one twelfth the number of men as in *Canada*, whereas our colonies contain between 900,000 and a million of *English*, out of whom 90 or 100,000 men for

defence, may be raised; but a few united, are an overmatch for divided numbers.

The *French* are intruders into *Canada*, part of *Cabot's* discovery, and have no right but by treaties, as appears from their claiming under *Verrozzani's* discovery 1524, though twenty seven years after *Cabot's*.

The *Dutch* have one settlement upon this continent called *Surinam* of the extent of 300 miles in length and 100 miles in breadth; bounded on the north and east by the *Atlantic* ocean; and on the south and west by *Caen*, and the other parts of *Guiana* or *Caribbiana*.

The native *Indians* are still in possession of many regions in *America*; as 1. The countries north-west of *Mexico*. 2. The country of the *Amazons*, and the greatest part of *Caribbiana* or *Guiana*; and, lastly, the south part of *South America*, viz. *Patagonia* and *Terra del Fuego*. These are generally barren desert countries, which no *Europeans* have thought it worth their while to plant.

*Amazonia* extends from *Peru* to *Brazil*, lying upon or near the equator, having *Terra Firma* on the north, and *La Plata* on the south.

*Guiana* or *Caribbiana*, is bounded by the northern or *Atlantic* ocean, on the north and east; by the country of the *Amazons*, on the south; and by the provinces of *Grenada* and *New Andahysia*, on the west. It extends from the equator to the 8th degree of north latitude, and lies between 50 and 63 degrees of western longitude, extending 1200 miles and upwards along the *Atlantic* ocean, viz. from the mouth of the river *Oronoque* to the mouth of the river *Amazon*; some divide it into two parts, calling that on the sea coast *Caribbiana*, and the inland country *Guiana*.

For though several *European* powers, have settlements on or near the sea coasts of this country, particularly the *Spaniards*, the *French*, and *Dutch*; yet the natives are possessed of much the greatest part of the inland country.

There are abundance of considerable rivers, (besides those of *Oronoque* and the river *Amazon*) and these having their sources in the mountains, on the south west, generally run towards the north-east, and fall into the *Atlantic* ocean.

The sea coast of this country is low, and subject to inundations in the rainy season; the air is excessive hot and unhealthful, especially in such parts of the country as are not cleared of the woods.

The *English* had formerly several settlements on the coast of *Surinam*, which were yielded to the *Dutch* by the treaty of *Breda*, in the year 1667; and

and the *Dutch* and *French* have still a great many forts and settlements here.

There is a good extent of country near the mouths of the rivers, which furnish them with sugar, tobacco, cotton, flax, skins, or peltry, dying woods, and several other considerable articles.

We shall close this treatise, on GEOGRAPHY, with a description of the AMERICAN ISLANDS; observing the same method of placing them under their respective sovereigns.

#### SPANISH ISLANDS in AMERICA.

I. CUBA is situate in the *Atlantic* or *American* ocean, between 74 and 87 degrees W. long. and between 20 and 23 degrees N. Lat. upwards of 800 miles long from E. to W. and 70 miles broad.

A chain of hills run through the middle of the island, but the land near the coast is generally a level champaign country, well watered with rivulets and flooded in the rainy season, when the sun is vertical; but there are scarce any navigable rivers, as they run so short a course from the hills into the sea. There are several good harbours in the island, the chief whereof are those of *St. Jago*, towards the east end of the island; *Cumberland* harbour further east; and the *Havanna*, at the N. W. part of the island.

The chief towns are, 1. *St. Jago*, W. Lon. 77. Lat. 20, strongly situated and well fortified, the capital of the island.

2. The *Havanna*, W. long. 83. lat. 23. a secure capacious harbour of difficult access, where the galleons from *Carthagen* and *Vera Cruz* rendezvous on their return to *Spain*.

3. *Baracoa*, situate on the N. E. coast of the island, has a good harbour for small vessels.

4. *Porto del Principe*, situate also on the N. coast, 300 miles east of the *Havanna*.

5. *Santa Cruz*, situate on the N. coast, 30 miles east of the *Havanna*.

This island produces the same animals as the continent, under the same parallel; the hills are pretty well planted with timber.

The soil produces maize, cassavi-root, tobacco, sugar, hides, cotton, indigo, ginger, aloes, and long-pepper: but *European* wheat, hemp, or flax, do not thrive here any more than vines.

II. HISPANIOLA, or *St. Domingo* is situate in the *Atlantic* or *Americ* ocean, between 67 and 74 degrees W. long. and between 18 and 20 degrees N. lat. upwards of 400 miles long, and 120 broad; 50 miles east of *Cuba*, and 70 E. of *Jamaica*, and 300 miles N. of *Terra-firma*; sometimes called *St. Domingo*, from its capital.

In the middle of the country are mountains well

planted with forest-trees, and other mountainous, barren rocks.

The rest of the country consists of fine fruitful plains, which produce sugar, cotton, indigo, tobacco, maize, and cassavi-root; and the *European* cattle are so multiplied, that they run wild in the woods, and are hunted for their hides and tallow.

This island is now divided between the *Spaniards* and the *French*; the *Spaniards* possessing most of the southern shores, and the *French* the north and west.

The chief towns are, 1. *St. Domingo*, capital of the *Spanish* settlements, situate on a spacious harbour on the south side of the island, W. long. 70 degrees, N. lat. 18, the most ancient royal audience in *N. America*, and seat of the governor; the inhabitants a mixture of *Europeans*, *Creols*, *Mulatto's*, *Mestees*, and *Negroes*; not a sixth part *Spaniards*, founded by *Bartholomew Columbus*, brother to the admiral, in 1504.

2. *Conception de la Vega*, 25 leagues north of *St. Domingo*, founded by *Columbus*, from whence he had the title of *Duke De la Vega*.

The chief towns belonging to the *French* in *Hispaniola*, are,

1. *Petit Guava's*, W. long. 73 degrees, N. lat. 16. a port town, situate on a bay at the west end of the island.

2. *Logane*, another port town, situate on the same bay.

3. *Port Lewis*, a good harbour on the south-west part of the island.

4. *Cape Francis*, the most easterly settlement of the *French* on the north shore.

III. PORTO RICO, is situate between 64 and 67 degrees W. long. and in 18 N. lat. about 120 miles long, and 60 broad. This island consists of little fruitful hills and vallies, and produces the same fruits as the former islands, and is equally unhealthful in the rainy season.

The town of *Porto Rico*, or *St. John*, is situate in 65 degrees W. long. 18 N. lat. in a little island on the north side of the main island, forming a capacious harbour, and joined to the chief island by a causey, and defended by forts and batteries, which render the town inaccessible.

IV. THE VIRGIN ISLANDS, situate at the east end of *Porto Rico*, are exceeding small.

V. The island of TRINIDAD is situate in the *Atlantic* ocean, between 60 and 62 degrees W. long. and between 10 and 11 N. lat. 90 miles long, and 60 broad; separated from the continent of *Andalusia*, in *Terra-firma*, by the narrow straight of *Boco del Drago*, 80 miles N. W. of the river *Oronoque*; an unhealthful, but fruitful soil, producing sugar, tobacco, indigo, cotton, ginger, and *Indian* corn.

VI. MARGARETTA is situate in 65 degrees W. long. and 11—30 N. lat. 60 miles N. of the continent of *Terra-firma*, and 200 W. of *Trinity*, being 50 miles long, and 24 broad; there is very little wood or water in this island.

The principal islands belonging to *Spain*, in the *Pacific* ocean, are, *Chiloe*, on the coast of *Chili*, and those in the bay of *Panama*, called the *Kings*, or *Pearl* islands; *Juan Fernandes*, situate in the *Pacific* ocean, 300 miles west of *Chili* in *America*, W. long. 83. South lat. 33 degrees.

*Gallipago's* islands situate in the *Pacific* ocean, under the equator, 400 miles W. of *Peru*, between 85 and 90 degrees W. long.

*Golden* island, *isle of Pines*, *Samballas* islands, and *Bastimentos* near *Porto Bello*, in *Terra-firma*.

The *PORTEGUEZE* have only three small islands at present, which lie on the coast of *Brazil*, where ships touch sometimes for provisions in their voyage to the *South-Seas*; particularly, 1. *Fernandes*, in 3 degrees S. lat. 2. *St Barbara*, in 18 degrees S. lat. and, 3. *St. Catherine's*, in 28 degrees S. lat.

AMERICAN ISLANDS under the BRITISH dominion.

1. *JAMAICA* measures 140 miles in length, and 60 miles in breadth. It lies in the *American* sea, about 100 miles south of *Cuba*, and 70 west of *Hispaniola*.

There are near 100 small rivers in the island, but none navigable.

Their well-water, near the sea, is brackish and unwholesome.

The bays and capes are, 1. The port of point *Morant*, at the east end of the island. 2. The harbour of *Port Royal*. 3. The port of old *Harbour*. 4. The harbour and point of cape *Negril*. 5. *Blewfield* bay. 6. *Port Pedro*: and 7. *Black* point; all on the south side of the island; and there are some others on the north.

In *May* and *October*, it rains violently night and day for a fortnight.

There is a ridge of hills runs from east to west through the island. These hills consist either of rock, or strong clay, and are covered with wood.

The vallies or *Savannas* are exceeding level, and without stones, fit for pasture, when cleared of wood; the most fruitful lying on the south side of the island.

The island is divided into 14 parishes or precincts; they have very few towns; the chief are, 1. *St. Jago de la Vega*, or *Spanish town*. 2. *Kingston*. 3. *Port Passage*; and 4. that of *Port-Royal*.

*St. Jago de la Vega*, or *Spanish town*, is pleasantly situated in a fine plain, upon the river *Cobre*, which

falls into a bay of the sea that forms the harbour of *Port-Royal*, about 7 miles below; it consists of 800 or 1000 houses.

*Kingston* is a port town, situate on the north side of the bay of *Port-Royal*, 10 or 12 miles south-east of *St. Jago*, and, since the repeated misfortunes of the town of *Port-Royal*, is become a large and populous place, much frequented by merchants and seafaring men.

*Port-Passage* is a sea-port town, situated at the mouth of the river *Cobre*, seven miles south-east of *St. Jago*, and obtained its name from being the greatest thorough-fare in the island.

*Port-Royal*, before it was destroyed by an earthquake in the year 1692, was situated in the south-east part of the island, at the extremity of a long slip or point of land, running westerly about 12 miles from the main island, having the ocean on the south, and a fine bay of the sea, which forms the harbour, on the north, well defended by several forts and platforms of guns; the harbour is about three leagues broad in most places, and so deep that a ship of 700 tons may lay her side on the shore, and load and unload at pleasure; nor does there want good anchorage in any part of it.

The principal vegetables and produce of this island are, sugar-canes, cocoa, of which chocolate is made; oranges, lemons, citrons, palms, coco-trees, cotton, indigo, tobacco, the prickly pear, woods for dying, salt, ginger, cod-pepper, or *Pimento*, drugs, such as *guaiacum*, *China* root, *sarsaparilla*, *castia-fistula*, *tamarinds*, *venella's*, *guans* and roots, used in medicines and surgery.

Here grows the manchineel tree, which bears a beautiful, but poisonous apple, and the mahogany, and animals; and they have the like forest-trees as are found in the continent of *America*, in the same climate.

There are in the *Savannas* great plenty of cattle, but they cannot keep beef many days, tho' it be salted, and fresh beef is ready to corrupt in four or five hours. Butchers always kill in the morning, therefore, just before day, and by seven o'clock the markets for fresh meat are over.

This and all the other governments in the *British American* islands are royal governments. The king appoints the governor and council, and the representatives are chosen by the freemen; and these assemblies make laws, but they must be confirmed by the court of *England*.

The principal part of the revenue, accruing to the crown of *Great Britain* from *Jamaica*, is the duty arising from sugar, rum, and molasses, imported from thence which is very considerable.

The inhabitants are either *English*, or of *English* extraction born in the island; *Indians*, *Negroes*, *Mulatto's*,

*Mulatto's*, or *Mestize*, or the descendants of them. The *English*, and those of *English* extraction, may be 40,000. The *Indians* are but few, most of the natives having been destroyed by the *Spaniards*. The negroes on the island are about one hundred thousand.

The religion of the church of *England* is also the established religion in all the *British* islands; but there are no bishops; the bishop of *London's* commissary is the principal ecclesiastick in these islands.

*Jamaica* was discovered by *Columbus* for the *Spaniards*, in his second voyage to *America*, Anno 1493.

In the year 1596, Sir *Anthony Shirley*, with a single man of war, made a descent on this island, and took their capital town *St. Jago de la Vega*, (now *Spanish Town*) consisting of about 2000 houses, and plundered it. It was taken and plundered again by Colonel *Jackson*, who landed 500 men here, about the year 1638, and the *Spaniards* were compelled to raise him a very considerable sum to ransom it from burning.

In the year 1656, Admiral *Penn* and *Venables* were commanded by *Cromwell* to invade *Hispaniola*; and not succeeding there, they made a descent on *Jamaica*, and reduced the whole island; which conquest was confirmed to *Great Britain* by a subsequent treaty.

II. NEWFOUNDLAND. *Newfoundland* is situate in the *Atlantic* ocean, between 47 and 52 degrees of north latitude, and between 55 and 60 degrees of west longitude; separated from *New Britain* by the straits of *Bellisle*, and from *Canada* by the bay of *St. Lawrence*, being 350 miles long, and 200 broad. It is a barren mountainous country, covered with snow great part of the year; but has several commodious harbours, and the greatest cod-fishery in the world upon its coast. The chief towns are, *Placentia*, *Bonavista*, and *St. John's*.

Several hundred ships are loaded with fish upon these banks every year, and carried to *Europe*.

There do not above a thousand families remain here in winter. The *French* were permitted to settle here in the reign of king *Charles II.* but were obliged to quit the island by the peace of *Utrecht*, Anno 1713, only they were left at liberty to dry their nets on the northern shores of the island.

It was the first *American* island discovered for *England*, by *Sebastian Cabot*, in the reign of *Henry V.*

III. BARBADOES. The island of *Barbadoes* is situate in the *Atlantic* ocean, in 59 degrees of west longitude, and 13 degrees of north latitude; being the most easterly of all the *Caribbee* islands; 90 miles south-east of *Martinico*, and 70 miles east of

*St. Vincent*; 25 miles long, and 15 broad; generally a level country, with some small hills, and but little wood, corn, or grafs.

It produces sugar, rum, molosses, cotton, indigo, ginger, pine apples, guava's, plantains, oranges, citrons, and other tropical fruits.

The chief town is *Bridge-Town*, on the south-west coast of the island.

A college is erected here with a revenue for professors in the several sciences: Colonel *Codrington* was the principal benefactor.

The number of white inhabitants are computed to be 20,000, and of their negroe slaves 100,000.

They get their corn, flour, cattle, flesh, and salted fish, from *Pennsylvania*, and other *British* northern colonies, or from *Ireland*; and their furniture and cloathing from *Old England*.

This island was first referred to by the *English* in the reign of King *James I.*

The adventurers applied themselves at first to the planting of *Tobacco*, which not thriving as they expected, they planted cotton and indigo, which yielded a considerable profit: but they made little sugar till 1647, when Colonel *Midford*, Colonel *Drax*, and Colonel *Walrond*, and other cavaliers, living uneasy under the usurpation, converted their estates into money, and transported themselves to *Barbadoes*, where they erected sugar-works, and acquired very great estates.

King *Charles II.* purchased the property of this island of the proprietors in the year 1661, ever since which *Barbadoes* has been a royal government, and the colony granted a duty of 4 and a half *per Cent.* on their sugars, for maintaining the forces and fortifications in the island, which amounts to 10 000*l.* *per Ann.* *De Ruyter*, the *Dutch* admiral, treacherously attempted to surprize this island in 1664, in a time of peace, but was bravely repulsed.

IV. ST. CHRISTOPHER'S. The island of *St. Christopher's* is situate in 62 degrees west longitude, and 17 north latitude. It is 20 miles long, and 7 or 8 broad produces the greatest quantity of sugar, next to *Jamaica* and *Barbadoes*, and some years it produces full as much as *Barbadoes*. It produces also cotton, ginger, and the tropical fruits.

A mountain runs through the middle of it, from whence there issue several rivulets. The *French* were possessed of the south-side of the island till the peace of *Utrecht*, 1713, when they yielded it to *Great Britain*.

*Christopher Columbus*, in the service of *Spain*, discovered this island in 1493, and gave it his christian name: The *Spaniards* deserting it, the *English* and *French* arrived here in 1625, and divided it between them.

V. ANTIGUA. The island of *Antigua* is situate in 61 degrees west long. and 17 deg. north lat. 60 miles east of *St. Christopher's*; it is of a circular form, almost 20 miles over either way, and has a great many good harbours; the governor of the *Caribbee* islands usually resides at *St. John's*, the chief town.

The produce is chiefly sugar, ginger, cotton, pine-apples, plantain, and other tropical fruits; they have no other water but the rains, which fall in the spring and autumn; this they reserve in cisterns, and if the rains fail, they are in great distress, being forced to fetch their fresh water from the neighbouring islands. Some springs of fresh water have been lately found here.

VI. NEVIS. *Nevis* is a little sugar island on the east of *St. Christopher's*, from which it is divided by a very narrow channel. The *English* sent the first colony to *Nevis*, Anno 1628.

VII. DOMINICA. *Dominica* is a small island, in 15 degrees north lat. 30 miles north of *Martinico*, but very little cultivated.

This was agreed to be a neutral island at the last treaty of *Aix la Chappelle*, though this, as well as the other three, viz. *St. Lucia*, *St. Vincent*, and *Tobago*, were in reality deemed part of the territories of *Great Britain* before this treaty, as appears by a commission given by the late King *George*, to the late duke of *Montague*, to send colonies to the island of *St. Lucia*, in the year 1722.

VIII. BARBUDA. *Barbuda* is situate in 18 deg. north lat. The inhabitants apply themselves chiefly to the breeding of cattle, and raising provisions, with which they supply the neighbouring islands.

This island is the property of the *Codrington* family, who have a great number of negroes here and in the island of *Barbadoes*.

IX. ANGUILLA. *Anguilla* is situate in 18 degrees odd minutes north latitude; 60 miles north-west of *St. Christopher's*; being about 30 miles long, and 10 broad.

The inhabitants apply themselves chiefly to feeding of cattle, planting of *Indian* corn, and other parts of husbandry.

X. MONTSERRAT. *Montserrat* is situate 30 miles south-west of *Antigua*, and affords its proportion of sugar.

XI. TOBAGO. *Tobago* is situate 11 deg. odd minutes north latitude, 120 miles south of *Barbadoes*; a fruitful soil, capable of producing whatever the sugar islands produce. King *Charles II.* granted it to the duke of *Courland*, by whose authority a colony of *English* and another of *Dutch* were settled here; but their plantations were so harassed and disturbed by the *Caribbees* of the neighbouring

continent, that they left the island; the *English* of *Barbadoes* only visiting it sometimes to cut wood here.

It was esteemed however part of the territories of *Great Britain*, till denominated a neutral island by the treaty of *Aix la Chapelle*, Anno 1748. The *French* had no colour to claim it.

XII. ST. VINCENT. *St. Vincent* is situate 60 miles and upwards, west of *Barbadoes*, and is 20 miles long, and almost as many broad.

*St. Lucia*. *St. Lucia* is near 80 miles north-west of *Barbadoes*; the soil of these two last islands is as good as that of any of the *Caribbees*, and has the advantage of good wood.

To these we may add the conquest lately made by the *British* arms, of *Guadalupe* and *Marigalante*.

XIII. GUADALUPE, so called by *Columbus*, from its hills resembling those of that name in *Spain*, is situate in 16 degrees north latitude, and 61 degrees western longitude, about 30 leagues north of *Martinico*, and almost as much south of *Antigua*; it is said to be the largest of all the *Caribbee* islands, being 22 leagues in length, and half as much in breadth at each end; but almost cut in two by a deep gulph, or bay, on each side, so that the ends are joined together by a very narrow isthmus. This, like *Martinico*, abounds in sugar, cotton, indigo, ginger, &c.

The *French* began to send colonies to this island about the year 1632.

XIV. MARIGALANTE is situate in 16 degrees N. lat. a little to the south-east of *Guadalupe*, and is about five leagues in length, and four in breadth; it was discovered by *Columbus* in his second voyage to *America*, Anno 1493, and named by him *Marigalante*, or the *Gallant Mary*, after the name of his ship. The *French* began to send colonies thither about the year 1647. The produce is the same with the rest of the *Caribbees*.

XV. LUCAYA'S or BAHAMA ISLANDS are situate between 73 and 81 degrees west long. and 21 and 27 degrees north lat. are very numerous, and 12 of them pretty large. These were the first lands discovered in *America*, by *Columbus*, Anno 1492.

The island of *Providence* is now planted and fortified by *Great-Britain*, being situate in 78 west long. 25. north lat. and is 200 miles east of the continent of *Florida*: None of the other islands are inhabited, but the *English* have plantations on some of them.

XVI. BERMUDA, or the SUMMER ISLANDS. These islands were so called from Sir *George Summer*, who

who lost his ship on their rocks, *Anno* 1609; they are situate in the *Atlantic* ocean, W. long. 65 degrees, N. lat. 32 degrees 20 minutes, 700 or 800 miles east of *Charles Town* in south *Carolina*; being a cluster of small islands, in the shape of a shepherd's crook, containing 20,000 acres, walled round with rocks. No part of the world enjoys a purer air, or more temperate climate, or is more remarkable for health, and plenty of flesh, fish, poultry, fruits, herbs, and roots. The chief town is *St. George*, in the north-west part of the island, containing 1000 houses. There are fine groves of cedar, with which they built their houses, and their swift sailing sloops, which they sell to the sugar islands, as well as provisions.

The FRENCH CARIBBEE ISLANDS, are *St. Martin*, *St. Bartholomew*, *Desada*, *Martinico*, *Granada*, Part of *Hispaniola*, and, *St. Croix*.

1. *St. Martin's* an island of no great consequence, situate a little to the north west of *St. Bartholomew's*.

2. *St. Bartholomew's*, is a small island about ten leagues north of *St. Christopher's*, taken by the *English* under the command of *Sir Timothy Thornhill*, in the year 1689, but restored to the *French* at the peace of *Ryswick*.

3. *Desada*, or *Desiderada*, the *Desirable* island, so called by *Columbus*, because it was the first land he discovered in his second voyage to *America*, *Anno* 1493; it is situate about ten leagues north-east of *Gualalupe*.

4. *Martinico* is situate between 14 and 15 degrees of north latitude, and 61 degrees of western longitude, lying about 40 leagues north-west of *Barbadoes*; it is 20 leagues in length, but of an unequal breadth. The inland part of it is hilly, and at a distance appears like three distinct mountains, being exceedingly well watered by numerous rivulets, which fall from the hills; and there are several commodious bays and harbours on the coast, some of them well fortified.

5. *Granada* is situate in 12 degrees north latitude, about 30 leagues south-west of *Barbadoes*, and about the same distance north of *Caribbiana*, or *New Andalusia*; this island is 25 leagues in circumference, and has several good bays and harbours, some of which are fortified: it is esteemed a fruitful soil, and well watered, producing sugar, and such other plants that are found in the rest of the *Caribbee* islands; there are abundance of very small islands that lie at the north end of *Granada*, which are called the *Granadilla's*.

6. *Hispaniola* has been already described amongst the *Spanish* islands.

7. *St. Croix*, or *Santa Cruz*, another small island situate in 17 degrees 30 minutes north lat. about 20 leagues west of *St. Christopher's*.

The DUTCH ISLANDS are, 1. *Curassoa*. 2. *Bonaire*, 3. *Aruba*, near the coast of *Terra-Firma*. 4. *Eustatia*; and, 5. *Saba*, among the *Caribbee* islands.

Nine or ten leagues from the continent of *Terra-Firma*, lies the island of *Curassoa*, or *Que-rissao*, the most northerly point of it, in 12 degrees 40 minutes north latitude; there is a good harbour on the south east part of the island, where the *Dutch* have a considerable town, defended by a strong fort; the country is level, and feeds abundance of cattle; they have also some sugar-farms, and small plantations of fruits and roots; but this island is not so much esteemed for its produce, as its situation for trade with the *Spanish West-Indies*. Formerly the harbour was never without ships from *Carthage* and *Porto Bello*; the *Spaniards* purchasing 1000 or 1500 negroes at a time of them, besides great quantities of *European* commodities; but part of this trade has of late fallen into the hands of the *English*. However, the *Dutch* have still a very extensive trade in the *Spanish West-Indies*, sending ships of good force from *Holland*, freighted with *European* goods, to this coast, from whence they make very profitable returns. Let the *Spanish* governors prohibit this smuggling trade never so severely, the *Spaniards* stand so much in need of *European* commodities, that they run any hazards to deal with the *Dutch*; and, as it is their common interest to connive at this kind of traffick, the people cannot be very hearty in their endeavours to prevent it.

The *Dutch* islands of *Bonaire* and *Aruba* are considerable, chiefly for their situation near the coast of *Terra-Firma*, which gives the inhabitants an opportunity of carrying on a clandestine trade with the *Spanish* settlements in *Terra-Firma*.

The *Dutch* islands of *Saba* and *Eustatia* produce sugar, &c. as the rest of the *Caribbee* islands do.

DANISH AMERICA, consists only of the island of *St. Thomas*, one of the *Caribbees*, producing sugar, &c.

There are also certain ISLANDS within the limits of *America*, which do not acknowledge the sovereignty of any *European* power or state, as the ISLAND of CALIFORNIA. Westward of *New-Mexico* is found, in the *South-Sea*, one of the greatest isles of the world, called *California*, which was thought, for a very considerable time, joined to the main land.

This island is situated between the 23 and 46 degree of latitude, separated from *New Mexico*, by the *Vermelle sea*; so that it is supposed to have more than 450 leagues in its greatest length from south to north; 150 in its greatest breadth, and about 1100 of circumference.

The climate is very wholesome, but cold with regard to its situation. Along the coasts are found some isles, as *St. Clement*, *Pararos*, *Ceintas*, and several others.

**ARCTICK LANDS.** These lands are called *Arctick*, because of the pole of the same name, round which they are situated. They are almost all situated in the frigid zone.

They confine, in our superior hemisphere, with the *Glacial Sea*, which separates them from *Muscovy*, and *Tartary*; and in the other part with the *South Sea*, and part with the *Christian Sea*, and the strait of *Hudson*, which parts them from *America*, viz. **SPITZBERG.** This land, which is the most northern of the *Arcticks*, was thus call'd from the name of *Spitsberg*, a *Dutch* Captain who discover'd it; or because of the great number of its sharp mountains.

It is situated northward of *Laponia*, under the 60 degree of longitude, and the 78 of latitude; but we know nothing of its extent: some make an island of it, equally distant from the pole, and from the polar circle.

The climate is so cold, that those sent thither have had the same fate of others upon *Greenland*. The soil produces nothing, at least in the neighbourhood of the coasts. The *English* and *Dutch* dispute with one another the dominion of that country: they fish whales on the coast.

**NOVA ZEMBLA.** This land, which is the *Cambic* of the antients, was called *Nova Zembla* by the *Dutch*, ever since they searched a passage through it to the *East-Indies*.

It is situated northward of *Muscovy*, from which it is separated by the strait of *Weigatz*, or *Nassau*, through which, it was imagined, that the sea of *Muscovy* had a communication with that of *Tartary*.

**LAND of JESSO.** We scarcely know any thing of this country but the name, though it be of a vast extent: our relations speak only of its coasts; found about the 42 degree of latitude, and which is the most known.

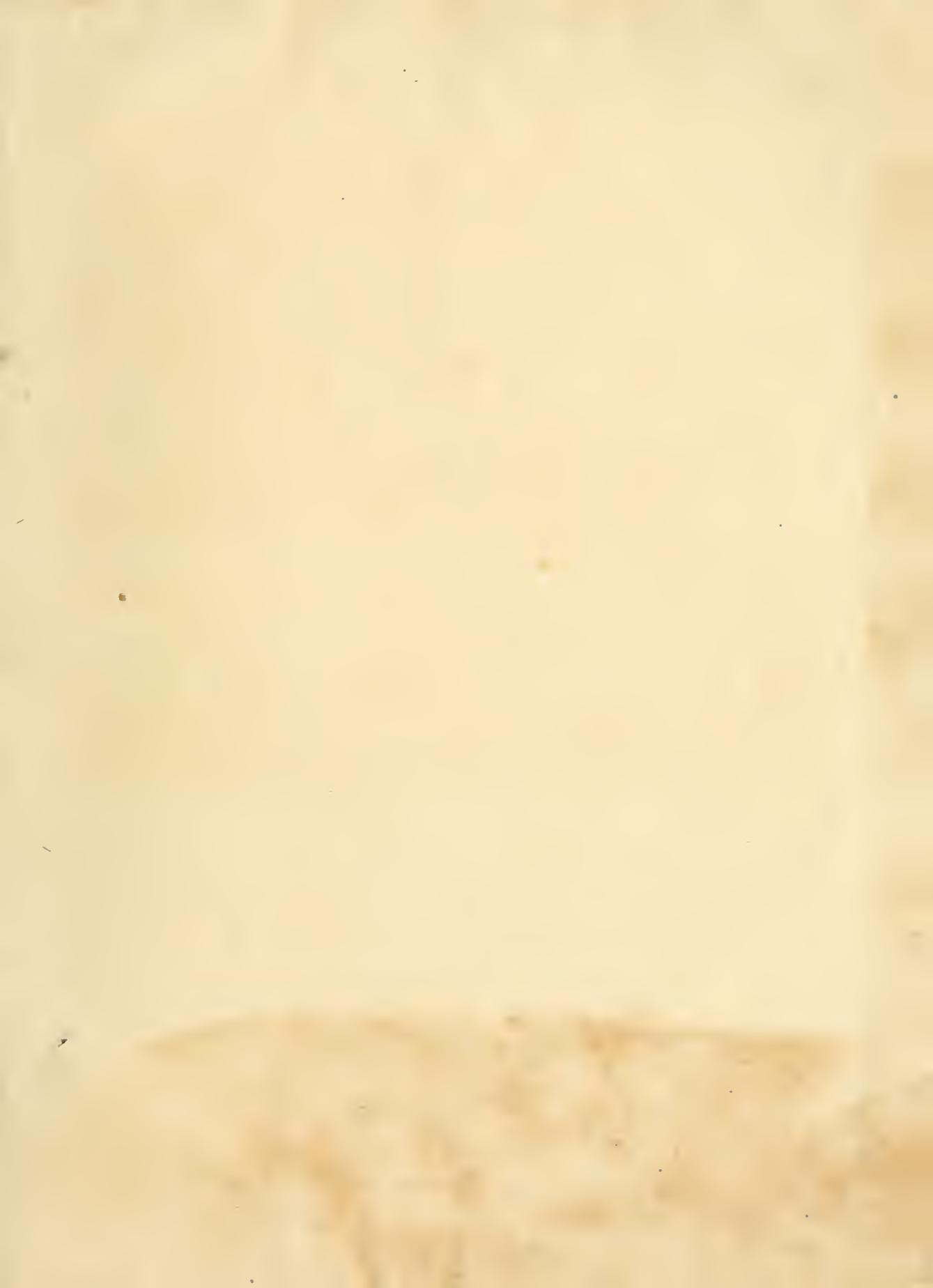
It is situated between *Asia* and *America*; eastward of the first, and westward of the other.

It seems to me, as if it was separated from those two regions, by two great arms of sea; and some have imagined, that through its strait the sea of *China* had communication with the northern ocean, but others pretend, that there is an isthmus which parts them. We know nothing particular of its quality.

The inhabitants of these coasts live on fish and game; and cloath themselves with skins of beasts: they carry on a commerce with the *Japanese*, of fish, skins, tongues, and fat of whales.

Part of this country acknowledges the king of *Japan*; and the governor, who resides in the city of *Matzumay*, carries him, every year, silver, feathers of various colours, and furs. Does not this give encouragement to prosecute the long desired discovery of a passage thro' this coast to *Japan*, &c.

*New-Deunmark*, *New North-Wales*, and the isles of *Cumberland*, &c. are situated northward of *America*, in the *Christian*, or *Hudson* Sea.







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