A NEW

OF

ARTS and SCIENCES,

SHEWING THEIR

AND EXHIBITING

The *Invention*, *Structure*, *Improvement*, and *Uses*,

Of the most considerable

WITH

Their *Nature*, *Power*, and *Operation*,

DECYPHERED IN

VOL. II.

Printed for J. Coote, at the King's Arms, in Pater-Noster-Row.

A NEW

UNIVERSAL HISTORY

OF

ARTS and SCIENCES.

GEOMETRY.

HERODOTUS, *Lib.* 2. and *Strabo*, *Lib.* 17. aſſert the *Egyptians* to be the firſt inventors of *Geometry*; and the annual inundations of the *Nile* to have been the occaſion; for that river bearing away all the bounds and landmarks of men's eſtates, and covering the whole face of the country; the people, ſay they, were obliged to diſtinguiſh their lands, by the conſideration of their figures and quantity; and thus by experience and habit formed themſelves a method or art, which was the origin of *Geometry*. A further contemplation of the draughts of figures, or fields thus laid down, and plotted in proportion, might naturally enough lead them to the diſcovery of ſome of their excellent and wonderful properties; which ſpeculation continually improving, the art became gradually improved, as it continues to do this day. *Joſephus*, however, ſeems to attribute the invention to the *Hebrews*; and others among the antients make *Mercury* the inventor.

The province of *Geometry* is almoſt infinite: few of our ideas but may be repreſented to our imagination by lines; upon which they ſtrait become of geometrical conſideration; it being *Geometry* alone that makes compariſons, and finds the relations of lines.

All the ſciences which conſider things ſuſceptible of more and leſs, *i. e.* all the preciſe and accurate ſciences may be referred to *Geometry*.

The uſefulneſs of this ſcience extends to almoſt every art and ſcience. It is by the help of it that aſtronomers turn their obſervations to advantage; regulate the duration of times, ſeaſons, years, cycles, and epochas: and meaſure the diſtance, motions, and magnitudes of the heavenly bodies. It is by it that geographers determine the figure and magnitude of the whole earth; and delineate the extent and bearings of kingdoms, provinces, harbours, &c. It is from this ſcience too, that architects derive their juſt meaſures, in the conſtruction of public edifices as well as of private houſes. It is by the aſſiſtance of geometry that engineers conduct all their works, take the ſituation and plans of towns, the diſtances of places, and the meaſure of ſuch things as are only acceſſible to the ſight. It is not only an introduction to fortification, but highly neceſſary to moſt mechanics, eſpecially carpenters, joiners,

joiners, mathematical-inſtrument-makers; and all who profeſs deſigning.

On geometry likewiſe depends the theory of muſic, optics, perſpective, drawing, mechanics, hydraulics, pneumatics, &c.

Geometry, of γῆ, earth, and μετρεῖν, to meaſure, is the ſcience or doctrine of extenſion, or extended things: that is, of *lines*, *ſurfaces*, and *ſolids*, and it is divided in four parts, *viz. planimetry*, *altimetry*, *longimetry*, and *ſtereometry*.

Planimetry is that part of *geography*, which conſiders lines, and plain figures, without any conſideration of heights or depths; but it is more particularly reſtrain'd to the menſuration of planes, or ſurfaces.

This art, of meaſuring the ſurfaces or planes of things, is performed with the ſquares of long meaſures, as ſquare inches, ſquare feet, ſquare yards, ſquare perches, &c. that is, by ſquares whoſe ſides are an inch, a foot, a yard, a perch, &c. So that the area or center of any ſurface is ſaid to be found, when we know how many ſuch ſquare inches, feet, yards, &c. it contains.

Altimetry is the art of taking or meaſuring altitudes or heights, whether acceſſible or inacceſſible. This art makes the firſt part of *geometry*.

Longimetry is the art of meaſuring lengths; both acceſſible, as roads, &c. and inacceſſible, as arms of the ſea.

Stereometry teaches how to meaſure ſolid bodies, *i. e.* to find the ſolidity, or ſolid contents of bodies; as globes, cylinders, cubes, veſſels, ſhips, &c.

Geometry, again, is diſtinguiſhed into *ſpeculative* and *practical*.

The firſt contemplates the properties of continuity; demonſtrates the truth of general propoſitions, called *theorems*.

The ſecond applies thoſe ſpeculations and theorems, to particular uſes in the ſolution of *problems*.

Speculative Geometry, again, may be divided into *elementary* and *ſublime*.

Elementary or *common geometry* is that employ'd in the conſideration of right lines, and plain ſurfaces, and ſolids generated therefrom.

Higher or *ſublime geometry* is that employed in the conſideration of curve lines, conick ſections, and bodies form'd thereof.

But previous to either part, we muſt obſerve that there are three ſorts of principals from which all *geometrical* propoſitions are deduced, *viz.* the *definition*, *poſtulate*, and *axiom*.

We call *definition*, the explication of the name, or of the thing; as when ſomebody ſays that he underſtands by the name of *triangle*, *a figure compoſed of three lines*.

A *poſtulate* is a clear, evident propoſition wherein it is affirmed or denied, that ſomething may or may not be done.

An *axiom* is a ſelf evident truth, or a propoſition, whoſe truth every perſon perceives at firſt ſight: Thus, that the whole is greater than its part, is an *axiom*.

Then of *propoſitions*, ſome propoſe ſomething to be done, and are *problems*; as to divide a line, to make an angle, to draw a circle thro' three points not in a right line: others conſider the properties of things already made, or done; and are called *theorems*. Thus if a triangle be compar'd with a parallelogram, ſtanding on the ſame baſe, and of the ſame altitude, and partly from their immediate definitions, and partly from other of their properties already determin'd, it is inferred that the parallelogram is double the triangle, that propoſition is a *theorem*.

Two things are to be chiefly regarded in every *theorem*, *viz.* the propoſition, and the demonſtration: In the firſt is expreſſed what agrees to ſome certain things 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, or does not agree thereto.

There are various kinds of *theorems*; as, *univerſal*, *particular*, *negative*, *local*, *plane*, *ſolid*, *reciprocal*.

Univerſal Theorem, is that, which extends to any Quantity, without reſtriction, univerſally; as this, *that the rectangle of the ſum, and difference of any two quantities is equal to the difference of their ſquares*.

Particular Theorem is that, which extends only to a particular quantity; as this, *in an equilateral right lined triangle, each of the angles is* 60 *degrees*.

Negative Theorem is that, which expreſſes the impoſſibility of an aſſertion; as, *that the ſum of two biquadrate numbers cannot make a ſquare number*.

Local Theorem is that, which relates to a ſurface; as, *that triangles of the ſame baſe and altitude are equal*.

Plane Theorem, is that which either relates to a rectilinear ſurface, or to one terminated by the circumference of a circle; as, *that all angles in the ſame ſegment of a circle are equal*.

Solid Theorem is that, which conſiders a ſpace terminated by a ſolid line; that is, by any of the three conick ſections, *e. gr.* this, *that if a right line cut two aſympotick parabola's, its two parts terminated by them ſhall be equal*.

Reciprocal Theorem is one, whoſe converſe is true; as, *that if a triangle has two equal ſides, it muſt have two equal angles:* The converſe of which

which is likewiſe true, that if it has two equal angles, it muſt have two equal ſides.

Others are only laid down in order to clear the way for ſome following demonſtration; and prefixed either to theorems, in order to render their demonſtration leſs perplexed and intricate; or to problems, to make their reſolution more eaſy and ſhort; and theſe are called *lemmas*. Thus to prove a pyramid one third of a priſm, or parallelepid, of the ſame baſe and height with it; the demonſtration whereof in the ordinary way is difficult and troubleſome; this *lemma* may be premiſed, which is proved in the rules of progreſſion, *that the ſum of the ſeries of the ſquares, in numbers in arithmetical progreſſion, beginning from* 0, *and going on* 1, 4, 9, 16, 25, 36, &c. is always ſubtriple of the ſum of as many terms equal to the greateſt; or is always one third of the greateſt term multiplied by the number of terms. Thus to find the inflection of a curve line, this *lemma* is firſt premiſed; *that the tangent may be drawn to the given curve, in a given point.*

Laſtly, others neceſſarily follow from others, and are called *corollaries*.

Scholium, is a note, annotation, or remark, occaſionally made on ſome propoſition whereby, it is better explained, or its uſe or utility made more apparent.

A *propoſition* is ſaid to be the converſe of another, when, after drawing a concluſion from ſomething firſt ſuppoſed, we proceed to ſuppoſe what had been firſt concluded, and to draw from it what had been ſuppoſed. Thus it is demonſtrated in *geometry*, that if the two ſides of a triangle be equal, the two angles oppoſite to thoſe ſides, are equal alſo: The converſe of the propoſition is, *that if the two angles of a triangle be equal, the two ſides oppoſite to thoſe angles are equal alſo.*

This mark + ſignifies *more*; — ſignifies *leſs*; = ſignifies *equality*.

From theſe general, and neceſſary obſervations, I'll paſs to the *ſpeculative* GEOMETRY, beginning by the *lines* and *angles*.

MAGNITUDE, is all that whereby a thing compared with another of the ſame kind, is ſaid to be equal, or unequal to it; therefore it comprehends local extenſion, number, motion and time.

Local extenſion, or quantity of bigneſs, is a certain and definite ſort of magnitude, *viz.* what is anſwered to a perſon who aſks, how big is ſuch a thing? and that quantity is either conſidered in length only, and is called *line*; or in length and breadth, and is called *ſuperficies*; or laſtly, in length, breadth, and depth, and is called *ſolid*.

A *point* in *geometry*, according to *Euclid*, is a quantity which has no parts; or neither length, breadth, nor thickneſs, an object the ſmalleſt and leaſt ſenſible, made by the prick of a pen, *&c.*

A *line* is a length without breadth, or a continuation of points. There are as many ſorts of lines, as the point is ſuſceptible of different movements; amongſt which the *right line* and *curve* are moſt in uſe.

A *right line* is that, which is drawn equally between its two extremities, whoſe points tend the ſame way, as A B. *Fig.* 1.

A *curve* is a line, whoſe ſeveral points tend ſeveral ways, as C D, *Fig.* 2.

If two or ſeveral lines are contained within the ſame terms, that which is right, is the ſhorteſt, as C B, *Fig.* 3. And the *curves* which contain the others, are bigger than thoſe they contain, as C *d* B is greater than C *e* B, which is only true when thoſe *curve lines* are incurvated in the ſame part; for if the line contained is bent in ſeveral parts, and forms ſeveral windings, it may be bigger than that which contains it, as C F B is greater than C A B.

If two lines are every where equidiſtant from each other; and though infinitely produced would never approach nearer, or recede farther from each other, they are called *parallel*, as A B, and C D, *Fig.* 4.

The *aperture*, or mutual inclination of two lines, which meet in one point of interſection, is called *angle*, as B A C, *Fig.* 5. and the point, in which the lines meet, is called the *vertex* of the angle, as A, therefore every angle is commonly expreſſed by three letters, that of the *vertex* being in the middle.

However the quantity of the angle is not taken from the length of the lines which form the angle, but from the arch deſcribed from its *vertex*, with any radius at pleaſure between its legs. For the angle D E F, *Fig.* 6. is greater than the angle G H I, *Fig.* 7. though formed of leſſer lines: For if the angle G H I be put on the angle D E F, marked with points, it will be eaſily underſtood, that the angle G H I is comprized in the angle D E F, and that the lines which form the angle D E F, are much more diſtant from each other, than thoſe which form the angle G H I

Angles, made by lines in the ſuperficies, are call'd *ſuperficial*; and if that ſuperficies be plane, they are call'd *plane angles*; if ſpherical, *ſpherical angles*.

A *plane Angle*, if made of two right lines, is call'd *rectilinear*; ſuch are the angles of *Fig.* 5 6, 7. if of *curve*, *curvilinear angle*; as L M N, *Fig.* 8.

Fig. 8 if of a right, and a curve, it is called *mixt*, as O P Q, *Fig.* 9.

Every *angle* is either *right*, *obtuſe*, or *acute*.

A *right angle*, is that formed by a line falling perpendicularly on another; or that which ſubtends an arch of 90 degrees; as the angle B E A, *Fig.* 10. The meaſure of a right angle, therefore, is a quadrant of a circle; and conſequently all right angles are equal to each other.

Therefore, when the right line A E, *Fig.* 10. placed on the right B E C inclines on neither part, and then forms angles every where equal; thoſe two angles, A E B and A E C, are right; and the right line A E, placed on the other, is call'd *perpendicular*.

Angles which have one ſide common and are formed of the one and other part of that ſide, are call'd *contiguous angles*; as *Fig* 10. A E B and B E D; but if B E be produced in C, as A E is produced in D, the angles B E A, and D E C, are call'd *oppoſite angles*.

An *obtuſe angle*, is that greater than a right *angle*, or whoſe meaſure exceeds 90°, as the angle E D C, *Fig.* 11.

An *accute angle*, is that which is leſs than a right *angle*, or than 90°; ſuch is, in the ſame figure, E D B. We muſt obſerve, that there are *obtuſe angles*, as well as acute ones, bigger than the others

The *angles* of any right-lined figure made without it, by producing all the ſides ſeverally, are called *external angles*; and thoſe made by the ſides of any right-lined figure within, *internal*.

All the *external angles* of any figure, taken together, are equal to four *right angles*; and the external angle of a triangle, is equal to both the internal and oppoſite ones The ſum of all the *internal angles* of any right-lined figure, is equal to twice as many *right angles* as the figure has ſides, excepting four. The *external angle* is demonſtrated to be equal to the internal oppoſite one; and the two internal oppoſite ones, are equal to two right ones.

Alternate angles are the *internal angles* made by a line cutting two parallels, and lying on the oppoſite ſides of the cutting line; the one below the firſt parallel, and the other above the ſecond.

Firſt Theorem. A right line reſting on another right line, makes again two right angles, or equal to two rights.

For if A D, *Fig.* 11. falls perpendicularly on the line C D B, the angles A D B, and A D C, will be right angles, by the definition 11 and 12; but if E D reſts obliquely on the ſame line C D B, A D muſt be conceived the perpendicular; ſince, then, the angles E D B acute, and E D C obtuſe, occupy the ſame ſpace as the two rights A D B; and A D C will be equal to them, by the axiom, where there is a mutual congruency, there is an equality.

Congruency is when things compoſed together agree in ſuch a manner, that the extremities of the one fall on the extremities of the other, and neither exceed, nor are exceeded. As if a pedal line, applied to another pedal line, the laſt points of one ſhould fall on the laſt points of the other, and both form a line.

Corollaries. It will be demonſtrated in the ſame manner, (if more than one right line fall on the ſame right line, at the ſame point) that the angles they form are, together, equal to two right ones.

Two right lines, cutting mutually one another, as A E D, and B E C, *Fig.* 10. form, in the point of interſection, four angles equal to four right ones.

All the angles formed round one point C. *Fig.* 13 are equal to four right ones; for they are four right ones cut into ſeveral parts.

Second Theorem. The *angles*, oppoſite at the vertex, are equal.

For the *angle* B, *Fig.* 12. is equal to the *angle* C; which the better to demonſtrate, both muſt be joined with the intermediate angle A; for the angle B, and the angle A, together, are equal to two right angles, by the firſt theorem. Likewiſe the angle C, and the angle A, are equal to two right angles, by the ſame firſt theorem. Therefore the angles C and A, taken together, are equal to the angles B and A, taken together, and conſequently the common angle A, being taken off, the angles B and C will remain equal, by this axiom; *that if you take equals off equals, thoſe that remain will be equals*, which was to be demonſtrated.

Third Theorem. If the right line O P cuts the two right parallels N L, and M I, it will make the internal angle equal to the external oppoſite on the ſame part.

For as the lines L N and M I, *Fig.* 12. are parallel, they incline equally to the line O P, towards the ſame parts by the ſixth definition, and the 9 axiom; therefore the angles B and F, or A and E, formed by the inclination of the lines L N, and I M, to the line O P, are equal.

Fourth Theorem. *Alternate angles* are equal between themſelves.

For the angle B, *Fig.* 12. is equal to the angle C, oppoſite to it at the vertex, by the ſecond theorem. But the ſame angle B is equal to the angle F, by the third theorem; therefore the angle C is equal to the alternate angle F, by the ſecond axiom.

Fifth Theorem. If a right line cuts two parallels,

rallels, it makes the internal angles equal to two rights at the same parts.

For the alternate angles C and F, *Fig.* 12. are equal between them, by the fourth theorem; but the angles C and D placed again are equal to two rights by the first theorem; therefore the angles D and F are equal to two rights, which was to be demonstrated.

SCHOLIUM. *Converse propositions* have place in the three preceding theorems; for if the two lines L N and I M, *Fig.* 12. with the third O P, render the external and internal angles B and F, opposed on the same part, equal; they'll incline equally to the line O P, whence they'll be parallel by the 9 axiom.

Likewise, from the alternate angles C and F being equal, it follows that the lines L N and I M are parallel; for as the angles B and C, opposite at the vertex, are equal, and C is equal to F; the external angle B will be equal to the internal angle F; therefore by the preceding demonstration, the lines L N and I M will be parallel.

Lastly. If the internal angles D and F be equal to two rights, the lines L N and I M will be parallel likewise. For the angles B and D repeated, are equal to two rights, by the first theorem. But the angles D and F are also put equal to two rights, therefore the external and internal angles B and F are equal between them, and consequently the lines L N and I M are parallel.

From *angles* I'll pass to *Triangles*, *Quadrilaterals*, *Pentagons*, *Hexagons*, and other *Polygons*.

A *figure* is a space inclosed on all sides, and is either plain or solid.

Plain figures are those which consist of lines traced on some superficies: which lines, if right, the figure is called *rectilinear*; if curve, *curvilinear*; if part curve and part right, *mixt*.

Those lines whereby the figure is terminated, taken together, are called its *circumference* or *circuit*, or *perimeter*. Whence figures which have an equal ambit, are called of the same name *isoperimetral*.

Of all *curvilinear*, and *mixt figures*, Geometers consider in a more particular manner, the circle or paction of the circle.

Among the *rectilinears*, the most simple is the *triangle*; because consisting only of three lines, which form as many angles.

A *triangle* is divided either according to its angles, or to its sides. If according to its angles it has either one of those angles right, and it is called *rectangular*, as A B C, *Fig.* 14. or it has one of them *obtuse*, and it is called *amblygonous*, as D E F, *Fig.* 15. or it has them all *acute*, and it is called *oxygonous*, as G H I, or K L M, *Fig.* 16. and 17.

But if it be divided according to its sides, and has three sides unequal, it is called *scalanous*, as A B C, *Fig.* 14. if it has only two sides equal, it is called *isosceles* or *equicrural Triangle*, as K L M, *Fig.* 17. if it has all the sides equal, it is said to be *equilateral*, as G H I, *Fig.* 16.

If two sides of a *triangle* be taken, they may be called limbs or legs, and then the third side will be called the *base*: any side may be taken for the base, though in a *rectangular*, or *amblygonous triangle*, the greatest side, *viz.* that which is opposed to a right angle, or to an *obtuse*, is commonly called the *base*, or the *hypotheneuse*, where it is question of a rectangular triangle: but in an *isosceles triangle* the unequal side is the base.

The figure which follows next the triangle is the *Quadrilateral*, which consists of four right lines, and as many angles.

If the *quadrilateral* has its opposite sides parallel, and equal to each other, it is called *parallelogram*, as A B C D, *Fig.* 18. otherwise *trapezium*, as E F G H, *Fig.* 19.

If the *parallelogram* has four right angles, it is called simply *rectangular*, as I K L M, *Fig.* 20.

If all the sides of a *rectangular* be equal, it is called a *square*, as C D E F, *Fig.* 21. which some make a species of *parallelogram*, others not: but if there are but the opposite sides equal, it is said *longer on the other parts.*

If all the sides be equal, and the angles unequal, it is called a *rhombus*, or *lozenge*, as G H I K, *Fig.* 22.

If both the sides and angles be unequal, it is called a *rhomboides*; as A B C D, *Fig.* 23.

A *parallelogram* is marked with four letters, placed at the four angles, as A B C D, *Fig.* 23. and likewise for brevity sake diametrically opposite, as B C and the diameter, or diagonal line, is that carried from an angle of the *quadrilateral*, to that opposite to it, as B C.

If thro' the point I, taken in the diagonal B C, *Fig.* 24. the two right lines E F, G H, are drawn parallel to the sides; the whole *parallelogram* will be divided into four *parallelograms*; two of which, *viz.* E G, H F, are called *parallelograms*, towards the diameter, and the two others, A I, I D, complements.

If the figure has more than four angles, and more than four sides, it is called a *polygon*; if six sides, an *hexagon*; if seven, a *heptagon*.

In every *parallelogram* the sum of the squares of the two diagonals is equal to the sum of the squares of the four sides. This proposition M. *de Lagny* takes to be one of the most important of all *Geometry*; he even ranks it with the celebrated 47th of *Euclid*, and with that of the similitude of triangles:

and adds, that the whole firſt book of *Euclid* is only a particular caſe hereof. For if the *parallelogram* be rectangular, it follows that the two diagonals are equal; and of conſequence, the ſquare of a diagonal, or which comes to the ſame thing, the ſquare of the hypotheneuſe of a right angle, is equal to the ſquares of the ſides. If the *parallelogram* be not rectangular, and of conſequence the two diagonals be not equal, which is the moſt general caſe the propoſition becomes of vaſt extent: It may ſerve, for inſtance, in the whole theory of compound motions, &c.

Firſt Theorem. In all triangles, the outward angle is equal to two oppoſite inward; and three angles are equal to two rights.

Let the triangle be A B C, *fig.* 24. whoſe ſide B C muſt be produced in D: I ſay, *firſt*, that the external angle A C D, is equal to the two oppoſite internals, A and B: *ſecondly*, that the three angles A and B, and A C B, are equal to two right angles.

Demonſtration of the firſt part. Let the line C E be conducted parallel to B A, and then the right line A C will fall on the parallels A B and C E; therefore the angle A, or B A C will be equal to the alternate A C E: Likewiſe, the right B C will fall on the parallels B A and C E; therefore the internal angle B is equal to the external E C D, and conſequently the two A, and B, are equal to the two A C E, and E C D, *i. e* to the whole A C D.

Demonſtration of the ſecond part. The two angles A and B are equal to the angle A C D. Therefore the common A C B being added, the three angles A, and B, and A C B, are equal to the two A C D, and A C B: but A C D, and A C B being repeated, are equal to two rights: therefore the three A and B, and A C B, are equal to two rights, according to this axiom, *that things equal to the ſame thing, are alſo equal between themſelves.*

Pythagoras is ſuppoſed the author of this important queſtion, which is the 32d of the firſt book of *Euclid*, and it is of a continual uſe in *Geometry*, it muſt be very well learned. But there is another manner of demonſtrating it, which will appear eaſier and is as follows.

Let the triangle be A B C, *fig.* 25. I ſay, 1. That the three angles A, C, and B, are equal to two right angles: but if the line E F be drawn parallel to the ſide C B, it is certain that the angles *a* and *b*, adjacent to the angle A, joined together with that angle A, are equal to two right angles; but the angle *a*, is equal to the angle C, and the angle C to the alternate angle B: therefore, likewiſe, the angles C and B. joined to the angle A, are equal to two rights, according to the axiom, *that if equals be added to equals, all will be equal.*

I ſay, 2. That the external angle *d*, is equal to the two internals A and C, oppoſite to it; for the external angle *d*, and the internal B, taken together, are equal to two rights: but the angles A and C, together with the angle B, are equal, likewiſe, to two right angles, by the preceding demonſtration; then the external angle *d*, is equal to the two oppoſite internal A and C.

Corollaries. Three angles, of any *triangle*, taken together, are equal to three angles taken together of any other *triangle*; for they are every where equal to two rights.

Every *triangle* muſt have two acute angles; for if it had but one, the two others would be either right, or obtuſe, which cannot be ſaid; ſince three angles of a triangle are together equivalent but to two rights.

As often as two angles in a triangle, or ſeparate, or together will be equal to two angles, or ſeperate, or together in another triangle, ſo often the third will be equal to the other third angle.

Second Theorem. In all triangles the greater triangle, is that oppoſed to the greater ſide, and *viciſſim*.

For the angle E, *fig.* 26. oppoſed to the greater ſide D F, is greater than the angle D, or the angle F; but as the magnitude of the angle is taken from the diſtention of the lines it conſiſts of; and the more thoſe lines are diſtended the greater is the ſide; it is evident that the angle E, oppoſite to the greater ſide, is greater than any of the two others, D or F.

Likewiſe, for the ſame reaſon the greater ſide is oppoſed to the greater angle.

Corollaries. In the equilateral triangle G H I, the three angles are equal between them, becauſe oppoſed to equal ſides. They are alſo all acutes, for they cannot be all right, or all obtuſe, by what we have already obſerved.

In the iſoſceles triangle K M L, *fig.* 28. the angles K and L, placed on the baſe K L are equal, becauſe oppoſed to equal ſides

The perpendicular A B, *fig.* 29. is the ſhorteſt of all the lines, which can be drawn from the point A, to the right B C: for as the angle B is a right one, the angle A C B muſt be acute: therefore A B is leſs than any of the lines A C.

From a point to a right line there cannot be drawn but one perpendicular.

Third Theorem. If one ſide of two triangles be equal to one, and the other to the other; and the angles contained in thoſe ſides be likewiſe equal, the baſes and all the triangles will be alſo equalized.

For if we underſtand that the triangle D E F muſt be put over the triangle A B C, the angle E will be congruous with the angle A, equal to it,

 and

and the sides E D and E F will agree with the equal sides A B, and A C; so that the three points D, E, F, will fall on the three points B A C, therefore the whole base D F will fall on the whole base B C, then there will be a *congruency* between the angles D and F, and F and C, and with all the triangles; and therefore all will be equal, by the axiom, *that all things which agree mutually are equal*, which was to be demonstrated.

COROLLARIES. For the same reason, *viz.* from the *congruency of two triangles*, if they should have all their sides mutually equal, they will have, likewise, all the angles equal, which are opposite to equal sides, and all will be equal.

Likewise if in a *triangle*, two angles taken separately, were equal to two angles of another *triangle*, taken also separately, and one side was equal to the other side, all the rest would be equal; because if a *triangle* be imposed on another *triangle*, they'll agree mutually.

Fourth THEOREM. In all *triangles*, any two sides are greater than the third: this proposition is like the axiom of *Archimedes*.

For, as we have already observed, a right line is the shortest of all the lines drawn from one point to the other point: and as when one side of the triangle is conducted, in a direct line, from one point to the other, the two other sides deviate from the strait way; and two sides of the *triangle* must be greater than the third.

Fifth THEOREM. The opposite sides of *parallelograms* are equal, and likewise the angles, and the parts made by the diameter.

Because A B, and C D, *Fig.* 23. are parallel; and the right line B C falls on them, which is the *diameter*, or diagonal line of the *parallelogram* A B C D, the alternate angles A B C, and B C D, will be equal. Likewise, because A C and B D are parallel, and the right line B C falls on them the alternate angles A C B, and C B D will be equal: therefore the whole angle A C D, is equal to the whole angle A B D.

In the same manner I'll shew the angles A and D, to be equal between them.

But because the triangles A B C, and C D B, have a common side B C, and the angles adjacent to that side are equal, the side A C will be likewise equal to that B D, as A B to C D; and likewise those triangles will be equal.

COROLLARIES. The complements A I, I D, *Fig.* 12. are also equal between themselves; for the two great triangles C B A, and C B D, are equal to the present theorem: therefore, if from them are drawn the equal triangles C I H, and C I F, and I B G, the residuous spaces A I, I D, which are the complements of the parallelogram, will be equal.

Between the parallels A B, C D, *Fig.* 4. the lines A C and B D, equally inclined towards them, are equal. The same thing may be said of the lines I L and K M, *Fig.* 9. placed between I K and L M, and perpendicular to them. For a parallelogram is formed on either way, whose opposite sides are equal.

Sixth THEOREM. *Parallelograms* placed on the same base, and between the same parallels, are equal.

Let the *parallelograms* be A E and A D, *Fig.* 30. placed on the same base A B, and between the parallels A B and C D; I say that they are equal, for in the triangles A C F and B E D, the side A C is equal to the side B E. By the preceding theorem likewise the lines C E and F D, being equal to the same A B, by the same theorem; if to both be added the common part E F, the whole side C F will be equal to the side E D, in the aforesaid triangles; but because of the parallels A C and B E, the internal and external angles A C F, and B E D are equal; therefore the triangles A C F and B E D are equal: therefore if the common part G E F be taken off, both the parallelograms C B and A D, will be equal; which was to be demonstrated.

COROLLARIES. The same demonstration may be easily applied to parallelograms placed on equal bases, and between the same parallels.

Triangles likewise, placed on the same or equal bases, and between the same parallels are equal: for the triangle A B C, *Fig.* 30. is half of the parallelogram A B C E, as the triangle A F B is half of the parallelogram A B F D; and those parallelograms A E, A D, are equal by the present theorem; and therefore the triangles are also equal by this axiom, which are halves of the same thing, are equal between themselves.

Seventh THEOREM. All polygons may be divided into so many triangles as it has sides: for if within the heptagon B C D F G H, *Fig.* 30. the point A be taken, from which lines are conceived drawn to every angle A B, A C, A D, *&c.* it is manifest that there will be as many triangles, as there are angles in the polygon.

COROLLARIES. All the angles together of any regular rectilinear figure, adequate twice as many right angles, taking off four, as the figure has sides.

Let right lines be drawn from the point A, within the same figure, to all its angles, which may cut it into so many triangles as it has sides; and because the angles of every triangle are equal to two rights, the angles of all together are twice equivalent to so many rights as there are sides; but the angles placed round the point A, are equal to four rights: therefore if you take off from all the triangles, the angles round the point A, the remaining angles placed at the circumference of the figure, adequate twice ſo many right angles, taking off four, as the figure has ſides.

Therefore, if we want to know to how many right angles, the angles of a regular rectilinear figure are equivalent, we muſt take 4 off the product, the right angles will remain, which are adequated by the internal angles of the figure. Thus a *chiliagon*, or a figure of 1000 ſides, has 1996 angles equal to right angles.

From the *triangle* I'll paſs to the *circle*.

A CIRCLE is a plain figure, comprehended under one ſingle line, which returns into itſelf, having a point in the middle, from which all the lines drawn to the circumference are equal.

This *circumference*, or *periphery*, is the line terminating the circle, which mathematicians divide into 360 parts, which parts are commonly call'd *degrees*: therefore, a ſemi-circumference is divided into 180 parts; and a quarter of a *circle* into 90: each *degree* is divided into 60 *minutes*, each minute into 60 *ſeconds*, each ſecond into 60 *thirds*, &c.

The *center* of the *circle*. is the point from which all lines are carried equal to the circumference, as the point A, *Fig.* 32.

The *diameter*, is a right line paſſing through the center of the circle, and terminated on each ſide by the circumference thereof: ſuch is the line B C in the ſame *Fig.*

The *radius* or *ſemidiameter*, is a right line drawn from the center to the circumference; as A F, and A E, in the ſame *Fig.*

The *ſemicircle*, is a figure comprehended between the diameter of the circle, and half its circumference, ſuch is B G F C in the ſame *Fig.*

The *chord*, is a right line, terminated at each extreme in the circumference of the circle, without paſſing through the center; dividing the circle into two equal parts, call'd *ſegments*; as the right line D E, in the ſame *Fig*

The arch, is a part of the circumference of the circle, leſs than a half, or ſemicircle; as the right line D E, in the ſame *Fig.*

Each arch is the meaſure of an angle, comprehended in the center of the circle, by two *radii* drawn to the extremes of the *arch*. Thus the arch D L E is the meaſure of the angle D A E, in the ſame *Fig.* and as in the center of every circle there may be formed four right angles, which ſhould divide the whole circumference or 360 degrees into four arches of 90 degrees each, each right angle muſt be of 90 degrees, as B A F, or F A C in the ſame *Fig* Therefore, as we have already obſerved, all the right angles are equal between themſelves, becauſe each conſiſting of 90 degrees; conſequently, obtuſe angles contain more than 90 deg. as G A C in the ſame *Fig.* but the acute angles contain leſs than 90 degrees, and are not always equal between themſelves, as F A G, G A B, B A D, D A E, E A C, in the ſame *Fig.* beſides, as often ſeveral angles take up the ſame number of degrees of their circumference, they are as often equal between themſelves.

The TANGENT, is a right line which touches the circle, that is, meets in ſuch a manner as that though infinitely produced, it would never cut the ſame, that is, never come within the circumference: ſuch is the line H C, *Fig.* 35. which touches the circle in the point C, and is call'd the *tangent* of the arch B C, or of the angle B A C, meaſured by that arch. Such is likewiſe the line L F, called the *tangent* of the arch B F, *Fig.* 43 or of the angle C A F, *Fig* 42. and ſuch is the line E B F, *Fig.* 33.

TANGENT of a *conic ſection*, as of a parabola, is a right line which only touches or meets the curve in one point, and does not cut or enter within the curve.

Method of TANGENTS. A method of determining the quantity of the *Tangent* of any algebraick curve; the equation defining that curve being given.

This method is one of the great reſults of the *Calculus Differentialis*.

Its uſe is very great in *geometry*; becauſe in determining the *tangents* of curves, we determine at the ſame time the quadratures of the culvilinear ſpaces, on which account it well deſerves to be here particularly inſiſted on.

To find the SUB-TANGENT in an algebraick curve, let the ſemi-ordinate $p\,m$ be infinitely near, another, then will be the differential of the abſciſs, and letting fall the perpendicular $= p$; will be the differential of the ſemi-ordinate. Draw therefore the *tangent*, the infinitely little arch m will be a right-lined right-angled triangle, uſually called the *characteriſtick triangle of the curve*, in regard curve lines are diſtinguiſhed from each other hereby.

Now by reaſon of the parallelcliſm of the right lines P M and $p\,m$: the angle $M\,m\,R = T\,M\,P$, wherefore the triangle $M\,m\,R$ is ſimilar to the triangle T M P. Let therefore $M\,P = x\,P\,M = y$, then will $P\,p = M\,R = d\,x$ and $R\,m = d\,y$ conſequently.

$$R\,m : M\,R :: P\,M : P\,T$$

$$d\,y : d\,x :: y : \frac{y\,d\,x}{d\,y}$$

If then from the given equation of any curve, you ſubſtitute the value of $d\,x$ to $y\,d\,x : d\,y$, in the general expreſſion of the *ſub tangent*; the differential quantities will vaniſh, and the value of the *ſubtangent* will come in common quantities; whence the *tan-*

gent

gent itself is easily determined.——This we shall illustrate in a few examples:

1. The equation defining the common parabola, is,

$$ax = y^2$$

Hence $a\,dx = 2y\,dy$

$$dx = 2y\,dy : a$$

$PT = y\,dx : dy = 2y^2\,dy : a\,dy = 2y^2 : a = 2ax : a = 2x$. That is, the sub-tangent is double the absciss.

2. The equation defining a circle is

$$ax - xx = yy$$

$$a\,dx - 2x\,dx = 2y\,dy$$

$$dx = 2y\,dy : (a - 2x)$$

$PT = dx : y\,dy = 2y^2\,dy : (a - 2x)\,dy = 2y^2 : (a - 2x) = (2ax - 2xx) : (a - 2x) = (ax - xx) : (\tfrac{1}{2}a - x)$ that is $PC : PB :: AP : PT$.

Therefore $AT = (ax - xx) : (\tfrac{1}{2}a - x) - x = (ax - xx - \tfrac{1}{2}ax + xx) : (\tfrac{1}{2}a - x) = \tfrac{1}{2}ax : (\tfrac{1}{2}a - x)$ that is $PC : PA :: CA : AT$.

3. The equation defining an ellipsis, is;

$$ay^2 = abx - bx^2$$

Hence $2ay\,dy = ab\,dx - 2bx\,dx$

$$2ay\,dy : (ab - 2bx) = dx$$

$PT = y\,dx : dy = 2ay^2 : (ab - 2bx) = (2abx - 2bx^2) : (ab - 2bx) = (2ax - 2ax^2) : (a - 2x)$ that is, as the distance of the semi-ordinate from the center, is to the half axis, so is the absciss to the portion of the *sub tangent* intercepted between the vertex of the ellipsis and the *tangent*.

Lastly, for all algebraick curves, the equation being,

$$ay^m + bx^n + cy^r x^s + d = 0$$

$$may^{m-1}\,dy + nbx^{n-1}\,dx + scy^r x^{s-1}\,dx + rcy^{r-1} x^s\,dy = 0$$

$$nbx^{n-1}\,dx + scy^r x^{s-1}\,dx = -may^{m-1}\,dy - rcy^{r-1} x^s\,dy$$

$$dx = -may^{m-1}\,dy - rcy^{r-1} x^s\,dy : nbx^{n-1} + scy^r x^{s-1}$$

$$PT = \frac{y\,dx}{dy} = \frac{may^m - rcy^r x^s}{nbx^{n-1} + scy^r x^{s-1}}$$

Suppose, *e. gr.* $y^2 - ax = 0$; then, by comparing with the general formula,

$ay^m = y^2$ $\quad bx^n = ax$

$a = 1 . m = 2$ $\quad b = -a . n = 1$

$cy^r x^s = 0$ $\quad f = 0$

$c = 0,\ r = 0.\ f = 0.$

These values being substituted in the most general formula of the *sub tangent*, we have the *sub tangent* of the parabola of the first kind, $(-2 . 1y^2 - 0 . 0y^0 x^0) : 1 - ax^{1-1} + 0 . 0y^0 x^0) = -2y^2 : = 2y^2 : a$.

Suppose $y^3 - x^3\ axy = 0$ then will

$ay^m = y^3\ bx^n = x^3$

$a = 1\ m = 3\ b = 1\ n = 3$

$cy^r x^s = -axy\ f = 0$

$c = -a\ r = 1\ f = 1.$

These values being substituted in the general formula of the *sub-tangent*, we have the *sub tangent* of the curve, whose equation is given, $PT = (-3 . 1y^3 - 1 . - ayx) : (3 . - 1x^{1-1} + 1 . - ayx^{1-1}) = (-3y^3 + ayx) : (-3x^2 - ay) = (3y^3 - axy) : (3x + ay)$ consequently $AT = (3y^3 - axy) : (3x^2 + ay)\ (-x = 3y^3 - axy - 3x^3 - axy) : (3x^2 + ay) = (3axy - 2axy) : 3x^2 + ay$. The value of $y^3 - x^3$, that is $axy : (3x^2 + ay)$ being substituted from the equation to the curve.

In the *Philosophical Transactions*, we have the following method of drawing *tangents*, to all *geometrical* curves, without any labour, or calculation, by M. *Slusius*.

Suppose a curve, whose points are all referable to any right-line given, whether that right-line is the diameter or not; or whether there be more given right-lines than one, provided their powers do but come into the equation. In all his equations he puts v for the line DA, y for BA; and for EB, and the other given lines, he puts $b\ d$, &c. that is, always consonants.

Then supposing DC to be drawn touching the curve in D, and meeting with EB produced in C; he calls the sought line CA, by the name of a.

To find which he gives this general method. 1. Reject out of the equation all members, which have not either v or y in them; then put all those that have y on one side; and all those which have v, on the other; with their signs + or —; and the latter for distinction and ease sake, he calls the right, the former the left side. 2. On the right side, let there be prefixed to each member, the exponent of the power, which v hath there, or which is all one, let that exponent be multiplied into all the members. 3. Let the same be done also alfo on the left fide, multiplying each member there by the power of the exponent of y, adding this moreover, that one y muft in each part, be changed into a. This done, the equation thus reformed, will fhew the method of drawing the required *tangent* to the point D: for that being given, as alfo y, v, and the other quantities expreffed by confonants, a cannot be unknown. Suppofe an equation $by - yy = vv$, in which E B is called b; BA $= y$, D A $= v$, and let a, or A C be required, fo as to find the point C, from whence C D being drawn, fhall be a true *tangent* to that curve Q D in D. In this example, nothing is to be rejected out of the equation, becaufe y or v are in each member; it is alfo difpofed, as required by the rule 1; to each part therefore, there muft be prefixed the exponent of the powers of y or v, as in rule 2; and on the left fide, let y be changed into a, and then the equation will be in this form, $ba - 2ya = 2vv$, which equation reduced, gives eafily the value of $a = \frac{2vv}{b - 2y} =$ A C, and fo the point C is found, from whence the *tangent* D C may be drawn.

To determine which way the *tangent* is to be drawn, whether towards B or E, he directs to confider the numerator and denominator of the fraction. For, 1. If in both parts of the fraction, all the figns are affirmative; or if the affirmative ones are more in number, then the *tangent* is to run towards B. 2. If the affirmative quantities are greater than the negative in the numerator, but equal to them in the denominator, the right-line drawn thro' D, and touching the curve in that point, will be parallel to A B: for in this cafe, a is of an infinite length. 3. If in both parts of the fraction, the affirmative quantities are lefs than the negative, changing all the figns, the *tangent* muft be drawn now alfo towards B: for this cafe, after the change, comes to the fame as the firft. 4. If the affirmative quantities are greater than the negative in the denominator, but in the numerator are lefs, or *vice verfa*, then changing the figns in that part of the fraction, where they are lefs, the *tangent* muft be drawn a contrary way, that is, A C muft be taken towards E. 5. But whenever the affirmative and negative quantities are equal in the numerator, let them be how they will in the denominator, a will vanifh into nothing; and confequently, the *tangent* is either A D itfelf, or E A, or a parallel thereto: as will eafily be found by the data. This he gives plain examples of, in reference to the circle: thus: Let there be a femicircle, whofe diameter is E B, in which there is given any point: from which the perpendicular D A is let fall to the diameter. Let D A $= v$, B A $= y$, B E $= b$; then the equation will be $by - yy = vv$, and drawing the *tangent* D C, we have A C, or $a = \frac{2vv}{b - 2y}$ Now, if b be greater than $2y$, the *tangent* muft be drawn towards B; if lefs, towards E; if it be equal to it, it will be parallel to E B, as was faid in the firft, fecond, and fourth rules.

Let there be another femicircle inverted; as N D D, the points of whofe periphery are referred to the right-line B E, parallel and $=$ to the diameter. Let N B be called d; and all things elfe as before; then the equation will be $by - yy = dd + vv - 2dv$; which being managed according to his rules, you have $a = \frac{2vv - 2dv}{b - 2y}$.

Now, fince v is here fuppofed to be always lefs than d; if b be greater than $2y$, then the *tangent* muft be drawn towards E, if equal, it will be parallel to BE; if lefs, changing all the figns, the *tangent* muft be drawn towards B, as by rules, fourth, fifth, and third.

But there could be no *tangent* drawn, or at leaft E B would be it, if NB had been taken equal to the diameter.

Let there be another femicircle, whofe diameter N B, is perpendicular to E B, and to which its points are fuppofed to be referred. Let N B be called b, and all the things elfe as above; the equation will be $yy = bv - vv$, and $a = \frac{bv - 2vv}{2y}$. If now b be greater than $2v$, the *tangent* muft be drawn towards B, if leffer, towards E, if equal, DA will be the *tangent*, as by rules 1, 4, and 5 appears.

Inverfe method of Tangents, is a method of finding the equation, or the conftruction, of any curve; from the *tangent*, or any other line, whofe determination depends on the *tangent* given.

Its application we fhall give in what follows.— The differential expreffions of the *tangent*, *fub-tangent*, *&c.* being delivered under the laft article; if you make the given value equal to the differential expreffion, and either fum up the differential equation, or, if that cannot be, conftruct it, the curve required, is had. For example:

1. *To find the curve line, whofe* fub-tangent $= 2yy : a$.

Since the *fub-tangent* of an algebraic line is $= y\,dx : dy$ we have

$$\frac{\frac{\frac{y\,dx : dy = 2yy : a}{ay\,dx = 2y^2\,dy}}{a\,dx = 2y\,dy}}{ax = y^2}$$

The curve fought therefore is a parabola.

2. *To*

2. *To find the curve, whose* sub-tangent, *is a third proportional to* r—x *and* y.

$$\text{Since} \quad r-x : y = y : \frac{y\,dx}{dy}$$

$$\text{We have} \quad r-x : y = dy : dx$$
$$r\,dx - x\,dx = y\,dy$$
$$rx - \tfrac{1}{2}x^2 = \tfrac{1}{2}y^2$$
$$2rx - xx = y^2$$

The curve sought therefore, is a circle.

3 *To find a line, wherein the* sub-tangent *is equal to the semiordinate.*

$$\text{Since} \quad y\,dx : dy = y$$
$$y\,dx = y\,dx$$
$$dx = dy$$
$$x = y$$

Hence it appears, that the line sought, is a right-line, which respects the cathetus of an equicrural triangle, as an axis, or the hypothenuse of an equicrural rectangled triangle. If x had been taken for the arch of a circle, the sought line had been a cycloid.

The line *secant* of some arch is a right line drawn from the center, carried through the other extremity of the same arch, and terminated by the tangent: as the line A B H, *fig* 45. C B is the *secant* of the arch, or of the angle C A B; as likewise, the line A B L is the *secant* of the arch B F, or of the angle B A F.

The *right sine* of an arch is a right line drawn from one extremity of the arch, perpendicularly upon the radius drawn from the other extremity; or the *sine* is half the chord, of twice the arch, as the line B I, is the *right sine* of the arch B C, in the same *fig* Hence the *sine* of a right angle is the radius itself, it being half the chord of a semicircle: it is called the *whole sine*, *viz.* the greatest of all.

The sine B G, is call'd the *sine-complement*, or *cosine*, of the arch B C; because the arch B F, is the complement of the arch B C, to a quadrant; for C B F, is a quadrant of a circle in the same *figure*.

The *versed sine*, is part of the whole sine, or radius, intercepted between the right line and the arch; as I C S is the *sine* towards the arch B C, because it is part of the semidiameter A C, intercepted between the arch B C K, the double of the arch B C, as its subtended B I K, in the same *fig*.

The *sines* of obtuse angles, are the same with those of their complements to two right angles; and that all *sines* of similar arches have the same ratio to their radii.

The SEGMENT *of a circle*, is a part of the *circle* comprehended between an arch and the chord thereof. Or it is a part of a circle comprehended between a right line less than a semicircle, and a part of the circumference, as D L E, *fig.* 32. is the *lesser segment*; and D E F the *greater segment*.

The *angle of a segment*, is that made by the tangent, and the chord carried through the point of contact; such are the angles E B C, of the lesser segment, and F B C, of the greater segment, *fig.* 32. where it must be observed, that the *segment* C A B, is call'd *alternate*, with regard to the angle of the segment C B E, as the segment C L B is call'd alternate, with regard to the angle of the segment F B C.

Angle in the segment, is that contained within two right lines, carried from the extremities of the chord to some point of the arch; as the angle B A C, on the segment B A C, *fig.* 33. This angle is call'd also angle to the circumference.

Angle at the periphery, is an angle whose vertex and legs do all terminate in the *periphery* of a circle, such is the angle B D C, *fig.* 33.

The SECTOR of a *circle*, is that part of the circle, comprehended between two radii and the arch; such is B C D, comprehended under the radii B D, and D C, and under the arch B D C.

Similar SEGMENTS, are those which contain equal angles: thus the *segments* of the greater and lesser circle will be similar, if they contain equal angles: as the arch *efg* in the lesser circle, and B C D in the greater, are similar, because they contain the equal angles *e* A *g*, and B A D, *fig.* 34.

Equal circles, are those whose diameters and radii are equal.

First THEOREM. A diameter, perpendicular to the chord cut in two, *viz.* B D *fig.* 36. is divided into two by the diameter A F C; for the sides B F and F D, being equal, by the definition of the circle, the triangle B F D is isosceles; therefore the angles in B and D are always equal to the base B D; but in the triangles B C F, D C F, the angle to C are right, because of the perpendicular F C, which is also the line common to both: Therefore these triangles are entirely equal; and consequently the side B C is equal to the side C D, which was to be demonstrated.

COROLLARIES For the same reason it will be demonstrated, that the right line which cuts perpendicularly the chord in two, is the diameter of the circle, or passes through the center; and the right which passes through the center, and divides the chord in two, is perpendicular to it.

The rights, without the center, do not divide themſelves mutually.

Second Theorem. If through the laſt term B of the diameter be carried D B, *Fig.* 37. perpendicular to the ſaid diameter, it will touch the circle in that ſole point.

For any other point of that perpendicular, *v. gr.* the point D will be out of the circle: And if the line A D be conceived drawn from the center A to the point D, there will be in the rectangular triangle the angle A B D greater than the reſt, to which the greater ſide is oppoſite, and which therefore is greater than the radius A B: And thus the point D falls out of the circle; which was to be demonſtrated.

Corollary. No right line can be drawn between the tangent and the circumference, through the point of the contact B, in the ſame *Fig.* without its cutting the circle. For let it be, if it be poſſible, B C, becauſe the angle A B D is a right angle, A B C will be acute: Therefore the drawn perpendicular A D, will be leſs than the Radius A B, which is oppoſed to the right angle; conſequently the point *d* falls within the circle.

Third Theorem. The angle at the center is twice the angle at the circumference, if they are both fixed to the ſame arch.

Three caſes may be conſidered in this Definition. The *firſt*, when one ſide of the angle on the circumference falls from one ſide of the angle at the center. The *ſecond*, when the ſides of the angles at the circumference include the angles at the center. The *third*, when the ſides of the angle at the circumference, and the angles at the center cut one another.

Let then the angles A B C, and A D C, in the firſt caſe, *Fig.* 38. be fixed to the ſame arch; I ſay that the angle A B C in the center is double the angle D in the periphery. For the angle ABC is external with regard to the triangle C D B. Therefore it is equal to two internal D and C; but theſe angles D and C are equal, when oppoſed to the Radii, or equal ſides, B C and B D: Therefore the angle A B C is double the angle D.

Likewiſe in the ſecond caſe, *Fig.* 39. the angle A B C is double the angle A D C: For if the line D B E be drawn paſſing thro' the center B, the angle A B E is double the angle A D E, and the angle E B C double the angle E D C, by the preceding demonſtration; therefore the whole angle A B C is double the whole angle A D C.

Laſtly, in the third caſe, *Fig.* 40. the angle A B C, is double the angle A D C; for, if the Line D B E, be drawn the whole angle C BE, by the preceding demonſtrations, is double the angle C D E. Likewiſe, the angle A B E is double the angle A D E: Theſe then being taken off, the angle A B C remaining, will be double the remaining A D C; which was to be demonſtrated.

Scholium. We have ſaid in the 8th definition, that the juſt meaſure of the angle placed in the center, is the arch comprehended between two radii. When then we ſay that the meaſure of any angle, *v. gr.* A D C. *Fig.* 38, 39. is this, or that arch, we underſtand that angle to be equal to the angle placed in the center; whereof this or that arch is the meaſure. Whence we make the following deductions.

Corollaries. The angle of the center A B F, *Fig.* 38, 39. fixed to the arch A F, is equal to half the arch A C, to which the angle A D C is fixed at the circumference: For the angle in the center A B C, is double the one and the other; and the whole arch A C, being the meaſure thereof, the arch A F, *i. e.* half A C, will be the meaſure of the angle A B F, and conſequently of the angle A D C, at the circumference.

The angles in the ſame ſegment A D C, A *d* C are equal between themſelves; every one being equal to half the angle A B C, placed at the center, or have the ſame meaſure, according to the preceding corollary, *viz.* half the arch A C, to which they are fixed.

The angle A D B, *Fig.* 41. in the ſemicircle, is a right angle; for its meaſure is a quadrant, or half of the circumference A E B, to which it is fixed. For the ſame reaſon, the angle A *b* D in the leſſer ſegment, will be obtuſe, and the angle A B D in the greater ſegment, acute; for that is fixed to the greater arch, and this to the leſſer. Therefore the meaſure of that will be an arch greater than half the circumference, and the meaſure of this a leſſer.

The oppoſite angles D and A, or I and E, inſcribed to the quadrilateral circle A I D E, *Fig.* 42. are equal, for the two arches to which are fixed the two oppoſite angles, take up the whole circumference, which is the meaſure of two right angles.

Fourth Theorem. The angle of the ſegment form'd by the tangent of the circle, and the chord carried through the point of the contact, is equal to the angle form'd in the alternate ſegment.

For let the tangent F A G, *Fig.* 42 and the chord A D be drawn, I ſay that the angle F A D, is equal to the angle A E D, in the alternate ſegment; and the angle G A D equal to the angle A I D, likewiſe in the ſame ſegment; carried to the diameter A C B, the angle F A B will be a right angle. But the angle A D B in the ſemicircle

circle, is a right angle; therefore in the rectangular triangle A D B, the two angles D A B, D B A, are equal to a right one. But the same angle D A B, with the angle D A F, forms a right angle; therefore the angles D A F, and A B D, or A E D in the same segment, even an alternate one, are equal.

I say, that the angles G A D, and A I D, are equal; for in the quadrilateral A I D E, the opposite angles I and E, are equal to two rights. But the angle E is equal to the angle F A D, by the preceding demonstration, then the angle I, will be equal to the angle D A G.

COROLLARIES. The measure of the angle of the lesser segment F A D, is half the arch A I D, subtended by the chord A D, like the measure of the angle D A G, of the greater segment, is half of the arch A E D. The two tangents F B, F D, *Fig* 43. are equal. For the chord B D joining the points of the contact, being drawn, the angles F B D, F D B, are made equal. The measure of both being the same, *viz.* half the arch subtended by the chord. Therefore an isosceles triangle is formed.

Fifth THEOREM. All *polygons*, circumscribed by a circle, are equal to a rectangular triangle, one leg whereof is equal to the radius of the circle, and the other to the whole periphery of the polygon.

For in the indefinite right line A A, *Fig.* 45. let the bases, A B, B D, &c. be taken, equal to the bases into which the polygon is divided, *Fig* 46. then in the Point A, *Fig.* 45. must be drawn the perpendicular A C, equal to the radius C g. *Fig.* 45. *i. e.* equal to the altitude of the triangles contain'd in the polygon; and let C P be parallel to the base A A, that all the perpendicular lines, $c\ g$, $c\ h$, &c. *Fig.* 46. may be equal to one another, as well as to the radius $c\ g$, *Fig.* 45.

It is manifest that the white triangles A c B, B c D, &c. *Fig.*45. are equal to the triangles $a\ c\ l$, $b\ c\ d$, &c. *Fig.* 46. into which the polygon is is divided. But to those white triangles, are equal those mark'd with black lines, *Fig.* 45 *e. gr.* the white triangle A g c, is equal to the black triangle A C c; and the white triangle B c g, to the black triangle B n c, &c. therefore the whole parallelogram A P, is double the white triangles.

But the same parallelogram A P, is double the triangle A A C; therefore the rectangular triangle A A C, the one leg whereof A A, is equal to the periphery of the polygon, and the other A C, equal to the radius $c\ g$; that rectangular triangle A A C, says I, is equal to the white triangles 45, and consequently to the whole polygon 44.

Sixth THEOREM. All ordinate, or regular polygons, (formed of the equal chords of a circle) drawn in a circle, are equal to the rectangular triangle, one leg whereof is equal to the periphery of the polygon, the other to the perpendicular $c\ g$, *Fig.* 46. carried from the center c, to either side of the polygon, $a\ b$.

The demonstration is the same as that of the preceding theorem

COROLLARY. As a polygon of almost infinite sides, can be circumscribed or inscribed by a circle; it follows hence, that their perimeters can attain *in infinitum*, the circumference of the circle, tho' the perimeter be always greater than the circumference of the circumscribed circle, and lesser than that of the inscribed.

But the polygon circumscribed by a circle, is equal to a rectangular triangle, one leg whereof is the radius of the circle, and the other the perimeter of the polygon; for a polygon formed within a circle, is equally equal to a rectangular triangle, one leg whereof is the perimeter of the polygon, and the other a perpendicular drawn from the center of the circle to any side of the polygon. Therefore the circle will be likewise equal to a rectangular triangle, one leg whereof is equal to the radius, and the other to the circumference of the circle; as demonstrated by *Archimedes*. in his small book of the dimension of the circle.

SCHOLIUM. Though the perimeter of a polygon, either drawn round a circle, or within a circle, may attain *in infinitum*, to the magnitude of the circumference of the same circle, it notwithstanding never becomes equal to it. Whence, by that method, we can never have a line equal to the circumference of a circle; *in which consists the difficulty of the* QUADRATURE OF THE CIRCLE, for if we could find that line, we could form a rectangular triangle, equal to the circle: and a parallelogram equal to that triangle; and a quadrate equal to that parallelogram. As I'll shew by the problems relating to this subject.

Of the SOLIDS. Solid is a magnitude endued with three dimensions, length, breadth, and depth.

The extremity of the *solid* is the superficies; that of the superficies, a line; and that of a line, a point.

As a plane angle consists of right lines drawn on a plane superficies, likewise a *solid* angle consists of several plane angles, but which are not placed on the same plane.

Therefore a *solid* angle is rectilinear, and is form'd by three or more plane angles B O A, C O A, &c. or D O E, E O F, *Fig.* 47. not plac'd in the ſame plane, but meeting in the point O.

A *priſm* is an oblong *ſolid*, contain'd under more than four planes, and whoſe two baſes ABC, and OEF, or GH, and KL, are equal, parallel, and alike ſituated; and the reſt parallelograms.

The priſm is generated by the motion of a rectilinear figure, deſcending always parallel to itſelf, along a right line.

If the deſcribent be a triangle, the body is ſaid to be a *triangular priſm*; if a ſquare, a *quadrangular one*, &c.

From the geneſis of the *priſm*, it is evident it has two equal, and oppoſite baſes; that it is terminated by as many parallelograms, as the baſe conſiſts of ſides; and that all the ſections of a priſm parallel to its baſe, are equal.

A *parallelopiped* is one of the regular *ſolid*, comprehended under ſix parallelograms, the oppoſite ones whereof are ſimilar, parallel, and equal; as K O L P G H I, *Fig.* 49. Therefore all parallelopipeds are priſms, but all priſms are not parallelopipeds.

If a regular *ſolid* conſiſts of ſix ſquares and equal faces, or ſides, and its angles all right, and therefore equal, it is a cube. Whence all cubes are parallelopipeds, but all parallelopipeds are not cubes.

The *Pyramid*, A B C *o*, or D E F *o*, *fig.* 47. is a ſolid ſtanding on a ſquare, triangular, or polygonal baſis, and terminating at top in a point; or a body whoſe baſe is a regular rectilinear figure, and whoſe ſides are plain triangles; their ſeveral vertices meeting together in one point.

Euclid defines it a ſolid figure, conſiſting of ſeveral triangles, whoſe baſes are all in the ſame plane, and have one common vertex.

Therefore the plane A B C, is called the *baſis* of the *pyramid*; and may be either a triangle, or a quadrangle, or any other figure, from each ſide whereof triangles are rais'd to the point O, which is called the vertex; from whence the perpendicular O I falling, it meaſures the height of the pyramid.

If without the plane of ſome circle C F, *fig.* 51. from which the indefinite right line O F be drawn, touching the circle in F; and which, the point O remaining fix'd, may be turn'd round the periphery of the circle, till it returns to the place O F, whence it begun to move: the ſuperficies, deſcrib'd by the right line F, will be conical; and the body contain'd in that ſuperficies, and the circle, call'd a *cone*. O is the vertex of the cone; the circle C F its baſis; the right line O I, drawn from the vertex to the baſe, its axis; and the right line drawn from the vertex to the circumference of the baſis, the ſide of the cone.

A cone may be cut in five different manners. 1 By a plane through the vertex A G B, *fig.* 55. and the triangle A G B is made. 2. By a plane, parallel to the baſe, and a circle is form'd. 3. By the plane F o F, parallel to the ſide of the cone A G, and this ſection is called *parabola*. 4. By the plane K L R, which paſſes through the vertex of the cone, without the ſuperficies thereof, that is neither cutting, nor touching it: and the cone being again cut by another, parallel to the former; and this ſection is called *ellipſis*. 5. By the plane E Q D, which cut the cone any how through the vertex, and by another plane parallel to the former plane; then the ſection made in the ſuperficies thereof is called an *hyperbola*. But when geometers mention *conick ſections*, none muſt be underſtood but the *parabola*, *ellipſis*, and *hyperbola*.

A parabola is defin'd a figure ariſing from the ſection of a cone, when cut by a plane, parallel to one of its ſides. From the ſame point of a cone, therefore only one parabola can be drawn; all the other ſections within thoſe parallels being ellipſes, and all without hyperbola's. *Wolfius* defines the parabola to be a curve wherein $a\,x = y^2$, that is, the ſquare of the ſemi ordinate, is equal to the rectangle of the *abſciſſe*, and a given right line, called the parameter of the axis, or *lacus rectum*. Hence a parabola is a curve of the firſt order; and as the abſciſſes increaſe, the ſemi-ordinates increaſe likewiſe; conſequently the curve never returns into itſelf. Hence, alſo, the abſciſſe is a third proportional to the parameter, and ſemi-ordinate; and the parameter a third proportional to the abſciſſe, and ſemi-ordinate; and the ſemi-ordinate a mean proportional between the parameter and abſciſſe.

The *ellipſis* is thus called from the ſquare O T of the ordinate O R, *fig.* 57. being equal to the rectangle A S; which applied to the parameter A P, is deficient from the rectangle O P, comprehended under part of the axis O A, and under the parameter A P, all theſe are determined thus: as the greater axis I A, is to the leſſer axis M N of the ellipſis, M N is to the parameter A P of the greater axis. Therefore the perpendicular A P being drawn to the extremity of the diameter I A, the triangle I P is formed, which is called the *figure of the axis* I A; the diameter of I P thereof will occur to the diameter I A of the ordinate line O R, and produced in S if it be neceſſary: whence will be formed the rectangle A S, equal to the ſquare O T of the ordinate O R. But that rectangle AS falls from the rectangle contained under part of the angle A O, and the whole parameter A P. It falls, I ſay, by the ſmall rectangle S P, which is ſemblable to the figure I P. If from the extremity N, of the

 leſſer

lesser axis N M, be described the arch F *f*, by the interval N *f*, equal to the greater semi-axis C I, the points F *f* will be the foci of the ellipsis; because the ellipsis is a figure, every point of the circumference whereof, are distant in such a manner from the foci, that the two distances F N, F N, or *fn*, *fn*, taken together are always equal to the whole greater axis I A.

The *ellipsis*, to define it from its form, is a regular continued curve line, including a space that is longer than it is broad, wherein are two points equally distant from the two extremes of the length; from which two right lines being drawn to any point, assumed at pleasure in the *ellipsis*, their sum is equal to the length of the *ellipsis*.

Lastly, the *hyperbola* is thus called from the square OT, of the ordinate OR, *fig.* 58, being equal to the rectangle A S, which applied to the parameter A P, exceeds the rectangle, made under part of the axis A O, and the parameter O P, by the rectangle P S, because the figures V P are semblable to the hyperbola BAD, and NVX are called opposite; the point C is their center. The line AV is the *determinate axis*, to which the other undeterminate axis may be carried at right angles. The points F *f*, are the foci of the counter-placed *parabola's*, which are placed in such a manner, that the line F N, drawn from one focus, at the point N of the hyperbola will always exceed the other line F N, drawn from the other focus to the same point N, by the bigness of the determinate axis AV; the right line CXCY, which drawn thro' the center C, can never occur to the opposite sections, are called *asymptotes*.

If round those equal circles, and the parallels BB, CC, *fig.* 55. the indefinite line B C be turned till it returns to the place whence it began to move; so that, while it moves, it remains always parallel to itself, the superficies described by the right line BC is called *cylindrical*; and the body contained within that superficies, and two circles, a *cylinder*. The bases of the *cylinder* are the said two circles; the axis is the right line O I, joining the centers of the bases; and the side of the *cylinder*, is the right line B C, touching both bases, in the superficies of the cylinder.

The *sphere* is a solid body, contained under one single surface, and having a point in the middle, called the *center*; whence all lines drawn to the surface are equal. The point C is called the center of the sphere, *fig.* 59. the diameter of the sphere is the right line OI, drawn through the center, producted and carried to the superficies, so as to attain to both extremes; one half whereof is the semidiameter C O, called also radius.

If a globe, or the greater circle A E B D of a globe, *fig.* 60. be moved on the right line D F, so as for its center C to describe, by an uniform motion, the line C H, then the point D will be moved, in such a manner, by a motion, composed of a right and a circulary, as to describe the curve D *d d d d d f*, called *Cycloïs* or *Trochus*, which are of great use in the oscillatory clocks, to regulate the motion of the pendulum: there is another line between that, and marked with points, which is called the *companion* of the *trochoïs*.

Those are called regular bodies, which are terminated on all sides by regular and equal planes, and whose solid angles are all equal These regular bodies are five in number, *viz.* the *cube*, C *c*, *fig.* 62, 63. which consists of six equal squares; the *tetrahedron*, T *t*, *fig.* 61. of four equal triangles; the *octahedron*, O *o*, *fig.* 64, 65 of eight: the *dodecahedron*, D *d d*, *fig.* 66. of twelve; and the *icosihedron*, I *i*, *fig.* 67. of twenty.—besides these five, there can be no other *regular* bodies in nature.

Of PROPORTIONS. When two magnitudes of the same genus are compared between themselves, the first term of comparison is call'd *antecedent*; the second *consequent*.

That comparation, or relation, can be made in two different manners; *viz.* when we consider by how much one of those quantities exceeds the other, or is exceeded by it; and that habit is call'd *excess*, or difference: Or when it is asked, how many times, or how one is included in the other, or contains it? and such habitude is commonly call'd *ratio*.

If the first *quantity* contains twice the second, the first is said to be the second in a *double ratio*; if thrice, in a *triple ratio*; if four times, in a *quadruple ratio*, &c. and that contained, is said to be in a *subduple*, *subtriple*, *subquadruple*, &c. as a line of eight feet, is to a line of four feet, in a *duple ratio*; and a line of four feet, to a line of eight feet, in a *subduple ratio*.

If there be several magnitudes, the first of which has the same *ratio* to the second, as the second to the third, and the third to the fourth; then the first is said to have a *ratio duplicate* of that, it has to the second; likewise it is said to have to the fourth a *ratio triplicate* of that it has to the second: That if there be four lines, the first of which be of sixteen feet, the second of eight, the third of four, and the fourth of two; if you search the *ratio* of the first line of sixteen feet to the second of eight feet, I say that it is *double*, or *duple*, or as 2 to 1; and if the *ratio* of the first of 16, to the third of 4 feet, I say that it is twice *duple*, because composed of the *ratio* of the first line of 16, to the second of 8 feet, which is *duple*; and of the *ratio* of the second, *viz.* 8, to the third 4,

which

which is alſo *duple*; whence the *ratio* of the firſt to the third, is *duplicate* of the *ratio* of the firſt to the ſecond; or is twice *duple*, or rather *quadruple*. Now the *ratio* of the firſt to the fourth, or of 16 to 2, is *triplicate* of the *ratio*, of the firſt to the ſecond. Therefore it muſt be compoſed of the *duple ratio*, which is of the firſt to the ſecond, and of the *quadruple ratio*; which is of the ſame firſt to the third, and thus it is twice *quadruple*, or rather *quadruple*.

If the firſt line has more magnitude comparatively to the ſecond, than the third to the fourth, the firſt would be ſaid to have a *greater ratio* to the ſecond, than the third to the fourth; and the third to have a *leſſer ratio* to the fourth, than the firſt to the ſecond, which is a familiar manner of ſpeaking to geometers.

Therefore all things which have the ſame ratio to a third, are equal; and thoſe things are equal to ſuch as they have one and the ſame *ratio*.

If a quantity, *v. g* a bipedal line, has ſome relation to another, *viz.* a pedal line, in whatever manner the firſt be multiplied, or divided, it will always have the ſame *ratio* to the ſecond, if the ſecond be likewiſe multiplied or divided in the ſame manner: For as a bipedal line is to a pedal line, ſo is a line of four feet to a line of two feet; or ſo is a line of one foot, to a ſemipedal line, &c.

Theſe magnitudes, thus multiplied by equality, are call'd *æque-multiple* of their ſimples.

Proportion is the identity, or ſimilitude, of *ratio's*, of differences, or exceſſes. The firſt is call'd *geometrical proportion*, and the ſecond *arithmetical*; but however, when we only mention the name of proportion, the *geometrical proportion* muſt always be underſtood, as the moſt eſſential.

Therefore as every *ratio*, or difference, requires neceſſarily two terms, viz. *antecedent* and *conſequent*; every *proportion* requires four ſuch terms. The firſt is called *firſt antecedent*; the ſecond *firſt conſequent*; the third *ſecond antecedent*; the fourth *ſecond conſequent*. The firſt and laſt are call'd the *extremes*, and the ſecond and third *medii*. They are marked in this manner. 4, 2 : : 6, 3, *i. e.* 4 is to 2, as 6 is to 3; or a line of four feet is to a line of two feet, as a line of ſix feet to a line of three feet. Thoſe four terms are *analogous*, or *proportional*; and that the *proportion* is call'd *geometrical*, which is an equality of ratio's. The following *proportion* is *arithmetical*; 4, 3 : : 2, 1. becauſe the *exceſs* of the *firſt antecedent* is the ſame with reſpect to the *firſt conſequent*; as that of the *ſecond antecedent*, with reſpect to the *ſecond conſequent*.

The ſecond term does, ſometimes, the office of the *antecedent* and *conſequent*, in this manner, — 8, 4, 2. *i. e.* as 8 is to 4, ſo 4 is to 2; or as a line of 8 feet is to a line of 4 feet: ſo the ſame line of 4 feet is to the line of 2 feet. In which *proportion*, which is call'd *continued*, the line of four feet is *conſequent*, with reſpect to the firſt *antecedent*; and *antecedent*, with reſpect to the ſecond *conſequent*; and this may happen both in the *arithmetical* and *geometrical proportion*.

The line of 4 feet, or any other quantity, which is the middle between two, is call'd *middle proportional*; and this either *geometrically* or *arithmetically*.

A ſeries or progreſſion, of more than four *geometrical proportions*, is call'd a *geometrical progreſſion*.

If three quantities be in continual *geometrical proportion*, the product of the two extremes is equal to the ſquare of the middle term; thus, in 6 : 12 : : 12 : 24, the product of 6, and 24, is equal to the ſquare of 12, *viz.* 144. Hence we have a rule.

To find a mean *geometrical proportional* between two numbers, *e. gr.* 8 and 72; multiply one of the numbers by the other, and from the product 576, extract the ſquare root 24; this will be the mean required: more of this in the theorems.

The third ſpecies of *proportion*, is the *harmonical proportion*, which is often mentioned by the antient mathematicians. This *proportion* conſiſts in three terms, ſo diſpoſed, that as the habit of the greater is to the leſſer, ſuch is the habit of the difference of the greater from the leſſer, to the difference of the middle from the leſſer, *v. gr.* let the numbers be 12, 8, 6; as the greater term 12 is to the leſſer 6, ſo is 4 the difference of the greater term 12 from the middle 8, to 2, the difference of the middle 8 from the leſſer 6 for as the greater term 12 contains twice the leſſer 6, ſo the difference 4, which intercedes between 12 and 8, contains twice the difference 2, which intercedes between 8 and 6.

For the ſame reaſon, 6, 4, 3, or 6, 40, 30, are in the *harmonical proportion*.

Between the ſides of the figures, ſeveral *ratio*'s or *exceſſes* can occur, whereby the habit of one figure to the other may be made apparent.

A line is carried into another, or is multiplied by another, when a rectangular parallelogram is made of both. Thoſe two lines being the two contiguous ſides thereof; as the line LM is carried into the line L I, when the rectangular parallelogram, I K LM, *Fig.* 9. is made of both.

If the line AB, *Fig.* 12, be carried into itſelf, or into a line equal to itſelf, *viz.* if C D be equal to A B, and be multiplied by the line C E, equal to itſelf, from that multiplication will ariſe the ſquare E F C D, for all its ſides will be equal.

A rectangle, or any other ſuperficies, is multiplied by a line, when of that ſuperficies and line is formed

formed a rectangular parallelopiped, whose base be that superficies; and the perpendicular altitude be that line. Thus *v. gr.* the superficies ABDH, *Fig.* 55. multiplied by the line IK, or by the line BE equal to it, makes the solid FA, whose base is the superficies ABDH, and the altitude KI, or BE equal to it.

If that superficies be square, and multiplied by a line equal to every one of its sides, there will arise a *cube*, every face whereof will be equal between themselves, as demonstrated by the same figure.

Of rectilinear figures those are said to be similar, which have every angle equal to every other, and their sides proportional to equal angles; such are the triangles ABC, and *abc*, *Fig.* 68, 69, for the angle A is equal to the angle *a*, &c. and as the side AB is to AC, so is the side *ab* to *ac*, &c. such sides which answer to themselves in the proportion are called *homologous*, as AB and *ab*, AC and *ac*, &c.

The altitude of any figure, is a perpendicular line drawn from its vertex to its base; as AP, *Fig.* 68. is the altitude of the triangle ABC.

The spaces, or intervals, comprehended between the parallels are equal, if their perpendiculars be drawn equal.

First THEOREM. In an *arithmetical proportion*, the sum of the extreme terms, is always equal to the sum of the middle terms.

As in this *arithmetical proportion*, 4 . 3 : : 2 . 1, the additional of the extremes, *viz.* 4 and 1 make 5, likewise the middle terms 3 and 2 added together make up 5, and this is easily understood; because, for as much 3 is surpassed by 4; as much 1, which is joined with 4, is surpassed by 2, which is put with 3; therefore the equality is perfect every where.

Second THEOREM. But in the *geometrical proportion*, the multiplication of the extremes, is equal to the product of the middle terms.

As in this proposition 4 . 2 : : 6 . 3, if you multiply 4 by 3, or 2 by 6, you'll have 12. The reason is, because 4 and twice 2 are the same thing; the same as 6 and twice 3 are the same thing. When, therefore, you multiply 3 by 4, it is the same as if you was to take twice 3 and twice 3, or rather four times 3; when, likewise, you multiply 2 by 6, it is the same as if you was to say twice 3, and twice 3. When the product is equal every where. See *Fig* 70.

COROLLARY. If the proportion be continual, the product of the middle term, by itself, *i. e.* its square, will be equal to the rectangle of the extremes.

SCHOLIUM. Therefore as often as the product of the extremes will be found equal to the product of the middle terms, so often four terms will be in *geometrical proportion.* And this will always happen in the following permutation of terms: For if it be,

4 . 2 : : 6 . 3.

It will be by inverting 2 . 4 : : 3 . 6.

By alternating 4 . 6 : : 2 . 3.

By compounding 4 . + 2 . 2 : : 6 . + 3 . 3.

By dividing 4 . — 2 . 2 : : 6 — 3 . 3

Third THEOREM. The sides of triangles equiangle, are proportional with respect to equal angles, and *vicissim*.

Let ABC, *abc*, *Fig.* 68, 69. be the triangles equiangle; I say that AB is to *ab*, as AC to *ac*, and BC to *bc*; and alternating thus, AB to be to AC, and BC as *ab* to *ac* and *bc*.

Let the perpendicular AP in the greater triangle, fall from the vertex A, and be divided into so many equal parts, *v. gr.* 7; and through each division let right lines be drawn parallel to the base BC, which will occur to the side AB, in the points FG, &c. from every one of which must be let fall, likewise, perpendicular on the base, or rather on the part BP of the base, it is manifest that the side AB, and the part BP, of the base, are divided into so many parts, as are contained in the perpendicular AP, which parts will be every one equal between themselves, as well in AB as in P.

Likewise a perpendicular being drawn in the lesser angle *ap*, in which must be taken the parts *ad*, *de*, &c. equal to the parts AD, DE, &c. and five must be contain'd in *ap*, like the seven found in AP, and through each division *de*, &c. let right lines be drawn parallel to the base *bc*, which will occur to *ab*, in the points *fg*, &c. from every one of which must be let fall perpendiculars on the base, or part of the base *bp*, it is clear that the side *ab*, and part of the base *bp*, are divided into so many parts equal between themselves, as are contain'd in the perpendicular *ap*.

Therefore the number of equal parts of the perpendicular AP, in the greater triangle, is to the number of parts of the perpendicular *ap* in the lesser triangle, as the number of parts of the side AB, or of the base BP, is to the number of parts of the side *ab*, or of the base *bp*.

The same will be demonstrated of the triangles APC, *apc*; and therefore as the side AP is to the side *ap*, so is the side *ac*, and PC, to *pc*; and consequently as the whole base BC, is to the whole base *bc*; which was to be demonstrated.

Fourth THEOREM. In rectangular triangles, a perpendicular let fall from the right angle on the base, makes two triangles equal to one another, and to the whole, *v. gr.* the perpendicular AD, *Fig.* 71. makes the triangles DAB and DAC, similar to one another, and to the whole triangle CAB.

For

For in the triangles CAB and DAB, the two angles C A B, which is a right angle, and A B C, are equal to the two A D B, which is alſo a right angle, and AB D. Therefore the third A C B, is equal to the third D A B; and therefore thoſe triangles are equiangles; and conſequently have their ſides proportional.

Firſt Corollary. The perpendicular AD, in the ſame figure, is a middle proportional, between the ſegments of the baſe CD and DB, *i. e.* as CD is to D A, ſo is D A to D B. For the triangles C A D and D A B, being equal, likewiſe as C D the leſſer angle of the triangle CAD is to DA, the greater angle of the ſame triangle, as DA the leſſer ſide of the triangle D A B, is to D B the greater ſide.

In the ſame manner CA is a middle proportional, between the hypothenuſe C B, and the ſegment CD; for the triangles C A B and C A D being equal, the hypothenuſe C B, in the greater angle C A B, will be to the leſſer ſide C A, as the hypothenuſe C A in the leſſer triangle C A D, is to its leſſer ſide C D.

Laſtly B A is a middle proportional between the hypothenuſe B C and the ſegment B D. For the triangles B A C and B A D being equal, the hypothenuſe B C in the greater angle BAC, will be to BA the greater ſide, as the hypothenuſe B A in the leſſer triangle B A D, is to its greater ſide B D.

Hypothenuſe, (from υποθεινω, *ſubtendo*, I ſubtend) in *geometry*, is the longeſt ſide of a right ang'ed triangle; or that ſide which ſubtends, or is oppoſite to the right angle.

Segment, is a part of a circle, comprehended between an arch and the chord thereof. Or it is part of a circle comprehended between a right line leſs than a ſemicircle, and a part of the circumference.

Second Corollary. The ſquare of the perpendicular A D, in the ſame figure, is equal to the rectangle contain'd under the ſegments of the baſe B D, and D C, becauſe it is a middle proportional between thoſe ſegments. By the ſame reaſon the ſquare of the ſide CA is equal to the rectangle made of the baſe B C, and its ſegment C D: Likewiſe the ſquare of the ſide BA, is equal to the rectangle comprehended under the baſe BC, and its ſegment BD.

Fifth Theorem. In all rectangle triangles, the ſquare of the baſe, or hypothenuſe BC, is equal to the ſides of the ſquares BA, and A C taken together, *Fig.* 71.

For the ſquare B M, muſt be divided into the two rectangles B E, and C E, by the production, or carrying on the perpendicular AD into E. The triangle B E, being contained under the baſe B C, or rather under B N, equal to itſelf, and under its ſegment B D; ſo that it is equal to the ſquare of the triangle B A.

For the ſame reaſon, the rectangle C E, contained under the baſe B C, or rather under C M, equal to itſelf, and under CD, is equal to the ſquare of the ſide AC; and thus the whole ſquare BM, is equal to the ſquares of the ſides B A and AC, taken together.

Scholium. This great and curious *theorem*, which is the 47th propoſition of *Euclid's* elements, is attributed to *Pythagoras*.

Among the different uſes this problem is of, in the mathematicks, I'll mark two principle ones, which all philoſophers ſhould be perfectly acquainted with.

For, firſt, it is demonſtrated by it that there are ſome lines which are *incommenſurable*, i. e. lines between which no common meaſure can be found; or which are not between themſelves, as a number to another number; for all numbers have at leaſt unity for common meaſure; from a repetition whereof they proceed.

Therefore, let us ſuppoſe in the rectangular triangle A B C, *Fig.* 71. the ſide A C to be of three feet; the ſide A B of four feet; and the hypothenuſe B C, of five feet: it follows hence, that the ſide of the ſquare A C, *viz.* A H, contains nine ſquare feet; becauſe the ſquare of a line is made of that line, being carried into itſelf, or multiplied in itſelf. But if three feet be taken thrice, or multiplied by a ternary number, they will form nine feet. Likewiſe the ſquare of the ſide A B, *viz.* A F, will be of ſixteen feet; and the ſquare of the hypothenuſe B C, *viz* B M, will contain twenty-five ſquare feet. Then if the ſquare A H, 9, and A F, 16, be added together, they will make 25; becauſe together they are equal to the ſquare B M, which comprehends alſo, twenty-five ſquare feet. And not only thoſe ſquares are expreſſed by numbers, but even their roots, or ſides, can be expreſſed by numbers. For all thoſe numbers, which multiplied by themſelves, form a ſquare are called the roots or ſides of ſquares. As 2 is the root of the ſquare 4, for 2 taken twice, make up 4; thus 3 is the root of the number 9; 4 is the root of 16; 5 the root of 25; 6 the root of 36: 7 the root of 49; 8 the root of 64; 9 the root of 81; 10 the root of 100, *&c.* Thoſe numbers 4, 9, 16, 25, 36, 49, 64, 81, 100, are ſquare, becauſe they ariſe from certain numbers carried into themſelves, and their unity can be diſpoſed in a ſquare form. Thus nine unities can be diſpoſed in a ſquare, each ſide whereof will contain three unities. Likewiſe ſixteen unities can be diſpoſed in a ſquare form the ſide whereof will conſiſt of four unities. The ſame may

may be said of the following numbers 25, 36, 49, &c. But if numbers cannot be disposed in a square, they are not to be called squares.

Therefore a number which is duple of a square one, cannot be square, because it cannot be disposed in a square form, *v. gr.* if a quarternary number be taken twice, it becomes octonary, which is not a square, because it cannot be disposed in a square form. But if the quarternary number be taken four times, it will produce 16, which is a square.

But though a square number cannot be the duple of another square number; a square extended, notwithstanding, can be the duple of another extended square. For if the rectangular triangle was isosceles, *v. gr.* if both its legs were of four feet, the square of either leg would be of 16 feet, and both taken together consist of 32 square feet; so that the square of the hypothenuse of that triangle would contain 32 feet, and be the duple of one another.

The number 32 is not square, but is contained between the square numbers 25 and 36; whose roots are 5 and 6, so that the root of the number 32, which is the hypothenuse of the proposed triangle, and marked thus R 32, must contain more feet than 5, and less than 6; but the magnitude of that number cannot be precisely determined; neither can the foot, or any part of the foot which measures the sides, be the common measure of their sides, and hypothenuse. Therefore the hypothenuse of the rectangle isosceles triangle, such as the diagonal of any square, is *incommensurable*. *Peripateticians* make use of this argument, to prove that the matter is divisible, *in infinitum*.

But there is another use of this theorem, which can never be prized too much, *viz.* the construction of the tables of *sines*, *tangents*, and *secants*; of which construction I will give an example. Having described the circle A E D F B C K, *fig.* 35. and the radius A B being applied to the circumference from B into K, and the side A K drawn, the triangle B A K, will be equilateral; and thus all its angles will be equal between themselves, or each of them will be of 60 degrees. Therefore the side or chord B K, being in two equal parts, the arch B C will be of 30 degrees.

But because the radius is commonly put of 10000000 parts, the chord B K equal to it, will be of so many parts: therefore its half B I, which is the *sine* of the arch B C, will be of 5000000 parts.

But then in the rectangular triangle A I B, the square of the hypothenuse A B, is equal to the quadrates of the sides A I, and B I, taken together. Therefore let the square of the hypothenuse A B, be made by carrying 10000000 into 10000000, it will be 100000000000000, then from this product, take off the square of the side B I, *viz.* 25000000000000, there will remain the square of the same A I, or of G B, the sine of the complement 75000000000000, from which if the square root be extracted, we shall have the line A I of almost 8660254 parts.

Besides, as the triangles A B I, and A H C are similar, let it be that as A I to B I, so A C to C H, the tangent C H should be had. That if the squares of the sides A C and C H be added together, we will have the square of the hypothenuse A H; from which if the root be extracted, then that hypothenuse A H, which is the secant of the arch B C, will appear.

I will finish here, that part of *Geometry*, which I call *speculative*; and pass to *practical Geometry*.

DEFINITIONS.

ORGYIA, was an ancient *Grecian* measure, containing six of our feet. Some represent the *Orgyia*, as the *Grecian* pace. *Hesychius* describes it as the space comprehended between the two hands, when the arms are extended, answering to the *Roman ulna*, and our fathom.

The foot contains twelve ounces, or inches; for the one is not only taken for a weight, in which sense it is a twelfth part of a pound; but likewise for a measure, in which sense it is a twelfth part of a foot; as a digit is a sixteenth part of a foot. Which, notwithstanding, the authors of our time, take indifferently the inch and digit, for a twelfth part of a foot; so that when it is a question of an eclipse of the moon, the name of digit is taken for a twelfth part of the apparent diameter of the moon. Therefore when it is said that the eclipse of the moon is of two or three digits, it is the same as if it was said, that it is of two or three twelfth parts of its apparent diameter.

The foot consists of twelve parts, which we call lines. The antients had other measures which are not in use among us.

The measures common to the *Romans*, and the *Gauls*, are expressed in the following verses:

*Quatuor ex granis * digitus componitur unus,*
Ex quater in palmo digitus; quater in pede palmus.

* By corn is understood here *barley-corns* placed length-wise, against one another; and by paces are understood geometrical paces, each consisting of three feet.

Quinque pedes ‡ *paſſum faciunt; paſſus quoque Centum.*
Vigenti quinque, ſtadium dat, at Miliare
Octo dabunt ſtadia: duplicatum dat tibi Leucam.

The *Engliſh* foot being divided into one thouſand parts, or into twelve inches, the other feet will be as follows:

Foot	Th. Pts.	F.	In.	lin.
London	1000	0	12	0.
Paris, the Royal	1068	1	00	8.
Amſterdam	942	0	11	3
Antwerp	946	0	11	2
Dort	1184	1	02	2
Rhineland, or *Leyden*	1033	1	00	4.
Lorrain	958	0	11	4
Mechlin	919	0	11	0
Middleburg	991	0	11	9.
Straſburg	920	0	11	0
Bremen	964	0	11	6.
Cologn	954	0	11	4.
Francfort on the *Mayne*	948	0	11	4.
Spaniſh	1001	0	12	0
Toledo	899	0	10	7
Roman	967	0	11	6
Bononia	1204	1	02	4
Mantua	1569	1	06	8.
Venice	1162	1	01	9
Dantzick	944	0	11	3
Copenhagen	965	0	11	6
Prague	1026	1	00	3
Riga	1831	1	09	9.
Turin	1062	1	00	7
Greek	1007	1	00	1.
Paris, by Dr. *Bernard*,	1066	1	00	1.
Old Roman	970	0	00	0.

The *Paris* foot being ſuppoſed to contain 1440 parts, the reſt will be as follows;

Foot	Parts
Paris	1440.
Rhineland	1391.
Roman	1320.
London	1350
Swediſh	1320
Daniſh	1403
Venetian	$1540\frac{2}{5}$
Conſtantinopolitan	3120.
Bononian	$1682\frac{2}{5}$
Straſburg	$1283\frac{3}{4}$
Norimberg	$1346\frac{1}{4}$
Dantzick	$1721\frac{1}{2}$
Hall	1320.

Firſt PROBLEM. In the given point of the right line, to form an angle equal to the other given.

Let B of the line AB, *Fig.* 72. be the point in which is to be formed the angle, equal to the given angle C D E, *Fig.* 73.

From the point D muſt be deſcribed the arch C E; then the ſame aperture remaining, the arch H G muſt be made from the point B, from which muſt be cut the arch HF, equal to the arch CE, and the line B F drawn; then the angle A B F, will be equal to the angle C D E, becauſe thoſe two angles are meaſured by the ſame arch.

Second PROBLEM. To draw a perpendicular from the point given in a line.

Let the point C be given in the line A B, *Fig.* 74. from which is taken on each ſide the equal parts C D, C E; and from the points D and E be deſcribed arches, cutting each other in the point I; then from the point C, through the point I, let the line CO be drawn, which will be the perpendicular required. Becauſe the point I, does not incline more towards the part D A, than towards the part E B, and *viciſſim.*

Third PROBLEM. From the point given without a line, to carry a perpendicular to that line.

Let C, *Fig.* 75. be the point given, from which is deſcribed the arch DE, cutting the line A in the points D and E; from theſe points D and E, let two arches be made, cutting one another in the point F; and the line CF be drawn to cut the line AB in O; then the line C O will be the perpendicular required; becauſe it is not more inclined towards the part D A, then towards the part E B.

Fourth PROBLEM. Through the point given, to draw a parallel to the line given.

Let A, *Fig.* 76. be the point given, through which is to be drawn a parallel to the line given C B, let the right line A D be drawn cutting the right line given C B in D; and from the point D be deſcribed the arch A F, and from the point A, at the ſame interval, be deſcribed the other arch DE, into which the arch A F is to be transferred, *viz.* from D into G; then the right line AG will be the parallel required; becauſe the alternate angles A D F, and D A G are equal.

Fifth PROBLEM. Between two lines given to find a *middle proportional.*

Let D, B D C, *Fig.* 78. be the lines given, placed in a direct line, and form the right one BC, from whoſe middle point E muſt be deſcribed the ſemicircle A B C, then from the point D will be drawn the perpendicular D A, meeting with the

‡ The foot is of different lengths in different countries. The *Paris Royal* foot exceeds the *Engliſh* by ſeven lines and a half; the antient *Roman* foot of the capital, conſiſted of four palms, equal to eleven inches, and ſeven tenths *Engliſh*: the *Rhineland*, or *Leyden* foot, by which the northern nations go, is to the *Roman* foot, as 970 to 1000. The proportions of the principal feet of ſeveral nations, compar'd with the *Engliſh* and *French*, are as above.

circum-

circumference in A; I ſay, that ſuch line is the middle proportional between B D, and D C.

For the lines BA and C A being drawn, the angle B A C is formed in the ſemicircle, and conſequently is a right angle; therefore the perpendicular A D, being let to fall on the baſe B C is the middle proportional, between the ſegments, or lines given B D, D C.

SCHOLIUM. By finding two *proportionals* between two lines given, the famous problem of *Delos* of the *duplication of the cube* is executed; and that you may have ſome notion how it is done, it muſt be underſtood that a ſquare is made of any quantity, *viz.* a number, or a line multiplied by itſelf, the ſide or root thereof is that ſame quantity; then if the ſquare be multiplied by the ſame root, there will ariſe a cube, whoſe ſide or root is the ſame quantity. For example, if you multiply 2 by 2 it will produce the ſquare 4, whoſe root is 2. Again, if the ſquare 4 be multiplied by the root 2 it will produce the cube 8, whoſe root is the ſame number 2, Likewiſe, if you carry 4 into 4 you'll produce the ſquare 16, which ſquare being multiplied by 4, will give the cube 64.

But if there be four quantities continually proportional, ſuch as 2 . 4 : : 8 . 16, the cube of the firſt is to the cube of the ſecond, as the firſt is to the fourth; for 2 is to 16, as 8 the cube of the ſaid 2, is to 64, the cube of the ſaid 4. becauſe as 2 is the eighth part of the number 16; ſo 8 is the eighth part of the number 64.

Therefore if two lines were given, the laſt whereof was the *dupla* of the firſt; and between thoſe two, other two proportionals ſhould be found, ſo as for the fourth proportional to become the *dupla* of the firſt; it is manifeſt that the cube, which would be form'd in the ſecond proportional, would be the *dupla* of that form'd in the firſt; becauſe the cube of the firſt line would be, with regard to the ſecond, as the firſt line to the fourth; but the firſt would be to the fourth as 1 to 2; therefore the firſt cube would be to the ſecond, as 1 to 2.

Therefore for the duplication of the altar of *Delos*, which was cubical, there ſhould have been taken a line *duple* each of its ſides; and between the ſide and that line, two middle proportionals ſhould have been ſearched.

Sixth PROBLEM. A triangle given, to make a rectangular parallelogram equal to it.

Let ABC, *Fig.* 77 be the triangle given, thro' whoſe vertex A, muſt be drawn the right line AG, parallel to the baſe B C; then the baſe B C is to be divided into two equal parts in the point D, from which the perpendicular DE is drawn as far as to the parallel AG: Let E F be taken equal to the ſide D C, and the ſide CF be drawn, the rectangle D F will be equal to the triangle given.

Seventh PROBLEM. A parallelogram being given, to make a ſquare equal to it.

Let C D E F, *Fig.* 79. be the parallelogram given, between the longitude thereof DC, and its altitude C F, or C*f*, the middle proportional CA muſt be found; the ſquare C B, of that middle proportional, will be equal to the given rectangle.

Eighth PROBLEM. To meaſure an horizontal line, which can only be acceſſible by one of its extremities.

Let it be the line AB, *Fig.* 89. which can only be acceſſible in the point B, the longitude of which line is to be ſearched.

Firſt, let a perpendicular be drawn in the point B, to that ſame line AB, *viz.* BC, in this manner: You muſt place the center of the inſtrument, *viz.* of the *ſemicircle*, deſcribed *Fig.* 90. in the point B, and through the holes of its immobile dioptre *d d*, *Fig* 90, 91. look at ſome fix'd object, placed in the other extremity of the line, *viz.* a ſmall tree, or the tower A, and move the dioptre, or mobile rule, till it departs from the baſe, or immobile rule, by the whole ſquare, or 90 degrees: if through the holes which are open in the *pinnulæ* of the dioptre, you look ſome mark placed in C, you'll have the right angle A B C.

Let the inſtrument be transferred into C, ſo that its center anſwers to the point C, and the holes of the immobile dioptre *d d*, be directed on the point B; turn the moveable dioptre without moving the inſtrument, till the ſign A appears thro' the moveable *pinnula e e*; then you'll know the quantity of the angle A C B in the limb *e d* of the ſemicircle.

To meaſure the line BC, you muſt draw on paper the line F E, *Fig.* 90. divided into ſo many equal parts, as there are feet found in the line BC, and let the angle F E G, *Fig.* 90. be equal to the angle B C A, afterwards the perpendicular F G muſt be drawn thro' the point F, meeting with the line E G in the point G. If with the ſcale you meaſure how many parts there are in FG equal to the parts of the line F E: I ſay that there are as many feet in A B.

Demonſtration. The triangle ABC, and GFI, are equiangles, by conſtruction; therefore as F D is to F G, ſo is C B to B A: ſo that as many aliquot parts of the line E F, are contained in F G; ſo many ſimilar aliquot parts from the line B C will be contained in B A.

Ninth PROBLEM. To meaſure an acceſſible altitude.

Make uſe, as in the preceding problem, of the ſemicircle ſo diſpoſed, that its diameter or baſe be parallel to the horizon; then riſe or lower its mobile

bile dioptre, till through its *pinnula* the vertex A, *Fig.* 91. be feen: afterwards look downward thro' the fame *pinnula*, that you may have the point C; mark carefully the angle A I, or E I C equal to it, to which the angle A C B is equal likewife. Suppofe it, for example, to be of 57 degrees, 25 minutes: then meafure with the hexapedes the diftance CB, which will be, *v. gr.* of 235 feet. If a triangle be made on paper like unto that, the altitude B A will be found to be of 367 feet, and a little more.

But this *problem* is refolved, with a greater accuracy, by the table of the *fines*: for if the circle be defcribed from the point C, in the internal CB, the *radius* CB will be the whole fine: the line CA, will be the fecant; and the line, or tower AB, will be the tangent of the angle A C B. Therefore if it be faid, as the *whole fine*, which in the table is 10000000, is to the tangent of the angle A C B, 57 degrees, 25 minutes, which is in the tables 15616590; fo is the diftance C B, which is found to be of 235 feet to the altitude or height B A: this altitude BA will be found by the rule of proportion to be of 367 feet eight inches.

As that part of *Geometry* which regards the folution of triangles, or whereby their fides are known by the rules of proportion, and expreffed by number, is called *Trigonometry*, I'll defer mentioning any thing about it, till I come to the letter T, where I defign to write an entire treatife of that art, *Trigonometry*.

G I L D I N G.

GILDING is the art of fpreading or covering a thing with gold, either in *leaf* or *liquid*.

There are feveral *methods* of *gilding* in ufe among us, as gilding in *water*, gilding in *oil*, gilding by *fire*, &c.

Water-gilding requires more preparation than *oil-gilding*, and is chiefly on *wooden* works, and thofe made of *ftucco*; and thefe too muft be fheltered from the weather. A fize is ufed for this way of *gilding* made of fhreads, &c. of parchment or leather boiled in water to the confiftence of a jelly: if the thing to be gilt be of wood, it is firft wafhed with this fize, boiling hot, and then fet to dry; and afterwards with white paint mixed up with the fame fize. Some ufe *Spanifh* white for this purpofe, and others plafter of *Paris*, well beaten and fifted: this fized paint muft be laid on with a ftiff brufh; which is to be repeated feldomer or oftener according to the nature of the work, as ten or twelve times in flat or fmooth works, but feven or eight will be fufficient in pieces of fculpture. In the former cafe they are applied by drawing the brufh over the work, in the latter by dabbing it. When the whole is dry, they moiften it with fair water, and rub it over with feveral pieces of coarfe linen, if it be on the flat; if not, they beat or fwitch it with feveral flips of the fame linen, tied to a little ftick, to make it follow and enter all the cavities and empreffures thereof.

Having thus finifhed the white, the next thing to be done, is to colour it with yellow ochre: but if it be a piece of fculpture in relievo, they firft touch it up, and prepare the feveral parts, which may have been disfigured, by the fmall iron inftruments, as gouges, chiffels, &c. The ochre ufed for this purpofe muft be well ground and fifted, and mixed up with the fize before-mentioned. This colour is to be laid on hot; and in works of fculpture, fupplies the place of gold, which fometimes cannot be carried into all the depreffures and cavities of the foliages and other ornaments; a lay is alfo applied over this yellow, which ferves for the ground on which the gold is to be laid: this lay is ufually compofed of *armenian-bole*, *blood-ftone*, *black-lead*, and a little *fat*; to which fome add *foap*, and *oil* of olives; others, *burnt-bread*, *biftre*, *antimony*, *glafs of tin*, *butter*, and *fugar-candy*. Thefe ingredients being all ground down together with hot fize, three lays of this compofition is applied upon the yellow, the one after the other has been dried; being cautious not to put any into the cavity of the work to hide the yellow.

The brufh, ufed for this purpofe, muft be a foft one; and when the matter is become very dry, they go over it again with a ftronger brufh, to rub it down, and take off the fmall grains that ftick out, in order to facilitate the burnifhing of the gold.

To be prepared for *gilding*, you muft have three forts of *pencils*; one to wet, another to touch up and amend, and a third to flatten; alfo a gilding *cufhion*, for fpreading the leaves of gold on, when taken out of the book; a *knife* to cut them, and a *fquirrel's-tail* fitted with a handle; or elfe a piece of fine foft ftuff on a ftick, to take them up directly and apply them.

You are firft to begin with wetting your pencils; by which the laft lay laid on with water is moiftened, that it may the better receive and retain the gold. Then you are to lay the leaves of gold on the

the cushion; and if whole, you must take it up with the squirrel's tail, but if in pieces, with the other instrument, or the knife wherewith they are cut, and lay and spread them gently on the parts of the work you had moistened before. If the leaves, as they frequently do, happen to crack or break in laying on, these breaches must be made up with small bits of leaf, taken up upon the repairing pencil, and the whole work is to be smoothed either with the same pencil, or another somewhat larger; the gold being pressed into the dents, into which it could not be so easily carried by the squirrel's tail.

The work having been thus far gilded, must be set to dry, in order to be burnished or flatted.

The last operation is the applying the *vermeil* in all the little lines and cavities; and to stop and amend any little faults with shell-gold. The composition called *vermeil* is made of *gum-guttæ*, *vermilion*, and a little of some *ruddy-brown*, ground together with *Venetian* varnish, and oil of turpentine. Some gilders, instead of this, make shift with fine *lacca*, or *dragon's blood*, with *gum-water*.

Sometimes instead of burnishing the gold, they burnish the ground or composition laid on the last before it, and only afterwards wash the part over with the size. This method is chiefly practised for the hands, face, and other nudities in relievo: which, by this means, do not appear so very brilliant as the parts burnished; though much more so than the parts perfectly flat.

To gild a piece of work, and yet preserve white grounds, they apply a lay of *Spanish* white, mixed with a weak fish-glue on all the parts of the ground, whereon the yellow or the last lay might run.

Gilding in *oil* requires much less apparatus than that before-mentioned. The basis or matter whereon the gold is laid, in this method, is the remains of colours found settled to the bottom of the pots in which painters wash their pencils. This matter, which is very viscid or sticky, is first ground, and then passed through a linen-cloth, and thus laid on the matter to be gilt, after it is washed once or twice over with size; and if it be wood, with some white paint.

When this is almost dry, but yet is still unctuous enough to catch and retain the gold, the leaf-gold is laid on, either whole, if the work be large, or cut to pieces, if smaller; the leaves of gold are taken up and laid on with a piece of fine, soft, well-carded cotton; or sometimes by a palat for the purpose; or sometimes with the knife with which the leaves were cut, according to the parts of the work that are to be gilded, or the breadth of the gold that is to be laid on. As the gold is laid on, they pass over it a coarse stiff pencil or brush, to make it stick and as it were incorporate with the ground; and after this they mend any cracks that may have happened in it, either with the same pencil or one that is smaller, as has been shewn before in *water-gilding*.

This kind of gilding is chiefly used for domes and roofs of churches, courts, banqueting houses, &c. and for figures of plaster of Paris, lead, &c.

Gilding with liquid gold is performed by gold reduced to a calx and amalgamated with *mercury*, in the proportion of about an ounce of *mercury* to a dram of *gold*. To perform this, they heat a crucible red-hot, and then put the gold and mercury into it, stirring them gently about till the gold be found melted, and incorporated into a mass with the mercury. When this is done, they cast them into water, to wash and purify them; and out of that into other waters, where the amalgama, which is almost as liquid as if there were nothing but quick-silver in it, may be preserved a long time for use.

Before they proceed to lay this amalgamated gold on the metal, they first render the metal rough, by washing it over with *aqua-fortis*, or *aqua secunda*; and afterwards rinse the metal in fair water, and scour it a little with fine sand, and then it is ready for the gold.

They next cover over the metal with the mixture of *gold* and *mercury*, taking it up with a slip of *copper*, or a brush made of brass-wire, spreading it as even as possible; to do which they wet the brush from time to time in fair water. Then they set the metal to the fire, upon a grate, or in a sort of cage, under which stands a pan of coals; and in proportion as the mercury, evaporating and flying off, discovers the places where gold is wanting, they take care to supply them by adding new parcels of amalgama.

Then the work is rubbed over with the wire-brush, dipt in beer or vinegar, which leaves it in a condition to be brought to a colour, which is the last part of the process, and which the gilders keep to themselves as a mighty secret.

To gild by fire on metal. To prepare the metal, they scratch it well, or rake it; then polish it with a polisher; and afterwards set it to the fire to blue, *i. e.* to heat, till it appears of a blue colour. When this has been done, they clap on the first lay of leaf-gold, rubbing it lightly down with a polisher; and expose it thus to a gentle fire. They usually give it but three such lays, or four at the most, each lay consisting of a single leaf for common works, and of two for extraordinary ones: after each lay, it is set a-fresh to the fire; and after the last lay, the gold is in condition to be burnished.

To gild paper, grind *bole-armoniac* with rain-water, and give one laying of it; when it is dry, take

take glair of eggs, and add to it a little ſugar-candy and gum-water, which lay over the former, and upon this, when it is dry enough, lay leaf-ſilver, or leaf-gold.

To gild the leaves of books, take *bole-armoniac*, eight penny-weight; ſugar-candy, two penny-weight: mix and grind them with glair of eggs: then on a bound book (while it is in the preſs, after it hath been ſmeared with glair of eggs, and is dried) ſmear the ſaid compoſition, let it dry, then rub it well and poliſh it; then with fair water wet the edges of the book, and ſuddenly lay on the gold, preſs it down gently with cotton: let it dry, and then poliſh it with a tooth.

G L A S S.

GLASS (from the *Latin* word *glaſtum*) ſeems to take its name from its colour, which is naturally *azure* or ſky colour; or from its reſemblance to *glacies* or ice, or from its tranſparency.

It is a tranſparent, brittle, factitious body or metal produced by the action of fire; and it is the laſt effect of fire, as all its force is not able to carry the change of any natural body beyond its vitrification.

The origin of this metal can't be quite aſcertain'd, for ſome authors carry its invention as high as the antediluvian age, and patronize it with the name of *Tubal Cain*, the ſon of *Lamech*; becauſe ſay they, it is ſcarce poſſible to calcine metals, without reducing them into *glaſs*; and it is allowed that *Tubal* was the firſt that found out the art of melting metals. See Gen. iv.

Others rather choſe to find its origin amongſt the *Brick-makers*, employed in the building of *Babel*; imagining it impoſſible to burn clay after their manner, without meeting with vitrification, or ſome part thereof run into *glaſs*. However this may be, it is certain that *glaſs* is mention'd in the Bible, not very diſtant from that epocha.

The great *Hermes*, father of philoſophers, was poſſeſſed of this art of *making glaſs*. And *Lucretius*, lib. iv. gives us another evidence of the greater antiquity of this invention.

Pliny, pretends to fix its invention in the city of *Sidon*, where he affirms the firſt *glaſs veſſels* were made, lib. 26. cap. 26. and ſpeaking of this art in another place, lib. 5. cap. 19. he allows, that we are indebted to chance for its invention, which was on the banks of the river *Belus*, in *Syria*, where certain merchants drove aſhore, diſcover'd that the herb *Kali* on that coaſt being reduced to aſhes by the fires they made to dreſs proviſions, and mixing it with ſand and ſtones, became a ſort of melted glaſs. See alſo *Joſephus's wars of the Jews*, lib. ii cap. 9. 17. which in a great meaſure confirms this account.

Venice for many years excelled all *Europe* in the manufacture of glaſs. But *England* now ſurpaſſes all the world, in all the different branches of this manufacture.

The ſeveral *characters* and *properties* of Glass whereby it is diſtinguiſhed from all other bodies, are thus enumerated by our learned countryman Dr. Merret.

1. It is an artificial concrete of ſalt and ſand, or ſtone. 2. Fuſible by ſtrong fire. 3. When fuſed, tenacious and coherent. 4. It does not waſte nor conſume in the fire. 5. When melted, it cleaves to iron. 6. When it is red hot, it is ductile, and may be faſhioned into any form; but not malleable; and capable of being blown into a hollowneſs, which no mineral is. 7. Frangible, when thin, without annealing. 8. Friable, when cold. 9. Diaphanous, whether hot or cold. 10. Flexible and elaſtic. 11. Diſſoluble by cold and moiſture. 12. Only capable of being graven or cut with a diamond, or other hard ſtone, and emery. 13. Receives any dye or colour both externally and internally. 14. Not diſſoluble by aqua fortis, aqua regia, or mercury. 15. Neither acid juices nor any other matter extract either colour, taſte, or any other quality from it. 16 Admits of poliſhing. 17. Neither loſes weight nor ſubſtance by the longeſt and moſt frequent uſe. 18. Gives fuſion to other metals, and ſoftens them. 19. The moſt pliable thing in the world, and that which beſt retains the faſhion given it. 20. Not capable of being calcined. 21. An open glaſs being filled with water in the ſummer-time, will gather drops of water on the outſide, juſt ſo far as the water on the inſide reaches; and a perſon's breath blown on it will manifeſtly moiſten it. 22. Little glaſs balls filled with water, mercury, and other liquor, and thrown into the fire; as alſo drops of green glaſs being broken, will fly aſunder with a great noiſe. 23. Neither wine, beer, nor any other liquor, will make it muſty, or change its colour, or ruſt it. 24. It may be cemented, as ſtones and metals. 25. A drinking-glaſs, partly filled with water, and rubbed on the brim with a wet finger, yields muſical notes, higher or lower as the glaſs is more or leſs full, and will make the liquor friſk and leap.

The

The materials whereof *glaſs* is made, are ſalt and ſand, or ſtones. The ſalt here uſed, is procured from a ſort of aſhes, brought from the *Levant*, called *polverine*, or *rochetta*; which aſhes are thoſe of a ſort of water-plant, called *kali*, cut down in ſummer, dried in the ſun, and burnt in heaps, either on the ground, or on iron grates; the aſhes falling into a pit, grow into a hard maſs, or ſtone, fit for uſe.

To extract the ſalt, theſe aſhes, or *polverine*, are powdered and ſifted, then put into boiling water, and there kept till one-third of the water be conſumed; the whole being ſtirred up, from time to time, that the aſhes may incorporate with the fluid, and all its ſalts be extracted: then the veſſel is filled up with new water, and boiled over again, till one-half be conſumed; what remains is a ſort of lee, ſtrongly impregnated with ſalt. This lee, boiled over again in freſh coppers, thickens in about twenty-four hours, and ſhoots its ſalt; which is to be laded out, as it ſhoots, into earthen pans, and thence into wooden fats to drain and dry. This done, it is groſsly pounded, and thus put in a ſort of oven, called calcar, to dry.

It may be added, that there are other plants, beſides *kali*, which yield a ſalt fit for *glaſs*: ſuch are the *alga* or *ſea-weed*, the *common way-thiſtle*, *bramble*, *hops*, *wormwood*, *woad*, *tobacco*, *fern*, and the whole leguminous tribe, as *peaſe*, *beans*, *&c.*

The ſand or ſtone, called by the artiſts *tarſo*, is the ſecond ingredient in *glaſs*, and that which gives it the body and firmneſs. Theſe ſtones, *Agricola* obſerves, muſt be ſuch as will fuſe; and of theſe, ſuch as are white and tranſparent are beſt; ſo that *cryſtal* challenges the precedency of all others.

At *Venice* they chiefly uſe a ſort of pebble, found in the river *Teſino*, reſembling white marble, and called *cuogolo*. *Ant. Neri* aſſures us, that all ſtones, which will ſtrike fire with ſteel, are fit to vitrify: but Dr. *Merret* ſhews, that there are ſome exceptions from this rule. *Flints* are admirable; and when calcined, powdered, and ſearched, make a pure white cryſtalline metal. Where proper ſtones cannot be ſo conveniently had, *ſand* is uſed; which ſhould be white, and ſmall, and well waſhed, before it be applied: ſuch is uſually found in the mouths and ſides of rivers. Our *glaſs-houſes* are furniſhed with a fine ſand for cryſtal, from *Maidſtone* and *Yarmouth*, the ſame with that uſed for ſand-boxes, and in ſcouring; and with a coarſer for *green-glaſs* from *Woolwich*.

For *cryſtal-glaſs*, to 200 lb. of *tarſo*, pounded fine, they put 130lb. of ſalt of *polverine*; mix them together, and put them into the *calcar*, a ſort of reverberatory furnace, being firſt well heated. Here they remain baking frying, and calcining, for five hours, during which the workmen keeps mixing them with a rake, to make them incorporate: when taken out, the mixture is called *frit*, or *bollito*.

Glaſs might be made by immediately melting the materials without thus calcining, and making them *frit*: but the operation would be much more tedious.

A *glaſs* much harder than any prepared in the common way may be made by means of *borax*, in the following manner. Take four ounces of *borax*, and an ounce of fine *white ſand*, reduced to powder, and melt them together in a large cloſe crucible, ſet in a wind furnace, keeping a ſtrong fire for half an hour: then take out the crucible, and when cold, break it; and there will be found at the bottom a hard, pure glaſs, capable of cutting common glaſs almoſt like a diamond. This experiment duly varied, ſays Dr. *Shaw*, may lead to ſome conſiderable improvements in the *art of glaſs*, *enamels*, and *artificial gems*. It ſhews us an expeditious method of making *glaſs* without the uſe of fixed ſalts, which has generally been thought an eſſential ingredient in *glaſs*, and which is the ingredient that gives common glaſs its ſoftneſs; and it is not yet known, whether calcined cryſtal, or other ſubſtances, being added to this ſalt, inſtead of ſand, might not make a glaſs approaching to the nature of a diamond.

Next to the materials or *ingredients* of which *glaſs* is made, it is neceſſary to ſubjoin an account of the *furnaces* and *inſtruments* required for the work.

A Glass-Maker muſt be furniſhed with Furnaces; *viz.* with one to prepare the *frit*, called the *calcar*; a ſecond to *work* the *glaſs*; and a third called the *leer*, to *anneal* it.

The firſt furnace, called the *calcar*, is made in faſhion of an oven, ten foot long, ſeven broad, and two deep. The fuel is ſeacoal and wood, and is put in a trench, on one ſide of the furnace: the flame reverberates from the roof back upon the *frit*, in order to calcine it.

The ſecond is the working furnace, ſerving to melt the metal in, or make the *glaſs*; its figure is round, three yards in diameter, and two high, being arched over. Round the inſide, are eight or more pots placed, and piling pots on theſe. The number of pots ſhould be double that of the bocca's or mouths, or that of the workmen; that each may have one pot refin'd, to work out of, and another for metal to refine in, while he works out of the former.

The furnace has two partitions, the lower, ſeparating the pots from the fire-place, has a circular hole in the center, covered with a grate, through which the flame paſſes from the fire-place into the

furnace,

furnace; from the arched ſides and roofs whereof it is reverberated into the melting pots. The ſecond partition divides this from the *leer*, or *annealing furnace*. Through the bocca's or working holes, the metal is taken out of the pots, and the pots put in the *furnace*. Theſe bocca's are ſtopp'd with moveable covers, made of lute and brick to ſkreen the workmen's eyes from the fire. On each ſide the bocca is a boccarella, out of which coloured *glaſs*, or the finer metal, is taken from the piling pots to the furnace; likewiſe ovens, or holes near the leer, for the calcining of tartar, iron, *&c.*

The *leer*, which ſerves to anneal and cool the veſſels, and which *Agricola* makes a particular *furnace*, conſiſts of a tower beſides the leer. The tower lies directly over the melting *furnace*, with a partition betwixt them a foot thick; having an aperture called *Occhio* or *Lumella*, through which the flame or heat aſcends out of the *furnace* into the tower: on the floor, or bottom of this tower, the veſſels faſhioned by the maſters are ſet to anneal. It has alſo two bocca's, or mouths, by which the *glaſſes* are put in with a fork, and ſet on the floor.

The *leer*, is an avenue five or ſix yards long, continued to the tower: through this the *glaſſes*, when annealed, are drawn in iron pans called *fraſhes*; by which they come to cool by degrees: being quite cold by that time they reach the mouth of the *leer*, which enters the *ſaroſel*, or room where the *glaſſes* are to be ſet.

The third is the *green glaſs furnace*, which is a kind of compound of all the former. It is made ſquare (the two former being circular) having an arch at each angle thereof, for annealing and cooling the glaſſes. The metal is wrought on two oppoſite ſides; and on the other two they have their *calcars*, into which are made linnet holes, for the fire to come from the *furnace* to bake the *frit*, and alſo to diſcharge the ſmoak. Fires are made in the arches to *anneal* the veſſels, ſo that the whole proceſs is done in one *furnace*.

The *inſtruments* made uſe of in this work, may be reduced to theſe that follow. A blowing pipe, made of iron, about two feet and a half long, with a wooden handle. An iron rod to take up the glaſs, after it is blown, and to cut off the former. Sciſſars to cut the glaſs when it comes off from the firſt hollow iron. Shears to cut and ſhape great glaſſes, *&c.* an iron ladle, with the end of the handle caſed with wood, to take the metal out of the refining pot, to put it into the workmens pots. A ſmall iron ladle, caſed in the ſame manner, to ſkim the alkalic ſalt, that ſwims at top. Shovels, one like a peel to take up the great glaſſes; another, like a fire ſhovel, to feed the furnace with coals. A hooked iron fork, to ſtir the matter in the pots. An iron rake for the ſame purpoſe, and to ſtir the *frit*. An iron fork, to change or pull the pots out of the furnace, *&c.*

By theſe means there may be made many ſorts of *glaſs*; the principal of which, in uſe, are, 1. The *cryſtal flint glaſs*. 2. The *cryſtal white glaſs*. 3. *Normandy* or *Crown glaſs*. 4. *Green-window*, or *Newcaſtle glaſs*, and 5. *Bottle glaſs*.

Of the *firſt* ſort is made *plate glaſs*, for *coaches*, *mirrors*, *teleſcopes*, &c. Of the *ſecond* ſort, all kind of drinking glaſſes, decanters, mugs, cups, *&c.* for the table; toys, phials, *&c.* Of the *third* ſort is made the beſt *glazing* for windows, and pictures. Of the *fourth* ſort is made the ordinary glazing for windows: and the *fifth* ſort ſerves for nothing but bottles, for beer and other liquors in the cellar.

We'll begin the operation with *cryſtal* and *white glaſs*. To prepare the matter for making *white* and *cryſtal glaſs*, which muſt be of the whiteſt *tarſo*, (pounded ſmall, and ſifted as fine as flour) two hundred pounds, and an hundred and thirty pounds of the ſalt of *polverine*: theſe are mixed together, and put into the furnace, call'd *calcar*, firſt heating it; for an hour keeping a moderate fire, and ſtirring continually the materials, that they may incorporate, and calcine together: then increaſing the fire for five hours; after which the matter muſt be taken out, which, being now ſufficiently calcined, is called *frit*; and which from the *calcar*, is to be put in a dry place, and covered up from the duſt, for three or four months.

The *glaſs*, or *cryſtal*, is made, by taking of this *frit*, called alſo *bollito*, and ſetting it in pots, in the furnace; adding to it a due quantity of *mangan̄eſe*: when the two are fuſed, the *fluor* is caſt into fair water, to clear it of the ſalt, call'd *ſandever*, which, otherwiſe, would make the cryſtal obſcure, and cloudy. This lotion muſt be repeated again, and again, as often as needful, till the cryſtal be fully purged. Then it muſt be ſet to boil four, five, or ſix days; which done, it muſt be ſeen if it has *mangan̄eſe* enough; if not, and it be *greeniſh* yet, more *mangan̄eſe* is to be added to it at diſcretion, by little and little at a time; taking care not to overdoſe it, by reaſon the *mangan̄eſe* inclines it to a *blackiſh hue*. Then the metal is ſet to clarify, till it becomes of a clear and ſhining colour; which done, it is fit to be blown, or formed into veſſels, at pleaſure.

Our materials thus prepared, we'll begin the operation, by *blowing round glaſſes*, and preſuppoſing that our *furnace* is heated as it ſhould be, and the matter

matter in the two of the fix pots, placed in it, fufficiently vitrified we'll take our *blowing iron*, and dipping it in one of thefe two pots, turn it about in it; the metal will ftick to the iron like a glutinous, or clammy juice, much like turpentine.

For each *glafs* we'll dip it four times, and at each dip roll the end of our blowing iron, with the *glafs* thereon, on a piece of iron, over which is a veffel of water, the coolnefs whereof helps to confolidate the *glafs* more readily, and difpofes it the better to bind with the next to be taken out of the pot.

After we have dipped a fourth time, and there is now matter enough on the inftrument, we begin to blow gently thro' the iron; by which we rife, according to the nature of the work, the fame as we do by blowing in a bladder; and to give it a polifh, we roll it to and fro on a ftone, or marble. This done, we blow a fecond time, and thus form the bunch, or belly of the *glafs*, the matter, by this fecond blaft, affumes the figure of a gourd.

As often as we blow into the iron we muft remove it haftily from our mouth to our cheek, left we fhould draw the flame into our mouth, when we re apply it to the iron.——We muft whirl our iron-rod many times round our head, to lengthen and cool the glafs; fometimes the *glafs*, thus blown round, is returned to the fire, where it flattens a little of itfelf; when flatten'd, it is taken out, and cool'd; and, if needful for the defign, we muft flat its bottom, by preffing it on the marble, or mould it in the ftamp-iron, and thus deliver it to the mafter-workman to break off the *collet*; which *collet* is the narrow part, which clave to the iron.

To fet the *glafs* at liberty, he muft lay a drop of cold water on the *collet*; which by its coldnefs will cut, or crack about a quarter of an inch: after which giving it a flight blow, the fracture is communicated all around the *collet*.

This done, we dip an iron-rod, or *ponteglo*, in the melting pots, and with the matter that fticks thereto, we'll apply and faften it to the bottom of the veffel, oppofite to the *collet*.—The veffel thus fuftained by the iron-rod, is carried to the great *bocca* to be heated, and fcalded; and while another perfon takes care thereof, the former operator refts, and prepares himfelf for the branching, or making the bowl, which is done by thrufting in an iron inftrument, called *paffago*, whereby the aperture is opened, and afterwards augmented further, and widened with the *procello*: in turning this inftrument about, to form the bowl, the edge becomes thickned; the *glafs* being, as it were, doubled in that part; whence the hem obferved on the circumference of our *glaffes*. What is fuperfluous, is cut off with the fhears.

The veffel thus opened is returned to the great *bocca*, where being fufficiently heated a fecond time, the workman gives the bowl its finifhing by turning it about with a circular motion; which it increafes in proportion as the bowl opens, and enlarges by means of the heat and agitation.

The *glafs* thus finifhed, they carry it from the *bocca* ftill turning it round, to a kind of earthen bench covered with brands, or coals extinguifhed: here they let it cool a little, and come to its confiftence, having firft detached it from the iron-rod, by a ftroke or two with the hand. Thus with blowing, fcalding, amplifying, and cutting, the glafs is framed into the fhape preconceived in the workman's mind. If need be he proceeds to put on a foot and handle, and with the *fpici* puts on rigarines and marblings.

When the mafter has finifhed a number of them, a fervitor takes them with an iron-fork, and fpeedily places them in the tower or *leer*, to *anneal* and harden.

Annealing, or *nealing* of *glafs*, is the baking of *glafs* to dry, harden, and give it the due confiftence, after it has been blown and fafhioned in the proper works. *Nealing* is alfo ufed in the art of ftaining *glafs* with metal colours.

What has been here faid, of *white* or *cryftal glafs*, holds equally of *common* or *green glafs*, the working being the fame in all, and the difference only in the falt or *polverine*.

So many mafters as there are, fo many pots at leaft, and fo many *bocca*'s there muft be; each man having his proper ftation. They fit in large wide wooden chairs, with two long elbows, to which their inftruments are hung. They work fix hours at a time, meafured by a fingle glafs; after which they are relieved by others for the like time, fo that the furnaces are never idle.

From *round*, *cryftal*, and *white glaffes*, we'll pafs to the blowing *crown*, *Normandy* or *table-glaffes*: for which operation the *furnace*, *melting-pots*, *materials*, and *fire*, are nearly the fame as for *round-glafs*; and the difference only commences after the operator has dipped his *blowing-iron* the fourth time in the melted metal. The *glafs* then being in this condition, they blow it; but inftead of rounding, or forming it into a bunch, the particular motion the workmen gives it in the directing and managing the wind, and the way of rolling it on the iron, makes it extend in length 16 or 20 inches, and form a cylinder, which being recommitted to the fire, and blown afrefh, when taken out, becomes of the extent required for the table of *glafs* to be formed.

Then the *blower* prefents it to the *flafher*, or the *mafter glafs-maker*, who, being ready with a *pointil*, *i. e.* an iron-rod tipt with a fmall quantity of hot metal, claps it clofe to the center of the bottom of the round ball of metal thus blown: which immediately uniting or cementing together, the *collet* is broke by the blower, and the master takes away the ball of metal, and presents it to the mouth of the flashing furnace, whose flames sallying forth at a large mouth, and entering into the metal presented by the hole made in the *collet*, enlarges the aperture, till it at last brings the globular metal into a circular plane of an equal thickness, excepting where a nob is made in the center by the tool that holds it: the master, with great dexterity, all the time keeping it twirling round in the flame, upon an iron prop before the mouth of this furnace. This performed, the table is struck off in the same manner as directed in the cutting of the *collet*; and delivered to the proper person to place it in the *leer*, to *anneal*, or temper.

The process for *green glass* for *windows* is nearly the same; only that when the *green glass* is blown to its proper extent, it is smaller at the end fastened to the iron, than at the other extremity; being blown cylindrical or long: so that to render the two ends nearly of the same diameter, after adding a little *glass* to that opposite to the iron, they draw it out with a pair of iron pincers; then they cut off the same end with a little water; and carrying the cylinder back to the *bocca*, they cut it likewise with water in two other places, one eight or ten inches from the iron, and the other the whole length.

The *glass* cylinder thus abridged of both its extremities, is next heated on a kind of earthen table, somewhat raised in the middle, in order to promote its opening at the place incided longitudinally. The workman here makes use of an iron, wherewith he alternately lowers and raises the two sides, or halves of the cylinder, which now begin to open and unfold like a sheet of paper, and at length grow perfectly flat. The table of *glass* is now in its last perfection, and needs nothing further but to be heated over again: when taken out they lay it on a table of copper; when, after it has cooled and come to its consistence, they carry it on forks to the tower of the furnace, where they leave it to *anneal* for twenty four hours. See the *Plate* of a Glass-house.

The last, and most curious operation perform'd in a *glass-house*, is that of *blowing*, and *casting* Looking-Glass Plates; which, tho' made of much the same materials as other *glasses*, *viz.* of alkali salt and sand; it must, however, be observed, that the *salt* should not be that extracted from polverine, or the ashes of the *Syrian* kali, but that from *barillia*, or the ashes of a plant of that name, of the genus of kalies, but growing about *Alicant* in *Spain*. This *barillia* is seldom to be got pure; the *Spaniards*, in burning the herb, making a practice of mixing another herb along with it, which alters its quality, or of adding sand to it, to increase the weight; which is easily discovered, if the addition be only made after the boiling of the ashes; but next to impossible, if made in the boiling: it is from this adulteration, that those threads, and other defects in *plate-glass* arise.

To prepare the *salt*, it must be well purged of all foreign matters; pounded, or ground with a kind of mill, and sifted pretty fine.

The *sand* is to be sifted, and washed, till such time as the water comes off very clear; and when it is well dried again, it is to be mixed with the salt, passing the mixture through another sieve. This done, they are laid in the annealing furnace for about two hours; in which time the matter becomes very light and white, and in which state they are called *frit*, and are to be laid up in a dry clean place, to give them time to incorporate, for at least a year.

When this *frit* is to be employed, it must be laid for some hours in the furnace; adding to some the fragments, or shards, of old *glass*; taking care, first, to calcine the shards, by heating them red-hot in the furnace, and casting them into cold water: to the mixture must likewise be added *manganese*, to promote the fusion, and purification. The matter thus prepared, is equally fit for *plate glass*, to be formed by *blowing*, or by *casting*.

The furnaces for melting the materials of this manufacture, are of enormous size; and those for annealing the *glasses*, when formed, much more so. Round a melting furnace there are, at least, twenty-four annealing furnaces or ovens, each from twenty to twenty five foot long: they are called *carquasses*, each *carquasse* has two *tissarts*, or apertures, to put in wood, and two chimneys. Add, that besides the annealing furnaces, &c. there are others for the making of *frit* and calcining old *glass*.

As *looking-glass* Plates are made in two different manners, *viz.* by *blowing*, and by *casting*; we'll begin with the most easy manner, which is that of *blowing*; and which is performed thus:— The materials to be blown, are fused in melting-pots, thirty-eight inches in diameter, and thirty-five feet high. After those materials are vitrified by the heat of the fire, and the *glass* is sufficiently refined, the master-workman dips in his blowing iron once and again, till he has got matter enough thereon.—This done, he mounts on a kind of block, or stool five feet high, to be more at liberty to balance it, as it lengthens in the blowing. If the work be too heavy for the workmen to sustain on his blowing iron, two or more attendants assist him, by holding pieces of wood under the *glass*, in proportion as it stretches, for fear it should fall off the iron by its own weight.

When after several repeated heatings and blowings, the *glass* is at length brought to the compass proper for its thickness, and the quantity of metal taken out; they cut it off with *forceps*, at the extremity

tremity oppofite to the iron, in order to point it with the *pointil*, which is a long firm piece of iron, having a piece going acrofs one of its ends in manner of a T. To point the *glafs* they plunge the head of the T into the melting pot, and with the liquid *glafs* fticking thereto, they faften it to the extremity of the *glafs* before cut off. When it is fufficiently faftened, they feparate the other extremity of the *glafs* from the blowing iron, and inftead thereof make ufe of the pointil to carry it to the furnaces apointed for that end; where by feveral heatings they continue to enlarge it, till it be equally thick in every part.

This done, they cut it open with the forceps; not only on the fides, by which it ftuck to the blowing iron, but likewife the whole length of the cylinder: after which, giving it a fufficient heating, it is in a condition to be entirely open'd, extended, and flatten'd: the manner of doing which is much the fame as for *table glafs*. Laftly, the *glafs* being fufficiently flatted, is laid to anneal for ten, or fifteen days, according to the fize and thicknefs.

See the Copper-Plates, B is the blowing-furnace; C the metal taken out of the pot; D a glafs-blower; E the flafher enlarging and opening the *glafs*, as mentioned in the *crown glafs*; F is the block to fupport the man.

Looking-glaffes thus *blown*, fhould never be above forty-five, or at moft fifty inches long, and of a breadth proportionable. Thofe exceeding thefe dimenfions, cannot have the thicknefs fufficient to bear the grinding; and, befide, are fubject to warp, which prevent them from regularly reflecting objects.

The next operation, the moft curious and moft valuable, it that of *running*, or *cafting* large *looking-glafs plates*.

The utenfils of the *glafs-houfes* for this operation, confifts in *melting-pots* as big as hogfheads, and capable to contain above two thoufand weight of metal; in *cifterns*, which ferve for the conveyance of the liquid glafs, which is drawn out of the pots to the cafting tables; of a *table* made of pot-metal, about nine feet long, and broad in proportion, whereon the *glafs* is to be run; of *iron-rulers* or *reins*, &c.

The firft thing to be done in this operation, as in all others of this kind, is to heat the furnace red-hot.

When the furnace is red-hot, the pots are filled with materials at three different times, to facilitate the fufion. When the matter is fufficiently vitrified, refined, and fettled, which ufually happens in twenty-four hours; the *cifterns* are filled, which are in the fame furnace, and which are left there about fix hours longer, till fuch time as they appear all white, through the exceffive heat. See the *Plate* for *cafting* and *running* Plate-Glass.

To get the *ciftern* K with the metal out of the furnace G, they make ufe of a large iron chain, which opens and fhuts with hooks and eyes; from the middle whereof, on each fide, arife two maffive iron pins, whereby, with the affiftance of pullies I, the ciftern is raifed upon a kind of carriage of a proper height, and thus conducted to the place where the *glafs* is to be run: here flipping off the bottom of the ciftern, there rufhes out a torrent of matter O, all on fire, wherewith the table M, prepared for that purpofe is prefently covered. This *table* is fupported on a wooden frame, with truftles, for the convenience of removing from one *carquaffe*, or annealing furnace, to another; in proportion as they are filled. ——To form the thicknefs of a *glafs*, there are two *iron rulers*, or *reins* NN, placed around the edge of the table; and on thefe reft the two extremes of a kind of roller L Q, which ferves to drive the liquid matter before it, to the end of the table, or mould. The iron rulers being moveable, and capable of being fet clofer, or further apart, at pleafure, determine the width of the *glaffes*, and retain the matter, that it does not run off at the edges. P P are the glafs-makers, R the labourer, H the mouth of the furnace, and A is a man breaking *frit* for ufe.

As foon as the matter is arrived at the end of the table, and the *glafs* is come to a confiftence, which is in about a minute, they fhove it off into the annealing furnace, where it flides with eafe enough, by reafon of the fand ftrewed thereon.

As faft as the cifterns are emptied, they carry them back to the furnace, and take frefh ones, which they empty as before: this they continue to do, as long as there are any full cifterns; laying as many plates in each *carquaffe* as it will hold, and ftopping them up as foon as they are full; to let them anneal, and cool again, which requires at leaft ten days.

The firft running being difpatched, they prepare another, by filling the cifterns anew, from the matter in the pots; and after the fecond a third, and even a fourth time, till the melting pots are quite empty.--The cifterns, at each running, fhould remain, at leaft, fix hours in the furnace to whiten; and when the firft annealing furnace is full, the *cafting-table* is to be carried to another.

The *glafs*, when taken out of the annealing furnace, needs nothing further than to be ground, polifhed, and foliated.

Glafs thus manufactured is fubject to feveral operations. It is *ground* and *polifhed* to give it luftre.

In order to grind *plate-glafs*, they lay it horizontally upon a flat ftone table, made of a very fine grained free-ftone; and for its greater fecurity they plafter it down with lime, or ftucco; for otherwife the force of the workmen, or the motion of the wheel, with which they grind it, would move it about.

F 2 This

This ſtone-table is ſupported by a ſtrong frame, made of wood, with a ledge quite round its edges, riſing about two inches higher than the glaſs. Upon this glaſs to be ground, is laid another rough glaſs not above half ſo big, and ſo looſe as to ſlide upon it; but cemented to a wooden plank, to guard it from the injury it muſt otherwiſe receive from the ſcraping of the wheel, to which this plank is faſtened; and from the weights laid upon it, to promote the grinding, or friture, of the glaſſes. The whole is covered with a wheel, made of hard light wood, about ſix inches in diameter; by pulling of which backwards and forwards alternately, and ſometimes turning it round, the workmen who always ſtand oppoſite to each other, produce a conſtant attrition between the two glaſſes, and bring them to what degree of ſmoothneſs they pleaſe by firſt pouring in water and courſe ſand: after that a finer ſort of ſand as the work advanceth, till at laſt they muſt pour in the powder of ſmalt. As the upper or incumbent glaſs poliſhes, and grows ſmoother, it muſt be taken away, and another from time to time put in its place.

This engine is called a *mill* by the artiſts, and is uſed only in the largeſt ſize glaſſes; for in the grinding of the leſſer glaſſes, they are content to work without a wheel, and to have only four wooden handles faſtened to the four corners of the ſtone, which loads the upper plank, by which they work it about.

When the grinder has done his part, who finds it very difficult to bring the glaſs to an exact plainneſs, it is turned over to the care of the poliſher, who with the fine powder of tripoli-ſtone, or emery, brings it to a perfect evenneſs and luſtre. The inſtrument made uſe of in this branch, is a board, furniſhed with a felt, and a ſmall roller, which the workman moves by means of a double handle at both ends. The artiſt in working this roller, is aſſiſted with a wooden hoop, or ſpring, to the end of which it is fixed: for the ſpring, by conſtantly bringing the roller back to the ſame points, facilitates the action of the workman's arm.

This operation only makes a plane; but our artiſts are now arrived at ſuch a perfection in *grinding of glaſs*, that they can cut or grind it into a variety of forms, in the ſame manner as diamonds are cut by a wheel. The cutting wheel is made of ſtone; which, with the help of ſand and water, makes the impreſſion: and when the glaſs is cut into the form intended, it is delivered to the poliſher, who with emery, and a leaden or wooden wheel, gives every part its luſtre. As we ſee in *ſmelling bottles*, *table-crewits*, and other houſhold *glaſs* furniture.

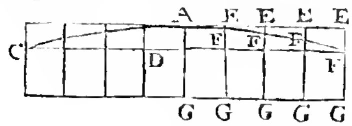
The moſt admirable operation in the grinding way, is the grinding of *optic glaſſes*; which is thus directed to be performed by Mr. *Huygens*. Make, ſays he, the breadth of the concave tool, plate, diſh, or form in which an object-glaſs muſt be ground, almoſt three times the breadth of the glaſs. Though in another place he ſpeaks of grinding a glaſs whoſe focal diſtance was 2co feet, and breadth $8\frac{3}{4}$ inches, in a plate only fifteen inches broad. But for eye-glaſſes, and others of leſſer ſpheres, the tools muſt be broader in proportion to the breadth of theſe glaſſes, to afford room enough for the motion of the hand in poliſhing. Mr. *Huygens* made his tools of copper, or of caſt braſs, which, for fear they ſhould change their figure by bending, can hardly be caſt too thick: however, he found by experience, that a tool fourteen inches broad, and half an inch thick, was ſtrong enough for the forming glaſſes to a ſphere of thirty-ſix feet diameter; when the tool was ſtrongly cemented upon a cylindrical ſtone an inch thick, with hard cement made of pitch and aſhes.

In order to make moulds for caſting ſuch tools as are pretty much concave, he directs, that wooden patterns ſhould be turned in a lathe, a little thicker and broader than the tools themſelves; but for tools that belong to ſpheres above twenty or thirty feet diameter, he ſays it is ſufficient to make uſe of flat boards turned circular to the breadth and thickneſs required. When the plates are caſt, they muſt be turned in a lathe exactly to the concavity required; and for this purpoſe it is requiſite to make a couple of braſs gages in the manner following, according to the directions of Mr. *Molyneux*.

Take a wooden pole, a little longer than the radius of the ſpherical ſurface of the glaſs to be formed; and through the ends of it ſtrike two ſmall ſteel points, at a diſtance from each other, equal to the radius of the ſphere intended; and by one of the points hang up the pole againſt a wall, ſo that this upper point may have a circular motion in a hole or ſocket made of braſs or iron, fixt firmly to the wall. Then take two equal plates of braſs or copper, well hammered and ſmoothed, whoſe length is ſomewhat more than the breadth of the tool of caſt braſs; whoſe thickneſs may be about a tenth or a twelfth of an inch, and whoſe breadth may be two or three inches. Then having faſtened theſe plates flat againſt the wall in a horizontal poſition, with the moveable point in the pole, ſtrike a true arch upon each of them. Then file away the braſs on one ſide exactly to the arch ſtruck, ſo as to make one of the braſs edges convex, and the other concave; and to make the arches correſpond more exactly, fix one of the plates flat upon a table, and grind the other againſt it with emery.

But

But if the radius of the ſphere be very great, Mr. *Huygens* directs the gages to be made as follows. Imagine the line A E, drawn upon the

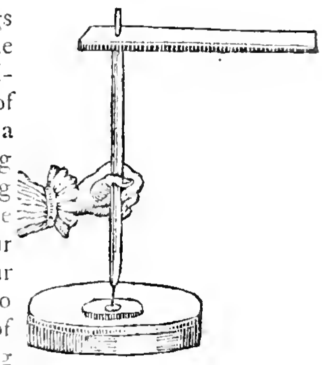


braſs plate to be the tangent of the required arch A F C, whoſe radius, for example, is 36 feet, and diameter 72. From A ſet off the parts A E, E E, &c. ſeverally equal to an inch, and let them be continued a little beyond half the breadth of the tool required: then as 72 feet. or 864 inches is to 1 inch, ſo let 1 inch be to a fourth number: this will be the number of decimal parts of an inch in the firſt line E F, reckoning from A. Multiply this fourth number ſucceſſively by 4, 9, 16, 25, &c. the ſquares of 2, 3, 4, 5, &c. and the ſeveral products will be the number of parts contained in the 2d, 3d, 4th, 5th, E F reſpectively. But becauſe theſe numbers of parts are too ſmall to be taken from a ſcale by a pair of compaſſes, ſubtract them ſeverally from one inch, repreſented by the lines E G, and the remainders being taken from a ſcale of an inch divided into decimal parts, and transferred by the compaſſes from G to F, will determine the points F, F, &c. of the arch required. And the ſame being done on the other ſide of the line A D, the braſs plates muſt be filed away exactly to the points of this arch, and poliſhed as before.

Mr. *Huygens* would have his plates or tools firſt formed in a turning lathe, and then ground together with emery; that is to ſay, the concave and convex tool of the ſame ſphere together; but the tools of very large ſpheres, he would have ground at firſt quite plane, by a ſtone-cutter; and then ground hollow with a round flat ſtone and emery, to the deſired gage.

The tools thus ground muſt be poliſhed by an incruſtation of pitch and emery, and perfected with blue hones.

The glaſs being planed to an equal thickneſs, and poliſhed a little by a glaſs-grinder, and rounded by a grind-ſtone; take away the plate with ſeveral ſteel cavities, and with ſome ſifted emery, made into a cement, fix on a ſmaller round piece of braſs, or rather ſteel, truly flat, and turned, about the bigneſs of a farthing, but thicker, having firſt made in the center thereof, with a triangular ſteel punch, a hole about the bigneſs of a gooſe-quill, and about the depth of $\frac{1}{12}$ of an inch; and at the very bottom of this triangular hole, a little round hole muſt be punched ſomewhat deeper, with a very ſmall ſteel punch. A ſmall ſteel point, of about an inch long, muſt be truly ſhaped and fitted to this triangular hole, and at the very apex to the ſmall round deep impreſſion. Nevertheleſs it muſt not be fitted ſo exactly, but that it may have the liberty to move a little to and fro; the apex always continuing to preſs upon the ſurface of the round hole below. This ſteel triangular point muſt be fixed to the end of a pole; to the other end of which another round iron point muſt be fixed, of about five or ſix inches long, to play freely up and down in a round hole, in a piece of braſs let into a board, fixed againſt the ceiling for that purpoſe; perpendicularly over the bench and over the center of the tool, which muſt be ſtrongly and truly fixed horizontally thereon, as here repreſented.



Having theſe things prepared, with ſome pots of emery of various fineneſſes, take of your rougheſt ſort a ſmall pugil, wetting the ſame, and daubing it pretty equably on the tool; then lay on your glaſs, and fix up your pole. and continue to grind for a quarter of an hour; not preſſing upon the pole, but barely carrying the glaſs round thereby: then take a little quantity of ſome finer emery, and work another quarter of an hour therewith: then take the like quantity of emery ſtill finer, and work for the ſame time: laſt of all take a leſs quantity of ſome of the very fineſt you have, which will be ſufficient for a glaſs of five inches diameter, and work therewith for an hour and a half; taking away by little and little ſome of the emery with a wet ſponge. Do not keep it too wet nor too dry, but about the conſiſtence of pap: for much depends on this. If it be too dry, your emery will ſtick, clog, and incorporate, and cut little or none at all, beſides it will ſcratch and cut your glaſs irregularly; and if it is too wet, and too much diluted, it will, from the irregular ſeparation of its parts, cut in ſome places more than others, as in the other caſe.

But Mr. *Huygens* tells us, that this method of uſing various ſorts of freſh emery is not good; finding by experience, that the ſurfaces of large glaſſes are often ſcratched. And therefore he ſays, that it is beſt to take a large quantity of the firſt and ſecond emery, and ſo work with the ſame from the firſt to the laſt, taking away, by little and little, every half hour, or quarter of an hour, more and more of the emery with a wet ſponge; by which means he could bring the glaſs extremely ſmooth

and

and fine, so as to see pretty distinctly, a candle or the sash-windows well defined through it, which is a mark when it is ground enough to receive a polish.

When you first begin to grind, and the emery begins to be smooth, the glass will stick a little to the tool, and run stiff; then fresh emery is to be added.

The method hitherto described of grinding with emery, is what is recommended by Mr. *Huygens*, *Le Pere Cherubin* prescribes another material, which is the *grit* of a hard *grind-stone*, well beaten into a fine powder, and sifted pretty fine: and here in *England* the same thing was used to be performed by Mr. *Cox*, with common clean *white sand*, taking away by little and little the said grit and sand, as it is ground finer and finer; but it seems this method is now quite disused.

But the most beautiful improvement of this art is *painting upon glass*.

The antient manner of *painting upon glass* was very simple, and consequently very easy; it consisted in the mere arrangement of pieces of glass of different colours in some sort of symmetry, and constituted what is now called mosaic work.

In process of time they came to attempt more regular designs, and also to represent figures heightened with all their shades: yet they proceeded no farther than the contours of the figures in black with water-colours, and hatching the draperies after the same manner, on glasses of the colour of the object they designed to paint. For the *carnation*, they used glass of a bright *red colour*; and upon this they drew the principal lineaments of the face, &c. with black.

But in time, the taste for this sort of painting improving considerably, and the art being found applicable to the adorning of churches, &c. they found out means of incorporating the colours in the glass itself, by heating them in the fire to a proper degree; having first laid on the colours.

The colours used in *painting* or *staining* of *glass*, are very different from those used in painting either in water or oil colours.

For *black*, take scales of *iron*, one ounce; scales of *copper*, one ounce; *jet*, half an ounce; reduce them to powder, and mix them. For *blue*, take *powder of blue*, one pound; *sal nitre*, half a pound; mix them and grind them well together. For *carnation*, take *red chalk*, eight ounces; *iron* scales and *litharge* of silver, of each two ounces; *gum arabic*, half an ounce; dissolve in water; grind all together for half an hour as stiff as you can; then put it in a glass and stir it well, and let it stand to settle fourteen days. For *green*, take *read lead*, one pound; scales of *copper*, one pound; and *flint*, five pounds; divide them into three parts; and add to them as much *sal nitre*; put them into a crucible, and melt them with a strong fire; and when it is cold, powder it, and grind it on a porphyry. For *gold colour*, take *silver*, an ounce; *antimony*, half an ounce; melt them in a crucible; then pound the mass to powder, and grind it on a copper plate; add to it *yellow oker*, or *brick-dust* calcined again, fifteen ounces; and grind them well together with water. For *purple*, take *minium*, one pound; *brown stone*, one pound; white *flint*, five pounds; divide them into three parts, and add to them as much *sal nitre* as one of these parts; calcine, melt, and grind it as you did the green. For *red*, take *jet*, four ounces; *litharge* of silver, two ounces; *red chalk*, one ounce; powder them fine, and mix them. For *white*, take *jet* two parts; white *flint*, ground on a glass very fine, one part; mix them. For *yellow*, take *spanish brown*, ten parts; *leaf-silver*, one part; *antimony*, half a part; put all into a crucible, and calcine them well.

Those beautiful works which were made in the glass-houses were of two kinds. In some, the colour was diffused through the whole substance of the glass. In others, which were the more common, the colour was only on one side, scarce penetrating within the substance above one third of a line; though this was more or less according to the nature of the colour; the yellow being always found to enter the deepest. These last, though not so strong and beautiful as the former, were of more advantage to the workmen, by reason that on the same glass, tho' already coloured, they could shew other kind of colours, where there was occasion to embroider draperies, enrich them with foliages, or represent other ornaments of gold, silver, &c.

In order to this, they made use of emery, grinding or wearing down the surface of the glass, till such time as they were got through the colour to the clear glass. This done, they applied the proper colours on the other side of the glass. By this means, the new colours were hindered from running and mixing with the former, when they exposed the glasses to the fire.

When indeed the ornaments were to appear white, the glass was only bared of its colour with emery, without tinging the place with any colour at all; and this was the manner by which they wrought their lights, and heightenings, on all kinds of colour.

The first thing to be done, in order to paint, or stain glass, in the modern way, is to design, and even colour the whole subject on paper. Then they choose such pieces of glass as are clear, even, and smooth, and proper to receive the several parts, and proceed to distribute the design itself, or papers it is drawn on, into pieces suitable to those of the glass; always taking care that the glasses may join in the contours of the figures, and the folds of the draperies; that the carnations, and other finer parts, may not be impaired by the lead with which the pieces are to be joined together. The distribution being made, they mark all the glasses as well as papers, that they may be known again: which done, applying every part of the design upon the glass intended for it, they copy, or transfer, the design upon this glass with the black colour diluted in gum water, by tracing and following all the lines and strokes as they appear through the glass with the point of a pencil.

When these strokes are well dried, which will happen in about two days, the work being only in black and white, they give a slight wash over with urine, gum arabic, and a little black; and repeat it several times, according as the shades are desired to be heightened, with this precaution, never to apply a new wash till the former is sufficiently dried.

This done, the lights and risings are given by rubbing off the colour in the respective places with a wooden point, or the handle of the pencil.

As to the other colours above-mentioned, they are used with gum-water, much as in painting in miniature; taking car to apply them lightly for fear of effacing the out-lines of the design; or even, for the greater security, to apply them on the other side; especially yellow, which is very pernicious to the other colours, by blending therewith. And here too, as in pieces of black and white, particular regard must always be had not to lay colour on colour, or lay on a new lay, till such time as the former are well dried.

It may be added, that the yellow is the only colour that penetrates through the glass, and incorporates therewith by the fire; the rest, and particularly the blue, which is very difficult to use, remaining on the surface, or at least entering very little. When the painting of all the pieces is finished, they are carried to the furnace, or oven, to anneal, or bake the colours.

The furnace here used is small, built of brick, from eighteen to thirty inches square; at six inches from the bottom is an aperture to put in the fuel, and maintain the fire. Over this aperture is a grate, made of three-square bars of iron, which traverse the furnace, and divide it into two parts. Two inches above this partition, is another little aperture, through which they take out pieces to examine how the coction goes forward. On the grate is placed a square earthen pan, six or seven inches deep; and five or six inches less every way than the perimeter of the furnace. On the one side hereof is a little aperture, through which to make trials, placed directly opposite to that of the furnaces destined for the same end. In this pan are the pieces of glass to be placed in the following manner: First, the bottom of the pan is covered with three strata, or layers, of quick lime pulverized; those strata being separated by two others of old broken glass, the design whereof is to secure the painted glass from the too intense heat of the fire. This done, the glasses are laid horizontally on the last or uppermost layer of lime.

The first row of glass they cover over with a layer of the same powder, an inch deep; and over this, they lay another range of glasses, and thus alternately till the pan is quite full; taking care that the whole heap always end with a layer of the lime-powder.

The pan being thus prepared, they cover up the furnace with tiles, on a square table of earthen-ware, closely luted all round; only leaving five little apertures, one at each corner, and another in the middle, to serve as chimnies. Things thus disposed, there remains nothing but to give the fire to the work. The fire for the first two hours must be very moderate, and must be increased in proportion as the coction advances, for the space of ten or twelve hours; in which time it is usually compleated. At last the fire, which at first was charcoal, is to be of dry wood, so that the flame covers the whole pan, and even issues out at the chimnies.

During the last hours, they make essays, from time to time, by taking out pieces laid for the purpose through the little aperture of the furnace, and pan, to see whether the yellow be perfect, and the other colours in good order. When the annealing is thought sufficient, they proceed with great haste to extinguish the fire, which otherwise would soon burn the colours, and break the glasses,

G L A Z I N G.

GLAZING is the art of poliſhing or cruſting over *earthen-ware*, by running melted lead or litharge over the clay-veſſel, *&c.*

The common ware is glazed with a compoſition of 50 lb. clean ſand, 70 lb. lead-aſhes, 30 lb. wood-aſhes, and 12 lb. ſalt, all melted into a cake. With this mixture they glaze it over, and then ſet it in an earthen glazing pan; taking care that the veſſels do not touch one another. As ſeveral colours are uſed for this purpoſe, we ſhall give the following receipts, from *Smith*'s Laboratory. 1. For a black, take lead-aſhes, 18 parts; iron filings, 3; copper-aſhes, 3; and zaffer, 2: this, when melted, will make a brown black; and if you would have it blacker, put ſome more zaffer to it. 2. For blue, take lead-aſhes, 1 lb. clear ſand or pebble, 2 lb. ſalt, 2 lb. white calcined tartar, 1 lb. venice or other glaſs, 16 lb. and zaffer, half a pound: mix them well together; and after melting quench them in water, and then melt them again; which operation is to be repeated ſeveral times; and if you would have it fine and good, it will be proper to put the mixture into a glaſs furnace for a day or two. 3. A brown glazing may be given with a mixture of lead-glaſs, 12 parts, and common glaſs and mangane ſe, of each one part. 4. A citron-yellow may be made of 6 parts of red-lead, 7 parts of fine red brick duſt, and two parts of antimony, all melted together. 5. A fleſh-colour, with 12 parts of lead-aſhes, and 1 of white glaſs. 6. For a green-colour, take 8 parts of litharge, 8 parts of venice glaſs, 4 parts of braſs duſt, and melt them together for uſe; or melt together two parts yellow-glaſs, with as much copper-duſt. 7. For a gold-yellow, take of antimony, red-lead, and ſand, an equal quantity, and melt them into a cake. 8. For a fine purple brown, take lead-aſhes, 15 parts; clear ſand, 18; manganeſe, 1; white glaſs, 15 meaſures; and one of zaffer. 9. For a fine red, take antimony, 2 lb. litharge, 3 lb ruſt of iron calcined, 1 lb. and grind them to a fine powder. 10. For a fine white glazing, take 2 lb. of lead, 1 lb. of tin, and calcine them to aſhes; of which take 2 parts; of calcined flint or pebble, 1 part; of ſalt, 1 part; and mixing them well together, melt them into a cake. At *Rotterdam*, they make a fine ſhining white glazing, by melting together 2 lb. clean tin-aſhes, 10 lb. lead-aſhes, 2 lb. fine venice glaſs, and half a pound tartar. 11. A yellow glazing is made of 4 ounces of red-lead, and two ounces of antimony, melted together. 12. For a fine yellow, take red lead, 3 pints; antimony and tin, of each 2 lb. then melting them into a cake, grind it fine; and repeating this ſeveral times, you will have a good yellow.

G O L D - B E A T I N G.

THIS is the art of reducing *gold* into exceeding thin leaves: for which purpoſe there muſt be choſen *gold* with as little alloy as poſſible.

The *gold-beater*'s ſhop is furniſhed with a ſmall forge, a ſmall anvil, crucibles, *&c.* and likewiſe with three ſorts of hammers formed like mallets, of poliſhed iron. The firſt, which is to weigh three or four pounds, will ſerve to chace, or drive; the ſecond, of eleven or twelve pounds, to cloſe; and the third, which muſt weigh fourteen or fifteen pounds, to ſtretch and finiſh. Beſides this, there muſt be a block of black marble, about a foot ſquare, and which is to be raiſed three foot high; and alſo four moulds of different ſizes, *viz.* two of vellum, the ſmalleſt whereof muſt conſiſt of forty or fifty leaves; and the largeſt of two hundred; the other two conſiſting each of five hundred leaves, made of bullocks guts well ſcoured and prepared.

Proceed to work, by melting a proper quantity of *gold*, and forming it into an ingot; this done, reduce that ingot, by forging, into a plate about the thickneſs of a ſheet of paper; and then cut it into little pieces, about an inch ſquare, and lay them in the firſt, or ſmalleſt mould, to begin to ſtretch them. After they have been hammer'd here a while with the ſmalleſt hammer, cut each of them into four; and put them into the ſecond mould, to be extended further.

Upon taking them hence, cut them again into four, and put them into the third mould; out of which they are taken, divided into four as before, and laid in the laſt or finiſhing mould, where beat them to the degree of thinneſs required: obſerving that the *gold* is beaten more or leſs according to the

the kind or quality of the work it is intended for: that for the gold-wire-drawers to gild their ingots withal, must be left thicker than that for gilding frames of pictures, *&c.* withal.

It is computed that an ounce may be beaten into sixteen hundred leaves, each three inches square; in which state it takes up more than 15.9092 times its former space.

The leaves thus finished are taken out of the mould, and disposed in little paper books prepared with red bole, for the gold to stick to: each book ordinarily containing twenty-five gold leaves. There are two sizes of these books; twenty-five leaves of the smallest only weighs five or six grains; and the same number of the largest nine or ten grains.

Shell gold used by the illuminers, and wherewithal we write gold letters, is made of the parings of leaf-gold, and even of the leaves themselves, reduced into an impalpable powder, by grinding on a marble with honey: and after it has been left to infuse some time in aqua-fortis, it is put in shells where it sticks.

GOLD-WIRE-DRAWING.

GOLD-WIRE-DRAWING, is the method of managing gold in order to fit it to be spun on silk, or to be used flat as it is, without spinning, in certain stuffs, laces, embroideries, *&c.*

The operation is performed by forging, first, an ingot of silver of twenty-four pounds into a cylinder about an inch in diameter: then drawing it through eight or ten holes of a large coarse wire drawing iron, both to finish the roundness, and to reduce it to about three fourths of its former diameter. This done, it is filed very carefully all over, to take off any filth remaining of the forge: then it is cut in the middle, making thus two equal ingots thereof, each about 26 inches long, which are drawn through several new holes, to take off any inequalities the file may have left, and to render it as smooth and equal as possible.

The ingot thus prepared, is heated in a charcoal fire; then taking some gold leaves, each of about four inches square, and weighing twelve grains; four, eight, twelve, or sixteen of these are joined together, as the wire is intended to be more or less gilt; and when they are so joined as only to make a single leaf, the ingots are rubbed reeking hot with a burnisher.

These leaves thus prepar'd, are applied over the whole surface of the ingot to the number of six, over each other; burnishing or rubbing them well down with the blood stone, to close and smoothen them.

When gilt, the ingots are laid a new in a coal-fire; and when raised to a certain degree of heat, the artist goes over them a second time with the blood-stone, both to solder the gold more perfectly, and to finish the polishing.

The gilding finished, it remains to draw the ingot into wire. In order to this, it is passed through twenty holes of a moderate drawing-iron, by which it is brought to the thickness of the tag of a lace: from this time, the ingot loses its name, and commences *gold wire.* Twenty holes more of a lesser iron, leave it small enough for the least iron: the finest holes of which last, scarce exceeding the hair of the head, finish the work.

Before the wire be reduced to this excessive fineness, it is drawn through above an hundred and forty different holes; and each time they draw it, it is rubbed fresh over with new wax, both to facilitate its passage, and to prevent the silver appearing through.

To dispose the wire to be spun on silk, they pass it between two rollers of a little mill. These rollers are of polished steel, and about three inches in diameter. They are set very close to each other, and turn'd by a handle fasten'd to one of them, which gives motion to the other. The *gold wire* in passing between the two, is render'd quite flat; but without losing any thing of its gilding; and is render'd so exceedingly thin and flexible, that it is easily spun on silk-thread, by a hand-wheel, and so wound on a spool or bobbin.

The prodigious ductility, which makes one of the distinguishing characters of gold, is no where more conspicuous than in this gilt wire. A cylinder of 48 ounces of silver, cover'd with a coat of gold, Dr. *Halley* informs us, is commonly drawn into a wire, two yards of which weigh only one grain: whence ninety-eight yards of the wire weigh only forty-nine grains. And one single grain of gold, covers the said ninety-eight yards: so that the ten thousandth part of a grain, is above half an inch long. The same author computing the thickness of the skin of gold, found it to be only $\frac{1}{134500}$ part of an inch. Yet so perfectly does it cover the silver, that even a microscope does not discover any appearance of the silver underneath. Mr. *Rohault* observes, that a like cylinder of silver covered with gold, two feet eight inches long, and two inches nine lines in circumference, is drawn into a wire 307200 feet long; *i. e.* into 115200 its former length. Mr. *Boyle* relates, that eight grains of gold, covering a cylinder of ſilver, is commonly drawn into a wire 30000 feet long.

G R A M M A R.

THOSE who are well verſed in *Grammar*, or who teach *Grammar*, are called *Grammarians*. — The *Grammarian* is conceived as a perſon wholly attentive to the *minutiæ* of language; induſtriouſly employed about words and phraſes; incapable of perceiving the beauties, delicacy, extent, *&c.* of a ſentiment. *Scaliger*, however, conſidered *Grammarians* in another light; *utinam eſſem*, ſays he, *bonus* grammaticus: *ſufficit enim ei, qui omnes authores vult intelligere, eſſe* grammaticum — The title *Grammarian*, it is certain, was antiently a title of honour; being given not only to ſuch as applied themſelves to *Grammar*, or excelled in philology; but to all who were reputed learned in any art, or faculty whatever; as is ſhewn by *Ger. Voſſius*, in his book of *Grammar*. The word was properly a title of literature and erudition, and frequently given to perſons who excelled in all, or many arts, call'd alſo *Polyhiſtores*. Thus *Philoponus*, a famous philoſopher in *Juſtinian*'s time, remarkable for the extent and variety of his knowledge, was ſurnamed *Grammaticus*. So *Saxo*, the *Daniſh* hiſtorian, in the 13th century, got the appellation *grammaticus*: and as late as the year 1580, *Thomas d' Averſa*, the famous *Neapolitan* lawyer, was ſurnamed the *Grammarian*.—The title *grammarian* was antiently beſtow'd on thoſe we now call *criticks*, men of learning, erudition, letters, *&c.* and particularly ſuch as wrote well, and politely in every kind. It is in this ſenſe that *Suetonius* entitles his book, which he wrote on the beſt *Latin* authors, *of the celebrated grammarians*; and that *Cornelius Nepos* calls the commentators on the orators, and poets, *grammarians*. And laſtly, it is in this ſenſe the apellation is attributed, by the antients to *Apion*, *Philoponus*, and *Solinus*.—The moſt celebrated *grammarians* of the ſecond century. were *Aper*, *Pollio*, *Eutychius*, *Proculus*, *Athenæus*, *Julius Pollux*, *Macrobius*, and *Aulus Gelius*. The works of theſe laſt authors are an aſſemblage of abundance of very different things and ſubjects, relating to the criticiſms of the antient writers, and polite literature.—If the name have loſt its antient honour, it is through the fault of thoſe who have aſſumed it; by treating of *grammar* in a low, pedantick, and dogmatick manner; reducing it to words and ſyllables; and dwelling altogether on trifling, puerile remarks and cenſures, whereas its antient office was to make an accurate, and thorough examen of an author: to enter into all his views. to point out the beauties and the defects thereof; to diſtinguiſh the true beauties from the falſe; and the genuine productions of an author from the ſuppoſititious: that is, a *grammarian* was then, what we call *a critick* now.—Thoſe who only taught to read, underſtand, and explain authors, were call'd *grammaticks*, *grammatiſtæ*; in contradiſtinction from *grammatici*: though, in courſe of time, the *grammatiſtæ* have roſe into the place of *grammatici*, who are preferred to that of *critici*.

Diogenes Laertius relates, after one *Hermippus*, that *Epicurus* was the firſt who gave the rules of *grammar* for the *Greek* tongue; but that *Plato* was the firſt who had taken the thing into conſideration, and even made ſome diſcoveries on that ſubject.—At *Rome*, *Crates*, ſurnamed *Mallotes*, contemporary with *Ariſtarchus*, gave the firſt lectures thereon to the *Romans*, during the time of his being embaſſador for King *Attalus*, to the common-wealth, between the ſecond and third *Punick* wars, ſoon after *Ennius*'s death. Before him it was not known at *Rome* what *grammar* meant.

GRAMMAR is the art of ſpeaking and writing a language with propriety, or correctneſs; and it is divided by ſome authors into four parts, *Orthography*, *Proſody*, *Etymology*, and *Syntax*.

Others chuſe to divide *grammar* ſomewhat more obviouſly, into the doctrine of *letters* or *ſounds*, which coincides with *orthography*, and *orthopy*; that of *ſyllables*, their accent, time, *&c.* which falls in with *proſody*; that of *words*, their kinds, derivations, changes, analogy, *&c.* which amounts to *etymology*; and that of *ſentences*, which conſiders the placing or joining of words together, called *ſyntax*.

Grammar is the ſame in all *languages*, as to its *general principles* and notions, which it borrows from *philoſophy*, to explain the order and manner, wherein we expreſs our *ideas* by *words*; but as each language has its particular *turns*, its ſeveral *characters* and *genius*, different from the genius and character of other languages, hence ariſe as many

I

grammars

grammars as *languages* Therefore to give a true notion of thoſe ſeveral different languages, I muſt take notice in this treatiſe, of the moſt *eſſential rules* peculiar to each different *grammar*; and as the *doctrine* of LETTERS is the firſt part of our diviſion of *grammar*, we'll begin, as all grammarians do, with the ALPHABET, which is the ſeveral *letters* of a language, diſpos'd in their natural or accuſtom'd order; and as there are as many ſorts of *alphabets*, likewiſe, as there are *languages*, (for this they may uſe the ſame *character* or *letters*, they differ in the pronunciation of theſe letters) I'll give here ſome of thoſe different ſorts, *viz.* the *Engliſh*, *French*, *Latin*, *Greek*, and *Hebrew*.

ENGLISH.	FRENCH.		LATIN.		HEBREW.					GREEK.		
26 Letters	*24 Letters*	*Pronunciation.*	*22 Letters*	*pronounced like* French.	*Names.*	*Figures.*	*Similitudes.*	*Powers.*		*Figures.*	*Names.*	*Powers.*
a	a	aw	a					*ſpiritus*		Α α	Alpha	a
b	b	bé	b		Aleph	א	צ	*lenis*	1	Β β ϐ	Beta	v
c	c	cé	c		Bheth	ב	כ	bh	2	Γ γ	Gamma	g
d	d	dé	d		Ghimel	ג	נ	gh	3	Δ δ	Delta	d
e	e	eé	e		Dhaleth	ד	ר ך	dh	4	Ε ε	Epſilon	e, *breve*
f	f	ef	f		He	ה	ח ת	h	5	Ζ ζ	Zeta	z
g	g	gé	g		Vau	ו	ו ז	v, *Con.*	6	Η η	Eta	e, *longum*
h	h	aſhe	h		Zajin	ז		z	7	Θ θ ϑ	Theta	th
i	i		i		Cheth	ח		hh	8	Ι ι	Iota	i
j	l	ell	l		Teth	ט	מ	t	9	Κ κ	Kappa	k, c
k	m	m	m		Jodh	י		j, *Con.*	10	Λ λ	Lambda	l
l	n	n	n		Chaph	כ ך		ch, x	20	Μ μ	Mu	m
m	o	o	o		Lamed	ל		l	30	Ν ν	Nu	n
n	p	pé	p		Mem	מ ם	ס	m	40	Ξ ξ	Xi	x
o	q	kûu	q		Nun	נ ן		n	50	Ο ο	Omicron	o, *parvum*
p	r	r	r		Samech	ס		ſ, *acutum*	60	Π π ϖ	Pi	p
q	ſ	ſ	ſ		Ghnajin	ע		ghn, ngh	70	Ρ ρ ϱ	Rho	r
r	t	té	t		Phe	פ ף		ph	80	Σ ς σ ς	Sigma	ſ
ſ	u	ue	u		Tzade	צ ץ		tſ	90	Τ τ	Tau	t
t	w		x		Koph	ק		k	100	Υ υ	Upſilon	u
u	x		y		Reſch	ר		r	200	Φ φ	Phi	ph
v	y	e *Greek*	z		Schin	שׁ		ſch ſh	300	Χ χ	Chi	ch
w	z	zede			Sin	שׂ		ſ		Ψ ψ	Pſi	pſ
x					Thau	ת		h	400	Ω ω	Omega	o, *magnum*
y												
z												

It is proper here to obſerve, that the *Chaldee*, *Syriac*, and *Samaritan* alphabets, have, like the *Hebrew*, each 22 letters; the *Arabick* 28; the *Perſian* 31; the *Turkiſh* 33; the *Georgian* 36; the *Coptick* 32; the *Muſcovite* 43; the *Sclavonian* 27; the *Dutch* 26; the *Spaniſh* 27; the *Italians* of *Bengal* 21; the *Baramas* 19; and the *Ethiopick* no leſs than 202; there being 7 vowels, which they combine with each of their 26 conſonants: to which they add 20 other aſpirated ſyllables. The like is ſaid of the *Tartarian*, each of their letters is a ſyllable, having one of the vowels join'd to its conſonant, as *la*, *le*, *li*, &c. The *Chineſe* have no alphabet, properly ſpeaking, except we call their whole language their alphabet; their *letters* are *words*, or rather *hieroglyphicks*, and are in number about 80,000.

Note alſo, That alphabets were not contrived with deſign, according to the juſt rules of reaſon, and analogy; but ſucceſſively framed and altered, &c. as occaſion offered.

The *characters* now uſed in all the alphabets of modern languages, throughout all *Europe*, are the *Latin* Characters of the antients.

Theſe *characters* are divided, by *grammarians*, into *vowels* and *conſonants*; into *mutes*, *dipthongs*, *liquids*, and *characteriſticks*; and are commonly called *letters*.

A VOWEL, is a letter which affords a compleat ſound of itſelf; or a letter ſo ſimple, as only to need

need a bare opening of the mouth to make it heard, and to form a diſtinct voice. Such are *a*, *e*, *i*, *o*, *u*; which are called *vowels*, in contradiſtinction to certain other letters, which depending on a particular application of ſome part of the mouth, as the *teeth*, *lips*, or *palate*, can make no perfect ſound without an opening of the mouth, that is, without the addition of a vowel; and are therefore called conſonants.

Though we ordinarily only reckon five vowels, yet, beſides, that each of theſe may be either long, or ſhort, which occaſions a conſiderable variety in the ſound; to conſider only their differences reſulting from the different aperture of the mouth in the *Engliſh* pronunciation, one might add four or five more vowels to the number.—For the *e* open, and the *e* cloſe, are different enough to make two vowels, as in *ſea* and *depth*; ſo alſo the *o* open, and *o* cloſe, in *hoſt* and *organ*. Add, that the *u* pronounced *ou*, as the *Latins* did, and as *Italians* ſtill do, has a very different ſound from the *u*, as pronounced by the *Greeks*, and as at this day by the *French* and *Engliſh*.—Again, *eo*, in *people*, make but one ſingle ſound, though written with two vowels.

Laſtly, the *e* mute is, originally, no more than a ſurd joined to a conſonant, when that is to be pronounced without a vowel, as when it is immediately followed by other conſonants. Thus, without regarding the differences of the ſame ſound, or vowel, as to length or ſhortneſs, one may diſtinguiſh ten ſeveral vowels, expreſſed by the following characters *a*, *ê*, *i*, *o*, *ô*, *eu*, *ou*, *u*, *e*, mute.

The Consonant, is a letter, which produces no ſound alone, or without ſome vowel joined with it: and conſidered philoſophically, it is nothing elſe but the modification of a ſound, produced by means of the organ of the voice, not a production of ſound itſelf: thus *v. gr.* the ſounds ſignified by the characters, *a*, *e*, *i*, *o*, *u*, are differently modified, when we ſay *ab* than when we ſay, *ac*, or *ca*, *ad*, or *da*; and thoſe modifications are called *conſonants*.

Conſonants are divided into ſingle, as *b*, *h*, *m*, *q*, &c. and double, as *ax*, in *axillary*; correſponding to the ξ of the *Greeks*.

Conſonants, again, are divided into liquid, as *l*, *r*, *m*, *n*; and mute, as *b*, *d*, and the reſt, which make no ſound at all without a vowel.

But the *Hebrew* grammarians, who have been imitated therein by the grammarians of other oriental languages, divide the *conſonants* into *five claſſes*, with regard to the five principal organs of the voice.

Theſe organs are the *throat*, *palate*, *tongue*, *teeth*, and *lips*; whence the five claſſes of conſonants are denominated *guttural*, *palatal*, *lingual*, *dental*, and *labial*.

There are ſixteen conſonants in the *Engliſh* alphabet, *viz.* *b*, *c*, *d*, *f*, *g*, *k*, *l*, *m*, *n*, *p*, *q*, *r*, *s*, *t*, *x*, *z*; to which the *h*, the *j* conſonant, and *v* conſonant, make the whole number of conſonants nineteen; one whereof is *guttural*, *viz.* the aſpirate *h*; five *palatal*, viz. *c*, as when pronounced before *a*, *o*, and *u*, as in *cavern*, *corn*, *curioſity*; *g*, as in *Geneva*; *j* conſonant in *julep*; *k*, in *kernel*; and *q*, in *query*.—The four *lingual conſonants* are *d*, *l*, *n*, *t*; the four dental are, *r*, *s*, *x*, *z*; the three laſt whereof are hiſſers; and five labial, *b*, *f*, *m*, *p*, and *v* conſonant.

With regard to which diviſion, it may be obſerved, that though the *g* be modified in three different manners, as is comes before an *a*, an *o*, or an *u*; yet it is ſtill a conſonant of the palate; that the *j* conſonant differs, in nothing but its figure, from the *g* before *e*, or *i*; that *k* has the ſame pronunciation with the *c*; that *x* comprehends the ſound of two letters in its ſound, *viz.* *c*, or *k*, and *ſ*, or another *c*, as in *Alexander*, and in *Alexis*, which we pronounce as if wrote *Alecſander*, and *Aleccis*, or *Alecſis*; and that the *c* before an *e* or *i* is no conſonant of the palate, becauſe in that caſe it loſes its proper ſound, and aſſumes the hiſſing ſound of the *ſ*

The exceſs of conſonants, in one language above another, only conſiſts in this, that there are more modifications of ſound received, and eſtabliſhed in the one than in the other; for all men, having the ſame organs, may form the ſame modifications; ſo that it is entirely owing to cuſtom, nothing to nature, that the *Engliſh* have not the ϑ of the *Greeks*, the *Ain* and *Heth* of the *Hebrews*, the *ch* of the *Germans*, the *gn* of the *French*, the *gl* of the *Italians*, the *ll* of the *Welch*, &c.

Alſo that the *Chineſe* have no *r*, the *Iroquis* no labial conſonants, the *Hurons* abundance of aſpirates; and the *Arabs* and *Georgians* abundance of double conſonants; which laſt is owing to this, that they make ſeveral organs concur ſtrongly, and equally to the modification of a ſound; whereas, in the reſt, only one organ is moved very ſtrongly and ſenſibly, and the reſt weakly.

It is alſo viſible, that, in all languages, the aſpirates, or guttural letters are real conſonants, ſince the throat modifies the ſound as much as the palate, tongue, or lips.

Laſtly, To find all the conſonants that may be formed in any language, there needs nothing but to obſerve all the modifications that the ſounds of ſpeech will admit of, by which we ſhall have all the conſonants practicable.

An *aſpirate* is alſo a *modificative*, or *conſonant*, as having all the properties of a *conſonant*; for, 1. It reſults from a motion of the organ, which of itſelf

ſelf produces no ſound; thus the *ſpiritus* of the *Greeks*, the *French*, and *Engliſh h* aſpirate, has no more ſound of itſelf than *b*, *c*, *d*, &c. and the ſame thing may be obſerved of the *Aleph*, *Beth*, and *Caph*, of the eaſtern languages. 2. On the contrary the *Engliſh h*, the *ſpiritus* of the *Greeks*, and the other aſpirates juſt mentioned, are pronounced with all the vowels, in the ſame manner as *conſonants* are. They modify thoſe vowels, and are effects of a motion of the organ ſuperadded to the motion neceſſary to form the vowel. Thus to pronounce *ha*, two motions of the organ are required as well as for *ba* or *ca*, &c. one for *a*, which itſelf is a ſound; the other for *h*, which yields no ſound no more than *b*, but adds ſomething to *a*, which modifies it, and makes that *ha* in not mere *a*, nor *ba*, nor *ca*, &c. and this muſt hold ſtill more ſenſibly in the ſtronger aſpirates of the oriental tongues; in all which there are evidently two motions, the one for the vowel, and the other to modify it: now this being the nature and eſſence of a conſonant, it follows, that let them be denoted in what manner they will, whether as the *Engliſh h*, as the oriental *do*, i. e. by proper characters in the courſe of the words themſelves; or, as the *Greeks* do ſome of theirs, by a ſign of aſpiration placed over the vowel, it matters not. The *aſpirote* is no leſs a conſonant in ἁιρω than in χαιρω; in εω, than in χεω; in ὁλη than in χολη; and ſo of others. The third and laſt reaſon is, that the eaſtern languages, which do not expreſs the vowels, do yet expreſs the aſpirates. Add, that the aſpirate is frequently changed into a conſonant, and expreſſed by a conſonant: thus if ἑξ is made *ſex*; of ἑπ7α, *ſeptem* of ἑσπερος, *Veſperus*, &c. of the *Hebrew* יין, ὁινος, and thence *Vinum*, &c. nay even in the ſame language, *Heſiod* ſpeaking of *Hercules*'s buckler, uſes Ἡρσυν for Θηρσυν; making no difference between a Θ and an aſpirate. Hence it evidently follows, that aſpirates are real conſonants; and that it muſt be an error to rank א,ה,ע, of eaſtern languages among the vowels; and to exclude the *h* in *Engliſh* out of the number of letters.

Mute letters, are thoſe which are not ſounded, or heard in the pronunciation, or letters which yield no ſound of themſelves, and without a vowel.

The *mutes* in the *Engliſh* alphabet are eleven, *viz.* *B*, *C*, *D*, *F*, *G*, *J*, *K*, *P*, *Q*, *T*, *V*. They are called *mutes*, becauſe a liquid cannot be ſounded in the ſame ſyllable before them, as *repo*; but a *mute* may be pronounced in the ſame ſyllable before a liquid, as *pro*.

Liquids are certain conſonants oppoſed to *mutes*; *l*, *m*, *n*, and *p*, are *liquids*.

Dipthong is a double vowel, or the union, or mixture of two vowels pronounced together, ſo as only to make one ſyllable; as the *Latin a e*, *æ*, *o e*, or *œ*; the *Greek* αι, ει; the *Engliſh ai*, *au*, &c.

Ae anſwers to *ai*, the proper, and ᾳ the improper dipthong of the *Greeks*, *e. g.* Αινειας, *Aneas*; σφαιρα *Sphaerae*, &c. And on the contrary, the *Romans* when they had occaſion to divide their *ae*, changed it into the *Greek ai*, *e. g.* *aulai* for *aulae*, &c.

Ai by ſome is made a *Latin* dipthong, as in *ais*, *caius*, &c. But in *ais* and *ait*, *i* manifeſtly belongs to the latter ſyllable; and the *Greeks* write not Γαῖος, but Γαιος; whence it ſeems plain that *ai* in the *Latin* tongue is not a dipthong as in the *Greek*.

The *Latins* pronounced the two vowels in their *dipthongs* much as we do, with this exception, that the two were not heard equally, but the one was ſomewhat weaker than the other, though the diviſion was made with all the delicacy imaginable. Among the *Engliſh* moſt of the *Latin* dipthongs are loſt in the pronunciation; their *æ* and *œ* are only ſpoke as *e*'s, ſo as alſo the *Engliſh ea*, *oa*, &c. though wrote with two characters, are pronounced as ſimple ſounds

In *French*, *Engliſh*, and divers other languages, one may diſtinguiſh *dipthongs* with regard to the eye, from *dipthongs* with regard to the ear.

Engliſh dipthongs proper, are *ai*, as in *fair*; *au*, in *laud*; *ee*, in *bleed*; *oi*, in *void*; *oo*, in *food*; and *ou*, in *houſe*.

Engliſh improper dipthongs, are *aa*, pronounced only like *a*, as in *Aaron*; *ea*, like *a*, as in *ſwear*, *heart*; or like *e*, as *already*; or like *ee*, as *veal*: *eo*, like *e*, in *feoffe*; or like *o*, in *George*: *eu*, or *ew*, like *u*, as *Deuteronomy*; *ie*, like *e*, as *cieling*, *field*: *ei*, like *a*, in *feign*; or like *e*, in *deceit*: *oa*, as in *cloak*, *doat*: *oe* as *doe*, *œconomy*: *ue*, as in *gueſs*: and *ui* as in *guile*, *recruit*.

From theſe different diviſions of letters, we'll paſs to every letter of our alphabet.

A is a vowel, and the firſt letter of the *French Engliſh*, and moſt other alphabets; and it is obſerved to be that, which dumb perſons are ſooneſt taught to pronounce. The reaſon is, that it does not depend on the muſcles, and other organs of the mouth and tongue, which are generally wanting in mutes; but on thoſe of the throat and noſe, which they commonly have.

It is ſo much the Language of Nature, that upon all ſudden and extraordinary occaſions we are neceſſarily led to it, as the inſtrument readieſt at hand. With this we ſpeak our admiration, joy, anguiſh, averſion, apprehenſion of danger, &c. where the paſſion is very ſtrong, we frequently enforce the *A*, by adding an Aſpirate, as *ah*.

It

It is obſerved of the *Engliſh* pronunciation, that they ſpeak the *A* with a ſlenderer and more puny ſound than any of their neighbours: Ordinarily it is ſcarce broad enough for a *French* E neuter; and comes far ſhort of the groſs *A* of the *Germans*, which would make their *au* or *aw*, or *o*.—In ſome words, however, as *talk*, *wall*, *ſtall*, &c. the *A* is broad, and deep enough; but this, it is obſerved, may not be the mere ſound of *A*, but the effect of the antient orthography, which, as low as queen *Elizabeth*, frequently added an *u* to the *A*, and wrote *taulk*, &c.

B, the ſecond letter of moſt alphabets, is the firſt conſonant, and firſt mute, and in its pronunciation is ſuppoſed to reſemble the bleating of ſheep.

B is alſo a *Labial*, becauſe the principal organs employed in its pronunciation are the lips. It has a near affinity with the other *labials* P and V, and is often uſed for P, both by the *Armenians*, and other orientals; as in *Betrus* for *Petrus*, *Apſens* for *Abſens*, &c. and by the *Romans* for *V*, as in *amabit* for *amavit*, *Berna* for *Verna*, &c. whence aroſe that jeſt of *Aurelian* on the Emperor *Bonoſus*, *Non ut vivat natus eſt, ſed ut bibat*.

B requires an entire cloſure and preſſure of the lips to pronounce it, and therefore can ſcarce ever end the ſound of a word: But when you endeavour to pronounce it there, you are obliged to add an E to open the lips again; as in *Job*, which is ſounded *Jobe*.

C, is the third letter, or ſecond conſonant of the alphabet, and is formed from the κ of the *Greeks*, by retrenching the ſtem, or upright line.

All the Grammarians agree that the *Romans* pronounce their *q* like our *c*, and their *c* like our *k*: *F. Mabillon* adds, that *Charlemagne* was the firſt who wrote his name with a *C*; whereas all his predeceſſors of the ſame name wrote it with a *K*, and the ſame difference is obſerved in their coins.

D, the fourth letter of the alphabet, and the third conſonant, is generally ranked by the grammarians among the *lingual* letters, as ſuppoſing the *tongue* to have the principal ſhare in the pronunciation thereof.

The form of our *D* is the ſame with that of the *Latins*, and the Latin *D* is no other than the *Greek* Δ, rounded a little by making it quicker.

E, the fifth letter of the alphabet, and the ſecond vowel, admits of ſome variety in the pronunciation in moſt languages; whence grammarians uſually diſtinguiſh ſeveral *E*'s, or kinds of *E*. The *Greeks*, *e gr.* have their ſhort and long, *viz.* ε and η, *Epſilon* and *Eta*. The *Latins* have an opener *e*, called *vaſtius*, ſuch was the ſecond *e* in the word *here*, maſter; and another cloſer, as that in the adverb, *here*, yeſterday. This later *e* they frequently uſed promiſcuouſly with *i*; thus for *here* they wrote *heri*, and in divers places we meet with *ſibe*, *quaſe*, &c. for *ſibi*, *quaſi*, &c.

In *Engliſh* they eaſily diſtinguiſh three *E*'s, or ſounds of *E*; the firſt mute, and not heard at all, as in *Amſterdam*, *ſenſe*, *blue*, &c. the ſecond cloſe, or ſhort, pronounced with the Lips nearly ſhut; as in *equity*, *nettle*, &c. the third open or long, as in *fear*, *eaſe*, &c.

The *French* have, at leaſt, ſix kinds of *E*; the firſt pronounced like *a*, as in *emporter*, *orient*, &c. the ſecond a final mute, in the laſt Syllable of divers words not pronounced at all; as in *bonne*, *donne*, &c. the third an imperfect mute, pronounced much like the dipthong *eu*, as *je*, *ne*, *te*; the fourth *e fermé*, or *e* maſculine, mark'd at the end of words with an *é*, as in *Jugé*, *Chaſtié*, &c. the fifth is *e ouvert*, or *long*, having the ſame ſound with *ai*, as in *Mere*, *Feſte*, &c. in the middle of words it is ſometimes marked with a circumflex, and in the end with an accent *è*: the ſixth is an intermediate *E* between the *ouvert* and *fermé*, as in *Cabaret*, *Lettre*, &c Some add a ſeventh kind of *e*, not reducible to any of the former, as that in *grammarien*, *hiſtorien*, &c. and others admit of only of three kinds, *viz.* the *mute*, *open*, and *ſhut*: but they make variations therein, which amounts to the ſame thing.

As to the figure of the letter *E*, we borrow it from the *Latins*, who had it from the *Greeks*.

The little *e* was formed of the great one, by writing it faſt, and making the croſs ſtrokes at top and bottom without taking the pen off the paper, and then adding the ſtroke in the middle.

F, the ſixth letter of the alphabet, and the fourth conſonant, may be conſidered abſolutely, and in itſelf, or with regard to the particular Languages where it is found. In the firſt view, *f* is generally placed by ſome grammarians among the mutes, like the Φ among the *Greek* grammarians; though others give it the quality of a ſemi-vowel.

This letter is derived to us from the *Romans*, who borrowed it from the *Æolians*, which of conſequence, is no other than a corruption of the *Greek* Φ: yet the ſound was much ſofter among the *Latins* than among the *Greeks*; as was long ago obſerved by *Terentianus*.

It may be added that the pronunciation of the *f* is almoſt the ſame with that of the *v*; as will be evident by attending to the manner of pronouncing the following words, *favour*, *vanity*, *felicity*, *vice*, *foment*, *vogue*, &c. The *French*, particularly, in borrowing words from other languages, uſually turn

turn the final *v* into an *f*, as *Chetif*, of the *Italian Cattivo*; *Neuf*, of the *Latin Novus*; *Nef* of the *Latin Navis*, &c.

In the latter *Roman* writers we find the *Latin f* and *Greek* φ, *ph*, frequently confounded; as in *Falanx*, for *Phalanx*; *Filosofhia*, for *Philosophia*, &c. which is still retained by many *French* writers, who write *Filosophie*, *Filippe*, *Episane*, &c. and by the *English*, as in *Fantasy*, *Filtre*, &c.

G, the seventh letter of our alphabet, and the fifth consonant, is of the mute kind, and cannot be any way sounded without the help of a vowel: it is formed by the reflection of the air against the palate, made by the tongue, as the air passes out of the throat. So that G is a palatal letter.

The *Latins* took the liberty to drop the letter *G* at the beginning of words before an *n*; as in *gnatus*, *gnosco*, *gnobilis*, *gnarrat*, &c. which they ordinarily wrote *natus*, *nosco*, *nobilis*, *narrat*, &c. they also frequently changed it into *C*, as *Gamelus*, into *Camelus*; *Gragulus* into *Graculus*, &c. sometimes it was put instead of *N* before a *C*, and another *G*; as *Agchises*, *Agora*, *Agguilla*, &c. for *Anchises*, *Anchora*, *Anguilla*, &c.

The northern people frequently change the *G* into *V* or *W*; as in *Gallus*, *Wallus*; *Gallia*, *Wallia*, *Vallia*, &c. for in this instance it must not be said that the *French* have changed the *W* into *G*, by reason they wrote *Gallus* long before *Wallus*, or *Wallia* were known, as appears from all the antient *Roman* and *Greek* writers.

The form of our G is taken from that of the *Latins*, who borrow'd it from the *Greek* gamma Γ.

H, the eighth letter of the alphabet, and the sixth consonant. Some will only have it an *aspiration* or *spirit*, because its sound is so weak.

But it is already shewn that the *h*, like all the other *aspirates*, from the time it is aspirated, and for this very reason that it is aspirated, is not only a letter, but a *real consonant*; it being a motion, or effort of the *larynx*, to modify the sound of the vowel that follows; as is evident in the words *heaven*, *health*, *hero*, &c. where the vowel *e* is differently modified from what it is in the words *endive*, *eating*, *ebb*, &c. and such modification is all that is essential to a consonant.

The *h* then is a letter, and a consonant of the *guttural* kind, *i. e.* a consonant, to the pronunciation whereof, the *throat* concurs in a particular manner, more than any other of the organs of voice.

When the *h* is preceded by a *c*, the two letters together have frequently the sound of the *Hebrew* ש, with a point over the right horn, as in *charity*, *chyle*, &c.

The aspirate, or sharp accent of the *Greeks*, which is the same with our *h*, is frequently changed for an *s*, as ἅλς. *sal*; ἑπτὰ *septem*, &c.

I, the ninth letter of the *English* alphabet, is both a vowel and a consonant, agreeable to which two different powers, it has two different forms.

The *Hebrews* called the *j* consonant *jod*, יוד, from יד, *hand* and *space*; because it is supposed to represent the hand clenched, so as to leave the space underneath void. With them it was pronounced as the consonant *y*, as it still is among the *Germans*, and some other people. The *Greeks* had no *j* consonant, and for that reason used their vowel *i* instead of it, as coming the nearest in sound. The *French* and *English* have two kinds of *j* consonants, the first has a snuffling kind of sound, and serves to modify that of the vowels, pretty much like *g*; as in *Jew*, *just*, *jovial*; the latter is pronounced like the *Hebrew* jod; instances of which we have in some of our words, which are indifferently wrote with a *y* or an *i* before a vowel, as *voiage*, *voyage*, *loial*, *loyal*, &c. in which cases the *i* is apparently a consonant, as being a motion of the palate, which gives a modification to the following vowel.

The vowel *i*, according to *Plato*, is proper for expressing fine and delicate, but humble things, on which account that verse in *Virgil*,

Accipiunt inimicum imbrem, rimisque fatiscunt.

which abounds in *i*'s, is generally admired.

K, a double consonant, and the tenth letter of the alphabet, is borrowed from the *Greek* Kappa, and was but little used among the *Latins*: we seldom find it in any *Latin* author, except in the word *Kalendæ*, where it sometimes stands in lieu of a *c*.

In the *English* the *k* is used much more than need be, particularly at the ends of words, after *c*, as in *publick*, *physick*, where it is of no manner of service.

L, a semi-vowel or liquid, makes the eleventh letter of the alphabet. It has a sweet sound, and is pronounced by applying the *tongue* to the *palate*.

The *Spaniards* and *Welch* usually double the *l* at the beginning of a word, which sounds nearly the same with the *English hl*, or *fl*.

The figure of our *l* we borrow from the *Latins*, they from the *Greeks*.

M, a liquid consonant, and the twelfth letter in the alphabet, is pronounced by striking the upper lip against the lower.

Quintilian observes, that the *Greeks* always change *m*, at the end of a word, into *n*, for the sake of the better sound.

N,

N, a liquid consonant, and the thirteenth letter of the *Greek*, *Latin*, *French*, *English*, &c. Alphabets, sounds like a *d*, passed through the nose. The Abbot *Dangeau* observes, that in the *French* the *n* is frequently a mere nasal vowel, without any thing of the sound of a consonant in it; he calls it the Sclavonick vowel.

N before *p*, *b*, and *m*, the *Latins* change into *m*, and frequently into *l* and *r*, as *in-ludo*, *illudo*; *in-rigo*, *irrigo*, &c. The *Greeks* also, before κ, γ, χ, ν, changed the ν into γ; in which they were followed by the antient *Romans*; who for *Angulus*, wrote *Aggulus*, &c.

O is the fourteenth letter of the alphabet, and the fourth vowel. The *grammarians* call it a close vowel, because pronounced with the mouth shut.

Among the *Latins*, the *o* bore so great an affinity with the *u*, that they frequently confound them; writing *consol*, and pronouncing *consul*.

The *Greeks* had two *o*'s, *viz.* Omicron ο, and Omega, ω; the first pronounced on the tip of the lips with a sharp sound, the second in the middle of the mouth with a full sound, equal to *oo* in *English*. The long and short pronunciation of the *English o*, are an equivalent to the two *Greek* ones; the first as in suppose, the second as in obey.

P, is a consonant, and the fifteenth letter in the *English* alphabet. When the *P* is followed with an *h*, in the same word, it has the sound of an *F*; thus *philosophy* is pronounced *filosophy*.

Q, a consonant, and the sixteenth letter of the alphabet, is always followed by an *u*,

The Q is formed from the *Hebrew* כ, *Caph*; which most other languages have borrow'd.

In effect, there is that resemblance between the Q and C in some languages, and K in others, that many grammarians, in imitation of the *Greeks*, banish the Q as a superfluous letter.

In the *French*, the sound of the *q* and *k* are so near akin, that some of their nicest authors think the former might be spared.

Some very learned men make *q* a double letter, as well as *k* and *x*. According to them, *q* is evidently a *c* and *u* joined together. It is not enough that the sound is the same, but they see the traces of *c u* in the figure of Q; the V being only laid obliquely, so as to come within the cavity of the C, as C<.

R, is a liquid consonant, and the seventeenth letter of the alphabet. The grammarians hold it a semi-vowel, especially in the *Greek*, where, in common with the other vowels, it admits an aspirate, *&c.* tho' whether the aspirate should be sounded before or after it, is some doubt.

The *Hebrews* allow the *r* the privilege of a *guttural*, that is, they never double it.

In the *French* the *r* is never pronounced at the end of a word, unless it be immediately before a vowel, *e. gr. aimer son roy*, that *r* in *aimer* is not sounded, and the word is pronounced as if there was none, and as if it was wrote *aimé son roy*: on the contrary, in *aimer a boire*, the *r* is pronounced, because immediately before a vowel; but then the pronunciation of the *r* must be very soft, as if the tongue should pass slightly over it, to lay the whole stress on the *a*.

S, a consonant, and the eighteenth letter of the alphabet; is accounted one of the three hissing consonants, the other two, being *z* and *j*. It is also held a semi-vowel, as forming a kind of imperfect sound, without the assistance of any vowels.

Of all others, the *s* is nearest a kin to the *r*; hence it was frequently changed, by reason of its disagreeable sound into *r*.

The old and the new orthography of the *French*, differ chiefly on the use of the *s*: the latter omitting it in writing, where it is not heard in the pronunciation, and the former retaining it. Thus the followers of the one, particularly the academy, in their dictionary, write *tempeste*, *huistre*, *fluste*; those of the other, *tempête*, *huitre*, *flûte*, &c. In the same language, *s* is never pronounced, or sounded at the end of a word, unless, like the *r* it be immediately before a vowel; as, *javois chanté*, *s* in *javois*, is not sounded before *chanté* and the word is pronounced as if there was no *s*, viz. *javoi chanté*; but it is not the same in *javois aimé*, where the *s* is pronounced, as if it was wrote *javoi saimé*.

T, a consonant, and the nineteenth letter in the alphabet, in sound, bears a resemblance to the *d*, for which reason they are often put for each other.

The *t* is one of the five consonants, which the Abbot *Dangeau* calls palatal, and which are *d*, *t*, *g*, *k*, and *n*: the four first whereof have the same relation to each other, as the labial *b*, *p*, and *v*, *f*, have. *D*, for instance, having the same relation to *t*, that *b* has to *p*, or *v* to *f*.

U, is the fifth vowel, and the twentieth letter in the alphabet. Besides the vowel *u*, there is a consonant of the same denomination, wrote *v*, or V.

The pronunciation of the *u* as now used among the *English*, *French*, &c. is borrow'd from the antient *Gaulish*; for all the other western people, with the *Romans*, pronounce it *ou*.

W, is a letter particular to the northern languages and people, as the *English*, *Dutch*, *Polish*, and others of *Teutonick* and *Sclavonick* original, and admitted into the *French*, *Italian*, &c in proper names, and other terms, borrowed from the languages where it is used.

In *English*, the *w* is usually a consonant, and as such may go before all the vowels, except in *u*: as

in

in *want*, *weapon*, *winter*, *world*, &c.

It is ſometimes alſo a vowel, and as ſuch follows any of the vowels, *a*, *e*, *o*, and unites with them into a kind of treble vowel, or tripthong; as in *law*, *ewe*, *ſow*, &c.

X, is a double conſonant, and the twenty-ſecond letter of the *Engliſh* alphabet.

The *x* of the *Latins*, and ξ of the *Greeks*, are compoſed of *c s*, and *κ σ*; whence to this day the letter *x*, in the *Engliſh* and *French*, has the ſame ſound with *c ſ*, or *k ſ*. Thus we pronounce *Alexander*, as if wrote *Alecſander* or *Alckſander*.

The *Italians* have no *x* at all in their language, but both ſpeak and write *Aleſſandro*. The *Spaniards* pronounce the *x* like the *Engliſh c* before *a*; viz. *Alexandro*, as if it were *Alecandro*. The *Portugueſe* pronounee it like *ſh*, as *muxo* is pronounced *muſho*.

In foreign words uſed in *Engliſh*, they ſometimes ſoften the *x* into a double *ſſ*; as *Bruſſels*, for *Bruxelles*, &c.

This letter is not known in the *Hebrew*, or other oriental languages; but in lieu of it, they write the two ſimple letters, whereof it is compounded, and the like do the modern *Germans*.

Y is the twenty-third letter in the *Engliſh* alphabet, borrowed originally from the *Greek* υ

It is occaſionally both *vowel* and *conſonant*. As a *vowel*, ſome authors have judged it unneceſſary in *Engliſh*, in regard its ſound is preciſely the ſame with that of the *i*. Accordingly it is but little uſed, except in words borrow'd from the *Greek*, to denote their origin, by repreſenting the *Greek* Υιλον.

The vowel *y* has a place in ſome words purely in *Engliſh*, and that both in the middle thereof, as in *dying*, *frying*, &c. and at the end as in *lay*, &c.

Z is the laſt letter in the alphabet, and one of the double conſonants, both among the *Latins* and *Greeks*. The ſound was not always the ſame as it is now, which is but as it were half that of an S.

All the *letters* of the alphabet, heretofore mentioned, were alſo *numeral characters* among the antients, *viz.*

A ſignified 500, with a daſh a-top $\overline{\text{A}}$ it ſtood for 5000. This uſage was introduced in the days of barbariſm.

$\overline{\text{B}}$ ſtood for 3000; with a kind of accent below it ſtood for 200: but among the *Greeks* as well as *Hebrews*, this letter ſignified only two.

C, among the *Romans*, ſignified 100.

D ſignified 500; $\overline{\text{D}}$ denotes 5000.

E ſignified 250.

F ſignified 40.

G ſignified 400; $\overline{\text{G}}$ ſignified 40,000.

H ſignified 200; $\overline{\text{H}}$ ſignified 200,000.

I, in the ordinary *Roman* way of numbering, ſignifies one; and when repeated, ſignifies as many units as it is repeated times. I. C. 100.

K ſignified 250; $\overline{\text{K}}$ ſtood for 250,000.

L ſignified 50; $\overline{\text{L}}$ ſtood for 50,000.

M ſignified 1000; $\overline{\text{M}}$ ſignifies a thouſand times a thouſand.

N ſignified 900; $\overline{\text{N}}$ ſtood for 9000.

O ſignified 11; $\overline{\text{O}}$ ſignified 11.000.

P ſignified the ſame with G, *viz.* 400, though *Baronius* thinks it rather ſtood for ſeven: $\overline{\text{P}}$ ſtood for 400,000.

Q ſignified 500: $\overline{\text{Q}}$ denoted 500,000.

R ſignified 80: $\overline{\text{R}}$ ſignified 80,000.—

S ſignified ſeven.

T ſignified 160: $\overline{\text{T}}$ ſignified 160,000.

V ſignifies five: $\overline{\text{V}}$ ſignified 5000.

X denotes 10.

Y ſignified 150, or according to *Baronius* 159; $\overline{\text{Y}}$ ſignified 150,000.

Z ſignified 2000: $\overline{\text{Z}}$ ſignified two thouſand times two thouſand.

The numeral characters, now chiefly in uſe, are the *common* and the *Roman*; to which may be added the *Greek*.

Common characters, are thoſe ordinarily called the *Arabick*, as ſuppoſed to have been invented by the *Arabick* aſtronomers; though the *Arabs* themſelves call them the *Indian* characters, as if they had borrowed them from the people of *India*. The *Arabick* characters are ten, *viz.* 1, 2. 3, 4, 5, 6, 7, 8, 9, 0, the laſt called a cypher.

The *Roman character*, conſiſts of the majuſcule letter of the *Roman* alphabet.

The numeral letters, that compoſe the *Roman characters*, are ſeven, *viz*, I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C hundred, D five hundred, M a thouſand. The I repeated twice makes two, II; thrice, three III; four is expreſſed thus IV; I before V or X taking an unit from the number expreſſed by each of thoſe letters. To expreſs ſix, an I is added to a V, VI: for ſeven, two, VII: and for eight, three, VIII: nine is expreſſed by an I before X, IX, agreeable to the preceding remark. The like remark may be made of the X before L or C, except that the diminution is by tens, not units, thus XL ſignifies forty, and XC ninety: and L followed with an X ſixty, LX, *&c.* The C before D or M, diminiſhes each by a hundred. Beſides the letter D which expreſſes five hundred, that number may alſo be expreſſed, by an I before a C inverted, thus IↃ, and thus in lieu of the M, which ſignifies a thouſand, is ſometimes uſed an I between two C's, the one erect, the other inverted, thus CIↃ: agreeable to this ſix hundred may be expreſſed IↃC, and ſeven hundred IↃCC, *&c.*

The *Greeks* had three ways of expreſſing numbers, the moſt ſimple was for every ſingle letter, according to its place in the alphabet, to denote a number from α 1, to ω 24, in which manner the books of *Homer's Iliads* are diſtinguiſhed. Another way was by dividing the alphabet into 8 units. α 1, β 2, &c. tens; ι 12, κ 20, &c. Hundreds; ρ 100, σ 200. Thouſands they expreſſed by a point, or accent under a letter. *e. gr.* α̦ 1000, ϐ 2000, &c. A third way was by ſix capital letters, thus I (ια for μία) 1, Π (πεντε) 5, Δ (δεκα) 10, Η (Ηεκατον) 100, Χ (χίλια) 1000, Μ (μυρία) 10000.

The *Hebrew* alphabet was divided into 9 units: א 1, ב 2, &c. — 9 tens: י 10, כ 20, &c. 9 hundreds; ק 100, ר 200, &c. ך 500, ם 600. ן 700, ף 800, ץ 900. — Thouſands were ſometimes expreſſed by units prefix'd to hundreds, as, אךלד, 1534, &c.

From the doctrine of *letters* and *characters*, we'll proceed to *Syllables*. A ſyllable is part of a word, conſiſting of one or more letters, which are pronounced together; or a compleat ſound, uttered in one breath, conſiſting either of a vowel alone, or of a vowel and one or more conſonants: or, according to *Scaliger*, a *ſyllable* is an element under one tone or accent, that is, which can be pronounced at once: or, according to *Priſcian*, a comprehenſion of ſeveral letters falling under one accent, and produced at one motion of the breath: or, a literal or articulate voice of an individual ſound.

In every word, therefore, there are as many *ſyllables* as there are *vocal ſounds*, and as many vocal ſounds, as there are ſimple, or compound *vowels*; each whereof requires a diſtinct motion of the *pectoral* muſcles. Thus *a*, *a*, *a*, make three *ſyllables*, formed by ſo many motions, diſtinguiſhed by ſmall ſtops between each expiration.

From the number of *ſyllables* in words, they are denominated *monoſyllables*, *biſyllables*, *triſyllables*, *polyſyllables*, q. d. words of one *ſyllable*, *two ſyllables*, *three ſyllables*, and many *ſyllables*.

Words are diſtinct articulate ſounds agreed on by mankind, to convey their thoughts and ſentiments.

Words, as obſerved, are divided into *monoſyllables*, *biſyllables*, &c.

Monoſyllables are words of a *ſingle ſyllable*, or which conſiſt of one or more letters pronounced together.

Words, again, are divided into *primitives* and *derivatives*, *ſimple* and *compound*, *ſynonymous* and *equivocal*.

Primitive, is a *root*, or a word in a language, which is neither derived from any other language, nor compounded from any other word of the ſame. Thus *God* is a *primitive*, *godly* a *derivative*, *god-like* a *compound*.

Derivative is a word which takes its origin from another word, called its *primitive*. *Manhood*, *deity*, *lawyer*, &c. are derived from *man*, *deus*, *law*, &c.

Equivocal is a word or expreſſion, that is dubious, and ambiguous; or that may have ſeveral ſenſes, one true and another falſe. — Such is the word *emperor*, which is both the name of a dignity, the proper name of a perſon, and the name of a plant.

In theſe caſes one word denotes divers conceptions, and divers things.

Synonymous is a word that has the ſame import, or ſignification with another.

The moſt celebrated Grammarians divide words into *eight claſſes*, called *parts of ſpeech*; which are *Noun*, *Pronoun*, *Verb*, *Participle*, *Adverb*, *Conjunction*, *Prepoſition*, and *Interjection*; to one or other of which, all the words, and turns in all languages, which have, or may be invented to expreſs our ideas, are reducible.

Noun is the name or word, which expreſſes the ſubject ſpoke of; or expreſſes a ſubject, whereof ſomething is, or may be affirmed; as *man*, *food*, *whiteneſs*, *Henry*, &c. A *Noun*, therefore, in language, anſwers to an idea in Logick.

Nouns, again, are divided into *Nouns Subſtantive*, and *Nouns Adjective*.

They are called *Subſtantives*, when the objects, they deſign, are conſider'd ſimply in themſelves, and without any regard to their qualities.

They are called *Adjectives*, when their objects are conſidered as cloath'd with any qualities. Thus, when I ſay ſimply, the *Heart*, in *Engliſh*, the word *Heart*, is called a *Noun Subſtantive*, inaſmuch as it does not expreſs any of its qualities; but if I ſay in *Engliſh*, *the generous Heart*, I then conſider the *Heart*, accompanied with the quality of *generous*. For this reaſon, the word *generous* is called a *Noun Adjective*; becauſe it adds a quality to the object.

Nouns are again divided into *proper* and *appellative*. *Nouns proper* are thoſe, which expreſs a *particular* thing or perſon, ſo as to diſtinguiſh it from all other things of the ſame kind, as *Socrates*, *Peter*, *Paul*, *James*, &c. *Nouns appellative* are thoſe common to *ſeveral* individuals, of the ſame kind, as *Man*, *Angel*, &c.

There are alſo heterogeneous Nouns, which are ſuch as are of one gender in the ſingular number, and of another in the plural. Theſe Nouns are alſo called *Heteroclite*, of which we have various sorts, *viz.* *defective* and *redundant Heteroclites*, &c. Under the class of *Heteroclites* come *Aptotes*, *Diptotes*, *Monaptotes*, *Triptotes*, *Tetraptotes*, *Pentaptotes*, &c.

Aptote is a noun without any variation of case; as, *fas nihil*, &c.

Diptote has only two cases; as, *Nom. fors*, *Abl. forte.*

Triptotes have only three cases; such is *dica*, *dicas*, *dicam.*

Tetraptote have only four cases, as *repetundæ*, &c.

Pentaptote has only five cases.

Pronoun is a part of speech, used in lieu of noun, or name; whence the denomination from *pro* and *nomen*, q. d. for *noun* or *name.*

As it would have been disagreeable to have been always repeating the same name, there are words invented in all languages, called *Pronouns*, to save the necessity thereof, and to stand in the place of names; as in *English*, I, thou, he.

They are called *Pronouns*, because used in the place of particular *Nouns.*

The *grammarians* ordinarily distinguish *Pronouns* into four classes, with regard to their different signification, formation, &c. viz. *Pronouns personal*, *relative*, *possessive*, and *demonstrative*, to which may be added, *indeterminate Pronouns.*

Personal Pronouns are those used in lieu of names of particular persons; such are *I*, *thou*, *he*, *we*, *ye*, *they*; or in *French*, *moy*, *toy*, *luy*, *nous*, *vous*, *eux.*

Pronouns relative are those placed after *Nouns*, with which they have such affinity, that without them they signify nothing, such are *who*, *that*; or in *French*, *qui*, *cela*, &c.

Pronouns possessive are those, which express what each possesses, or what belongs to him, as *mine*, *thine*, *his*; or in *French*, *mien*, *tien*, *siene*, &c. These are pure Adjectives, and only differ from the rest by the relation they bear to *Pronouns*, whence they are derived, and by some particular inflections, which they have in some languages.

Pronouns demonstrative are those, which serve to indicate or point out the subject spoken of; as *this*, *those*; or in *French*, *cecy*, *cela*, *ceuxla*, or *celles la*, &c.

Pronouns indefinite are those, which express their subject indeterminately; as *however*, *any*, &c.

Pronouns are likewise divided into *Substantive* and *Adjective.* To the first belong *I*, *thou*, *he*; to the second, *my*, *mine*, *who*, *what*, &c.

Pronouns may also be consider'd in two states; the first or foregoing state, as *I*, *we*; the second or following one, as *me*, *us.*

It has been thought proper, in order to render discourse more express and distinct, as also to embellish it by a variety of terminations, to contrive certain diversities in Adjectives, accommodated to the Substantives they are applied to: whence from a regard to that notable difference there is between the two sexes, all Nouns Substantive have been distinguished, in *masculine* and *feminine genders*; and the Nouns Adjective also varied to correspond therewith.

But as there was an infinity of words, which had no proper relation, either to the one sex or the other, they had *genders* assigned them, rather out of caprice than reason; and hence it is that the *gender* of a Noun, is frequently dubious and fluctuating.

This institution of *genders* was introduced by custom and usage. At first there was only a difference between the names of animals, when spoke of males and females; by degrees the same regulation was extended to other things: the Grammarians have only noted and allowed what usage had established.

The oriental languages frequently neglect the use of *genders*; and the *Persian* language has none at all. The *Latins*, *Greeks*, &c. generally content themselves to express the different *genders* by different terminations; as *bonus equus*, a good horse; *bona equa*, a good mare; but in *English* they go farther, and express the difference of sex, by different words; as boar, sow; boy, girl; buck, doe; bull, cow; cock, hen; dog, bitch, &c. The *French* follow in some things the practice of the *Latins*, and in others that of the *English.* For they sometimes express the difference of genders, by different terminations; as *asne*, *asnesse*; *chien*, *chiene*; *chat*, *chatte*, &c. and sometimes by different words; as *gargon*, *fille*: *toreau*, *vache*; *cerf*, *biche*, &c.

The *English* have only about twenty-four feminines, distinguished from the males, by the variation of the termination of the male into *ess*; of which number are abbot, abbess; count, countess; actor, actress; heir, heiress; prince, princess, &c. which is all the *English* know of any thing like *genders.*

The eastern languages, as well as the vulgar ones of the west, have only two *genders*; the masculine and feminine. The *Greeks* and *Latins* have likewise the *neuter*, *common*, and the *doubtful gender*; and besides these, they have the *epicene* or promiscuous, which under one single *gender* or termination, includes both the kinds.

The *Masculine* Gender, is that which belongs to the male kind, or something analogous to it.

The *Feminine* Gender is that which denotes the noun or name to belong to a female.

The *Neuter* is a ſort of gender of nouns, which are neither maſculine nor feminine. In *Engliſh*, and other modern languages, there is no ſuch thing as Neuter Nouns.

Epicene is a term applied to Nouns, which under the ſame *gender* and termination, mark indifferently two kinds or ſexes; ſuch in *Latin* is *aquila*, *veſpertilio*, &c. which ſignify equally a male or female eagle, or bat.

Grammarians diſtinguiſh between *Epicene* and *Common*.——A Noun is ſaid to be common of two kinds, when it may be joined either with a maſculine or a feminine article; and *Epicene*, when it is always joined to ſome one of the two articles, and yet ſignifies both *genders*.

The Inflection of a Noun, according to its different caſes, is called Declension, which is a different thing in the modern languages, which have not properly any caſes, from what it is in the antient *Greek* and *Latin* which have.

Declenſion in languages, wherein the Nouns admit of changes, whether in the beginning, middle, or end, is properly the expreſſing or reciting of all thoſe changes in a certain order, and by certain degrees, called *caſes*.

In languages wherein the Nouns do not admit of changes, *declenſion* is the expreſſing of the different ſtates or habitudes a Noun is in, and the different relations it has; which difference of relation is mark'd by particles, called *articles*, as *a*, *the*, *to*, *from*, &c. and in *French* (in the ſingular number) *le*, *la*, *du*, *ò*, *au*, or *à*, *le*; and in the plural number, *les*, *des*, *aux*, *les*, &c.

Every declenſion has commonly two *numbers*, *viz.* the *ſingular* and the *plural*; which numbers are a modification of Nouns, *&c.* to accommodate them to the varieties in their objects, conſider'd with regard to number.

When a Noun indicates an object, conſider'd as ſingle or alone, or a number of them conſider'd as united together, it is ſaid to be of the ſingular number; as a *tree*, a *troop*, a *temple*, &c. or in *French*, *un homme*, *un fille*, *un temple*, &c.

When it indicates ſeveral objects, and thoſe as diſtinct, it is of the plural number; as *temples*, *trees*, &c. or in *French*, *hommes*, *filles*, &c. Thus when I ſpeak of myſelf, as making part of ſeveral others, inſtead of *I*, I ſay *we*, in *French*, *nous*, &c.

The *Greeks* have a third number, which they call the *dual number*, as ſignifying two. The *Hebrews* have ſomething like it, but then it only takes place when the words ſignify a thing double by nature, as the hands, the eyes, *&c.* or by art, as ſciſſars, tongs, *&c.*

As to common and appellative names, they ſeem all naturally to require a plural number; yet there are ſeveral which have none, as the names of *gold*, *ſteel*, &c.

The difference of numbers in Nouns, is expreſs'd by a difference of *termination* or *ending*.

In *Engliſh* and *French*, the ſingular is uſually converted into plural, by adding *s*; as *tree*, *trees*, *hand*, *hands*; and in *French*, *arbre*, *arbres*, *main*, *mains*, &c. where the pronunciation requires it in *Engliſh*, as when the ſingular ends in *s* or *x*, *ſh* or *ch*, it is uſually done by the addition of *es*, inſtead of *s*.

The plurals of Adjectives, though varied from the ſingulars in moſt other languages, yet in *Engliſh* are generally the ſame.

Every number has commonly *ſix caſes*, or different inflections, or terminations of nouns; ſerving to expreſs the different ſtates or relations they bear to each other, and to the things they repreſent.

They are called *Nominative*, *Genitive*, *Dative*, *Accuſative*, *Vocative*, and *Ablative*.

Though ſeveral of theſe caſes be frequently alike, as the Gentive and Dative ſingular, of the firſt declenſion of the *Latin*; the Dative and Ablative plural of the ſecond, *&c.* the Genitive and Dative dual of the *Greek*, &c. ſo that the termination is not the ſole criterion of the caſe.

The ſimple poſition, or laying down of a noun or name, which is declinable, is called the *Nominitive caſe*, yet it is not ſo properly a caſe, as the matter, or ground whence the other caſes are to be form'd, by the ſeveral changes and inflections given to this firſt termination. Its chief uſe is to be placed in diſcourſe before all verbs, as the ſubjects of the propoſition or affirmation, as *dominus regit me*, the Lord governs me; *Deus exaudit me*, God hears me.

The relation of one thing, conſider'd as belonging in ſome manner to another, has occaſioned a peculiar termination of nouns, called the *Genitive caſe*.

In *Engliſh*, the *genitive caſe* is made by prefixing the particle *of*; in *French*, *de*, or *du*, &c.

The *Dative* expreſſes the ſtate or relation of a thing, to whoſe profit or loſs ſome other thing is referr'd. It is called *Dative*, becauſe uſually govern'd by a verb implying ſomething to be *given* to ſome perſon; as *commodare Socrati*, to lend to *Socrates*.

In *Engliſh* this relation is expreſſed by the ſign *to* or *for*; and in *French*, by the ſign *a*, or *au*.

The *Accuſative* is the fourth caſe of nouns, that are declin'd. Its uſe may be conceived from this, that all verbs, which expreſs actions, that paſs from the agent, as to *beat*, &c. muſt have ſubjects

to

to receive those actions; for, if I *beat*, I must beat something; so that such Verb, evidently requires after it a Noun or name, to be the object of the action expressed. Hence in all languages, which have cases, the Nouns have a termination, which they call *Accusative*; as, *amo Deum*, I love God.

In *English* and *French*, they have nothing to distinguish this case from the *Nominative*; but as they ordinarily place words in their natural order, it is easily discovered; the *Nominative* constantly preceding, and the *Accusative* following the Verb. Thus when we say that *John* loves *Jane*, and *Jane* loves *John*; *John* is the *Nominative* in the first, and the *Accusative* in the last; and *Jane* is the *Accusative* in the first, and the *Nominative* in the last.

The *Vocative* is the fifth case, or state of Nouns. When we name the person we are speaking to, or address ourselves to the thing we are speaking of, as if it were a person, the Noun or name requires a new relation, which the *Latins* and *Greeks* express by a new termination called *Vocative*. Thus of *Dominus*, Lord, in the *Nominative*, the *Latins* have made *Domine*, O Lord, in the *Vocative*; of *Antonius*, *Antonii*, &c. But as this was a thing not absolutely necessary, and as the *Nominative case* might serve on such occasions, this new case or termination, was not universal in the plural; for instance, it was the same with the *Nominative*; even in the singular, it was only practised in the second declension among the *Latins*; and in *Greek* where it is the most common, it is frequently neglected, and the *Nominative* used instead of it; as in that passage in the *Greek* Psalms, quoted by St. *Paul*, to prove the divinity of *Jesus Christ*, θρόνος σου ὁ Θεός, thy throne O God!

In *English*, and most of the modern tongues, this case is ordinarily expressed in Nouns, that have an article in the *Nominative*, by suppressing that article; as, *The Lord is my hope. Lord, thou art my hope!* Though on many occasions we use an Interjection.

The *Ablative* is the sixth case of *Latin* Nouns. The *Ablative* is opposite to the *Dative*; the first expressing the action of *taking away*, and the latter that of *giving*.

In *English*, *French*, &c. there is no precise mark, whereby to distinguish the *Ablative* from other cases; and we only use the term in analogy to the *Latin*. Thus in the two phrases, *the magnitude of the city, and he spoke much of the city*; we say, that *of the city*, in the first is *Genitive*, and in the latter *Ablative*; because it would be so, if the two phrases were expressed in *Latin*.

VERBS are thus called of the *Latins*, *verbum*, word, by way of eminence; the Verb being the principal word of a sentence.

The common definition given by grammarians, is, that a *Verb* is a word that betokens *being*, *doing*, or *suffering*.

To conceive the origin and office of Verbs, it may be observed, that the judgment we make of any thing, as when I say, *the earth is round*, necessarily includes three terms. The first called the *subject*, is the thing we affirm of, *e. gr. earth*. The second called *attribute*, is the thing affirmed, *e gr. round*. The third, *is*, connects those two terms together, and expresses the action of the mind, *affirming* the attribute of the subject.

This last is what we properly call *Verb*. Its principal use is to shew the discourse, wherein that word is used, is the discourse of a man, who does not only conceive things, but judges and affirms somewhat of them.

Verbs are variously divided: with respect to the subject they are divided into *active*, *passive*, *neuter*, &c. With respect to their inflections, into *regular*, and *irregular*; *personal*, and *impersonal*, *auxiliary*, *substantive*, &c.

VERB *active* is a *Verb*, which expresses an action, that falls on another subject, or object. Such are, *I love*, *I work*, &c. which signify the action of *loving*, *working*, &c.—Of these Grammarians make three kinds; the one called *transitive*, where the action passes on a subject different from the agent;—*reflected*, where the action returns upon the agent —*reciprocal*, where the action returns mutually upon the two agents that produce it.

VERB *passive* is that, which expresses a passion, or which receives the action of some agent, and which is conjugated in the modern tongues with the *auxiliary Verb*, *I am*, *je suis*, &c.

VERB *neuter* is that, which signifies an action, that has no particular object whereon to fall; but which, of itself, takes up the whole Idea of the action;—as, *I sleep*, *thou yawnest*, *he snores*, *we walk*, *you run*, *they stand*.—The *Latins* call them *neuters*, by reason they are neither *active* nor *passive*; though they have the force and signification of both: as *I languish*, signifies as much as to say, *I am languishing*; *I obey*, as much as *I exercise obedience*, &c. only that they have no regimen to particularize this signification.

Of these *Verbs* there are some, which form their tenses by the *auxiliary Verb*, *to have*; as. *I have slept*, *you have run*.—Grammarians call these *Neuters active*.

Others there are, which form their compound parts by the auxiliary, *to be*: as *to come*, *to arrive*, &c. for we say *I am come*, not *I have come*; in *French*, *Je suis venû*, not *J'ai vennû*, &c. These are are called *Neuters passive*.

A

A VERB *ſubſtantive* is that, which expreſſes the being, or ſubſtance, which the mind forms to itſelf, or ſuppoſes in the object; whether it be there or not; as, *I am, thou art*; in *French*, *Je ſuis, tu es.*

Auxiliary, or *helping Verbs*, are thoſe, which ſerve in conjugating *active* and *paſſive Verbs*; ſuch are, *I am*, *I have*, &c.

Verbs in the *Engliſh*, and moſt modern tongues, do not change their endings, as in *Latin*, to denote the ſeveral times, modes, *&c.* of their being, doing, or ſuffering; but in lieu thereof, make uſe of auxiliaries: as, *have*, *am*, *be*, *do*, *will*, *ſhall*, *may*, *can*, &c.

Regular VERBS are thoſe, which are conjugated after ſome one manner, rule, or analogy.

Irregular, or *anamolous* VERBS are thoſe, which have ſomething ſingular in the terminations, or formation of their Tenſes.

The irregularity in *Engliſh* Verbs lies wholly in the formation of the preter Tenſe, and paſſive Participle.—The firſt, and moſt general irregularity, took its riſe from the quickneſs of our pronunciation, by changing the conſonant *d* into *t*; the vowel *e*, in the regular ending *ed*, being cut off, that the pronunciation might be more ready: thus for *dwelled*, *keeped*, *ſended*, we ſay *dwelt*, *kept*, *ſent*.

VERBS *imperſonal* are thoſe, which have only the third perſon, as it behoves, *&c.*

As the Nouns are declined, the *Verbs* are conjugated: and what is called *Declenſion*, with regard to Nouns, *&c.* is called *Conjugation* with regard to *Verbs*.

CONJUGATION is an orderly diſtribution of the ſeveral parts or inflexions of *Verbs*, in their different Moods and Tenſes, to diſtinguiſh them from each other.

The *Latins* have four *Conjugations*, diſtinguiſhed by the terminations of their Infinitive, *āre*, *ēre*, *ĕre*, *īre*; and moſt of the *French* grammarians reduce the *Conjugations* of their language to the ſame number, ending in *er*, *re*, *ir*, and *oir*.

In *Engliſh*, where the Verbs have ſcarce any natural inflections, but derive all their variations from additional Particles, Pronouns, *&c.* we have hardly any ſuch things as ſtrict *Conjugations*.

Conjugations conſiſt of *Moods*, *Tenſes*, *Perſons*, and *Numbers*.

MOOD, or MODE is uſed to ſignify the different manners of conjugating Verbs, agreeably to the different actions, or affections to be expreſſed; as *ſhewing*, *commanding*, *wiſhing*, &c.

Hence ariſe five *Moods*, viz the *Indicative*, *Imperative*, *Optative*, *Subjunctive*, and *Infinitive*.

Some Grammarians reckon but four *Moods*, confounding the *Optative* with the *Subjunctive*, and ſome make *ſix*, dividing the *Optative* into *Potential*, and *Optative*.

The *Greeks* have five *Moods* of Verbs differing in termination; but the *Latins* have but four.—In *Engliſh*, the terminations are the ſame in all the *Moods*.

The *Indicative* is the firſt *Mood*, or manner of conjugating Verbs, ſhewing either the time preſent, paſt, or future.

The *Imperative* is the *Mood*, or manner of conjugating a Verb, ſerving to expreſs a commandment, as *go*, *come*; or in *French*, *alles*, *venes*, &c.

The *Optative* is the third *Mood*, in the conjugation of Verbs, ſerving to expreſs an ardent deſire, or wiſh for any thing.

Inſtead of a particular *Mood*, or a particular ſet of inflections to expreſs this deſire, the *Engliſh*, *Latins*, &c. expreſs it by an Adverb of wiſhing prefixed to it; the *Latins* by *utinam*; and the *Engliſh* by *would to God*, &c.

The *Subjunctive* is the fourth *Mood*, or manner of conjugating Verbs; thus called, becauſe uſually ſubjoined to ſome other Verbs, or at leaſt to ſome other particle, as *if I love*; *tho' this were true*, &c.

The *Greek* is almoſt the only language, that properly has any *Subjunctive Mood*; though the *French*, *Spaniſh*, and *Italian* have ſome ſhew thereof.—In all other languages the ſame inflections ſerve for the *Optative* and *Subjunctive Moods*.

The *Infinitive* is the fifth *Mood*, or manner of conjugating of Verbs.

The *Infinitive* does not denote any preciſe time, nor does it determine the number, or perſons, but expreſſes things in a looſe indefinite manner, as *to teach*, &c.

In moſt languages both antient and modern, the *Infinitive* is diſtinguiſhed by a termination peculiar to it, as τυπτειν in the *Greek*, *ſcribere* in the *Latin*, *ecrire* in the *French*, *ſcrivere* in the *Italian*, &c. but the *Engliſh* is defective in this point; ſo that to denote the *Infinitive*, they are obliged to have recourſe to the article *to*, except ſometimes when two or more *Infinitives* follow each other.

Of all the *Moods* we have mentioned, the oriental languages have none but the *Imperative*. The method taken for it in *Engliſh* is either to omit the Pronoun, or tranſpoſe it; thus, *we love*, is a ſimple affirmation; *love we*, or *let us*, an *Imperative*.

TENSE, *time* (the next thing I conſider in the conjugation of Verbs) is one inflection of Verbs, whereby they are made to ſignify, or diſtinguiſh the circumſtance of time, of the thing they affirm or attribute.

The affirmatives made by Verbs, are different as to point of time; ſince we may affirm a thing *is*, *was*,

was, or *will be*; hence a neceſſity of a ſet of inflections, to denote thoſe ſeveral times; which inflections the *Engliſh* Grammarians call by a barbarous word *tenſes*, from the Latin *tempus*, time; and moſt other languages call them ſimply *times*.

There are but three ſimple *Tenſes*; the *preſent*, as *I love*, *amo*, in *Latin*, *j'aime*, in *French*; the *preter*, *preterit*, or *paſt*, *I have loved*, *amavi*, in *Latin*, *j'ai aime*, in *French*; and the *future*, as *I will love*, *amabo*, in *Latin*, *j'aimerai*, in *French*.

The ſeveral *tenſes* or *times*, are properly denoted in the *Greek* and *Latin* by particular inflections: in the *Engliſh*, *French*, and other modern tongues, the auxiliary Verbs *to be*, and *to have*, *etre* and *avoir* are called in.

As to the oriental languages, they have only two *ſimple tenſes*, the *paſt*, and *future*, without any diſtinctions of *imperfect*, more than *perfect*, &c. which renders thoſe languages ſubject to abundance of ambiguities, which others are free from.

Verbs when conjugated, are applicable to three different *perſons*, *e. gr.* — *I love*, *J'aime*, is a Verb uſed in the *firſt perſon*; *thou loveſt*, *tu aime*, deſigns the *ſecond perſon*; *he loveth*, *il aime*, marks the *third*, and thus in the plural number: for Verbs in their conjugations, like Nouns in their declenſions admit of two numbers, *viz.* the *ſingular*, and the *plural number*.

From the *Verbs* we'll paſs to the PARTICIPLE, which is an Adjective formed of a Verb; ſo called, becauſe it ſtill *participates* of ſome of the properties of the Verb, retaining the regimen and ſignification thereof; whence moſt authors confound it with Verbs.

There are two kinds of *Participles*, the one called *active*, becauſe expreſſing the ſubject, which makes the action of the Verb; as *legens*, *audiens*, *reading*, *hearing*. The other called *paſſive*, becauſe expreſſing the ſubject that receives the action of the Verb, as *lectum*, *auditum*, *read*, *heard*.

As the *Engliſh* Adjectives are not declined, the *participles* being real Adjectives, are not declined neither; in the *Latin*, &c. where the Adjectives are declined, the *participles active*, are declin'd likewiſe. Thus they ſay *audiens*, *audientis*, *audienti*, &c. and in the *French*, the *participles paſſive* are declinable as their Adjectives, as *j'ai leu*, *il a leu*, *nous avous lus*, &c.

In the *Engliſh*, the *Participles* and *Gerunds* are not at all diſtinguiſhable.

GERUND is a ſort of tenſe or time of the infinitive Mood, like to the participle, but indeclinable

It differs from the participle, in that it expreſſes the time which the participle does not. And from the tenſe, properly ſo call'd, in that it expreſſes the manner, which the tenſe does not.

Grammarians are much embaraſſed to ſettle the nature and character of *Gerunds*: it is certain they are no verbs, nor diſtinct moods of verbs, in regard they do not mark any judgment or affirmation of the mind, which is the eſſence of the verb. And beſides they have caſes, which verbs have not. ſome, therefore, will have them to be adjectives paſſive, whoſe ſubſtantive is the infinitive of the verb, on this footing. they denominate them *verbal nouns*, or names formed of verbs, and retaining the ordinary regimen thereof; thus ſay they, *tempus eſt legendi libros*, or *librorum*, is as much as to ſay, *tempus eſt* τὸ *legere libros*, *vel librorum*; but others ſtand up againſt this deciſion.

The ADVERB is a particle join'd to a verb, adjective, or participle, to expreſs their manner of acting or ſuffering; or to mark ſome circumſtance or quality ſignified by them.

The word is formed from the prepoſition *ad*, to, and *verbum*, a word, and ſignifies literally a word joined to a verb, to ſhew how, or when, or where one is, does, or ſuffers; as the boy paints *nearly*, writes *ill*; the houſe ſtands *there*, &c.

Not that the *adverb* is confin'd purely to the verb, but becauſe that it is moſt ordinarily in uſe, whence it becomes ſo denominated, κατ' ἐξοχήν. We frequently find it join'd to adjectives, and ſometimes even to ſubſtantives, particularly where thoſe ſubſtantives ſignify an attribute, or quality of the thing ſpoken of; *v. gr.* he is *very* ſick, he acts *prudently*, he is truly king.

An *Adverb* is likewiſe join'd ſometimes to another *Adverb*, to modify its meaning, *v. g.* *very devoutly*; in *French*, *fort devotement*, whence ſome Grammarians chuſe rather to call adverbs, *modificatives*; comprizing under this one general term, both *adverbs*, *conjunctions*, *prepoſitions*, and even *adjectives*.

Adverbs are very numerous, but may be reduced under the general claſſes of *Adverbs* of *time*, of *place*, of *order*, of *quantity*, of *quality*, of *manners*, of *affirmation*, of *doubting*, and of *compariſon*.

A CONJUNCTION is a particle, which expreſſes a relation, or dependance between words and phraſes, thus called, becauſe ſerving to join or connect the parts, or members of a diſcourſe.

Conjunctions render the diſcourſe more ſmooth, and fluent; and ſerve very good purpoſes in the argumentative and narrative ſtyle, but muſt ever be omitted

omitted where a perſon ſpeaks with emotion, as ſerving to weaken and enervate it.

Conjunctions are of various kinds. — *Copulative*, or *conjunctive Conjunctions* are thoſe, which expreſs a relation of union, or compariſon between things; as, and, *&c*; only, *tantum*; as much as, *tantum quantum*; in the ſame manner as, *quemadmodum*; neither more nor leſs, *tantumdem*; inaſmuch as, *quippe*; not only, *non modo*; but alſo, *ſed etiam*, &c.

Conjunctions *adverſative* are thoſe, which expreſs a reſtriction, or contrariety; as, but, *ſed*; nevertheleſs, *tamen*; although, *etiamſi*; far from, *adeo non*.

Conjunctions *cauſal* are thoſe, that ſhew that the reaſon of ſomething is brought; as, for, *nam*; becauſe, ſeeing, *quippe quia*; the rather ſince, *eo magis quo*; inaſmuch as, *quatenus*.

Conjunctions *concluſive* are thoſe, which denote a conſequence drawn; as, for which reaſon, *qua propter*; but then, *atqui*; of conſequence, *ideoque*: ſo that, *ita ut*, &c.

Conjunctions *conditional* are thoſe, which import a condition; as, if, *ſi*; if not, *ſi minus*; on condition that, *câ lege ut*; provided that, *dummodo ut*; in caſe of, *ſi vero*.

Conjunctions *continuative* are thoſe, which expreſs a ſucceſſion, or continuation of the diſcourſe; as in effect, *reipſa*; even, *etiam*; whatever it be, *quicquid ſit*.

Conjunctions *disjunctive* are thoſe, which expreſs a relation of ſeparation or diviſion; as, neither, *nec*; whether, *ſive* or *vel*.

Conjunctions, *dubitative* are thoſe, which expreſs ſome doubt or ſuſpenſion of opinion, as if, *that is to ſay*; if, *&c*.

Conjunctions *exceptive* are, if it be not, *niſi ſi*; unleſs that, *niſi*, &c.

A Preposition is an indeclinable particle, which yet ſerves to govern the nouns (either of the accuſative, or ablative caſe) that follow it: ſuch are *per*, *pro*, *propter*, *in*, with, through, from, by, *&c*.

They are called *prepoſitions*, becauſe *prepoſitions* are placed before the nouns they govern.

Interjection, is an expreſſion uſed to denote ſome ſudden motion, or paſſion of the mind; as *oh! ho!*, &c.

As the greateſt part of the expreſſions uſed on thoſe occaſions are taken from nature alone, the real *interjections* in moſt languages are monoſyllables. And as all nations agree in thoſe natural paſſions, ſo do they agree in the ſigns and indications of them, as of *love*, *mirth*, *&c*.

The *Greeks* confound their *interjections* with adverbs: and the *Hebrews* confound them with their adverbs and prepoſitions, calling them all by the general name *particle*.

Let us now proceed to the laſt diviſion of *Grammar*, *i. e.* the *doctrine* of *ſentences*, which conſiders the placing or joining words together, called *ſyntax*.

The Syntax is the conſtruction, or connection of the words of a language into ſentences, or phraſes: or the manner of conſtructing one word with another, with regard to the different terminations thereof, preſcribed by the rules of Grammar. For the office of *Syntax* is to conſider the natural ſuitableneſs of words with reſpect to one another; in order to make them agree in the gender, number, perſon, mood, *&c*.

It is properly the *Syntax* that gives the forms to language, and it is that on which turn the moſt eſſential parts of *Grammar*.

There are two kinds of *Syntax*, the one of *concord*, wherein the words are to agree in gender, number, caſe and perſon. The other of *regimen* or *government*, wherein one word governs another, and occaſions ſome variation therein.

The firſt, generally ſpeaking, is the ſame in all languages, as being the natural ſeries of what is uſed almoſt every where; the latter to diſtinguiſh diſcourſe. Thus the diſtinction of two numbers, ſingular and plural, has rendered it neceſſary to make the adjective agree with the ſubſtantive in number; that is, to make the one ſingular or plural, when the other is ſo; for as the ſubſtantive is the ſubject confuſedly, though directly marked by the adjective; if the ſubſtantive expreſſes ſeveral, there muſt be ſeveral ſubjects expreſſed in that form by the adjective; and by conſequence it ought to be in the plural, as *homines docti*, learned men: but there being no variety of termination in the adjective, in *Engliſh*, to diſtinguiſh the number, it is only implied.

The diſtinction of maſculine and feminine gender obliges the languages, which have diſtinct terminations to have a *concordance*, or *agreement* between the ſubſtantive and adjective, in *gender*, as well as number: and for the ſame reaſon, the verbs are to agree with the nouns and pronouns in *number* and *perſon*. If at any time we meet with any thing that ſeems to contradict theſe rules, it is by a figure of ſpeech, *i. e.* by having ſome word underſtood, or by conſidering the thoughts rather than the words themſelves.

The *Syntax of government*, on the contrary, is generally arbitrary, and on that account differs in moſt languages. One language, for inſtance, forms their regimen by *caſes*, as the *Latin* and *Greek*: others uſe *particles*, in lieu thereof, as the *French*, *Engliſh*, *Italian*, *Spaniſh*, &c.

One or two general rules, however, may be here noted, which obtain in all languages. 1. That there is no *nominative caſe*, but has a relation to ſome

ſome *verb*, either expreſſed or underſtood: ſince we do not only ſpeak to expreſs what we perceive, but to expreſs what we think of what we perceive, which is done by the verb.

2. That there is no *verb*, but has its *nominative caſe*, either expreſſed or underſtood; for the office of the verb being to affirm, there muſt be ſomething to affirm of, which is the ſubject, or nominative caſe of the verb, except before an infinitive, where it is an accuſative, as, *ſcio Petrum eſſe doctum*, I know *Peter* to be learned.

3. There is no *adjective* but has a relation to ſome *ſubſtantive*, becauſe the adjective marks confuſedly the ſubſtantive; which is the ſubject of the form or quality, marked by the adjective.

4. That there never comes any *genitive caſe*, but what is govern'd by ſome other noun.

5. The *government of verbs* is frequently taken from various ſorts of references, included in the caſes, according to the practice of cuſtom or age; which yet does not change the ſpecifick relation of each caſe, but only ſhews that cuſtom has made choice of this or that. Thus the *Latins* ſay, *juvare aliquem, & opitulari alicui*: the *French*, *ſervir quelqu'un, & ſervir a quelque choſe*; and in the *Spaniſh*, the generality of verbs govern indifferently a dative and an accuſative caſe.

It is eaſy to underſtand, that theſe *general rules* are the foundation of the doctrine of *ſentences*; ſince a *ſentence* denotes a *period*, or a ſet of words comprehending ſome perfect ſenſe, or ſentiment of the mind.

Every *ſentence* comprehends at leaſt three words.

In every *ſentence* there are two parts neceſſarily requir'd; a *noun* for the *ſubject*, and a *definite verb*: whatever is found more than theſe two, affects one of them, either immediately or by the intervention of ſome other, whereby the firſt is affected.

Again, every *ſentence* is either *ſimple* or *conjunct*: a *ſimple ſentence* is that conſiſting of one ſingle ſubject, and one finite verb. — A *conjunct ſentence* contains ſeveral ſubjects, and finite verbs, either expreſly or implicity.

A *ſimple ſentence* needs no point or diſtinction, only a period to cloſe it; as, *a good man loves virtue for itſelf.* In ſuch a *ſentence*, the ſeveral adjuncts affect either the ſubject or the verb in a different manner; thus the word *good*, expreſſes the quality of the ſubject; *virtue*, the object of the action; and, *for itſelf*, the end thereof. Now none of theſe adjuncts can be ſeparated from the reſt of the *ſentence*, for if one be, why ſhould not all the reſt? and if all be, the *ſentence* will be minced into almoſt as many parts as there are words.

But if ſeveral adjuncts be attributed in the ſame manner, either to the ſubject or to the verb, the *ſentence* becomes *conjunct*, and is to be divided into parts.

In every *conjunct ſentence*, as many ſubjects, or as many finite verbs as there are; either expreſſly, or implied, ſo many diſtinctions may there be; thus, *my hopes, fears, joys, pains, all center in you*; and thus *Cicero*; *Catilina abiit, exceſſit, evaſit, erupit.* The reaſon of which pointing is obvious; for as many ſubjects or finite verbs as there are in a *ſentence*, ſo many members does it really contain. Whenever, therefore, there occur more nouns than verbs, or contrarywiſe, they are to be conceived as equal; ſince, as every ſubject requires its verb, ſo every verb requires its ſubject, wherewith it may agree, excepting perhaps in ſome figurative expreſſions.

Indeed there are ſome other kinds of *ſentences*, which may be ranked among the *conjunct* kind, particularly the *abſolute ablative*, as it is called; thus, *phyſicians, the diſeaſe once diſcover'd, think the cure half wrought.* Where the words, *diſeaſe once diſcover'd*, are equivalent to, *when the cauſe of the diſeaſe is diſcovered.* So alſo in nouns, added by appoſition, as, *the* Scots, *a hardy people, endured it all*; ſo alſo in vocative caſes, and interjections; as, *this, my friend, you muſt allow me*; and, *what, for heaven ſake, would he be at?*

The caſe is much the ſame when ſeveral adjuncts affect either the ſubject of the *ſentence*, in the verb, in the ſame manner, or at leaſt ſomething whereby one of them is affected; as, *a good, wiſe, learned man, is an ornament to the common wealth*; where the ſeveral adjectives denoting ſo many qualities of the ſubject, are to be ſeparated from one another. Again, when I ſay, *your voice, countenance, geſture terrified him.* The ſeveral nominative caſes denote ſo many modes of the verb, which are likewiſe to be diſtinguiſhed from each other. The caſe is the ſame in adverbs; as, *he behaved himſelf modeſtly, prudently, virtuouſly.* In the firſt example, the adjuncts immediately affect the ſubject; in the third, the verb; in the following one, another adjunct; as, *I ſaw a man loaden with age, ſickneſs, wounds.*

Now as many ſuch adjuncts as there are, ſo many ſeveral members does the *ſentence* contain, which are to be diſtinguiſhed from each other, as much as ſeveral ſubjects, or finite verbs; and that this is the caſe in all *conjunct ſentences*, appears hence, that all thoſe adjuncts, whether they be verbs or nouns, &c. will admit of a *conjunction copulative*, whereby they may be joined together: but wherever there is a copulative, or room for it, there a new member of a *ſentence* begins.

The *points* uſed to divide a diſcourſe into periods, and members of periods (to expreſs the pauſes to be made in the reading thereof) are four, *viz.* the *period* or *point*, *colon*, *ſemicolon*, and *comma*.

The

The *period*, *point*, or full ſtop, is thus formed (.) and ſhews that the ſenſe of the ſentence is complete.

A *colon* is a point or character, formed thus (:) ſerving to mark a pauſe, and to divide the members of a period. Grammarians generally aſſign the uſe of a *colon*, to mark the middle of a period, or to conclude a ſenſe leſs perfect than the dot or period. Others ſay a *colon* is to be uſed when the ſenſe is perfect, but the ſentence not concluded.

The mark or character of the *ſemicolon* is (;) It has its name, as having a ſomewhat leſs effect than a *colon*, or as demanding half its pauſe. The *ſemicolon* is properly uſed to diſtinguiſh the conjunct members of ſentences. By a conjunct member of a ſentence, we mean ſuch a one as contains at leaſt two ſimple members. Whenever then a ſentence can be divided into ſeveral members of the ſame degree, which are again diviſible into other ſimple members, the former are to be ſeparated by a *ſemicolon*.

A *comma* is a point or character form'd thus (,) ſerving to mark a ſhort ſtop or pauſe ; and to divide the members of a period.

The *comma* ſerves to diſtinguiſh thoſe members of a period, in each whereof is a verb, and the nominative caſe of the verb. Beſides this, the *comma* is uſed to diſtinguiſh in the ſame member of a period, ſeveral nouns ſubſtantive, or nouns adjective, or verbs not united by a conjunction ; for if they be united by a conjunction, the *comma* is omitted : it may alſo be omitted between two phraſes that are very ſhort, eſpecially if they depend on the ſame regimen, and are united by a conjunction.

The pauſes to be made at each of theſe points or ſtops, are equal to the time we can ſay *one* for a *comma* : *one*, *one*, for a *ſemicolon* : *one*, *one*, *one*, for a *colon* : and *one*, *one*, *one*, *one*, for a *period*.

Beſides theſe above-mention'd, the *Grammar* admits of other *punctuations*, viz. *the parentheſis* mark'd thus ( ) and which includes ſome words, which, if left out, would not break, or alter the ſenſe, or ſmoothneſs of the ſtyle The *interrogation* mark'd thus ? and which is made at aſking a queſtion. *Note of admiration* or *exclamation* thus ! *Hyphen* thus - which couples together two words, as *well-ſpring*, and is uſed when a word is parted into ſyllables, at the end of a line The ſection thus § which divides a large diſcourſe into ſeveral parts. *Aſteriſm* thus * which refers to the margin. *Obeliſk* thus † notes from the matter to the margin. *Note of citation* thus " when authors are cited word for word. *Apoſtrophe* thus ' when a letter is purpoſely left out, as *'tis*, for *it is* ; *'twas*, for *it was*. *Induction* thus ‸ is made to bring in ſomething omitted. *Diæreſis* or *Dialyſis* thus ¨ is uſed to part a dipthong, and is made over the vowels *aër*, *poëta*, that it may not be pronounced *ær*, *pœta*. *Grave accent* thus ´ uſed over a vowel, when the voice is depreſſed. *Acute accent* thus ` when the voice is to be raiſed higher. *Croſis* thus ˆ uſed over *circumflex* ſyllables, long by nature, as *dî* for *dij*, *amârunt* for *amaverunt*.

Grammar admits of figures, which occaſion changes in the form, *&c.* of words, there are *ſyncope*, *apocope*, *apoſtrophe*, *aphæreſis*, *proſtheſis*, *epentheſis*, *paragoge*, *metathoſis*, &c.

Syncope denotes an eliſion or retrenchment of one or more letters, or ſyllables from a word : as when we ſay *virum*, for *virorum*, and *manet alta repôſtum*, for *repoſitum*.

Apocope is a figure wherein part of the end of a word is cut off ; as in *dic* for *dice*, *fac* for *face*, *nil* for *nihil*, *hyp* or *hypo*, for *hypochondriacal*.

Apostrophe denotes a note or character, placed over a letter, in lieu of a vowel, to denote that the vowel is cut off, and not to be pronounced: as *ev'n* for *even* ; *th' angelick hoſt*, for *the angelick*, &c.

Aphæresis is a figure, whereby ſomething is taken away from the beginning of a word ; thus *Ciconia*, by *aphæreſis*, is wrote *Conia* ; *contemnere*, *temnere* ; *omittere*, *mittere*, *&c.*

Prosthesis is a ſpecies of metaplaſm ; being the prefixing of ſome letter, or ſyllable at the beginning of a word ; as, in *gnavus*, for *navus*.

Epenthesis is the addition, or inſertion of a letter or ſyllable, in the middle of a word. — As *relligio* for *religio* ; *mavors* for *mars*.

Paragoge is a figure, whereby a word is lengthened out, by adding a ſyllable at the end thereof: as in *dicier* for *dici*.

Metathesis is a figure, whereby letters or ſyllables of a word are tranſpoſed, or ſhifted out of the natural ſituation : as *evandre* for *evander*, *ipræ* for *præi*.

I ſhall add to this treatiſe on *grammar*, ſome remarks upon *languages*.

A Language is a ſet of words, which any people have agreed upon, whereby to communicate their thoughts to each other.

There is ſound a conſtant reſemblance between the genius, or natural complexion of each people, and the language they ſpeak.—Thus the *Greeks*, a polite, but voluptuous nation, had a *language* perfectly ſuitable, full of delicacy and ſweetneſs.—The *Romans*, who ſeem'd only born to command, had a *language* noble, nervous, and auguſt ; and their deſcendants, the *Italians*, are deſcended into ſoftneſs and effeminacy ; which ſome ſay, is as viſible in their *language*, as in their manners.—The *language* of the *Spaniards*, is full of that gravity, and haughtineſs of air, which makes the diſtinguiſhing character

character of that people.—The *French*, who have a world of vivacity, have a *language* that runs extremely brisk and lively.—And the *English*, who are naturally blunt, thoughtful, and of few words, have a *language* exceeding short, concise, and sententious.

The diversity of *languages* is generally allowed to have taken its rise from the confusion of *Babel*, both by *Jews*, *Christians*, and *Mahometans*.

Languages are divided into *original*, or *mother tongues*; as the *Hebrew* and *Arabick* in the east, the *Teutonick* and *Sclavonick* in the west.

Secundary or *derivative languages*, which are those formed of a mixture of several others, as *Latin*, *English*, *French*, &c.

Kircher will have the *Coptick* a mother tongue independant of all others. *Du John* maintains the *Gothick*, a primitive *language*, and the mother of all the *Teutonick* tongues; that is, of all those spoke in the north. Some add the *Basque* or *Biscayan*, and *Bas Briton*, to the number of mother tongues, imagining them to have been those of the antient *Celtæ* or *Gauls*.

Languages are also divided into *learned*, or *dead languages*, and *living languages*.

Learned, or *dead languages*, are those which only subsist in books, and which must be learned by the rules of *Grammar*, as the *Hebrew*, *Arabick*, *Syriack*, *Chaldee*, *Greek*, and *Latin*.

HEBREW is the *language* spoke by the *Hebrews*, and wherein all the books of the Old Testament are wrote. Whence it is also called the *holy* and *sacred language*.

The *Hebrew* appears to be the most antient of all the *languages* in the world, at least it is so with regard to us, who know no older.

The *Hebrew*, such as we have it in the holy scripture, is a very regular, analogical *language*; and particularly so in its conjugations. Properly speaking, there is but one simple conjugation, but this is varied in each verb, seven or eight ways, which has the effect of so many different conjugations, and affords a great number of expressions, whereby to represent under one single word, all the different modifications of a verb; and several ideas at once; which in the modern, and most of the antient and learned languages, are to be expressed only by phrases

The original and primitive words in this *language*, which they call *radices*, *i. e.* roots, rarely consist of more than three letters, or two syllables, which are expressed by two sounds, or by the same sound redoubled, which is indicated by a point.

Usually they only reckon five vowels in the *Hebrew*, which are the same with ours, *viz.* *a*, *e*, *i*, *o*, *u*; but then each vowel is divided into two, *a*, *long*, and *a*, *breve*, or *short*: the sound of the former is somewhat graver and longer; and that of the latter shorter, and more acute. It must be added that the two last vowels have quite different sounds; different we mean in other respects besides quantity and degrees of elevation.

To these ten or twelve vowels must be added some others, called *semi-vowels*, which are only slight motions serving to connect the consonants, and make the easier transitions from one to another.

The number of accents is prodigious in the *Hebrew*; there are near forty different ones; and of these there are several whose use is not well ascertained, notwithstanding all the inquiries of the learned into that matter.

In the general, we know these three things, 1. That they serve to distinguish the sentences, and the members thereof, like the points, and comma's, &c. in *English*. 2. To determine the quantity of the syllables: and 3. To mark the tone wherewith they are to be spoke or sung. It is no wonder then, there should be more accents in the *Hebrew* than in other languages; as they do the office of three different things, which in other languages are called by different names.

The language used by the *Rabbins* in the writings they have composed, is called *rabbinical*, or *modern Hebrew*. The basis or body hereof is the *Hebrew* and *Chaldee*, with divers alterations in the words of those two languages; the meaning whereof they have considerably enlarged and extended. Abundance of things they have borrowed from the *Arabick*. The rest is composed of words and expressions chiefly from the *Greek*, some from the *Latin*, and others from the other modern tongues; particularly that spoken in the place where each *Rabbin* lived, or wrote.

The *rabbinical Hebrew*, must be allowed a very copious language. M. *Simon* observes, that there is scarce any art or science, but the *Rabbins* have treated thereof in it. They have translated most of the antient philosophers, mathematicians, astronomers, and physicians; and have wrote themselves on most subjects: they do not want even orators and poets. Add, that this language, notwithstanding it is so provided with foreign words, has its beauty visible enough in the works of those who have wrote well.

The ARABICK is a branch or dialect of the *Hebrew*. Father *Angelo de St. Joseph*, speaks much of the beauty and copiousness of the *Arabick*.

The SYRIACK, and CHALDEE, are also dialects of the *Hebrew*.—The *Chaldee* paraphrase in the *rabbinical* stile, is called *Targum*.

The GREEK, absolutely so called, is the language spoken by the antient *Grecians*, and still preserved in in the works of their authors, as *Plato*, *Aristotle*, *Isocrates*, *Demosthenes*, *Thucydides*, *Xenophon*, *Homer*, *Hesiod*, *Sophocles*, *Euripides*, &c.

The *Greek* has been preserved entire longer than any other language known, maugre all the revolutions that have happened in the country where it was spoke.

The *Greek* has a great *copia*, or stock of words: its inflections are as remarkable for their variety as those of most of the other *European* tongues, for their simplicity.

The *Greek* was the language of a polite people, who had a taste for arts and sciences, which they cultivated with success. In the living tongues are still preserved a great number of *Greek* terms of art; some descended to us from the *Grecians*, and others formed a new. When a new invention, machine, rite, order, instrument, *&c.* has been discovered, recourse has commonly been had to the *Greek* for a name; the facility wherewith words are there compounded readily affording us names expressive of the use, effect, *&c.* of such instruments.

Modern, or *vulgar Greek*, is the language now spoke in *Greece*. One may distinguish three ages of the *Greek* tongue; the first ended at the time when *Constantinople* became the capital of the *Roman* empire; not but there were several books, particularly of the fathers of the church, wrote with great purity after that time; but as religion, law, and policy, both civil and military, began then to introduce new words into the language, it seems necessary to begin the second age of the *Greek* tongue from that epocha; which lasted to the taking of *Constantinople* by the *Turks*, where the last age commences.

The LATIN was first spoken in *Latium*, and afterwards at *Rome*.

Some authors rank the *Latin* among the number of original languages, but by mistake; it is formed principally from the *Greek*, and particularly the *Æolick* dialect of that tongue; tho' it has a great number of words which it borrowed from the languages of the *Etrusci*, *Osci*, and other antient people of *Italy*: and foreign commerce and wars, in course of time added a great many more.

The *Latin* is more figurative than the *English*, less pliant than the *French*, less copious than the *Greek*, less pompous than the *Spanish*, less delicate than the *Italian*, but closer and more nervous than any of them.

After the translation of the seat of the empire from *Rome* to *Constantinople*, the emperors of the east being always desirous of retaining the title of *Roman* emperors, appointed the *Latin* to be still retain'd in use, both in their rescripts and edicts. But at length the emperors neglecting the empire of the west, abandon'd all care of the *Latin* tongue, and allowed their judges to pass sentence in *Greek*.

Charlemagne coming to the empire of the west, appointed the law proceedings in sovereign courts to be in *Latin*, and the notaries were to draw their acts and instruments in the same tongue: this practice continued a long time through a great part of *Europe*, but at length it gave way, and the *French* took place of the *Latin*, not only in *France*, but in some measure in *England* too; and the reason given for it was, that abundance of difficulties arose about understanding of *Latin* terms.

The *Latin* however, was prodigiously degenerated and corrupted ere it came to be laid aside. The incursions of the *Goths* and *Vandals* into *Italy*, brought an inundation of foreign words and phrases into it, insomuch that *Valla* calls *Boethius* the last *Latin* author. But that was not all; when it once got into the courts of justice, it was still worse handled, till at last being introduced among the Monks, and become the common language of *Missals* and *Breviaries*, it was debauched to that degree, that it was almost become scandalous to use it.

Living Languages, are those still spoke in some country or other, and which may be learned by conversation. The most popular among these are the *French*, *Italian*, *Spanish*, *English*, *German*, &c.

The *French*, as it now stands, is no original, or mother language; but a medley of several: scarce any *language*, but it has borrowed words, or perhaps phrases from.

The *languages* that prevail most, and that are, as it were, the basis thereof, are, 1. The *Celtic*; whether that were a particular *language* itself, or whether it were only a dialect of the *Gothic*, as spoke in the west, and north. 2. The *Latin*, which the *Romans* carried with them into *Gaul*, when they made the conquest thereof. And, 3. The *Teutonic*, or the dialect of the *Teutonic*, spoke by the *Franks*, when they passed the *Rhine*, and established themselves with the *Gauls*.

Of these three *languages*, in the space of about 1300 years, was the *French* formed; such as it is now found: its progress was very slow; and both the *Italian*, and *Spanish*, were regular *languages* long before the *French*.

As to the analogy of *Grammar*, and the simplicity wherewith moods of verbs are formed; the *English* has the advantage, not only over the *French*, but over all the known languages of the world: but then the turns, the expressions, and the idioms of the *English* are sometimes so quaint, and extraordinary, that it loses a great deal of the advantage, which its *grammatical* simplicity gives it over the rest.

The

The *French* have but few compound words, wherein it differs widely from the *Greek*, *High Dutch*, and *English*. This the *French* authors own a great disadvantage in their language; the *Greek* and *Dutch* deriving a great part of their force and energy, from the composition of words; and frequently expressing that in one sounding word, which the *French* cannot express but by a periphrasis. And the diminutives in the *French* are as few as the compounds; the greatest part of those remaining in use, having lost their diminutive signification. But what distinguishes the *French* most, is its justness, purity, accuracy, and flexibility.

French is the most universal and extensive language in *Europe*; the policy of states and courts, has render'd it necessary for the ministers of princes and their officers, &c. and the taste of arts and sciences has had the same effect with regard to the learned.

Tho' the court of *Vienna* was a long while an exception from this rule; *French* was there very little used: The Emperor *Leopold* could not bear to hear it spoke in his court.

The several nations who speak *Sclavonick*, do not so much speak the same language, as different dialects of the same language. In several parts of *Europe*, there are as many different languages as there are states; and in *Italy* there are reckoned no fewer than ten or twelve dialects, some of which differ as much from the common *Italian*, as from the *French* or *Spanish*.

The *Italian* is derived principally from the *Latin*, and of all the languages formed from the *Latin*, there is none which carries with it more visible marks of its original, than the *Italian*. It is accounted one of the most perfect among the modern tongues, containing words, and phrases to represent all ideas, to express all sentiments, to deliver one's self on all subjects, to name all the instruments and parts of arts, &c.

The *Spaniards* seem to place the nobleness and gravity of their language, in the number of syllables, and the swelling of words, and speak less to be understood than to be admir'd. Their terms are big and sonorous, their expressions haughty and boisterous, and pomp and ostentation run through all they say: their language cannot paint a thought to the life; it always magnifies it, frequently distorts it, and does nothing, if it does not exceed nature.

The *English*, or *English* tongue, is of *Gothic* or *Teutonic* extraction: this was the root or stock, upon which several other dialects have been since grafted.

The language antiently spoke in this island, was the *British*, or *Welch*, which is pretended was common to the *Britons* and *Gauls*; and which still subsists in more or less purity in the principality of *Wales*, the county of *Cornwal*, the islands, and the province of *Bretagne* in *France*.

As the *Roman* Empire, extending itself towards the western parts of *Europe*, came to take in *Gaul* and *Britain*, the *Roman* tongue became propagated therewith; all the edicts, &c. relating to publick affairs, being designedly wrote in that language.

The *Latin*, however, it is certain, never got so much ground, or prevailed so far in *England*, as in *Lombardy*, *Spain*, and the *Gauls*; partly, on account of its great distance from *Rome*, and the small resort of *Romans* hither; and partly for that the entire reduction of the kingdom was not effected till so late as the Emperor *Claudius*, when the empire was on the declining hand, and the new province was forced to be soon deserted by its conquerors, called to defend their territories nearer home. *Britain* thus left naked, became an easy prey to the *Angli*, or *Anglo-Saxons*, a stroling nation from *Jutland* and *Norway*, who took an easy possession thereof; much about the time that the *Franks*, another *German* nation, enter'd *Gaul*. The *Gauls* and *Franks*, it seems, at length came to terms, and found means to unite it into one nation: thus the antient *Gaulish*, with its mixture of *Latin*, continued the prevailing tongue, only further intermix'd with the *Francic*, or *Lingua Franca*, of their new inmates: But the *Britons* were more constant, and determin'd absolutely to refuse any such coalition; they had embraced christianity, and their competitors were heathens; rather than admit of such an union, therefore, they chose to be shut up, with their language, in the mountainous parts of *Cambria* or *Wales*.

The *English Saxons* thus left absolute lords, changed every thing; their own language was now fully established, and the very name of the country was henceforth to be *Anglo-Saxon*.

The new language remained in good measure, pure and unmixed till the *Norman* invasion: the attempts of the *Danes*, and the neighbourhood of the *Britons*, indeed wrought some lesser innovations therein; but, in the main, it preserved itself: for as to the *Danes* their language was not much different therefrom. *William* I. and his *Normans*, having got possession of *England*, an alteration was soon attempted: the conquest was not compleat, unless the conqueror's language, the *French* or *Franco Gallic*, was introduced; and accordingly all his acts, diploma's, edicts, pleadings, and other judicial matters were written, &c. in that tongue.

Under *Henry* II. Dr. *Swift* observes, the *French* made a still greater progress, by reason of the large territories he possessed on that continent, both from his father and his wife, which occasioned frequent journies

journies thither, with numerous retinues, *&c.* and for ſome centuries after, there was a frequent intercourſe between *France* and *England*, by the dominions the *Engliſh* poſſeſſed there, ſo that the language two or three hundred years ago, ſeems to have had more *French* than at preſent.

Beſides this alteration from the conquerors, the language in proceſs of time, underwent divers others; and came to have numerous words and phraſes of foreign dialects, ingrafted into it, in lieu whereof the antient *Saxon* ones gave way; particularly by means of negotiations, and commerce with other nations; by the marriages of royal families; by the affectation of many writers in moſt ages, who are fond of coining new words, and altering the uſual forms of ſpeech, for the greater delicacy; and by the neceſſity of framing or borrowing new words, according as new things and inventions turn up. And by ſuch means was the old *Anglo-Saxon* converted into the preſent *Engliſh* tongue.

The perfections aſcribed to the *Engliſh*, and that in a degree ſuperior to any of the other modern tongues, are,—1. That it is ſtrong and ſignificant; to which the finely compounded words, formed on the model of the *Greeks*, do not a little contribute.

2. Copious; of which Mr. *Greenwood* gives us inſtances in the word *ſtriking*: which the *Engliſh* have about 30 ſynonymous expreſſions for; as to *ſmite*, *bang*, *beat*, *bale*, *buffet*, *cuff*, *hit*, *thump*, *thwack*, *ſlap*, *rap*, *tap*, *kick*, *ſpurn*, *box*, *yerke*, *pummel*, *punch*, &c. and the word *anger*, for which he enumerates above 40.

3. Muſical and harmonious; in which reſpect Mr. *Dennis* makes no ſcruple to aſſert it ſuperior even to any other.

The *Teutonic language* is the antient language of *Germany*, which is ranked among the mother-tongues.

The *Teutonic*, now called the *German* or *High Dutch*, is diſtinguiſhed into *Upper* and *Lower*.

The *Upper* has two notable dialects, *viz.* 1. the *Scldian*, *Daniſh*, or perhaps *Gothic*; to which belong the languages ſpoke in *Denmark*, *Norway*, *Sweden*, and *Iceland*. 2. The *Saxon*, to which belong the ſeveral languages of the *Engliſh*, *Scots*, *Friſian*, and thoſe on the north of the *Elbe*.

To the *Lower* belong the *Low Dutch*, *Flemiſh*, &c. ſpoke through the *Netherlands*, &c.

The *Sclavonic*, is the language of the *Sclavi*, an antient people of *Scythia Europea*; who about the year 518, quitting their native country, ravaged *Greece*, and eſtabliſhed the kingdom of *Poland* and *Moravia*, and at laſt ſettled in *Illyria*; which thence took the name of *Sclavonia*.

The *Sclavonic* is held, after the *Arabick*, the moſt extenſive language in the world: it is ſpoke from the *Adriatick* to the *North Sea*, and from the *Caſpian* to *Saxony*, by a great variety of people, all the deſcendants of the antient *Sclavi*, *viz.* the *Poles*, *Muſcovites*, *Bulgarians*, *Carinthians*, *Bohemians*, *Hungarians*, *Pruſſians*, *Suabians*, &c. each of whom however, have their particular dialect; only the *Sclavonic* is the common mother of their ſeveral languages, *viz.* the *Poliſh*, *Ruſſian*, *Hungarian*, &c.

The *Japaneſe language* is very curious, wherein they have ſeveral words to expreſs one thing, ſome in deriſion, others in honour; ſome for the prince, others for the people; as alſo for the quality, age, and ſex of the ſpeaker, and perſon ſpoke to.

The *Ethiopian*, or *Abyſſinian tongue* ſeems to have ſome affinity with the *Hebrew*, and *Chaldee*.

The *languages* of other countries in *Africa*, and *America* are but mere jargons, wholly rude, and harſh to themſelves, and unknown, as well as unintelligible to us.

The difference and affinity of ſeveral *languages*, may be ſeen from that famous ſentence of *Habbakuk*, ii. 4. *But the juſt ſhall live by his faith*, expreſſed in thirty-three *languages*, or ſeveral tongues, which I have ſet down in our common printing letters.

Hebrew] Ve-tzaddig, be emunatho jichjeh.
Chaldee] Vetzaddikaia al kuſhethon jith kaigemun.
Syriack] Decana min himenuta nacha.
Arabick] Vaadili minalamj anj jaccaij.
Greek] Ho de dikaios ec ſteoos mec zeſetaij.
Latin] Juſtus autem ex fide ſuâ vivet.
Spaniſh] El juſto en ſu ſe bivira.
Italian] Il giuſto vivera per la ſua fede.
Portugal] Oa juſto em ſua fei vivara.
French] Mais le juſt vivera de ſa foy.
Armenian] Shedeck mart eer ſerdoven kapree,
Perſian] Raſt adem eis fiſk hodmigzeratt.
Georgian] Mortalee katſeca tavis ſumartlitta darchebis.
Javan, *Mallay*] Ozany betool deah-pooniah emaun ollough cubbool.
Eaſt Indian, *Surat*] Neek zaut oousſkah ema un coodawtah haut.
Weſt-Indian, *New-England*] Sampivenſſeanuta piſh pomantum kiſke wunnamptamoouke.
Hungarian] Azigar ember pedig hit altellel.
Tranſilvanian] Aſſigas emberpedig itt altel el.
Moldavian] Wom kudireptate kulege alui trayeſti.
Tartarian, *Coſſackian*] Ho dikaios athropos metin biſte too zee.
High-German] Dun der Gerechte bebet ſines glaubens.

Bohemian]

Bohemian] Geſt ſprawedliwy ziw budzwiſry.
Sclavonian] Pravedne oot vearca zeove boudet.
Moſcovian, Ruſſian] Prawidliwy zcjut prze wiare.
Turkiſh] Sadick adam onung ich tikat eila decillet.
Lattoiſh] Taiſus per wiera ſawo girens.
Poliſh] Spraviedliwij Z. wiarij ſwey bendzie zil.
Daniſh] Den retferdige ſcal leff ve aff ſin tro.
Swediſh] Then retferdiga ſcall leff ve aff ſine tro.
Netherlandiſh] De rechtverdige ſal uyt den Geloove leven
Iriſh] Dee-yow een feerian flawhaunus le creddiff.
Welſh] Y cyfiawn a fydd byw trwy fydd.
Engliſh] But the juſt ſhall live by his faith.

The beſt of the modern *Grammars* are, 1. For the *Hebrew*, that of *Pagninus*, the edition of *Henry Stephens*, or *le Preux*, at *Geneva*, in 1592; that of *Petrus Martinius*, at *Rochel*, 1592; that of *Buxtorff*; that of *Ludovicus Deus*, in three languages; that of *Sixtinus Amama*, which is a collection from *Martinius* and *Buxtorff*; that of *Bellarmine*, with the notes of *Muis*; that of Father *Sylanter* is uſeful for beginners.—For *Chaldee*, the beſt are thoſe of *Martinius*, *Buxtorff*, and *Lud. Deus*, in three languages.—3. For the *Syriack*, thoſe of *Amira*, *Myricæus*, *Waſerus*, and *Beveridge*; with the *Chaldee* and *Syriack* ones of *Buxtorff*, of *Lud. Deus*, in three languages, and that of *Lembden*.—4. For the *Coptic*, the *Pedromus Coptus*, and *Lingua Ægyptiaca Reſtituta* of *Kircher*.—5. The *Arabick*, that of *Erpenius*, and that of *Golius*, which is only *Erpenius*'s a little augmented.—6. For the *Ethiopick*, that of *J. Ludolphus*.—7. For the *Perſian*, that of *Lud. Deus*, —8. For the *Armenian*, thoſe of *Shroder* and *Galamus*.—9. For the *Greek*, thoſe of *Mart. Rulandus*, *Sylburgus*, F. *Mocquet*, *Voſſius*, *Port Royal*, and *Busby*.—10. For the *Latin*, thoſe of *Deſpauter*, the *Minerva* of *Sanctius*, thoſe of *Voſſius* and *Sprat*, that of *Port Royal*, which is only a collection from the reſt, and that of *Lowe*, the moſt exact of all.—11. For the *Italian*, thoſe of *Berger*, *Lanfredini*, *Port Royal*, and *Veneroni*.—12. For the *Spaniſh*, thoſe of *Salazar*, *Port Royal*, the Abbot *de Veirac*, &c.—13. For the *Portugueſe*, that of *Pereira*.—14. For the *French*, thoſe of the Abbot *Regnier*, and F. *Buffier*.—15. For the *High Dutch*, thoſe of *Claius*, *Hertsburgenſis*, *Schottelius*, *Boedicher*, and *Steinbach*.—16. For the *Engliſh*, that of *Wallis*, *Brightland*, and *Greenwood*.

GUNNERY.

GUNNERY, is the art of charging, directing, and exploding fire-arms, as cannons, mortars, muſkets, &c. to the beſt advantage.

To the ART of GUNNERY belongs the knowledge of the force and effect of gunpowder, the dimenſions of cannon, &c. and the proportion of the powder and ball they carry, with the method of *managing*, *charging*, *pointing*, *ſpunging*, &c.

A *cannon* is a military engine, or fire-arm, for throwing iron, lead, or ſtone-bullets, by force of gun-powder, to a place exactly oppoſite to the axis of the cylinder whereof it conſiſts.

Cannons are made cylindrical, that the motion of the ball might not be retarded in its paſſage; and that the powder, when on fire, might not ſlip between the ball and the ſurface of the *cannon*, which would hinder its effect.

The names of the braſs *cannons*, antiently caſt, their weight, length, and the weight of the ball, or their *caliber*, were as follows:

NAMES.	Caliber, *or wt. of the iron ball.* *lb.*	*wt. of the cannon.* *lb.*	*Length.* *Feet.*
The *Baſilick*,	48	7200	10
The *Dragon*,	40	7000	16½
The *Flying Dragon*,	32	7200	22
The *Serpentine*,	24	4300	13
The *Culverine*,	20	7000	16
The *Half-Culverine*,	10	4250	11
The *Saker*,	5	2850	13
The *Sacret*,	4	2500	12½
The *Falcon*,	3	2300	8
The *Falconet*,	2	1350	10½
The *Ribadequin*,	1	750	8
The *Emerillon*,	¼	400	4 or 5

The names of the ſeveral *cannon*, their length, weight, and that of their balls as they obtain in *England* and *France*, are already ſet down under the title FOUNDERY, on page 516, 517, with ſome obſervations upon the length, charge, and members of a *cannon*.

In-

In the laſt century was invented, at *Lyons*, a piece of ordnance, called *Jumelle*, or double *cannon*, the figure whereof is in our plate.—The two *cannons* carry a ball or bullet four pounds weight: they are caſt together, with a ſingle touch-hole for both, and they are charged with two iron bars tied together, of 12 foot extent, and 65 pounds weight. This was improved, as may be ſeen in the *Armory* in the Tower of *London*; where there are *cannon* made in this form, with 3, 4, and 12 bores. But they are not found fit for uſe.

Each ſort of *ordnance* is more or leſs *fortified*; which fortification is reckon'd by the thickneſs of the metal at the touch-hole, at the trunnions, and at the muzzle, in proportion to the diameter of the bore.

There are three degrees uſed in fortifying each ſort of ordnance, both *cannons* and *culverines*. Firſt, ſuch as are ordinarily fortified, which are called *legitimate pieces*. Secondly, ſuch whoſe fortifications are leſſen'd, which are called *baſtard pieces*: Thirdly, double fortified pieces, or extraordinary pieces.

The *cannons* double fortified have full one diameter of their bore in thickneſs of metal, at their touch hole, and $\frac{11}{16}$ at their trunnions, and $\frac{7}{16}$ at their muzzle. The *leſſened cannons*, have at their touch-hole, but $\frac{3}{4}$ or $\frac{12}{16}$ of the diameter of their bore in thickneſs of metal, and $\frac{9}{16}$ at their trunnions, and $\frac{5}{16}$ at their muzzle. The *ordinary fortified cannons*, have 7 at the touch-hole, $\frac{5}{8}$ at the trunnions, and $\frac{3}{8}$ at the muzzle. All the *double fortified culverines*, and all leſſer pieces of that kind, have one diameter and $\frac{1}{8}$ at the touch-tole, $\frac{15}{16}$ at the trunnions, and $\frac{9}{16}$ at the muzzle. And all the *ordinary fortified culverines*, are fortified every way as the double fortified *cannons*; and the *leſſen'd culverines*, as the ordinary *cannons* in all points.

Gun powder is a compoſition of *ſalt petre*, *ſulphur*, and *charcoal* mix'd together.

The *ſulphur* and *ſalt-petre* being purified, and reduced to powder, are put with the *charcoal-duſt* in a mortar, moiſten'd with water or ſpirit of wine, or the like, and pounded 24 hours together; taking care to wet the maſs from time to time, to prevent its taking fire. Laſtly, ſqueezing it through a ſieve, it is formed into little grains or globules; which being dried the powder is compleat.

There are three kinds of *powder*, viz. *cannon-powder*, *muſket powder*, and *piſtol powder*; and each of theſe ſorts, is *ſtronger* and *weaker*: which differences ariſe only from the different proportions.

In the *ſtronger cannon-powder*, to every hundred pounds of *ſalt petre*, twenty-five pounds of *ſulphur*, are generally allowed with the ſame quantity of *charcoal*; and in the *weaker cannon-powder*, to every hundred pounds of *ſalt-petre*, twenty pounds of *ſulphur*, and twenty-four of *charcoal*.

Semienowitz preſcribes for mortars, an hundred pounds of ſalt-petre, twenty-five of ſulphur, and as many of charcoal; for great guns an hundred pounds of ſalt-petre, fifteen of ſulphur, and eighteen of charcoal.

Miethus extols the proportion of one pound of ſalt-petre to three ounces of charcoal; and two, or two and a quarter of ſulphur. He adds, that the uſual practice of making the *gun powder* weaker for mortars than *cannons*, as in the example above, is without any foundation, and renders the expence needleſly much greater: for, whereas, to load a large mortar, twenty-four pounds of common powder is requir'd; and conſequently to load it ten times, two hundred and forty pounds; he ſhews, by calculation, that the ſame effect would be had by one hundred and eighty pounds of the ſtrong powder.

There are three ways to prove the goodneſs of *gun-powder*. 1. By *ſight*; for if it be too black, it is too moiſt, or has too much charcoal in it; ſo alſo if rubbed upon white paper, it blackens it more than good powder does: but if it be a kind of azure colour, ſomewhat inclining to red, it is a ſign of good powder. 2. By *touching*; for if in cruſhing it with your fingers ends, the grains break eaſily and turn into duſt, without feeling hard, it has too much coal in it; or if, in preſſing under your fingers upon a ſmooth, hard board, ſome grains feel harder than the reſt, or, as it were, dent your fingers ends, the ſulphur is not well mix'd with the nitre, and the powder is naught. 3. By *burning*; wherein heaps of powder are laid upon white paper, three inches or more aſunder, and one of them fired; which, if it only fires all away, and that ſuddenly, and almoſt imperceptibly, without firing the reſt, and make a ſmall thundering noiſe, and a white ſmoak riſes in the air, almoſt like a circle, the powder is good; if it leaves black marks, it has too much coal, or is not well burnt: if it leaves a greaſineſs, the ſulphur or nitre is not well cleanſed or order'd. Again, if two or three corns are laid on paper an inch diſtant, and fire be put to one of them, and they all fire at once, leaving no ſign behind but a white ſmoaky colour in the place, and the paper not touch'd, the powder is good.

To recover damag'd powder, the method of the powder merchants is, to put part of the powder on a ſail-cloth, to which they add an equal weight of what is really good; and with a ſhovel mingle it well together, dry it in the ſun, and barrel it up, keeping it in a dry and proper place.

Obſervations on the force of Gun-powder. *Gun-powder* fired either in *vacuum*, or in air, produces

by

by its explosion a permanent elastic fluid. For if a red-hot iron be included in a receiver, after being exhausted, and gun-powder be let fall on the iron, the powder will take fire, and the mercurial gage will suddenly descend upon the explosion; and though it immediately ascends again, yet it will never rise to the height it first stood at, but will continue depressed by a space proportioned to the quantity of gun-powder which was let fall on the iron.

The same production likewise takes place, when gun-powder is fired in the air: for if a small quantity of powder be placed in the upper part of a glass tube, and the lower part of the tube be immerged in water, and the water be made to rise so near the top, that only a small portion of air is left in that part where the gun-powder is placed; if in this situation the communication of the upper part of the tube with the external air be closed, and the powder be fired, which will easily be done by a burning-glass, the water will in this experiment descend upon the explosion as the quicksilver did in the last; and will always continue depressed below the place at which it stood before the explosion; and the quantity of this depression will be greater, if the quantity of powder be increased, or the diameter of the tube be diminished. From whence it is proved, that as well in air as in a vacuum, the explosion of fired powder produces a permanent elastic fluid. It also appears from experiment, that the elasticity or pressure of the fluid produced by the firing of gun-powder, is, *cæteris paribus*, directly as its density.

This follows from hence, that if in the same receiver a double quantity of powder be let fall, the mercury will subside twice as much as in the firing of a single quantity.

To determine the elasticity and quantity of this elastic fluid, produced from the explosion of a given quantity of gun-powder, Mr. *Robins* premises, that the elasticity of this fluid increases by heat, and diminishes by cold in the same manner as that of the air; and that the density of this fluid, and consequently its weight, is the same with the weight of an equal bulk of air having the same elasticity, and the same temperature.

From these principles, and from his experiments, for a detail of which we must refer the reader to his *new principles* of *gunnery*, in *scholium*, to prop. II. he concludes, that the fluid produced by the firing of gun-powder will be $\frac{3}{10}$ of the weight of the gun-powder, and the ratio of the respective bulks of the powder, and the fluid produced from it, will be in round numbers 1 to 244.

Hence we are certain, that any quantity of powder fired in any confined space, which it adequately fills, exerts, at the instant of its explosion, against the sides of the vessels containing it, and the bodies it impels before it, a force at least 244 times greater than the elasticity of common air; or which is the same thing, than the pressure of the atmosphere; and this without considering the great addition, which this force will receive from the violent degree of heat, with which it is endued at that time, the quantity of which augmentation is the next head of Mr. *Robins*'s enquiry.

He determines that the elasticity of the air is augmented when heated to the extremest heat of red-hot iron, in the proportion of 796 to $194\frac{1}{3}$, and supposing that the flame of fired gun-powder is not less hot than red hot iron, and the elasticity of the air, and consequently of the fluid, generated by the explosion, being augmented by the extremity of this heat in the ratio of 796 to $194\frac{1}{3}$, it follows that if 244 be augmented in this ratio, the resulting number which is $999\frac{1}{3}$ will determine how many times the elasticity of the flame of fired powder exceeds the elasticity of common air, supposing it to be confined in the same space, which the powder filled before it was fired.

Hence, then, the absolute quantity of the pressure exerted by gun-powder, at the moment of its explosion may be assigned: for since the fluid then generated has an elasticity of $999\frac{1}{3}$, or in round numbers 1000 times greater than common air; and since common air by its elasticity exerts a pressure on any given surface equal to the weight of the incumbent atmosphere, with which it is in *equilibrio*, the pressure exerted by fired powder, before it has dilated itself, is 1000 times greater than the pressure of the atmosphere; and consequently the quantity of this force on a surface of an inch square, amounts to above six tun weight, which force however diminishes as the fluid dilates itself.

The variations of the density of the atmosphere does not any way alter the action of powder by any experiment that can be made. But the moisture of the air has a very great influence on the force of it: for that quantity which in a dry season would communicate to a bullet a velocity of 1700 feet in one second, will not in damp weather communicate a velocity of more than 12 or 1300 feet in a second, or even less, if the powder be bad and negligently kept.

The velocity of expansion of the flame of *gun-powder*, when fired in a piece of artillery, without either bullet, or any other body before it, is prodigious. By the experiments of Mr. *Robins*, it seems this velocity cannot be much less than 7000 feet in a second. This, however, must be understood of the most active part of the flame. For as was observed before, the elastic fluid in which the activity of gun-powder consists, is only $\frac{3}{10}$ of the substance of the powder, the remaining $\frac{7}{10}$ will in the explosion be mixed with the elastic part, and will by its weight retard the activity of the explosion; and yet they will be so compleatly united, as to move with uncommon motion; but the unelastic part will be less accelerated than the rest, and some of it will not even be carried out of the barrel, as appears by the considerable quantity of unctuous matter, which adheres to the inside of all fire-arms, after they have been used. These inequalities in the expansive motion of the flame render it impracticable to determine its velocity, otherwise than from experiments.

A *bullet* is an iron ball, wherewith *cannons* are loaded. A *bullet* should be very round, well shaved, and without vacuities.

There are *bullets* of various kinds, *viz. red-hot bullets*, intended to set fire to places, where combustible matters are found. The *bullet* is made red-hot, by digging a place in the earth, and lighting in it a great quantity of charcoal, or sea-coal; and placing over it a strong iron grate. When the fire is well lighted, the *bullets* are placed on the grate, where, in a very short time, they grow red-hot; they are taken out with tongs, or iron ladles for the purpose, and carried into the piece; having before put some clay over the powder the *cannon* is loaded with, lest it should be set on fire by the *red-hot bullet*: then the piece is fired. Wherever the *bullet* passes, and meets with combustible matters, it sets them on fire. But when a trench is before the battery of *red-hot bullets*, hay is rammed over the powder; because, if it was clay, the pieces of it would wound and kill the workmen.

Red-hot bullets are never fir'd but with eight or four pounders. For if they were of a stronger *caliber*, the *bullets* could not be serv'd easily.

Hollow bullets are shells made cylindrical, with an aperture and fusee at one end, which giving fire to the inside, when in the ground, it bursts, and has the same effect with a mine.

Chain bullets consist of two balls joined by a chain, three or four foot a part.

Branch bullets are two balls joined by a bar of iron, five or six inches a part.

Two-headed-bullets, called also *angels*, being two halves of a bullet, joined by a bar or chain: these are chiefly used at sea, for cutting of cords, cables, sails, &c. See all those *bullets* in the *plate*.

As *bullets*, as well as the pieces of ordnance, are of different *caliber*, which *caliber*, in a piece of ordnance, is the diameter of the mouth thereof, and in a *bullet*, its circumference; there are means found to proportion these two *calibers* to one another, *viz.* with an instrument called *caliber-rule*, wherein a right line is so divided, as that the first part being equal to the diameter of an iron or leaden ball, of one pound weight, the other parts are to the first, as the diameters of balls of two, three, four, &c. pounds, are to the diameter of one ball of one pound.

The *caliber* consists of two thin pieces of brass, six inches long, join'd by a rivet, so as to move quite round each other: the head, or one end of the piece, is cut circular, and one half of its circumference divided into every second degree. On the other half are divisions from one to ten; each again subdivided into four: the use of which divisions and sub-divisions, is when the diameter of a *bullet*, &c. not exceeding ten inches, is taken, the diameter of the semi-circle will, among the divisions, give the length of the diameter, taken between the points of the *calibers*, in inches, and fourth parts.

The degrees on the head, serve to take the quantity of an *angle*, the method of which is obvious. If the *angle* be inward, apply the outward edges to the planes that form the *angle*; the degree cut by the diameter of the semi-circle, shews the quantity of the *angle* sought. For an outward *angle*, open the branches till the points be outward, and applying the streight edges to the planes that form the *angle*, the degrees cut by the diameter of the semi-circle, shew the *angle* requir'd; reckoning from 180, towards the right hand.

On one branch of the *calibers*, on the same side, are, first six inches; and each of these subdivided into ten parts. Secondly, a scale of unequal divisions, beginning at two, and ending at ten, each subdivided into four parts. Thirdly, two other scales of lines, shewing when the diameter of the bore of a piece, is taken with the points of the *calibers* outwards, the name of the piece, whether of the iron or brass, *i. e.* the weight of the bullet it carries, or that it is such or such a pounder, from one to forty-two pounds.

On the other branch of the *calibers*, on the same side, is a line of cords to about three inches radius; and a line of lines on both branches, as on the sector; with a table of the names of the several pieces of ordnance. On the same face is a hand graved, and a right line drawn from the finger towards the center of the rivet, shewing by its cutting certain divisions made on the circle, the weight of an iron shot, when the diameter is taken by the points of the *calibers*. Lastly, on the circle or head, on the same side, are graved several geometrical figures, inscribed in each other, with numbers; as a cube, whose side is supposed one foot; a pyramid on the same base or altitude, and the proportions of their weight, &c. a sphere inscrib-ed ed in a cube; a cylinder, cone, circle, ſquare, &c.

The outſide of the *caliber* ſerves to take the diameter of the mouth of the piece; and the inſide, called the *heel*, that of the *bullet*.

There is another method of taking the *caliber* of the pieces, which is to have a rule very well divided, on which are graved the *calibers*, both of the pieces and bullets. That rule muſt be applied on the mouth of the piece, and the *caliber* is preſently found.

But to be more particular on this important ſubject, here follows the different *calibers* of the pieces of ordnance.

A piece which receives a *bullet* an ounce weight (twelve ſuch ounces to the pound) has of aperture at its mouth, 9 lines and $\frac{5}{16}$ of a line.

That which receives a *bullet* two ounces weight, has of aperture at its mouth, 11 lines and $\frac{3}{4}$ of a line. I'll continue according to the ſame order.

Weight of the bullet.	*Aperture of the* caliber.		
Ounces.	*Inches.*	*Lines.*	*Fractions.*
1	0	9	$\frac{5}{16}$
2	0	11	$\frac{3}{4}$
3	1	1	$\frac{1}{16}$
4	1	2	$\frac{3}{4}$
5	1	4	
6	1	4	$\frac{7}{8}$
7	1	5	$\frac{10}{32}$
8	1	6	$\frac{5}{8}$
10	1	8	$\frac{1}{12}$
12	1	9	$\frac{1}{3}$
14	1	10	$\frac{7}{16}$

The piece that receives the *bullet* one pound weight, which makes ſixteen ounces, has of aperture at its mouth, 1 inch, 11 lines, and $\frac{1}{2}$ of a line.

Weight of the bullet.	*Aperture of the* caliber.		
Ounces.	*Inches.*	*Lines.*	*Fractions.*
1	1	11	$\frac{1}{2}$
2	2	5	$\frac{19}{32}$
3	3	9	$\frac{13}{16}$
4	3	1	$\frac{5}{16}$
5	3	4	$\frac{1}{6}$
6	3	6	$\frac{2}{3}$
7	3	8	$\frac{7}{8}$
8	3	11	
9	4	0	$\frac{7}{8}$
10	4	2	$\frac{3}{16}$
11	4	4	$\frac{1}{4}$
12	4	5	$\frac{3}{4}$
13	4	7	$\frac{1}{16}$
14	4	8	$\frac{3}{16}$
15	4	9	$\frac{7}{8}$
16	4	11	$\frac{7}{32}$
17	5	0	$\frac{7}{16}$
18	5	1	$\frac{9}{16}$
19	5	2	$\frac{19}{32}$
20	5	3	$\frac{23}{32}$
21	5	4	$\frac{3}{4}$
22	5	5	$\frac{25}{32}$
23	5	6	$\frac{13}{16}$
24	5	7	$\frac{5}{8}$
25	5	8	$\frac{3}{8}$
26	5	9	$\frac{1}{2}$
27	5	10	$\frac{1}{2}$
28	5	11	$\frac{1}{3}$
29	6	0	$\frac{1}{6}$
30	6	1	$\frac{1}{32}$
31	6	1	$\frac{25}{32}$
32	6	2	$\frac{3}{8}$
33	6	3	$\frac{12}{32}$
34	6	4	$\frac{1}{8}$
35	6	4	$\frac{7}{8}$
36	6	5	$\frac{17}{32}$
37	6	6	$\frac{9}{32}$
38	6	6	$\frac{15}{16}$
39	6	7	$\frac{19}{32}$
40	6	8	$\frac{12}{32}$
41	6	9	
42	6	9	$\frac{2}{3}$
43	6	10	$\frac{1}{3}$
44	6	10	$\frac{29}{32}$
45	6	11	$\frac{9}{16}$
46	7	0	$\frac{1}{4}$
47	7	0	$\frac{25}{32}$
48	7	1	$\frac{1}{3}$
49	7	1	$\frac{29}{32}$
50	7	2	$\frac{9}{16}$
55	7	5	$\frac{1}{2}$
60	7	7	$\frac{28}{32}$
64	7	10	

Sometimes, in lieu of bullets, the pieces are charged with *cartouches*, which are caſes loaded with muſket balls, nails, chains, and pieces of old iron; ſometimes, alſo, with ſmall cannon balls. See the *Fig.* on the plate of *Gunnery*.

There are *cartouches* made in form of grapes, which are muſket balls joined together with pitch, and diſpoſed on a ſmall board, in a pyramidal form round a wooden ſtick, which ariſes from the middle of the board.

The *cartouches* made of tin are the beſt, becauſe they carry further.

There are alſo *cartouches* made in form of pine-apples, whoſe figure is pyramidal. Their baſe is equal to the *caliber* of a bullet, propoſed for the piece they are to be fired with; their height is of a *caliber* and a half; they are dipped in tar, and afterwards rolled on muſket balls, and when well covered with thoſe balls, dipped again in the ſame tar, after which they may be uſed, thruſting the biggeſt foremoſt into the piece. Theſe pine-apples are very good at ſea, becauſe, beſides that the muſket balls flying about wound a great number

of

of people, the bullet which is at the bottom of the cartouch, does also much execution.

There are several sorts of *carriages*, for ordnance, *viz.* *Bastard carriages*, with low wheels; and high wheels. *Sea carriages*, made in imitation of those for ship guns: And *carriages for field-pieces*, of which there are two kinds.

The *carriages* must be proportion'd to the pieces mounted on them. — The ordinary proportion is, for the *carriage* to have $1\frac{1}{2}$ of the length of the gun; the wheels to be half the length of the piece in eight; four times the diameter or caliber, gives the depth of the planks at the fore end, in the middle $3\frac{1}{2}$.

The piece thus mounted on its carriage, several instruments are employed, some to prepare the piece to be loaded, some to load it, others to point it, and others to cleanse it, &c. Those instruments have each their proper name, which are as follows:

The *lantern* or ladle, (*ibid.*) which serves to carry the powder into the piece, and which consists of two parts, *viz.* of a wooden box, appropriated to the caliber of the piece for which it is intended, and of a caliber and a half in length with its vent; and of a piece of copper nailed to the box, at the height of a half caliber.

This *lantern* must have three calibers and a half in length, and two calibers in breadth, being rounded at the end to load the ordinary pieces.

The *rammer*, (*ibid*) which is a round piece of wood, commonly called a *box*, fastened to a stick twelve foot long, for the pieces from twelve to thirty-three pounders; and ten for the eight and four pounders; which serve to drive home the powder and ball to the breech.

The *spunge*, (*ibid.*) which is a long staff or rammer, with a piece of sheep or lamb skin wound about its end, to serve for scouring the cannon when discharged, before it be charged with fresh powder; to prevent any spark of fire from remaining in her, which would endanger the life of him who should load her again.

Wad-Screw, (*ibid.*) which are two points of iron turned serpent-wise, to extract the wad out of the pieces, when one wants to unload them, or the dirt which had chanced to enter into it.

The *boutefeux*, (*ibid.*) which are sticks two or three feet long, and an inch thick, split at one end, to hold an end of the match twisted round it, to fire the cannon.

The *priming iron*, (*ibid.*) which is a pointed iron rod, to clear the touch-hole of the pieces of powder or dirt; and also to pierce the cartridge, that it may sooner take fire.

The *primer*, (*ibid.*) which must contain a pound of powder at least, to prime the pieces.

The *quoin of mire*, (*ibid.*) which are pieces of wood with a notch on the side to put the fingers on, to draw them back or push them forward, when the gunner points his piece. They are placed on the sole of the carriage.

Leaden plates, which are used to cover the touch-hole, when the piece is charged, lest some dirt should enter it and stop it.

Before you charge the piece spunge it well, to clean it of all filth and dirt within side; then the proper weight of gunpowder, which powder drive in and ram down; taking care that the powder be not bruised in ramming, which weakens its effect; run over it a little quantity of paper, hay, or the like; and then throw in the ball.

To *point*, level, or direct the piece, so as to play against any certain point, is done by the help of a quadrant with a plummet; which quadrant consists of two branches made of brass or wood; one about a foot long, eight lines broad, and one line in thickness; the other four inches long, and the same thickness and breadth as the former. Between these branches is a quadrant, divided into 90 degrees, beginning from the shorter branch, and furnished with thread and plummet.

Place the longest branch of this instrument in the cannon's mouth, and elevate or lower it till the thread cuts the degree necessary to hint the proposed object. Which done, prime the cannon (if not done before) and then set fire to it.

To point a cannon well, so as to do the execution proposed, we must know the path of a bullet, or the line it describes, from the mouth of the peice to the point where it lodges, which path is commonly called *range*.

If the piece be laid in a line parallel to the horizon, it is called the right or level *range*; and if it be mounted to 45 degrees, the ball is said to have the utmost range, and so proportionably; all others between 00 degrees and 45, being called intermediate *ranges*.

A shot made when the muzzle of a cannon is raised above the horizontal line, and is not designed to shoot directly or point-blank, is called *random shot*.

The utmost *random* of any piece is about ten times as far as the bullet will go point-blank; and the bullet will go furthest when the piece is mounted to about 45 degrees above the level *range*.

Mr. *Norton* observes, that

Paces.

	Paces. Level.	Paces. Utmost Random.
A *Base* shoots ——	60	600
A *Rabinet*, ——	70	700
A *Falconet*, ——	90	900
A *Falcon*, ——	130	1300
Minion ordinary ——	120	1200
Minion largest, ——	125	1250
Sacker least, ——	150	1500
Sacker ordinary, ——	160	1600
Sacker old Sort, ——	163	1630
Demi-culverine least,	174	1740
Demi-culverine ordinary	175	1750
Demi-culverine old Sort	178	1780
Culverine least, ——	180	1800
Culverine ordinary,	181	1810
Culverine largest,	183	1830
Demi-cannon least,	156	1560
Demi cannon ordinary,	162	1620
Demi-cannon large,	180	1800
Cannon-Royal ——	185	1850

A 24 pounder may very well fire 90 or 100 shots, every day in summer; at 60 or 75 in winter. In case of necessity it may fire more. And some *French* officers of artillery assure, that they have caused such a piece to fire every day 150 shots in a siege.

A 16 and a 12 pounder fire a little more, because they are easier serv'd. There have even been some occasions, where 200 shots have been fired from those pieces, in the space of nine hours, and 138 in the space of five.

To range pieces in a battery, take care to reconnoitre well the ground where it is to be placed, and the road to convey to it, in the night-time, the cannon and the munitions. See page 507, 508.

The pieces must be arm'd, each with two lanterns or ladles, a rammer, a spunge, and two priming-irons. The battery must also be provided with carriages, and other implements, necessary to remount the pieces, which the enemy should chance to dismount.

To serve expeditiously and safely a piece in battery, it is necessary to have to each a sack of leather, large enough to contain about twenty pounds of powder to charge the lanterns or ladles, without carrying them to the magazine; and to avoid thereby making those trains of powder in bringing back the lantern from the magazine, and the accidents which frequently happen thereby.

A *battery* of 3 pieces, must have 30 gabions, because six are employ'd on each of the two sides or epaulments, which make twelve, and nine for each of the two merlons.

There ought to be two gunners and six soldiers to each piece, and four officers of artillery.

The gunner posted on the right of the piece, must take care to have always a pouch full of powder, and two priming-irons; his office is to prime the piece, and load it with powder. That on the left, fetches the powder from the little magazine, and fills the lanthern or ladle which his comrade holds; after which he minds that the match be very well lighted, and ready to set fire to the piece at the first command of the officer.

There must be three soldiers on the right, and three on the left of the piece. The two first to take care to ram, and spunge the piece, each on his side. The rammer and spunge must be placed on the left, and the lantern or ladle on the right. After having rammed well the wad put over the powder, and that put over the bullet, they then take each a handspike, which they pass between the foremost spokes of the wheel, the ends whereof will pass under the head of the carriage, to make the wheel turn round, leaning on the other end of the handspike, towards the embrasure.

It is the office of the second soldier on the right, to provide wad, and to put it into the piece, as well over the powder as over the bullet; and that of his comrade on the left, to provide 50 bullets, and every time the piece is to be charged, to fetch one of them and put it into the piece, after the powder has been rammed. Then they both take each an handspike, which they pass under the hind part of the wheel, to push it in *battery*.

The officer of artillery must take care to have the piece diligently served.

In the night he must employ the gunners and soldiers, who shall relieve those who have served 24 hours, to repair the embrasures.

If there be no water near the *battery*, care must be taken to have a cask filled with it, to dip the spunges in it, and cool the pieces, every ten or twelve rounds.

The Mortar is a short piece of ordnance, thick and wide, proper for throwing bombs, carcasses, shells, stones, &c.

There are chiefly two kinds of *mortars*: the one hung or mounted on a carriage with low wheels, after the manner of guns, called *pendent* or *hanging mortars*; the other fix'd on an immoveable base, called *standing mortars*. See the *Plate* Gunnery.

At the head of the bore, or chase of the *mortar*, is the chamber for the charge of the powder. This is usually made cylindrical, all but the base which they make hemispherical: though some of the later engineers prefer hemispherical chambers; as the surface of those being less, under equal capacities, make less resistance to the gun-powder.

The

The thickness of the *mortar* about the chamber, is to be much greater than about the chase, by reason the gun-powder makes a much greater effort about the chamber than elsewhere. The diameter of the chamber to be much less than that of the bore; by reason bombs, shells, &c. are much lighter than the bullets of equal diameters, and consequently less powder suffices.

The first *mortar-piece* used for throwing stones, weighs commonly 1000 *lb.* and whose utmost random is 150 fathoms, loaded with two pounds of powder, it has 15 inches of diameter at its mouth, and 2 foot 7 inches in height.

The depth of its bore or chase is 1 foot 7 inches, and the depth of its chamber, without including the entrance where the tampion is placed, 8 inches. The tourillons have 5 inches of diameter.

The chamber must enter an inch into the tourillons. The thickness of the metal about the chamber, 3 inches; the thickness of the belly, 2 inches; and the length of the chase, 1 inch and $\frac{1}{2}$; about each ring, 1 inch and $\frac{1}{2}$.

Mortars, for throwing bombs, are of several kinds.

There are some, in the antient manner, of 6,7,8, 9,10, 11,12,and 18 inches diameter at their mouth, and which contain in their chambers, 3, 4, 5, 6, and 12 pounds of powder.

The chamber where the powder is put is cylindrical, *i. e.* of the same breadth every where, and a little rounded at bottom.

Those of new invention, have a concave chamber. And of these there are some which have 12 inches and $\frac{1}{2}$ at the mouth, and contain in their chambers 18 pounds of powder; others 12, and others 8.

The proportions of *mortars* are as follow. The *mortar* which throws a bomb of 17 inches 10 lines of diameter, has the bore $27\frac{1}{2}$ inches long, and 18 inches 4 lines of diameter: it has in thickness between the bourelet, and its small reinforced ring, $3\frac{1}{2}$ inches; its small reinforced ring, is $3\frac{1}{2}$ inches thick; its great one, 4 inches; the entrance of its chamber has $5\frac{1}{2}$ inches of diameter; the chamber, in form of a pear, is 13 inches long, and $7\frac{1}{2}$ inches of diameter at its greatest breadth; and also $7\frac{1}{2}$ thick, and contains 12 pounds of powder.

The tourillons of the *mortar* have 32 inches in length from one end to the other, and 9 of diameter. The *mortar* has in height 4 foot 4 inches.

The *bomb* has 17 inches 10 lines of diameter, is 2 inches thick every where, except the bottom, which has 2 inches 10 lines. The aperture of the touch-hole is of 20 lines within and without.

The *bomb* contains 48 *lb.* of powder, and weighs 490 *lb.* and a little more.

The bore of the *concave mortar*, whose chamber contains 18 pounds of powder, has $12\frac{1}{2}$ inches of diameter, and is $18\frac{1}{2}$ inches long. It has in thickness, between the bourrelet, and its reinforced ring, $3\frac{1}{2}$ inches; and its reinforced ring is $4\frac{1}{2}$ inches thick. Its chamber has 9 inches 7 lines of diameter at its greatest width: the higher part thereof has 6 inches of diameter, and 4 inches in height; and its lower part $2\frac{1}{2}$ inches. The thickness of the metal round the chamber is of 26 inches 9 lines. The tourillons have from one end to the other 8 inches of diameter. The mortar has in height 3 feet 5 inches 4 lines. It throws a bomb of 11 inches 8 lines diameter, which is 1 inch 4 lines thick every where, except at its *cullot*, which has 1 inch 8 lines. The aperture of its touch-hole is 16 lines inside and outside. The bomb contains 15 pounds of powder, and weighs 130 pounds, or thereabout.

The bore or chase of the *concave mortar*, whose chamber contains 12 pounds of powder, has 12 inches 6 lines of diameter, and 17 inches 6 lines in length. Its thickness between the bourrelet and its reinforced ring, is of $2\frac{1}{2}$ inches. Its reinforced ring is 3 inches thick. Its chamber has of diameter at its greatest width, 9 inches 6 lines. The portion of that chamber a-top has 5 inches 4 lines of diameter, and 2 inches at bottom. The thickness of the metal round the chamber is 6 inches. The tourillons are from one end to the other, 30 inches long, and 7 inches of diameter; and the mortar is in all 3 foot 2 inches high.

It throws a bomb, 11 inches 8 lines of diameter, which is 1 inch 4 lines thick every where, except at its cullot, which has 1 inch 8 lines.

The aperture of its touch-hole, outside and inside, is 16 lines.

The bomb contains 15 *lb.* of powder, and weighs 130.

The *mortar*, which has a concave chamber containing 8 pounds of powder, must throw a bomb of 11 inches 8 lines.—Its diameter is of $12\frac{1}{2}$ inches; its bore 18 inches long; its thickness at the chase $2\frac{1}{2}$ inches; its reinforced ring 6 inches long, and 3 inches thick; its concave chamber 8 inches 8 lines long, and 7 inches in diameter; the thickness of the metal round it 5 inches; its tourillons 3 inches long from one end to the other, and 7 inches in diameter.—The concave chamber contains 8 pounds of powder, and throws a bomb as above.

The *ordinary mortar*, which throws a bomb of 11 inches 8 lines, has a bore of 12 inches diameter, and 18 long; its thickness at the neck 2 inches; at its reinforced ring $2\frac{1}{2}$ inches, its chamber $9\frac{1}{2}$ inches in length, its diameter of $5\frac{1}{4}$ inches, the thickness of the metal round the chamber 7 inches, which chamber contains 6 pounds of powder; the

tourillons

tourillons have in length from one end to the other 28 inches, and 8 inches of diameter.

The *mortar*, which throws a bomb of 8 inches, has the bore 12 inches long, and 8 inches 4 lines in diameter; its thickneſs 1 inch 4 lines at the chaſe; its reinforc'd rings 4 inches 8 lines long, and 1 inch 8 lines thick; its chamber 6 inches long, and 2 inches 8 lines of dameter; its tourillons 18 inches 8 lines in length, and 4 inches 8 lines of diameter.—The bomb of 8 inches of diameter is 10 lines thick every where, except at the cullot, which is 13, and its touch-hole 1 inch of diameter inſide and outſide. The chamber contains 4 pounds of powder, and the bomb weighs 40 lb.

The bore of the mortar, which is to throw a bomb of 6 inches, is of 6 $\frac{1}{4}$ inches of diameter, and 9 inches long; its thickneſs at the chaſe 1 inch; its reinforced ring 1 $\frac{1}{4}$ inch thick, and 3 $\frac{1}{2}$ inches long; its chamber 4 $\frac{1}{2}$ inches long, and 2 inches of diameter; the thickneſs of the metal 2 inches, and from the bottom of the chamber to behind the recoil of the mortar 4 inches thick.

That common *mortars* are very good for the bombardment of a place, when they can be carried near the place; throwing the bomb to 45 degrees of elevation, and to 700 fathoms diſtance: the chamber charged with 5 or 6 pounds of powder, which is the greateſt charge, and carries further: the nearer a place a mortar is mounted, the leſs powder is wanted for its charge. The *mortars* with a concave chamber of the ſame diameter, *i. e.* of 12 and 12 $\frac{1}{2}$ inches pointed at 45 degrees, are proper to bombard places afar off; they carry their bombs from 1200 to 1800 fathoms. Thoſe whoſe chamber contains 8 pounds of powder throw the bomb to 1200 fathoms, and weigh 2000 *lb.* Thoſe of 12 pounds of powder will carry their bombs to 1400 fathoms, and weigh 2500 *lb.* Thoſe of 18 pounds of powder will carry to 1800 fathoms, and weigh 5000 *lb.*

The *carriage* for a mortar of 12 inches of diameter muſt be 6 foot long, the flaſks 12 inches long, and 10 thick. The trunnions are placed in the middle of the *carriage*.

The *carriage* of 18 muſt be 4 foot long; and the flaſks 11 inches high, and 6 thick.

To mount the *mortars* of new invention, they uſe *carriages* of caſt iron.

In *Germany*, to mount *mortars* from 8 to 9 inches, and carry them into the field, and execute them horizontally as a piece of cannon, they make uſe of a piece of wood 8 feet 2 inches long, with a hole in the middle to lodge the body of the *mortar* and its trunnions as far as their half diameter, and mounted on two wheels four feet high, to which they join a vantrain proportioned to it, and made like thoſe which ſerve to the cariages of cannons

Having mounted our *mortars* on its carriage, the next thing we do we'll *caliber* our bomb, by means of a great *caliper*, (See the plate of *Gunnery*) the two branches whereof embrace the whole circumference of the bomb: Theſe two branches are brought on a rule where the different calibers are marked, among which that of the bomb is found.

A *bomb* is a hollow iron ball, or ſhell filled with gunpowder, and furniſhed with a vent for a fuſee or wooden tube filled with combuſtible matter to be thrown out from a mortar. The method of preparing a bomb is as follows: A hollow iron globe is caſt pretty thick, having a round aperture by which it may be filled and lighted; and circular anſæ for the commodious putting it into the mortar. To prove whether it be ſtaunch, after heating it red hot on the coals, it is expoſed to the air, ſo as it may cool gently; for ſince fire dilates iron, if there be any hidden chinks or perforations, they will thus be opened enlarged; and the rather becauſe of the ſpring of the included air continually, acting from within. This done, the cavity of the globe is filled with hot water, and the aperture well ſtopped, and the outer ſurface waſhed with cold water and ſoap; ſo that if there be the ſmalleſt leak, the air, rarified by the heat, will now perſpire and form bubbles on the ſurface.

If no defect be found in the bomb, its cavity is filled, by means of a funnel, with whole gunpowder; a little ſpace or liberty is left, that when a fuſee or wooden tube, of the figure of a truncated cone, is driven through the aperture (with a wooden mallet not an iron one, for fear of accident) and faſtened with a cement made of quick lime, aſhes, brick-duſt, and ſteel-filings worked together in a glutinous water, or of four parts of pitch, two of colophony, one of turpentine, and one of wax; the powder may not be bruiſed. This tube is filled with a combuſtible matter, made of two ounces of nitre, one of ſulphur, and three of gunpowder-duſt well rammed.

This fuſee ſet on fire, burns ſlowly till it reaches the gunpowder, which goes off at once, burſting the ſhell to pieces with incredible violence. Special care however muſt be taken, that the fuſee be ſo proportioned, as that the gunpowder do not take fire ere the ſhell arrives at the deſtined place; to prevent which, the fuſee is frequently wound round with a wet clammy thread.

Our *mortar* mounted on its carriage, and the bomb ready, we'll place our piece in battery, which battery muſt conſiſt; — 1. Of an epaulment to ſhelter the *mortars* from the fire of the enemy. 2. Of platforms on which the *mortars* are

are placed. 3. Of ſmall magazines of powder. 4. Of a boyau which leads to the great magazines 5. Of ways which lead from the battery to the magazine of bombs. 6. Of a great ditch before the epaulment. 7. Of a berm or retraite. See page 507, 508.

The platforms for mortars of 12 inches muſt have 9 feet in length, and 6 in breadth. — The *lambourds* for common mortars muſt be 4 inches thick; thoſe of a concave chamber of 8 *lb.* of powder, 5 inches; thoſe of 12 *lb.* 6 inches; thoſe 18 *lb.* 7 inches, or thereabouts. Their length is at diſcretion, provided there be enough to make the platforms 9 feet long.—The fore-part of the plat-form will be ſituated at two foot diſtance of the epaulment of the battery. — The bombardiers, to ſhelter themſelves in their battery, and not be ſeen from the town beſieged, raiſed an epaulment of 7 foot or more high, which epaulment has no embraſures.

To ſerve expeditiouſly a mortar in battery are required, — five ſtrong *handſpikes*, a *dame* or *rammer*, of the caliber of the conick chamber, to ram the wad and the earth, a wooden knife a foot long to place the earth round the bomb, an iron ſcraper two foot long, one end whereof muſt be 4 inches broad and roundwiſe to clean the bore, and the chamber of a mortar, and the other end made in form of a ſpoon to clean the little chamber, a kind of *brancard* to carry the bomb, a ſhovel, and pick-ax.

The officer who is to mind the ſervice of the mortar muſt have a quadrant to give the degrees of elevation.

Five *bombardiers*, or others are employed in that ſervice; the firſt muſt take care to fetch the powder to charge the chamber of the mortar, putting his priming-iron in the touch-hole before he charges the chamber; and never going to fetch the powder before he has aſked his officer at what quantity of powder he deſigns to charge, becauſe more or leſs powder is wanted according to the diſtance where it is fired; the ſame will take care to ram the wad and earth which another ſoldier ſhall put in the chamber.

That on the right will put again two ſhovels full of earth in the bottom of the bore, which ſhould be likewiſe very well rammed down.

This done the *rammer* or *dame* ſhall be returned into its place againſt the epaulment on the right of the mortar: he'll take an handſpike in the ſame place to poſt himſelf behind the carriage of the mortar, in order to help to puſh it into battery. having laid down his handſpike, he'll take out his priming-iron, and prime the touch-hole with fine powder.

The ſecond ſoldiers on the right and left, will have by that time brought the bomb ready loaded, to be placed in the mortar, which muſt be received in the mortar by the firſt ſoldier, and placed very ſtrait in the bore or chaſe of the mortar.

The firſt, on the right, ſhall furniſh him with earth to put round the bomb, which he muſt take care to ram cloſe with the knife given him by the ſecond on the left.

This done, each ſhall take a handſpike, which the two firſt, on the right and left, ſhall put under the pegs of retreat of the fore part, and the two behind, under thoſe of the hind-part; and they together ſhall puſh the mortar in battery.

Afterwards the officer ſhall point or direct the mortar.

During that time the firſt ſoldier ſhall take care to prime the touch-hole of the mortar, without ramming the powder; and the laſt on the right, ſhall have the match ready to ſet fire on the fuſee of the bomb on the right, while the firſt ſhall be ready with his on the left, to ſet fire to the touch-hole of the mortar; which he ought not to do till he ſees the fuſee well lighted,

The foremoſt ſoldiers will have their handſpikes ready to raiſe the mortar upright, as ſoon as it has diſcharged; while the hindmoſt on the left ſhall, with the ſcraper, clean the bore and chamber of the mortar.

The *magazine* of powder for the ſervice of the battery, ſhall be ſituated 15 or 20 paces behind, and covered with boards, and earth over it. — The loaded bombs are on the ſide of the ſaid magazine, at 5 or 6 paces diſtance.

The officer who commands the ſervice of the mortar, muſt take care to diſcover, as much as poſſible with the eye, the diſtance of the place where he intends to throw his bomb, giving the mortar the degrees of elevation, according to the judgment he has formed of the diſtance. Having thrown the firſt bomb, he'll diminiſh or increaſe the degrees of elevation, according to the place upon which it ſhall fall. Several make uſe of *tables* to diſcover the different diſtances according to the differences of the elevations of the mortar, eſpecially the degrees of the quadrant from 1 to 45.

M. *Blondel* has wrote a large treatiſe on that ſubject, where he pretends to give a demonſtration to throw bombs with great exactneſs.

They ſay then (ſays M. *Blondel* ſpeaking of *bombardiers*) that the mortars chaſe more or leſs, according as it is more or leſs charged with powder; and that a mortar, for example, of 12 inches caliber, charged in its chamber with 2 lb. of powder, gives every degree 48 feet difference in the random, and for the greateſt extent under the elevation of 45 degrees, 2160 feet. The

The same mortar will give every degree 50 foot difference, if it be charged with $2\frac{1}{2}$ of the same goodness, and 2700 foot for the greatest random.

Lastly, it will give 72 foot difference every degree, if the charge be of 3 *lb.* of the same powder, and at the elevation of 45 degrees, which, they say, is the greatest random, it will throw the bomb at the distance of 3240 foot.

On this foundation they have made the following tables.

TABLES *for* Mortars *of* 12 *inches of* Caliber.

First Table at 2 *pounds* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
5	240 *Feet*	28	1344 *Feet*
10	480	29	1392
11	528	30	1440
12	576	31	1488
13	624	32	1536
14	672	33	1584
15	720	34	1632
16	768	35	1680
17	816	36	1728
18	864	37	1776
19	912	38	1824
20	960	39	1872
21	1008	40	1920
22	1056	41	1968
23	1104	42	2016
24	1152	43	2064
25	1200	44	2112
26	1248	45	2160
27	1296		

Note, That the difference is of 48 feet every degree.

Second Table at *two pounds* and *half* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
36	2160 *Feet*	41	2460 *Feet*
37	2200	42	2520
38	2280	43	2580
39	2340	44	2640
40	2400	45	2700

Note, That the difference is of 60.

Third Table at *three pounds* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
37	2664 *Feet*	42	3024 *Feet*
38	2736	43	3096
39	2808	44	3168
40	2880	45	3240
41	2952		

The difference is of 72.

TABLES *for* mortars *of eight inches* caliber.

First table at *half pound* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
5	210 *Feet*	28	1176 *Feet*
10	420	29	1218
11	460	30	1260
12	504	31	1302
13	546	32	1344
14	588	33	1386
15	630	34	1428
16	672	35	1470
17	714	36	1512
18	756	37	1554
19	798	38	1596
20	840	39	1638
21	882	40	1680
22	924	41	1722
23	966	42	1764
24	1008	43	1806
25	1050	44	1848
26	1092	45	1890
27	1134		

The difference is of 42 feet every degree.

Second table at *three quarters* of a *pound* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
31	1922 *Feet*	39	2418 *Feet*
32	1984	40	2480
33	2046	41	2542
34	2108	42	2604
35	2170	43	2666
36	2232	44	2728
37	2294	45	2790
38	2356		

The difference is of 62.

Third table at *one pound* of *powder.*

Degrees	*Randoms*	*Degrees*	*Randoms*
35	2870 *Feet*	41	3362 *Feet*
36	2952	42	3444
37	3034	43	3526
38	3116	44	3608
39	3198	45	3690
40	3280		

Granadoes are charged like the *bombs*, and are very much like them, except that they have no *ansæ*.

A GRANADO, (*ibid*) is a hollow ball, or shell of iron, brass, or even glass, or potters earth, filled with gun powder, and fitted with a fusee to give it fire.

Of thefe there are feveral kinds, the one large for ditches, or foffees, called fometimes bombs, whofe caliber is the fame with that of the bullets of 33 *lb.* and which weigh 16 *lb.* of 24, and which weigh 12 *lb.* of 16, which weigh 8 *lb.*

Thofe *Granadoes* are rolled from the ramparts, or other works into the ditch, or on a breach, and do much execution.

The other are *hand granadoes*, of the bignefs or caliber of a bullet of 4 *lb.* and weigh only 2 *lb.* containing 4 or 5 ounces of powder, or thereabout.

Thefe ferve to throw with the hand into the trenches, or retrenchments, in the middle of a troop or company, and they infallibly lame or kill

Care is taken, as much as poffible, that they be well emptied, fhaved, and of brittle iron. Their aperture or orifice, muft have fix lines, or thereabout.

Small lanterns or ladles of copper, and fmall rammers are ufed to charge the *granadoes.*

As to the proportions of *granadoes*, thofe of the caliber of a bullet of 33, have 6 inches of diameter, and fomething more, they are 8 lines thick, and weigh 16 *l.*

Thofe of the caliber of 24, have 5 inches 5 lines diameter; are 6 lines thick, and weigh 12 *lb.*

Thofe of the caliber of 16, have 4 inches 9 lines of diameter, are 5 lines thick, and weigh 8 *lb.*

Thofe which weigh 6 *lb.* have 3 inches 5 lines diameter, and 5 lines in thicknefs.

Thofe of 5 *lb.* weight, have 3 inches $2\frac{1}{4}$ lines diameter, and 5 lines in thicknefs.

Thofe which weigh 3 *lb.* have 2 inches 8 lines diameter, and are $4\frac{1}{2}$ lines thick.

Thofe of 2 *lb.* weight, have 2 inches 4 lines diameter, and 4 lines in thicknefs.

Thofe of 1 *lb.* weight, have 1 inch 10 lines diameter, and are three lines thick.

Thofe of $\frac{3}{4}$, have 1 inch 8 lines diameter, and are 3 lines thick.

Thofe of $\frac{1}{2}$, have 1 inch 6 lines diameter, and are 3 lines thick.

Thofe of a $\frac{1}{4}$, have 1 inch 2 lines diameter, and are $2\frac{1}{2}$ lines thick.

All thefe *granadoes* muft be thicker at bottom than any where elfe.

Thefe different forts of *granadoes* have alfo different forts of fufees.

Thofe of the caliber of,	33	24	16	12	8	4
are, at the biggeft end, of	12 *lin.*	11	$10\frac{1}{2}$	10	$9\frac{1}{2}$	$8\frac{1}{2}$
The diameter of the orifices,	4	4	3	3	3	2
The fufees are in length, in all, of	$5\frac{1}{2}$ *inch.*	5	4	4	$3\frac{1}{2}$	$2\frac{1}{2}$

And as the large *granadoes*, which are made to throw into the *foffes*, or ditches, or with fmall mortars, they muft have fufees of different lengths; thefe are for fmall mortars; thofe for ditches muft be fhorter.

The *Germans* cover over the fufee with paper or parchment, tied with a thread round the fufee.

In *France* they ufe a compofition of black pitch, mixed with a little tallow, with which they rub over the fufee, when fixed to the *granado.*

The fufee muft burn fo long, and no longer, as is the time of the motion of the bomb or *granado*, from the mouth of the mortar, *&c.* to the place where it is to fall, which time is about 27 feconds; fo that the fufee muft be contrived, either from the nature of the compofition, or the length of the pipe, which contains it, to burn juft that time.

At *Paris* they charge the fufees for the bombs and *granadoes*, with a compofition made with powder-duft and charcoal, very well pounded, and fifted very fine, putting two ounces of charcoal on each pound of powder, and make feveral proofs, to know if the compofition be not too quick.

There are feveral other compofitions to charge the fufees for bombs or *granadoes.*

The firft is of 4 *lb.* of powder, 2 *lb.* of falt-petre, and 1 *lb.* of fulphur.

The fecond is of 5 *lb.* of powder, 2 *lb.* of falt-petre, and 1 pound of fulphur.

The third, which is the beft, is of 3 *lb.* of powder, 2 *lb.* of falt-petre, and 1 *lb.* of fulphur.

The fourth is of 3 *lb.* of powder, 2 *lb.* of falt-petre, and $\frac{1}{2}$ *lb.* of fulphur.

The fufees muft be charged even, *i. e.* they muft burn without fpitting.

The fufee of the hand-granado, which is of the caliber of 4, muft be 2 inches 2 lines long, 9 lines of diameter, and 6 lines at the fmall end: the orifice of the fufee $2\frac{1}{2}$ lines.

As foon as the fufee is placed to the *granado*, the head thereof muft be fauced in melted pitch, and afterwards dipped in water, which hinders the compofition from fpoiling, and the wood from rotting.

The Petard (*ibid.*) is the next piece of artillery, which deferves our attention, and is a kind of engine of metal, fomewhat in fhape of a high-crown'd hat, ferving to break down gates, barricades, draw-bridges, or the like works; which are intended to be furprized. It is very fhort, narrow at the breech, and wide at the muzzle, made of copper mix'd with a little brafs, or of lead with tin.

The *petards* are not always of the fame height and bignefs: they are commonly 10 inches high, 7 inches of diameter a-top, and 10 inches at bottom. They weigh commonly 40, 45, and 50 pounds.

The Madrier (*ibid.*) on which the *petard* is placed, and where it is tied with iron circles, is of two feet for its greateft width, and of 18 inches on the

the sides, and no thicker than a common *madrier*. Under the *madrier* are two iron bars passed crosswise, with a hook, which serves to fix the *petard*.

To charge a *petard* 15 inches high, and 6 or 7 inches of caliber or diameter at the bore, the inside must be first very well cleaned and heated, so that the hand may bear the heat; then take the best powder that may be found, throw over it some spirit of wine, and expose it to the sun, or put it in a frying-pan, and when it is well dried, 5 or 6 *lb.* of this powder is put into the *petard*, which reaches within three fingers of the mouth: the vacancies is filled with tow, and stopped with a wooden tampion; the mouth being strongly bound up with cloth tied very tight with ropes; then it is fixed on the *madrier*, that has a cavity cut in it to receive the mouth of the *petard*, and fastened down with ropes.

Some, instead of gun-powder for the charge, use one of the following compositions, *viz.* gun-powder seven pounds, mercury sublimate one ounce, camphor eight ounces; or gun-powder six pounds, mercury sublimate three ounces, and sulphur three; or gun powder six, beaten glass ½ an ounce, and camphor ¾.

What has been said of the art of charging and directing of *cannons*, may be properly illustrated by a few problems in the doctrine of *projectiles*: for, as an author of great repute in this subject observes, it is only the great importance of *Gunnery*, that makes it a distinct doctrine from *projectiles* in general; it being no more than an application of those laws, which all bodies observe, when cast into the air, to such as are put in motion by the explosion of guns or other engines of that sort. And it is the same thing whether it is treated in the manner of *projectiles* in general, or of such only as belong to *gunnery*; for, from the moment the force is impressed, all distinction with regard to the power, which put the body first in motion, is lost, and it can only be considered as a simple *projectile*.

Prob. I. The impetus of a ball, and the horizontal distance of an object aimed at, with its perpendicular height or depression, if thrown on ascents or descents, being given, to determine the direction of that ball.

From the point of projection A draw Am repre-

Fig. 5.

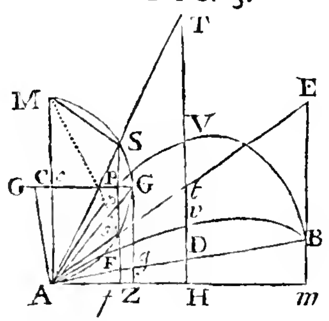


Fig. 6.

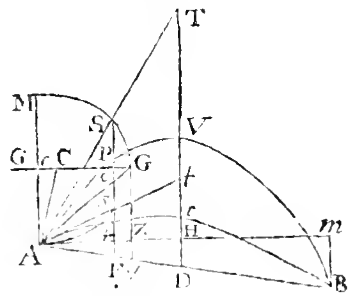


Fig. 7.

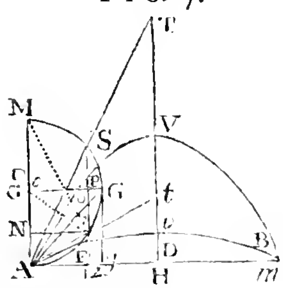
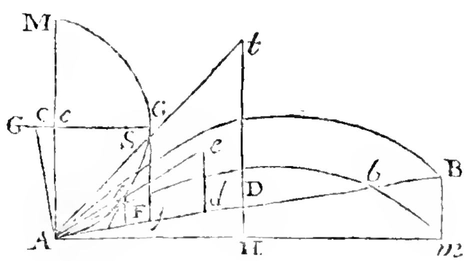


Fig. 8.



senting the horizontal distance, and Bm the perpendicular height of the object aimed at: bisect Am in H, and AH in f; on H and f erect HT, fF perpendicular to the horizon, and bisecting AB the oblique distance or inclined plane in D, and AD in F. On A raise the impetus AM at right angles with the horizon, and bisect it perpendicularly in c, with the line GG. Let the line AC be normal to the plane of projection AB, and cutting GG in C; from C as center, with the radius CA, describe the circle AGM cutting if possible the line FS in S, s, points equally distant from G; lines

lines drawn from A through S, s will be the tangents or directions required.

Continue A S, A s to T, t; biſect D T, D t, in V v; and draw lines from M to S, s; then the $\angle ASF = \angle MAS = \angle AMs = \angle sAF$; and for the ſame reaſon $\angle AsF = \angle MAs = \angle AMS = \angle SAF$; wherefore the triangles M A S, S A F, s A F are ſimilar, and $AM : As :: As : sF = tv$; conſequently A T is a tangent of the curve paſſing through the points A, v, and B; becauſe $tv = vD$, A D is an ordinate to the diameter T H, and where produced muſt meet the curve in B.

In horizontal caſes (*Fig.* 7.) v is the higheſt point of the curve, becauſe the diameter T v H is perpendicular to the horizon.

When the mark can be hit with two directions (the triangles S A M, s A F being ſimilar) the angle which the loweſt direction makes with the plane of projection is equal to that which the higheſt makes with the perpendicular AM, or $\angle sAF = \angle SAM$. And the angle S A s, comprehended between the lines of direction, is equal to the angle SCG, and is meaſured by the arch S G.

When the points S, s coincide with G, or when the directions A S, A s become A G; (*Fig.* 8.) AB will be the greateſt diſtance that can be reached with the ſame impetus on that plane; becauſe S F coinciding with G g the tangent of the circle at G, will cut off A g a fourth part of the greateſt amplitude on the plane A B. The rectangular triangles m A B, c A C are ſimilar, becauſe the angle of obliquity $mAB = cAC$; wherefore $mA : mB :: \frac{1}{2}$ impetus $: cC$, and $mA : AB :: Ac : AC$.

Horizontal projections (*ibid. Fig.* 7, 8.) When the impetus is greater than half the amplitude, there are two directions, TAH, and t AH for that amplitude; when equal to it, only one; and when leſs, none at all: and converſely. For in the firſt caſe the line F S cuts the circle in two points S, s. in the ſecond caſe it only touches it, and in the laſt it meets not with it at all; and converſely. When there is but one direction for the amplitude A m, the angle of elevation is of 45°; and when the angle of elevation is of 45° A m is the greateſt amplitude for that impetus, and equal to twice the impetus. The impetus remaining the ſame, the amplitudes are in proportion to one another as the ſines of double the angles of elevation, and converſely. For drawing s N (*Fig.* 7.) parallel and equal to A F a fourth part of the amplitude, and ſuppoſing lines drawn from s to the points C and M, the angle $ACs = 2\,AMs = 2\,sAF$; therefore N s the ſine of A C s, is the ſine of twice the angle s A F; half the impetus being radius.

Whence, at the directions of 15° or 75° the amplitude is equal to the impetus: for from what has been ſaid, half the impetus being radius, a fourth part of the amplitude is the ſine of twice the angle of elevation; but the ſine of twice 15°, that is, the ſine of 30°, is always equal to half the radius; or in this caſe a fourth part of the impetus is equal to a fourth part of the amplitude.

From this and the preceding *prop.* there are two eaſy practical methods for finding the impetus of any piece of ordnance. The fourth part of the amplitude is a mean proportional between the impetus at the curve's principal vertex and its altitude. For $MN : Ns :: Ns : NA = sF = vD$.

The altitudes are as the verſed ſines of double the angles of elevation, the impetus remaining the ſame. For making half the impetus radius, A N the altitude is the verſed ſine of the angle $ACs =$ twice $\angle sAF$. And alſo, radius : tangent $\angle$ elevation $:: \frac{1}{4}$ amplitude : altitude, that is, R : tangent $\angle sAf :: Af : fs = Dv$.

Projections on aſcents and deſcents, Fig. 5. 6.

If the mark can be hit only with one direction AG, the impetus in aſcents will be equal to the ſum of half the inclined plane and half the perpendicular height, and in deſcents it will be equal to their difference; but if the mark can be reached with two directions, the impetus will be greater than that ſum or difference. For when AG is the line of direction, the $\angle gGA$ being $= MAG = GAg$; $Gg = Ag$, and gz added to or ſubtracted from both makes G z half the impetus equal to the ſum or difference of Ag a fourth part of the perpendicular height. In any other direction F P is greater than $Fo = AF$; and Ff added to or ſubtracted from both, makes fP half the impetus greater than the ſum or difference of AF a fourth part of the inclined plane, and Ff a fourth part of the perpendicular height. Whence if in aſcents the impetus be equal to the ſum of half the inclined plane and half the perpendicular height, or if in deſcents it be equal to their difference, the mark can be reached only with one direction; if the impetus is greater than that ſum or difference, it may be hit with two directions; and if the impetus is leſs, the mark can be hit with none at all.

Prob. II. The angles of elevation, the horizontal diſtance, and perpendicular height be given, to find the impetus. *Fig*. 5. 6.

From theſe data you have the angle of obliquity, and length of the inclined plane; then as

$As : AM :: S.\angle AMs : S.\angle AsM :: S.\angle sAF : S.\angle MAF$ and $AF : As :: S.\angle MAs : S.\angle MAF$; whence by the ratio of equality, $AF : AM :: S.\angle \overline{sAF \times S.\angle MAs} : S.\angle \overline{MAF \times S.\angle MAF}$, which gives this rule.

Add the log. of AF to twice the logarithmic ſine of the angle MAF; from their ſum ſubtract the logarithmic ſines of the angles s AF and MAs, and the remainder will give the logarithm of AM the impetus.

When the impetus and angles of elevation are given, and the length of the inclined plane is required, this is the rule. Add the log of AM to the log. ſines of the angles s AF and MAs; from their ſum ſubtract twice the log. ſine of ∠ MAF, and the remainder will give the log of AF the fourth part of the length of the inclined plane.

If the angle of elevation t AH and its amplitude AB (*Fig.* 8.) and any other angle of elevation t AH is given; to find the amplitude Ab for that other angle, the impetus AM and angle of obliquity DAH remaining the ſame.

Deſcribe the circle AGM, take AF a fourth part of AB, and Af a fourth part of Ab: from the points F, f, draw the lines Fs and fp parallel to AM, and cutting the circle in the points s, p; then $AF : AM :: \overline{S.\angle sAF \times S.\angle MAs} : \overline{S.\angle MAF \times S.\angle MAF}$; and $AM : Af :: \overline{S.\angle MAF \times S.\angle MAF} : \overline{S.\angle pAf \times S.\angle pAM}$; whence by the ratio of equality.

$AF : Af :: \overline{S.\angle sAF \times S.\angle MAs} : \overline{S.\angle pAf \times S.\angle pAM}$, which gives this rule.

Add the log. of A F to the log. ſines of the angles p A f, p AM; from their ſum ſubtract the log. ſines of the angles s A F, s AM. and the remainder will give the log. of Af, a fourth part of the amplitude required.

Prob. III. To find the force or velocity of a ball or projectile at any point of the curve, having the perpendicular height of that point, and the impetus at the point of projection given. From theſe two data find out the impetus at that point; then 2 × 16 feet 1 inch is the velocity acquired by the deſcent of a body in a ſecond of time; the ſquare of which (4 × □ 16 feet 1 inch) is to the ſquare of the velocity required, as 16 feet 1 inch is to the impetus at the point given; wherefore multiplying that impetus by four times the ſquare of 16 feet 1 inch, and dividing the product by 16 feet 1 inch, the quotient will be the ſquare of the required velocity; whence this rule. Multiply the impetus by four times 16 feet 1 inch. or 64 feet $\frac{1}{3}$, and the ſquare root of the product is the velocity.

Thus ſuppoſe the impetus at the point of projection to be 3000, and the perpendicular height of the other point 100; the impetus at that point will be 2900. Then 2900 feet multiplied by 64 $\frac{1}{3}$ feet gives 186566 feet, the ſquare of 432 nearly, the ſpace which a body would run through in one ſecond, if it moved uniformly.

And to determine the impetus or height, from which a body muſt deſcend, ſo as at the end of the deſcent it may acquire a given velocity. this is the rule:

Divide the ſquare of the given velocity (expreſſed in feet run through in a ſecond) by 64 $\frac{1}{3}$ feet, and the quotient will be the impetus.

The duration of a projection made perpendicularly upwards, is to that of a projection in any other direction whoſe impetus is the ſame, as the ſine complement of the inclination of the plane of projection (which in horizontal projections is radius) is to the ſine of the angle contained between the line of direction and that plane.

Draw out A t (*Fig.* 5.) till it meets m B continued in E, the body will reach the mark B in the ſame time it would have moved uniformly through the line A E: but the time of its fall through M A the impetus, is to the time of its uniform motion thro' A E, as twice the impetus is to A E. And therefore the duration of the perpendicular projection, being double the time of its fall, will be to the time of its uniform motion through AE, as four times the impetus is to A E; or as A E is to E B; that is, as A t is to t D; which is as the ſine of the angle t DA (or MAB its complement to a ſemicircle) is to the ſine of the angle t A D,

Hence the time a projection will take to arrive at any point in the curve, may be found from the following data, *viz.* the impetus, the angle of direction, and the inclination of the plane of projection: which, in this caſe, is the angle the horizon makes with a line drawn from the point of projection to that point.

Hence alſo in horizontal caſes, the durations of projections in different directions with the ſame impetus, are as the ſines of the angles of elevation. But in aſcents or deſcents their durations are as the ſines of the angles which the lines of direction make with the inclined plane. Thus, ſuppoſe the impetus of any projection were 4500 feet; then 16 feet 1 inch : 1″ :: 4500 feet : 275″ the ſquare of the time a body will take to fall perpendicularly thro' 4·00 feet, the ſquare root of which is 16″ nearly, and that doubled gives 32″ the duration of the projection made perpendicularly upwards. Then to find the duration of a horizontal projection at any elevation, as 20°; ſay R : S. ∠ 20° :: 32″ : duration of a projection at that elevation with the impetus 4500. Or if with the ſame impetus a body at the direction of 35° was projected on a plane inclined to the horizon 17°, ſay as ſine 73° : ſine 18° :: 32″ : duration required.

The two following tables, at one view, give all the neceſſary caſes as well for ſhooting at objects on the plane of the horizon, with proportions for their ſolutions, as for ſhooting on aſcents and deſcents,

TABLE

TABLE I For horizontal projections. *Fig* 7.

Caſes.	Given.	Required.	Proportions.
1	A M, A *m*	*t* A H H *v*	2 : A M : A *m* : : A *m* : : R : S. 2 ∠ *t* A H R : T. ∠ *t* A H : : $\frac{A\,m}{4}$ H *v*.
2	A M, *t* A H	A *m*	R : S. 2 ∠ *t* A H : : 2 A M : A *m*.
3	A *m*, *t* A H	A M	S. 2 ∠ *t* A H : R : : $\frac{A\,m}{2}$: A M
4	A M, H *v*.	A *m*	$\sqrt{AN \times NM} = \frac{A\,m}{4}$, or $\frac{1}{2}$ Log AN + $\frac{1}{2}$ Log. N M = Log. $\frac{1}{4}$ A *m*.
5	A *m*, H *v*	*t* A H A M	$\frac{A\,m}{4}$: H *v* : : R : T. ∠ *t* A H. AN : $\frac{A\,m}{4}$: : $\frac{A\,m}{4}$: N M, and A N + N M = A M.
6	H *v*, *t* A H	A *m*	T. ∠ *t* A H : R : : H *v* : $\frac{A\,m}{4}$
7	*t* A H, A *m* and any other angle. any other amplitude.	any other amplitude belong. to that angle. any other angle belong. to that ampl.	S. 2 ∠ *t* A H : S, 2 any other ∠ : : A *m* : amplitude required. A *m* : any other amplitude : : S. 2 ∠ *t* A H : S. 2 ∠ required.
8	*t* A H. H *v*, any other angle. any other altitude.	any other altitude. any other angle	V. S. 2 ∠ *t* A H : V. S. 2 any other ∠ : : H *v* : altitude required. H *v* : any other altitude : : V. S. 2 ∠ *t* A H : V. S. 2 ∠ required.

TABLE II. For projections on aſcents and deſcents. *Fig*. 5, 6.

Caſes.	Given.	Required.	Proportions.
1	A M, A *m*, B *m*, A B.	T A H. *t* A H.	A *m* : B *m* : : R : T. ∠ B A *m*, half of which added to 45°, gives ∠ G A *z*. AM : A B : : A *c* : A C = CG. T. ∠ G A *z* : R : : G *z* : A *z*, and A *z* — A *f* = *f z* = P G. CG : P G : : R : V. S. of S G, half of which added to, or taken from G A *z*, gives the higher or lower direction required.
2	T A H, *t* A H, AF	A M	Log. of A M = Log. of A F + 2 Log. S. ∠ M A F — Log. S. ∠ *s* AF — Log. S. ∠ M A *s*.
3	T A H, *t* A H, A M	A F	Log. of A F = Log. A M ; Log. S. ∠ *s* A F + Log. S. ∠ M A *s* — 2 Log. S. ∠ M A F.
4	B A *m*, *t* A H, A B, and any other angle *t* A H	A *b* the amplitude for that other angle.	*Fig* 8. Log. A *f* = Log. A F + Log. S ∠ *f* A *f* + Log. S ∠ *p* A M — Log. S ∠ *s* A F — Log. S. ∠ M A *s*.
	A M, D A H	A *g*	*Fig* 5, 6. T. ∠ G A *z* : Sec. ∠ *g* A *z* : : G *z* : A *g*.

Before

Before any of these pieces are appropriated for service, it is necessary to have each undergo a particular trial of its soundness, which is called a proof, to be made by or before one authorized for the purpose, called the *proof master*.

To make a proof of the piece, a proper place is chosen, which is to be terminated by a mount of earth very thick to receive the bullets fired against it, that none of them may run through it. The piece is laid on the ground, supported only in the middle by a block of wood. It is fired three times: the first with powder of the weight of the bullet and the two others with ⅔ of the weight; after which a little more powder is put in to singe the piece; and after this water, which is impressed with a spunge, putting the finger on the touch-hole, to discover if there be any cracks: which done they are examined with the cat, which is a piece of iron with three grasps, disposed in the form of a triangle, and of the caliber of the piece; then it is visited with a wax candle, but it is of very little service in the small pieces, because if they be a little long, the smoak extinguishes it immediately.

The proof of mortars is made in this manner: where there are carriages of cast iron, the mortar is placed on one of those carriages. Under that carriage is made a platform of madriers 5 or 6 inches thick, the mortar is charged with the best powder, and with as much of it as its chamber can contain, observing to leave no vacuity at the neck of the mortar but what is necessary to put a little wadd over the powder, and which is rammed with the end of an handspike, to keep the powder together as much as possible. A large green turf, with earth two fingers deep is put over the wad, which must have width enough to fill up the bottom of the mortar. This turf and earth are very well rammed down, then the bomb is placed over it as upright as possible, leaving a small place round it, which is to be filled with clay as tight as possible, pressing it between the mortar and the bomb with a pointed stick; and as it is not necessary to spend much powder in these sort of proofs, the bomb must be filled with as much earth as it would contain powder.

For want of carriages of cast iron, holes are dug in the earth where the mortars are buried as far as the touch-hole; and in order that the mortars thus buried may find more resistance, and make a greater effort, large pieces of wood in form of joists are put under the mortar, chusing always the hardest ground, to resist better the recoil of the mortar.

A fusee for granado's is put on the touch-hole of each mortar, that the gunner may have time to retire, in case the mortar was to burst in the proof; which is also practised in the proof of the pieces.

This proof is made three times, without increasing or diminishing any thing.

Besides the large pieces mention'd throughout this treatise, invented for the destruction of mankind, there are others called small guns, *viz. muskets of ramparts*, *common muskets*, *fusils*, *carabines*, *musketoons*, and *pistols*.

A *musket*, or *musquet*, is a fire-arm borne on the shoulder, and used in war, formerly fir'd by the application of a lighted match, but at present with a flint and lock.

The *common muskets* are of the caliber of 20 leaden balls to the pound, and receive balls from 22 to 24: its length is fix'd to 3 feet 8 inches from the muzzle to the touch pan.

A *fusil*, or *fire-lock*, has the same length and caliber; and serves at present instead of a musket.

A *carabine* is a small sort of fire arm, shorter than a fusil, and carrying a ball of 24 in the pound, borne by the light-horse, hanging at a belt over the left shoulder.

The *carabine* is a kind of medium between the pistol and the musket; and bears a near affinity to the arquebuss, only that its bore is smaller. It was formerly made with a match lock, but of late only with a flint lock.

The *musquetoon* is of the same length of the carabine, the barrel polished, and clean within.

The *musquetoon* carries five ounces of iron, or seven and a half of lead, with an equal quantity of powder.

The barrel of a pistol is generally 14 inches long.

As to the invention of *cannon* and *gun powder*, we are certain that they are discoveries of a modern date: but there is no depending upon the various accounts given of them by authors. All that can be said with certainty is, that there is mention made of gun-powder, in the register of the chamber of accounts in *France*, in the year of Christ 1338. That *Alphonsus* XI. king of *Castile*, besieged the *Moors* with iron mortars, in the year of Christ 1343, and that our king *Edward* in 1346, first carried those thundering machines of war and death into *France*, where he avail'd himself of five or six pieces of cannon at the battle of *Cressi*; which after ages remember with so much honour to *England*.

Before the invention of these instruments of war, the ancients made use of the Aries, or *Battering-ram*, the *Catapultæ*, the *Ballista*, *Scorpion*, and *Testudo*.

The ARIES, or *battering ram*, was an engine with an iron head, to batter and beat down the walls of places besieged.

Of this there were two kinds; the first, simple and plain, the other artificial and compound.

The first seems to have been no more than a *great beam*, which the soldiers bore in their arms, and with an end of it, by main force, assailed the walls.

The second, or *compound ram* is described by *Josephus*, (*de excid. Hierosol.* 3.) thus 'The *ram* 'is a vast long beam like the mast of a ship, 'strengthned at one end with a head of iron, some-'thing resembling that of a ram, whence it took 'its name. This is hung by the middle with ropes 'to another beam, which lies across a couple of 'posts, and hanging thus equally balanced, is by 'a great number of men violently thrust forwards, 'and recoiled backwards, and so shake the wall 'with its iron head, nor is there any tower or 'wall so thick or strong, as to resist the repeated 'assaults of this forcible machine.'

M. *Feilibien* describes another sort of *battering ram*, which runs on wheels, and was the most perfect and effectual of them all.

Vitruvius affirms, that the battering ram was first invented by the *Carthaginians*, while they laid siege to *Cadiz*. That was the simple kind above-mentioned. *Pephasmenos* a *Tyrian*, contrived to suspend it with ropes; and *Polydus* the *Thessalian*, to mount it on wheels at the siege of *Byzantium*, under *Philip* of *Macedon*. Yet *Pliny* assures us the ram was invented at the siege of *Troy*; and that this gave occasion to the fable of a wooden horse.

Plutarch tells us, that *Mark Antony*, in the *Parthian* war, used a ram of 80 feet long; and *Vitruvius* assures us they were sometimes made 106, and sometimes 120 feet long, to which perhaps, the force of the engine was in a great measure owing.

The ram was managed at once by a whole century of soldiers, so that it played continually, and without intermission; being usually covered with a *vinea* to protect it from the attempts of the enemy.

The *vinea* was a kind of mantelet, or moveable parapet, built slighter, and yet larger than ours, being eight or nine feet high, as many broad, and sixteen long: they were defended by a double covering, the one of boards, the other of faggots, with the ribs of osiers, and cased without with skins steeped in water, to prevent fire; for in process of time, a certain composition of combustibles was invented, called *greek fire*, because first used by the *Greeks*. to burn those machines.

The composition was made of sulphur, naphtha, pitch, gum, and bitumen; and was only extinguishable by vinegar, mixed with sand and urine, or with raw hides.

The CATAPULTA was a machine us'd for throwing huge stones, and sometimes large darts, and javelins 12 or 15 feet long on the enemy.

The *Catapulta* is said to be the invention of the *Syrians*. Some authors make it the same with the *Ballista*: others different.

The BALLISTA is a round iron cylinder fastened between two planks, from which reaches a hollow square beam placed cross ways, fastened with cords, to which are added screws; at one end of this stands the engineer, who puts a wooden shaft with a big head into the cavity of the beam; this done, two men bend the engine by drawing some wheels: when the top of the head is drawn to the utmost end of the cords, the shaft is driven out of the *Ballista*, &c.

The SCORPION was also a military machine of the antients, used chiefly in the defence of walls, *&c.*

Marcellinus describes the *Scorpion*, as consisting of two beams bound together by ropes: From the middle of the two rose a third beam, so dispos-ed as to be pulled up and let down at pleasure; and on the top of this were fastened iron hooks, where was hung a sling, either of iron or hemp. Under the third beam lay a piece of hair-cloth full of chaff tied with cords.

To use the engine, a round stone was put into the sling, and four persons on each side, loosening the beams bound by the ropes, drew back the erect beam to the hook; when the engineer standing on an eminence, giving a stroke with a hammer, on the cord, to which the beam was fastened with its hook, set it at liberty; so that hitting again the soft hair-cloth, it struck out the stone with a great force.

It has its name *Scorpion*, because when the long beam or tiller was erected, it has a sharp top in manner of a sting — more modern times have given it the name of *Onager*, wild ass.

The TESTUDO, *Tortoise*, was a kind of cover, or skreen, which the soldiers, *e. gr.* a whole company made themselves of their bucklers, by holding them up over their heads, and standing close to each other, this expedient served to shelter them from darts, stones, *&c* thrown upon them, especially those thrown from above, when they went to the assault.

Testudo was also a kind of large wooden tower which moved on several wheels, and was covered with bullocks hides flead, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams. It was called *Testudo* from the strength of its roof, which covered the workmen, as the shell does the Tortoise.

There were also moveable *towers of wood* mounted on wheels, to set the besiegers on a level with the walls, and drive the besieged from under the same. These *towers* were sometimes 30 fathom high; they were covered with raw skins, and 100 men employ'd to move them.

HAT-

H A T - M A K I N G.

HAT-MAKING is the art of preparing, mixing, and working together the hair of beaver, of hares, rabbits, or other animals, into a certain form to cover the head, both for uſe and ornament.

The antiquity of this manufacture goes no higher than about the year 1400. Before this time the head was covered with a *chaperoon* or ſort of a hood, ornamented and enriched, according to the degree or rank of the man that wore it.

Some date the uſe of caps at the ſame epocha: but, it is certain, from antient paintings, that the *pileus* or cap is of a much antienter invention and uſe. The cap made of velvet was called *mortier*, and was wore only by princes, kings and knights. The ſecular clergy and graduates in univerſities, wore peculiar caps by way of diſtinction.

They that make hats muſt be provided with a commodious ſhop, one part furniſhed for preparing the hair or wool; and the other for making the felts, and for dying and finiſhing the hats.

To make the *beaver hats*, they tear off the long and ſhort hair from the ſkin, with knives.

After which they proportion the quantity of the ſeveral ſorts of *beaver hair*, by mixing one third of the dry *caſtor* to two thirds of old coat: which is a term for a ſkin that has been worn ſome time by the Indians of *America*, who catch and ſell them to the *Europeans*.

The hair, ſo mixed, is carded and weighed out into parcels, according to the ſize and thickneſs of the hat intended. The ſtuff is laid upon the *hurdle*, with an inſtrument called a *bow*, reſembling that of a violin, but larger; whoſe ſtring being worked with a ſmall bow-ſtick, and made to play on the furs, they fly, and mix themſelves together, the duſt and filth at the ſame time paſſing through the chinks.

Thus hats are formed of an oval figure, ending with an acute angle at the top: with what ſtuff remains they ſtrengthen them where ſlendereſt, yet deſignedly make them thicker in the brim near the crown, than towards the circumference, or in the crown itſelf. They next harden the ſtuff, ſo managed, into more compact flakes, by preſſing down a hardened leather upon it.

This done, they are carried to the *baſon*, upon which laying one of the hardened hats they ſprinkle it over with water, and mould it; and the heat of the fire, with the water and preſſing, imbody the ſtuff into a ſlight hairy ſort of felt; after which, turning up the edges all round over the mould, they lay it by, and proceed with another, which being in like manner reduced to the ſame conſiſtence and form, they are both joined together, ſo as to make them meet in an angle at top, making only one conical cap.

The next proceſs is to remove the hat to a trough, reſembling a mill-hopper, which is a copper-kettle filled with water and grounds, kept hot for the purpoſe; and, after being dipped in the kettle, the hat is laid on the ſloping ſide, called the *plank*. Here they proceed to work it, by rolling and unrolling it again and again, one part after another, firſt with the hand, and afterwards with a ſmall wooden roller, taking care care to dip it from time to time, till at length, by thus fulling and thickening it four or five hours, it is brought to the dimenſions intended. In this violent labour, the workmen uſually guard their hands with thick leather, which they call gloves.

The hat thus wrought into the form of a conical cap, is reduced into proper ſhape on a block of the ſize of the intended crown, by tying it round with a ſtring, called a commander; after which, with a bent iron, called a *ſtamper*, they gradually beat down the commander all round, till it has reached the bottom of the block, and what remains at the bottom below the ſtring forms the brim.

In this ſtation it is ſet to dry, and afterwards ſinged, by holding it over the blaze of a fire, made of ſtraw, or ſhavings; it is then rubbed with *pumice ſtone*, to take off the coarſer nap; then rubbed over with ſeal-ſkin, to lay the nap ſtill finer; and laſtly, carded with a fine card, to raiſe the fine cotton, with which the hat is to appear when finiſhed: then fitting it to the block, they tie it, cut round the edges, and deliver it to the dyers.

The dye being completed, the hat is dried by being hung in the roof of a ſtove, heated with a charcoal-fire; and, when dry, it is ſtiffened with melted glue, or rather *gum-ſenega*, which is ſmeared over the hat with a bruſh, and rubbed in with the hand. Then, having ſpread a cloth over the ſteaming baſon, which is a little fire-place raiſed about three feet high, with an iron-plate laid over it, exactly covering the fire, the hat is laid upon the cloth, with the brim downwards, the cloth being firſt ſprinkled with water, to raiſe a ſtrong ſteam, to force in the ſtiffening. When it is moderately hot, the workman ſtrikes gently on the brim, with the flat of his hand, to make the joinings incorporate, and bind ſo as not to appear, turning it from time to time, and at laſt ſetting it on the crown. And when it has been ſufficiently ſteamed and dried, it is put again on the block, bruſhed, ironed, well ſmoothed, and fitted for lining.

Hats are alſo made for women's wear, of chips, ſtraw,

ſtraw, or cane, by platting, and ſewing the plats together; beginning with the center of the crown, and working round till the whole is finiſhed. Hats for the ſame purpoſe are alſo wove and made of horſe-hair, ſilk, *&c.*

HERALDRY.

HERALDRY, is the art of armory and blazoning; or, the knowledge of what relates to the bearing of arms, and the laws and regulations thereof.

Arms, or *Armories*, are marks of dignity and honour, regularly compoſed of certain figures and colours, given or authorized by ſovereigns, and bore in banners, ſhields, coats, *&c.* for the diſtinction of perſons, families, and ſtates, and paſſing by deſcent to poſterity.

They are called *arms*, in regard they are bore principally on the buckler, cuiraſſe, banners, and other apparatus of war; and by the *Engliſh coats of arms*, *coat armour*, &c. becauſe antiently embroider'd on a cloak or habit, worn by the antient knights over their arms, both in war and at tournaments; and ſtill borne by the heralds at arms.

It was a kind of ſurcoat, reaching only as low as the navel, open at the ſides, with ſhort ſleeves; ſometimes furred with *ermine* and *vair*, wherein were applied the *armories* of the knight, embroidered with gold and ſilver, and enamelled with beaten tin, colour'd *black*, *green*, *red*, and *blue*; whence the rule never to apply colour on colour, nor metal on metal.

The *coats of arms* were frequently open, and diverſified with bands and fillets of ſeveral colours, alternately placed, as we ſtill ſee cloths ſcarleted, watered, *&c.* Hence they were alſo called *divices*, or *diviſes*, and being divided, or compoſed of ſeveral pieces ſewed together, whence the words *feſſe*, *pale*, *chevron*, *bend*, *croſs*, *ſalter*, *lozenge*, &c. which have ſince become honourable pieces, or ordinaries of the ſhield.

The ſurcoat being embroider'd with *gold* and *ſilver*, was the occaſion that thoſe two metals have been ſince placed in the coats of arms, under their *French* name of *or* and *argent*; and there being colour'd *black*, *green*, *red*, and *blue*; that thoſe different colours have alſo been introduced in them: therefore,

There are two metals in *Heraldry*, viz. *or* and *argent*; and ſeven colours, which are, *gules*, *azure*, *ſable*, *vert*, *purpure*, *tenne*, and *ſanguine*.

OR, in the coats of arms is painted yellow, and repreſented in engraving by ſmall points or *dots*, all over the field, or bearing,

In the coats of nobles it is called *topaz*; and in thoſe of ſovereign princes *ſol*; by the *Engliſh* Heralds,

Without this, or *argent*, there can be no good armory; and it is accounted the ſymbol of wiſdom, temperance, faith, force, conſtancy, *&c.*

ARGENT, from the *Latin argentum*, ſilver; is painted *white* in the eſcutcheons, and expreſſed in engraving, by the parts being left *plain*, without any ſtrokes from the graver.

The *Engliſh* obſerve the ſame diſtinction in this, as in *or*, and call for barons and all nobles, the white colour *pearl*; and for ſovereign princes, *luna*.

In the doubling of mantles, where the white is ſuppoſed to repreſent a fur, and not a metal, it may be blazon'd white.

GULES, is painted *red*; and in engraving expreſſed by *perpendicular ſtrokes*, drawn from the top of the eſcutcheon to the bottom.

Gules is reputed a ſymbol of charity, valour, hardineſs, generoſity, and repreſents blood colour, cinnabar, and true ſcarlet. Antiently it was prohibited any perſon to wear *gules* in his coat armour, unleſs he was a prince, or had permiſſion from the prince.

AZURE, is painted *blue*; and in engraving is repreſented by ſtrokes or hatches drawn *horizontally*.

SABLE, is painted *black*; and expreſſed in engraving by *perpendicular* and *horizontal* hatches drawn a-croſs each other.

VERT, is painted *green*; and in engraving is expreſſed by *diagonals*, or lines drawn athwart from right to left, from the dexter chief corner to the ſiniſter baſe.

PURPURE, or PURPLE, is a compound of *gules* and *azure*; bordering on violet, it is painted in its natural colour, and repreſented in engraving by *diagonal lines* drawn from the ſiniſter chief to the dexter baſe point, as in the *Plate*.

Spelman allows *purple* the preference before all other colours, as having been an enſign of royalty for many ages; yet he allows it to have been excluded by the antient Heralds as only an imperfect colour.

TENNE, TENNY, or TAWNY, is a bright colour made of *red* and *yellow* mixed, ſometimes alſo called *bruſk*, and expreſſed in engraving by *thwart* or *diagonal* ſtrokes or hatches, beginning from the ſiniſter chief, like purpure.

SANGUINE is the colour uſually called *murrey*, being made of *red lake*, tinged with a little *Spaniſh* brown.

It

It is reprefented in engraving by tranfverfe hatches like purpure, and is moftly ufed in the coats of knights of the bath.

An *efcutcheon* * is a fhield or coat, wherein the bearing or arms of any perfon is reprefented, and is of a fquare figure, excepting the bottom part, which is ufually a little rounded, ending in a point in the middle.

Till within a few hundred years the *efcutcheons* of the *French* and *Englifh* were triangular: thofe of the *Spaniards* are ftill quite round at bottom without any point: thofe of the *Italians* are oval; and thofe of the *Germans* in form of cartoozes.

The antient *efcutcheons* were generally couched or inclin'd; and they only began to place them upright, when crowns, &c. were put over them by way of creft.

The feveral parts or points of the *efcutcheon* have their feveral names, *viz.* the *dexter chief point*; the *middle chief*; and the *finifter chief point*; the *honour point*; the *feffe point*; the *nombril point*; the *dexter bafe*; the *middle*, and the *finifter bafe* point.

The *efcutcheon* is diverfly denominated, according to its divifions. It is called *dextered*, when the perpendicular line that divides it, is to the right of a third part of the *efcutcheon*; *finiftered*, when on the left; *tierced in pale*, when this line is double, and divides the *efcutcheon* into three equal parts; *paled*, when increafed to the number of fix, eight, or ten. A horizontal line makes the chief, when at a third part from the top; the *plein*, when at a third part from the bottom; and when double, in the middle, at an equal diftance from both extremes, it makes the *fefs*, and the *tierced in fefs*; when it is multiplied, it denominates it *feffed*; when there are 8 or 10 equal fpaces, *burelle*; a diagonal from the dexter point of the chief, to the finifter of the bafe, makes it *tranché*; the contrary, *double*. If it be double at equal diftances, the firft makes *bandé*, and the *tierce in bende*, and the other *barré*, or *tierce in bar*; increafing the number of the firft makes *bande* and *cotticé*; and increafing that of the fecond, *barré* and *traverfé*.

There is alfo *efcutcheon of pretence*, which is an *inefcutcheon*, or little *efcutcheon*, which a man who has married an heirefs, and has iffue by her, may bear over his own coat of arms; and in it the arms of his wife; and the furviving iffue will bear both coats quarterly.

The furface, or face of the *efcutcheon*, is called the FIELD, becaufe it contains the atchievements antiently acquir'd in the field of battle, *e. gr.* the field in the coat of arms of *England*, is *gules*; in that of *France*, *azure*, &c. which field is always named in blazoning, before any other part of the *efcutcheon*.

The field being laid, we'll charge it with fome pieces, obferving that all common charges, or bearings are born *in*, *upon*, *within*, or *between*, *chief*, *pales faltier*, *chevron*, *crofs*, *canton*, *fefs*, *gyron*, *pile*, *efcutcheon*, *bordure*, or *orle*.

Counter-charges of colour or metal, is when a field is divided by a fingle line, and the charge exchanges colour as it goes over both.

There are different lines in the *efcutcheon*, as *right*, *crooked*, *engrailed*, *invecked*, *waived*, *crenelled*, or *embattled*, *nebuled*, or *cloudy*, *indented*, and *dancette*.

A *right line* is carried equally throughout the *efcutcheon*, without rifing or falling.

A *croocked line* is either *bunched* or *corner'd*, which crooked line is the origin of all the following ones, *viz.*

ENGRAILED, or INGRAILED, (from the *French grefle*, hail) is when a thing is reprefented with its edges ragged, or notched circularly, as if broke by fomething falling on it.

INVECTED denotes a thing flatted or furrowed and is the juft reverfe of engrailed, becaufe the points of *invected* are turn'd inward to the ordinary.

WAVED, is when a bordure, or any ordinary charge, has its outer lines indented, in manner of the rifing or falling of waves. This is alfo called *undy*, *undé*, or *ondé*.

CRENELLED, or EMBATTLED, is when any honourable ordinary is dented, after the manner of battlements of a wall.

NEBULED is when a coat is charged with feveral little figures in form of clouds, running within one another, or, when the outline of a bordure, ordinary, &c. is indented or waved.

INDENTED, INDENTEE is when the outline of a bordure, ordinary, &c. is notched in form of the teeth of a faw.

DANCETTE is when the outline of any bordure, or ordinary, is indented very largely; the largenefs of the indentures being the only thing that diftinguifhes it from the indented.

There is alfo a bearing of a bend, called double *dancetté*; thus he beareth azure, a bend double *dancetté* argent.

Of thefe different lines are compofed all bordures, and honourable ordinaries, an *efcutcheon* is charged with.

* From the *Latin fcutum*, fhield; which was the place, arms were originally bore on, before ever they came in banners; and ftill wherever they are placed, it is on fomething reprefenting the form of a fhield. The *Latin fcutum*, no doubt, came originally from the *Greek* σκῦτος *leather*, wherewith the fhields were ufually covered.

A Bordure is a kind of addition on the limb of an *eſcutcheon*, in form of a hem, or girdle, encompaſſing it all round. The *bordure* muſt be about one ſixth part of the breadth of the ſhield.

Simple bordure, is that which is of the ſame colour or metal throughout; and is the firſt addition of younger brothers.

There are others *componed*, *countered*, *ingrailed*, *indented*, and *charged* with other pieces; which make different additions for younger brothers, in ſeveral degrees.

If the line which conſtitutes the *bordure* be ſtrait, and the *bordure* plain, the colour of the *bordure* alone is named: as *he beareth gules*, *a bordure or*. If a bordure be charged with any parts of plants or flowers; they ſay, *verdoy of trefoils*. If it conſiſt of ermines *vairy*, or any of the furs, the term is *perflew of ermines*. If the *bordure* be charged with martlets, the word is, *charged with an enaluron of martlets*, &c.

The Honourable, or *honourable ordinaries*, are the principal *ordinaries* or bearings, which, when in their full extent, may poſſeſs one third of the field.

Theſe are ten in number, *viz.* the *croſs*, *chief*, *pale*, *bend*, *feſſe*, *bar*, *ſaltier*, *chevron*, *bordure* and *orle*.

The Cross is defined by *Guillim*, an ordinary compoſed of four-fold lines; whereof two are perpendicular, and the other two tranſverſe; for ſo we muſt conceive of them, though they be not drawn throughout, but meet by couples, in four right angles, near the feſs-point in the *eſcutcheon*.

The content of a *croſs* is not always the ſame: for when it is not charged, canton'd, nor accompanied, it has only the fifth part of the field; but if it be charged it muſt contain the third part thereof.

This bearing was firſt beſtow'd on ſuch as had perform'd, or at leaſt undertaken, ſome ſervice for *Chriſt*, and the *chriſtian* profeſſion; and is held by divers the moſt honourable charge in *Heraldry*. What brought it into ſuch frequent uſe, was the antient expeditions into the *Holy Land*; and the holy war pilgrims, after their pilgrimage, taking the *croſs* for their cognizance, and the enſign of that war being the *croſs*; whence its name *croiſade*.

St. *George's croſs*, or the *red croſs*, in a field argent, is now the ſtandard of *England*.

Guillim enumerates thirty-nine different ſorts of *croſſes*, *viz.*

A *croſs voided*, which differs from the *croſs fimbriated*, in that this latter does not ſhew the field through it, as the other does. And the ſame obtains in other ordinaries.

A *croſs wavy-voided*, which is a *croſs* whoſe outlines are indented, in manner of the riſing and falling of waves.

A *croſs patee* is a *croſs* ſmall in the center, and widening towards the extremes.

A *croſs-patee fitched* on the foot, is a *croſs* whoſe foot is made ſharp, that it may be more apt to be faſtened any where.

A *croſs patee* on three parts, and *fitched* on the fourth, which is a *croſs* whoſe whole fourth part is *figetive*.

A *croſe ingrailed*, which is a *croſs* whoſe edges are ragged, or notched circularly.

A *croſs patonee*, which is a *croſs* formed of bunched lines; extending and ſtretching to a certain *patee* form. *Colomb* calls it *croix enhencee*, and not *patonee*.

Croſs fleury, which is a *croſs*, that turns down its extremities like a *Fleur de lys*.

A *croſs velane*, which is a *croſs* whoſe quarters reſemble the filberd nuts.

A *croſs croſſelet*, which is a *croſs* terminating in *croſſelets*, or little *croſſes*.

A *croſs botone*, which is the *croſs* the *French* heralds call *treſſlee*, from *treſſle*, a trefoil, or three-leaved graſs, which the ends of this *croſs* imitate.

A *croſs pomel*, which is a *croſs* whoſe extremities are in the form of round balls, like the end of the guard and graſp of a ſword, whence it borrows the name *pomel*.

A *croſs urde*, which ſeems to be the ſame with what we call *clechée*.

A *croſs degraded fichée*, which is a *croſs* with degrees or ſort of ſteps at each extream.

A *croſs potent*, which is a *croſs* with its extreams in the form of a *crutch*.

A *croſs cavalry*, which is a *croſs* long in the pale, and ſhort in the arms, reſembling the *croſs* of our redemption fixed on Mount *Calvary*.

Patriarchal croſs, which is that, where the ſhaft is twice croſſed, the lower arms or traverſe being longer, and the upper ſhorter; it is alſo called a *croſs of Lorrain*.

An *anchored croſs*, which is a *croſs*, whoſe points are made ſharp, like thoſe of an anchor.

A *croſs moline*, which turns round both ways at all its extremities, though not ſo wide or ſharp as that ſaid to be anchored.

Croſs clechee, which is a *croſs* open to the light, or pierc'd through with another inner one of the ſame figure, *e. gr.* when a *croſs* appears as if charged with another *croſs* of the ſame colour with the field, or as if the field appear'd through the apertures thereof.

Croſs flory, or *fleur de liſee*, which is a *croſs*, the extremities whereof are in the form of flowers, lilies, flower de luces.

A *croſs double fiche*, or *double fichy*, which is a *croſs* whoſe extremities are pointed at each angle; that is, is, each extremity has two points: In contradistinction to *fiche*, where the extremity is sharpened away to one point.

Cross à seize pointes, which is a *cross*, each extremity whereof has four points.

Cross milrine, which is a *cross*, the extremities whereof are hooked.

A *raguled cross*, which is a *cross* whose outlines are jagged or knotted.

A *cross pall*, which is a *cross* representing the *pallium*, or archiepiscopal ornament sent from *Rome* to metropolitans.

A *tau*, or *cross of St. Anthony*, which is a *cross* in the form of a T.

A *cross pierced*, which is a *cross* perforated, or struck through, shewing as it were a hole in it.

This *piercing* is to be expressed in blazon, as to its shape: Thus if a *cross* has a square hole or perforation in the center, it is blazon'd *square pierced*. When the hole or perforation is round, it must be expressed *round pierced*, which *Gibbon*, in *Latin* calls *perforata*, because all holes made with piercers or augers are round. If the hole in the center be in the shape of a lozenge, it is expressed *pierced lozenge ways*.

All piercings must be of the colour of the field, because piercing implies the shewing of what is under the ordinary or bearing. Though when such figures appear on the center of a *cross*, &c. of another colour, the *cross* is not to be supposed pierced, but that the figure on it is a charge, and must be accordingly blazoned.

The *Saltier* is a kind of St. *Andrew's cross*, and was antiently called the *cross of Burgundy*.—The *Saltier* may be said to be composed of a bended dexter and sinister, crossing each other in the center of the escutcheon. Its ordinary breadth when alone is one third of the escutcheon. It is sometimes bore alaizé, and sometimes in number, placed in different parts of the field: Sometimes charged, countercharged with the field, accompanied, raguled, engrailed, indented, quarterly-quartered, *&c.*

Colombiere adds thirty-three more sorts of *crosses* to those above-mentioned, *viz.* — *A croix remplie*, which is only one *cross* charged with another; a *cross party*, that is, one half of one *colour*, and the other of another; a *cross quartered*, that is, the opposite quarters of several colours; a *cross of five pieces*, that is, of so many colours; a *cross mouffüe* and *abaissée*; a *cross barbée*; a *cross croissantie*, or *crescented*, that is, having a crescent at each end; a *cross forked* of three points; a *cross panitée* of three pieces; a *cross resserceléé*; a *cross pointed*; a *cross ankered*, and *sur ankered*; a *cross ankered* with snakes heads; a *cross orled*; a *high cross*; a *cross rayonnante*, or casting out rays of glory; a *cross of Malta*; a *cross of the holy Ghost*; a *cross forked* like the antient rests for muskets; a *cross with eight points*; a *cross bourdonnée*; a *cross cramponée* and *tournée*; a *cross cablée*; a *cross inclining*; a *cross pater nostree*, that is made of beads, though we most properly call it *une croix en chapellet*; a *cross trefle*; a *cross fleuronée*; a *cross vaidée*, *clechée*, and *pommetée*; a *cross crenelle* and *battilee*, a *cross* with four steps to every arm; a *cross rounded*; a *cross and an half*; a *cross estoillee* or starways; a *cross corded*; a *cross doubled* of six pieces set together; a *double cross* split in pale, a *long cross* cut in pieces and dismembered; a *cross couped*, or cut through in fesse, of the two contrary colours to the field; a chevron surmounted by an *half cross*; four tails of ermines in a *cross*, the tops of the ermines opposite to each other in the middle; four pieces of wire placed cross-ways, and counterpointing in the center; the *cross* or *sword of St. James*; *cross potence cramponée* on the dexter upper arm, and a potence about the middle of the shaft.

These are the various *crosses* we find in authors, which some may think too many, as not being all used in *England*; but *Heraldry*, like all other arts and sciences, extends to all countries, and all terms used require to be explained.

The *Chief* is the second honourable ordinary, and is placed athwart the top of the coat, containing one third part of its height.

When the escutcheon is cut in stone, or in relievo, the *chief* stands prominent beyond the rest, and is supposed to represent the diadem of the antient kings and prelates, or the casks of the knights.

It is frequently without any ornament; sometimes it is charged with other bearings; sometimes it is of a colour or metal different from that of the coat.

The line that binds it at bottom is sometimes strait, sometimes indented, engrailed, embattelled, lozenged, *&c.* Thus, say they, the field is gules, a chief argent, *&c.* Again he bears gules, a chief crenele, or embatteled argent.

Sometimes one *chief* is borne on another, expressed by a line drawn along the upper part of the *chief*; when the line is along the under part it is called a *fillet*. The first is an addition of honour, the second a diminution.

The *chief* is said to be *abaissed*, when it is detached from the upper edge of the coat by the colour of the field which is over it, and which retrenches from it one third of its height.— They also say, a *chief* is *chevroned*, *paled*, or *bended*, when it has a chevron, pale, or bend contiguous to it, and of the same colour with itself. — A chief is said to be fupported, when the two thirds a-top are of the colour of the field, and that at bottom of a different colour.

Pale, the third honourable honorary, is the reprefentation of a pale or ftake placed upright; and comprehending the whole height of the coat, from the top of the chief to the point —When the *pale* is fingle, it is to contain one third of the breadth of the fhield; when there are feveral more properly called *pallets*, they are proportioned fo, as that two take up two fifths of the fhield, and three take up three fevenths: and in thofe cafes the number of pieces is fpecified as well as that of thofe they are charged withal, &c.

Pales are bore various ways, as *wavy*, *crenelle*, *faillis*, *maentea*, *ingrailed*, &c. There are alfo *cometed*, and *flaming pales*, which are pointed, fometimes waved, &c.

A Pallet, in the *Englifh* Heraldry, is the moiety or one half of the *pale*, and therefore receives its name of diminution, as being a demy or little pale: and an endorfe is the fourth part of the *pallet*.

The Bend, our next honourable ordinary, is formed by two lines, drawn diagonally or athwart, from the upper part of the fhield on the right, to the lower part on the left; being fuppofed to reprefent a fhoulder belt, or fcarf worn over the fhoulder. — It contains a third part of the field when charged, and a fifth when plain. It is fometimes indented, ingrailed, &c.

Heralds fpeak of a *bend dexter*, and a *bend finifter*.—A *bend dexter* is that properly and abfolutely called a *bend*; which word *dexter* is ufually annexed to prevent miftakes, and diftinguifh it from the *bend finifter*, which is the fame with what is otherwife called after the *French* heralds, a *bar*, *barre*.

The *bend finifter* is fubdivided into the *fcarf* or *fcarp*, and the *battoon*; which latter is the fourth part of the *bend*, and the moft ufual mark of illegitimacy; but then it never extends itfelf quite athwart the fhield, but is cut off a little at each end

When two ftrait lines drawn within the *bend*, run nearly parallel to the outward edges of it, this is called *voiding*; and he that bears it, is faid to bear a *bend* voided.

A *bend* is fubdivided into a *benlet* or *bandelet*, which is the fixth part of the fhield; a *garter*, which is the moiety of a *bend*; a *coft*, which is the fourth part of a *bend*; and a *ribband*, which is the moiety of a *coft* or *cotife*.

Fesse, the next honourable ordinary of the efcutcheon, divides it horizontally in the middle, and feparates the chief from the point. It is fuppofed to reprefent a broad girdle, or belt of honour, which knights at arms were antiently girded withal. The *feffe* poffeffes the center of the efcutcheon, and contains in breadth one third part thereof. When it takes up lefs than its proper breadth it is called a *bar*.

Chevron, or Cheveron, the next ordinary, reprefents two rafters of a houfe joined together, without any divifion. It defcends from the chief towards the extremities of the coat, in form of a pair of compaffes half open.

When it is alone it fhould take up the third part of the coat: when it is accompanied with any other bearings, its breadth muft be adjufted thereby.

It is bore divers ways, fometimes in chief, fometimes in bafe, fometimes marched, fometimes reverfed, &c.

The *chevron* is fometimes charged with another *chevron*, one third of its own height.

Two *chevrons* are allowed in the fame field, but not more; when they exceed that number they are called *chevronwife* or *chevronels*. There are *chevrons* of feveral pieces.

A *chevron* is faid to be abafed, when its point does not approach the head of the chief, nor reach further than the middle of the coat; *mutilated* when it does not touch the extremes of the coat; *cloven*, when the upper point is taken off, fo that the pieces only touch at one of the angles; *broken*, when one branch is feparated into two pieces; *couched*, when the point is turned towards one fide of the efcutcheon; *divided*, when the branches are of feveral metals, or when metal is oppofed to colour: *inverted*, when the point is towards the point of the coat, and its branches towards the chief.

A coat is faid to be *chevroned*, when it is filled with an equal number of *chevrons*, of colour and metal.

Counter-chevroned, is when it is fo divided, as that colour is oppofite to metal, and *vice verfa*.

The next in order to the chevron is the *bar*, *barr*, or *barre*, nearly refembling the *feffe*; from which it only differs by its narrownefs, and by this, that the *bar* may be placed in any part of the field, whereas the fefs is confined to a fingle place.

Giron is an ordinary confifting of two ftrait lines drawn from divers parts of the efcutcheon, and meeting in an acute angle in the fefs point of the fame.

The word is *French*, and literally fignifies the *gremium* or lap. In *Latin* they are called *pinnulæ octonæ*, and *merli octango-laxi* by the *Italians*.

If the *Girons* be eight in number, fays *Mackenzy*, they need not be expreffed, but if there be fewer, or more, it muft.

Girons are bore diverfely, *viz.* fingle, by couples of fix, of eight, of ten, and of twelve.

When

When a coat has six, eight, or ten of these *Girons*, meeting or centering in the middle of the coat, it is said to be *gironné* or *girrony*.

Some, instead of *gironné*, say *pa ti*, *couppé*, *tranché*, and *taillé*, by reason the *Girons* are formed by such divisions of the field. Four *Girons* form a saltier, and eight a cross.

The heralds give several reasons for the heretofore mention'd ordinaries, being called *honourable*. 1. Their great antiquity, as having been used ever since armory was set on foot. And, 2. For that they denote the ornaments most necessary for noble and generous men: thus the *chief* represents the helmet, wreath, or crown, covering the head: the *pale* represents his lance or spear: the *bend* and *bar*, his belt: the *fesse*, his scarf: the *cross* and *saltier*, his sword: the *chevron*, his boots and spurs: and the *bordure* and *orle*, his coat of mail.

As to the allotting or distributing of these *ordinaries*, some authors write, that when a gentleman having behaved himself gallantly in fight, was presented to the prince, or general, and a suitable coat armour order'd him; if he were wounded in the head, they gave him a chief; if in the legs he had a chevron; and if his sword and armour were discolour'd with the blood of enemies, a cross or bordure.

Besides the above mention'd *honourable ordinaries*, there are other ordinaries, composed of the like lines, *viz.*

The CANTON, which is a square portion of the escutcheon, parted from the rest. It has not any fixed proportion; tho' regularly it should be less than a quarter: it is often only a ninth part, and used as an addition or difference, frequently to express bastardy.

The *canton* is sometimes placed at the right corner, and sometimes at the left, in which latter case, it is called a *canton* sinister.

The *canton* is form'd of two strait lines, the one drawn perpendicularly from the chief, and the other transverse from the side of the escutcheon, and meeting therewith in a right angle, near to the corner of the escutcheon.

The QUARTER, an ordinary of the like composition with the canton, and occupies the same places, and bears a great resemblance to it; insomuch that the same rules that serve for the one, may be attributed to the other. The sole difference between them is, that the canton keeps only a cantle or small portion of the escutcheon; and the *quarter* comprehends the full fourth part of the escutcheon.

The PILE, which is an ordinary consisting of two-fold lines, formed in the manner of a wedge; that is to say, broad at the upper end, and diminishing by degrees throughout with a comely narrowness, and taper growth, meeting together at the lower end in an acute angle.

The *pile* is borne inverted, ingrailed, &c. like other ordinaries, and issues indifferently from any point of the verge of the escutcheon. He bears a *pile* gules by the name of *Chandois*.

The FLASK, or FLANCH, which is an ordinary formed by an arched line, which begins at the corner of the chief, and ends in the base of the escutcheon. *Flanches* are always borne by pairs.

The VOIDER, an ordinary, whose figure is much like that of the *Flask* or *Flanch*; only that it does not bend so much.

This armory, they say, is properly the reward of a gentlewoman that has well served her prince. It is always borne by pairs.

Besides the above-mention'd charges of the escutcheon, which are called *proper*, there are others called *common charges*, viz. *celestial intelligences*, as *Angels*, *Cherubims*, &c. Planets, as the *Sun*, *Moon*, *Stars*, &c. Fossils, as all sorts of precious and other stones; Vegetables, as *Fruits*, *Trees*, *Flowers*, &c. Animals, as *Lions*, *Leopards*, *Wolves*, *Horses*, *Griffins*, *Bears*, *Eagles*, *Cocks*, &c. *Fishes* of all sorts.

Angels and *cherubims*, are either *volent*, *standing*, or *kneeling*, with their wings either *extended*, *displayed*, or *crossed*; and these are often of different metals or colours. The *angels* almost always at full length; and the *cherubims* with only their head and wings.

Of the *heavenly bodies*, the *Star* is the first in dignity.

The *Star* in *Heraldry*, usually consists of five rays or sparks. When it has six or eight, as among the *Germans* and *Italians*, particular mention must be made thereof in blazoning.

The *Sun* is blazoned according to his different phases, and is either called *in its glory*, or *rayoning*, when in its greatest radiancy; or eclipsed, or in a cloud, and sometimes none but his rays appearing.

The *Moon* is also blazon'd according to its phases; and is either *crescent*, when with her horns up to the chief of the escutcheon; or *increscent*, when she enters into her first quarter, and has her horns towards the dexter part of the escutcheon; and when in her eclipse, it is called *detriment*.

A *Comet* has also its place in *Heraldry*, and is called *streaming*.

The *elements*, sometimes found in an escutcheons, are,

The

The *Fire*, which is conſider'd as the moſt noble of them, and is either *flamant* or *ſcintillant*, and ſometimes both.

The *Sea*, which we'll take for water in general, is blazon'd waved in *French ondoiee*.

The *Earth*, is ſeldom or never repreſented but in part, in the blazon, which admits only of mountains, rocks, and iſlands, which are differenced by their metal or colour.

Of all precious ſtones, the *eſcarbuncle* is the moſt in uſe in *Heraldry*; and is a charge or bearing conſiſting of eight radii, or ſpokes; four whereof make a common croſs and the four a *ſaltier*.

Some call theſe radii *battons*, or *ſtaves*, becauſe round and enriched with buttons, or pearl'd like pilgrims ſtaves; and frequently tipped or terminated with flower de luces. Others blazon them royal ſcepters, placed in ſaltier pale and feſſe.

We'll paſs from theſe to the *vegetables*, and among them place *trees* firſt in order; which are blazoned in a different manner, according to their different products, ſhapes, &c. for example, according to their products, an oak is blazoned *acorned*, a pine apple-tree, pear-tree, &c. *fructed*; if repreſented with fruits on them.

According to their ſhapes, they are either trunks of trees, and are blazon'd *eradicated*, or *rooted up by the root*; or limbs of trees, and are blazon'd *trunkated* or *raguled*, or both; or ſtocks or ſtumps of trees, and are blazon'd *couped*, or *eradicated* or both; or branches of trees, which are blazon'd either *ſlarved* or *ſlipped*, or both: or ſlips or leaves, which are blazon'd either *pendant*, *bendways*, *barways*, *ſlipped*, *proper*, *in ſaltier*, or *erected*.

The fruits of trees have alſo their place in *Heraldry*, and are either *ſlipped*, *pendant*, *erected*, *proper*, or have their ſtalks trunkated.

Trees, their trunks, limbs, branches, ſlips, fruits, &c. are all of the different metals and colours adapted to *Heraldry*.

Flowers are the next charges which fall under our conſideration; and are blazon'd either *bearded*, *ſeeded*, or *ſlipped*.

Corn is blazon'd either *couped*, *bladed*, *eared*, or in *ſtalks*, or in *garbe* or *ſheaf*, which ſheaf is ſubject to different changes, according to the different metals and colours of *Heraldry*.

The *fleur de lys*, which is the bearing of the kings of *France*, are blazon'd either *or*, *argent*, &c, according to the different ſorts of metals, and colours of *Heraldry*.

Trefoil is blazon'd either *erazed in the ſtalk*, or *ſlipped*; as well as the *cinquefoils*.

Animals are the next in order.

Lions, griffins, wolves, and bears, if exactly in *pale*, are ſaid to be *rampart*; but if ſet more bend-ways, lions, wolves, and bears, are *ſaliant*; griffins, *ſegrant*. Lions are alſo *langued* (i. e. *tongued*) and *armed*, i. e. have their nails of ſome different colour from that of the body. Griffins are armed, *i. e.* their talons are of a different colour from the reſt of their body. Eagles and ſwans *membered*, i. e. when their feet are of a different colour from the reſt of their body. Hawks are *jeſſed* and *balled*; *jeſſed*, when they ſeem to ſpring or ſhoot out of ſome other charge. Cocks are *armed*, *creſted*, and *velloped*. *Creſted* when their *creſt* is different from the reſt of the body. Capons are *armed*, *creſted*, and *jowlopped*.

Lions are moſt commonly borne whole, and then they are either *rampant*, *guardant*, or *rampant-regardant*. When they are ſet more bend ways, they are term'd *ſaliant*. Alſo they are borne *paſſant*, *paſſant regardant*, *ſejant* (or *ſitting*) *couchant* (or *lying*) *dormant* (or *ſleeping*) *jeſſant*, *iſſuant*, and *naiſſant*.

Lions, or any other creature that proceeds from the bottom of any ordinary, is term'd *iſſuant*; when over two colours, *jeſſant*; when from the middle, *naiſſant*, or *ſwimming*; yet theſe are ſometimes called *demi lions*. A *lion*, or other thing, ſaid to be *umbraled*, is when the ſhape is only ticked out with a pencil, and the field appears through it. *Lions* are ſometimes borne *barry*, *vairy*, *nebulee*, &c.

Stags are blazon'd either *tripping*, *ſtanding at gaze*, *lodged* (when reſting on a mount) *ſpringing forward*, and *currant* (when running). *Bucks*, when their horns are ſpoke of, are ſaid to be *attired*. All creatures that are ſet one paſſing contrary to the other, are ſaid to be *counter paſſant*; if two ſtand face to face upright, they are term'd *combatant*; if back to back, *endorſed*.

Creatures partly borne, as the *head*, *leg*, &c. are either *eraſed* (torn off) or *couped* (cut off) The paw of a lion being called a *gamb*.

When lions, eagles, and other fierce creatures are eating, they are termed *ravening*; but when they appear with flower de luces, &c. in their mouth, it may be ſaid *ſwallowing* or *devouring*.

All Fowls are borne *going*, *ſitting*, *ſtanding*, or *volan*, i. e. *flying*. The beeks and feet of cocks, &c. are termed *armed*. But eagles feet are called *talons*, they are often borne with two heads, and now and then cloſed, which is when their wings are not ſpread.

Fishes are either term'd *naiant* or *hauriant*. *Naiant* or *natant*, when drawn in an horizontal poſture, feſſe-wiſe, or traverſly a-croſs the eſcutcheon;

cheon; that being their swimming posture. *Hauriant* when standing upright. When three or four are borne intermixing with each other, it is termed *fretted*.

Beasts, birds, flowers, or any other thing, when but three in the field, and not said to be in *pale*, in *bend*, or in *fesse*, they always stand two above, and one below; and when there are six, three. two, and one. If there be any ordinary in the field, where are three things, it alters not their position; but if there be six, they are commonly set otherwise.

Beasts, birds, flowers, &c. when of the colour natural to them, in blazoning, are term'd *proper*.

Martlets are birds always painted without legs, because they never use them, although they have them; and *alerions* are birds wanting beaks, legs, and feet.

Furs have also a place in *Heraldry*, particularly *ermin*, or *ermine*, which is a white *fur*, powder'd or interspersed with black spots.

It is supposed to represent the skin of an animal of the same denomination; which some will have a *water-rat*, others a sort of *weesel*, and others an *Armenian mouse*. In effect, there is no animal whose skin naturally corresponds to the *herald's ermine*.

The sable spots in *ermine*, are not of any determinate number, but may be more or less at the pleasure of the painter or furrier.

We call *ermine*, v. g. a *cross ermine*, a cross composed of four ermine spots. It must be observed, that the colours in such arms are not to be expressed, by reason neither the cross nor the arms can be of any colour but white and black.

VAIR is also a kind of fur or doubling, consisting of divers little pieces, *argent* and *azure*, resembling a *Dutch* U, or a bell-glass.

Vairs have their point *azure*, opposite to their point *argent*, and the base *argent* to the *azure*.

When there are only two or three *vairs*, the antient Heralds call it *great vair*; and when they are more *small vair*.

It was properly the skin of a kind of squirrel, called also in *French vair*, and in *Latin scriveus*; which was white underneath, and dove-colour a-top.

Regularly there must be but four rows, or ranks of *vair* in the shield; if there be either more or less, the number must be specified. The smallest number being three rows, is called *defroy de vair*; and the most being five or six, is called *menu* or *small vair*.

The *Beffroy* is also known by the first figure on the dexter side of the escutcheon, being always of metal, and in form of a belt; whereas that of mere *vair*, is in shape of a glass.

When a coat is charged, or chequer'd with *vair* it is blazon'd *vairy*, or *vairé*.

When the colours are *argent* and *azure*, or white and blue, it is *very proper*; if it be otherwise, the colours are to be expresly named, *viz* *vairy*, of such a colour or metal. *He bears vairy, or, and vert*. This is particularly called *vair composed*.

The bearings are likewise said to be *vairy*, when they are charged with *vairs*. When chiefs, crosses, pales, fesses, &c. happen to be *vairy*, the number of ranks are to be specified.

Artificial things have also been borrowed by the inventors of the art of *Heraldry*, to make of them charges for their escutcheons, as crowns, scepters, swords, rings, battering-rams, cannons, bows, arrows, stirrups, horse-shoes, rowels of stirrups, lozenges, fusils, &c. All which charges have the same different positions in a shield, with the *honourable ordinaries*; for they are either placed in chief, in pale, or in point, or saltier-wise, bend-wise, or bar-wise, &c.

There are several charges, singular in their kind, and which are found no where but in *Heraldry*, and have scarce any meaning, *viz. fret*, *compony*, and *gobony*.

FRET is a bearing consisting of six bars, crossed, and interlassed *fret wise*, from the *French* word *fret* in architecture. Some call this the *true lover's knot*; others *Harrington's knot*, because it is their arms, and *nodo firmo* the motto. *Gibbon* is for calling it *heraldorum nodus amatorius*.

When it consists of more than six pieces, the number must be specified.

COMPONY —A bordure *compone*, is that form'd or compos'd of a row of angular parts, or chequers of two colours.

Compound or *composed*, is also used in the general for a bordure, a pale, or a fesse, composed of two different colours or metals disposed alternately, separated, and divided by fillets, excepting at the corners; where the junctures are made in the form of a goat's foot.

GOBONY, is the same as *compony*.

CHECKY, is where the shield, or a part thereof, as a bordure, is checquer'd, or divided into chequers, or squares.

Where there is but one row of squares, it is not properly called *checky*, but *counter-componed*.

Checky, according to *Colombiere*, is one of the most noble, and antient figures in all armory; and ought never to be given but to persons who have distinguished themselves in war: for it represents a chess-board, which itself is a representation of a field of battle. The pawns and men, placed on both ſides, repreſent the ſoldiers of the two armies; which move, advance, attack, or retire, according to the will of the two gameſters, who are the generals. But had *Colombiere* been acquainted with *England*, he had known that ſo noble a piece of armory is rendered ſo deſpicable here, as to be made the diſtinguiſhable ſign of an ale-houſe; becauſe, perhaps, it is often made a field of battle, when the knights of malt find themſelves inſpired with a warlike humour.

Checky is always compoſed of metal and colour. Some authors would have it ranked among the ſorts of furs.

When the whole eſcutcheon is chequer'd, it ſhould ordinarily contain ſix ranges: there is no need of blazoning to expreſs them; only it muſt be obſerved to begin to blazon by the firſt ſquare in chief on the dexter ſide; ſo that, if that be *or*, and the next *gules*, the houſe or family is ſaid to bear *checky*, *or*, *and gules*.

When the whole ſhield is not chequer'd, but only the chief, a bend, croſs, or the like, the number of ranges ſhould be expreſſed.

Heralds have alſo invented pieces, wherewith they charge their eſcutcheon to diſtinguiſh families, and make a difference between brothers, as alſo to diſtinguiſh legitimate from natural iſſues, or children.

Thoſe pieces are, a *label* of three points for the eldeſt ſon.

A *label* is eſteemed the moſt honourable of all differences, and is form'd by a fillet uſually placed in the middle, and along the chief of the coat, without touching its extremities. Its breadth ought to be a ninth part of the chief. It is adorn'd with pendants, ſomething like the drops under the triglyphs in the dorick freeze. When there are above three pendants, the number muſt be ſpecified in blazoning. There are ſometimes ſix.

A *creſcent* for the ſecond ſon.
A *mullet* for the third ſon.
A *martlet* for the fourth ſon.
An *annulet* for the fifth ſon
A *flower de luce* for the ſixth ſon.

And they have appointed for the eldeſt ſon of the ſecond houſe, a *label* upon a *creſcent*; the ſecond a *creſcent* upon a *creſcent*; the third a *mullet* upon a *creſcent*; and ſo on.

And for the eldeſt ſon of a third houſe, a *label* upon a *mullet*, the ſecond a *creſcent* upon a *mullet*, &c. but daughters all bear their father's coat without any difference.

A *baſtard's* arms ſhould be croſſed with a bar, fillet, or traverſe from the left to the right. They were not formerly allowed to carry the arms of their father, and therefore they invented arms for themſelves. The difference for the king of *France's* legitimated children, is a *battony pery en barre*.

Having given an exact deſcription of all the different charges of any kind whatſoever an eſcutcheon can be charged with, and of the pieces, which mark the diſtinction of families, and the difference between brothers, I muſt paſs to thoſe which Heralds have placed over the eſcutcheon, to mark the difference of nobility, beginning with the *helmet*.

The Helmet was antiently an armour of defence, wore by the cavaliers, both in war and in tournaments, as a cover and defence of the head; and ſtill uſed by way of creſt or ornament over the ſhield, or coat of arms.

The *helmet* is known by divers other names, as the caſk, head-piece, ſteel cap, &c.

The *helmet* cover'd the head and face, only leaving an aperture about the eyes, ſecured by bars, which ſerved as a viſor.

The *helmet* is bore in armory as a mark of nobility; and by the different circumſtances of the bearing of the *helmet*, are the different degrees of nobility indicated. In *France*, the following rules obtain.

A *perſon* newly enobled, or made a gentleman, bears over his eſcutcheon a *helmet* of bright iron or ſteel, in profile, or ſtanding ſideways; the viſor quite cloſe.

A *gentleman* of three deſcents bears it a little open, but ſtill in profile; ſhewing three bars of the viſor.

Antient knights, &c. have it in profile, but ſhewing five bars; the edges of ſilver.

A *baron's helmet* is of ſilver, the edges gold; with ſeven bars, neither quite in profile, nor yet in front; with a coronet over it, adorned with pearls.

Viſcounts, and *earls*, formerly bore a ſilver *helmet*, with gold edges, its poſition like the former; but now they bear it quite fronting, with a coronet over it.

Marquiſſes bear a ſilver *helmet*, damaſked, fronting; with eleven bars, and their coronets.

Dukes, and *princes*, have their *helmet* damaſked, fronting; the viſor almoſt open, and without bars; with their coronets over them.

Laſtly, the *helmets* of *kings* and *princes* are all of gold, damaſked, full fronting, and the viſor quite open, and without bars.

The *helmets* of *baſtards* are turned to the left, to denote their baſtardy.

Among the *Engliſh* Heralds, theſe laws are of late ſomewhat varied.—*Leigh* will have the *helmet* in profile, and cloſe, to belong to knights:

I but

but all other authors give it to esquires and gentlemen.

To a *knight* they assign the *helmet* standing right forward, and the bearer a little open.

The *helmet* in profile, or posited sideways, and open, with bars, belongs to a nobleman under the condition of a duke.

The *helmet* right forward, and open, with many bars, is assigned to dukes, princes, and kings.

Over the *helmet* is placed a *crown*, or *coronet*, different, according to the different degree of nobility, from a *baron* to an *emperor*.

Over the *helmet* of a *baron*, the *English* Heralds put a *coronet*, which has but six pearls, four of them in sight: the *French* Heralds place a gold circle, adorned with pearls turned round it, in form of necklaces.

Over that of a *viscount*, a *coronet* set full of pearls close to the circle.—And the *French*, one which has but six pearls, three of them in sight.

Over that of an *earl*, a *coronet* of pearls, and strawberry leaves.—And the *French*, one set of pearls, close to the circle or ring.

Over that of a *marquis*, a *coronet* of strawberry leaves, and pearls.—And the *French* the same.

Over that of a *duke*, a *coronet*, all strawberry leaves.—The *French* the same.

Over that of a *prince*, a *coronet* composed of crosses and flower de luces.—The *French* all flower de luces for the princes of the blood.

The *electoral crown*, or *coronet*, is a scarlet cap, turned up with ermine, closed with a semi-circle of gold, all covered with pearls: on the top is a globe with a cross thereon.

The *Spanish crown* is adorned with large indented leaves, covered with diadems, bordering on a globe, surmounted with a cross.

The *English crown* is adorned with four crosses, in the manner of those of *Malta*; between which are flower de luces: it is covered with four diadems, which meet at a little globe supporting a cross.

The *French crown* is a circle of flower de luces, encompassed with six diadems; bearing a-top a double flower de luce, which is the crest of *France*.

The *Imperial crown* is a bonnet, or tiara, with a semi-circle of gold, supporting a globe, with a cross a-top.

In the remotest antiquity, the *crown* was only given to gods: *Pliny* says, that *Bacchus* was the first who used it.

The first *crowns* were no more than a bandelet or head-band, drawn round the head, and tied behind; as we still see it represented on medals, around the head of *Jupiter*, the *Ptolemies*, and the kings of *Syria*. Afterwards they consisted of two bandelets; by degrees they took branches of trees of divers kinds: at length they added flowers; insomuch that *Tertullian de Coronâ* assures us (from *Claudius Saturninus* who had wrote expresly on the subject) there was not an plant whereof crowns had not been made. Woods and groves were searched to find different crowns for the several deities.

The *Roman* emperors had four kinds of crowns, still seen on medals, *viz.* a crown of laurel, a radiating crown, a crown adorned with pearls and precious stones, the fourth a kind of bonnet, or cap.

The first was that ordinarily used from the time of *Julius Cæsar*: the right of bearing it was granted him by the senate; *Justinian* was the first who took that of the bonnet-kind.

Among the *Romans* there were various kinds of crowns, distributed as rewards of military atchievements. The oval crown was the first made of myrtle; and was bestowed on generals who had been victorious over slaves or enemies unworthy of the *Roman* valour, and who were entitled to the honour of the lesser triumph, called *ovation*.

The second was the naval, or rostral crown, consisting of a circle of gold, raised with prows and poops of ships; given to the captain who first grappled, or the soldiers who first jumped aboard an enemy's ship.

The third called *vallaris* or *castrensis*, was also a circle of gold, raised with piles or pallisades, given him who first leaped into the enemy's camp, or forced the pallisades.

The fourth called mural crown, was a circle of gold, indented or imbattled; given him who first mounted the wall of a place besieged, and there lodged a standard. This crown we also find given on medals, to the particular genii and guardians of provinces and places.

The fifth the civick crown, made of a branch of green oak; given him who had saved the life of a citizen in a battle or an assault.

The sixth was the triumphal crown, made of branches of laurel, given to a general who had gained a battle, or conquered a province. This was afterwards made of gold.

The seventh, the *corona obsidionalis*, or *graminea*, made of grass or herbs found on the ground; given to a general who had delivered a *Roman* army, besieged by the enemy, and obliged them to decamp.

The eighth was also a crown of laurel, given by the *Greeks* to their *athletæ*; and by the *Romans* to those who had negotiated or confirmed a peace with an enemy; this was the least esteemed. Besides these in antiquity we meet with radial crowns, given

given to princes at their tranſlation among the gods, whether before or after their death. *Caſaubon* ſays, this ſort of crowns was peculiar to deities, yet it is certain *Nero* took it in his life-time.

Athletick crowns were deſtined to crown victors at the publick games.

Galiot derives the word *corona*, whence crown, from the *Latin cornu*, horn; becauſe the antient crowns were pointed in manner of horns; which were antiently, both by *Jews* and *Gentiles*, eſteemed as marks of power, ſtrength, authority, and empire. Hence, in the holy ſcriptures, horns are uſed for the regal dignity: and accordingly horn and crown in the *Hebrew*, are expreſſed by the ſame words.

Biſhops and abbots, inſtead of a helmet, place a mitre over their eſcutcheon; the biſhops theirs in front, and that of an abbot in profile. Tho' biſhops in *France*, cauſe to be placed over their eſcutcheon, the coronet borne by their houſe or family, together with the mitre, placed frontwiſe, on the right of the coronet, and the croſier on the left. An archbiſhop, beſides the mitre and croſier, places a double croſs in pale behind his eſcutcheon, the double arms of the croſs, ſurmounting the coronet, and placed in front. The biſhops of the church of *England* content themſelves with impaling their arms with thoſe of their dioceſe, over which is placed a mitre in front

If the biſhop be a cardinal, the cardinal's *hat* with ſixteen loops is placed over all.

The pope has over his eſcutcheon a *crown* compoſed of a cap or tiara, and a triple *crown* incompaſſing it, having two pendants like the biſhop's mitres: thoſe three *crowns* are ſuppoſed to repreſent the triple capacity attributed to him by the catholicks, *viz.* as high prieſt, ſupreme judge, and ſole legiſlator of the chriſtians.

The helmet, crown, coronet, *&c.* are alſo often ſurmounted with what is called *creſt*; which is always one of the pieces of *Heraldry*, oftener an animal, or part thereof, than any thing elſe.

Guillim ſays, that next to the mantle, the *creſt* or cognizance claims the higheſt place, being ſeated on the moſt eminent part of the helmet; yet ſo as to admit an interpoſition of ſome eſcrol, wreath, chapeau or hat, crown, *&c.*

The *creſt* of the arms of *England*, a *lion paſſant gardant*, crowned with an imperial crown.

The antient warriors bore *creſts* to ſtrike terror in their enemies, at the ſight of the ſpoils of animals they had killed; or to give them the more formidable mien, by making them appear taller, *&c.* ——

The *creſt* is eſteemed a greater mark of nobility than the armory, as being bore at tournaments; to which none were admitted till they had given proof of their nobility. Sometimes it ſerves to diſtinguiſh the ſeveral branches of a family: it has ſerved on occaſions, as the diſtinguiſhed badge of factions.

The *motto* of an eſcutcheon, is a ſhort ſentence or phraſe carried in a ſcroll, generally under the arms, alluding to the name of the bearer, ſometimes to the bearing, and ſometimes to neither.

In ſtrictneſs it ſhould expreſs ſomething in the atchievement; but cuſtom has now received whatſoever is the fancy of the deviſer.

Next we will put *ſupporters* to our eſcutcheon, thus charged and adorned; which *ſupporters* are figures in an atchievement, placed by the ſide of the ſhield, and ſeeming to hold or ſupport it.

Supporters are chiefly figures of beaſts; figures of human creatures uſed for the like purpoſes, are more properly called tenants.

Some make another difference between *tenant* and *ſupporter*; when the ſhield is bore by a ſingle animal, it is called *tenant*, when by two, they are called *ſupporters.*

The figures of things inanimated ſometimes placed aſide the eſcutcheons, but not touching, or ſeeming to bear them; though ſometimes called *ſupporters*, are more properly called *cotiſes.*

The *ſupporters* of the *Engliſh* arms are a lion and an unicorn; ſome of the former kings had a leopard and an unicorn, others griffins, and others eagles.

In *England* none below the degree of a banneret are allowed *ſupporters*, which are reſtrained to thoſe called the *high nobility.*—The *Germans* permit none but princes and noblemen of rank to bear them. Among the *French* the uſe is more promiſcuous.

Supporters are always the laſt blazoned.

The eſcutcheon of kings, princes, and dukes, with all its ornaments and *ſupporters*, is wrapped in a *mantle*, which has the appearance of folding of cloth, flouriſhing, or drapery, that is in any atchievement drawn about the coat of arms.

It is ſuppoſed originally to have been the repreſentation of a *mantle*, or military habit worn by antient cavaliers over their armour to preſerve it from ruſt: or as others hold, a ſhort covering only worn over the helmet; which in after-times was lengthened, and made to hang from the helmet below the whole ſhield.

The *mantle* is always ſaid in blazon to be doubled, that is, lined throughout with one of the furs, as ermine, pean, vairy, *&c.*

The *mantle* is ſeldom mentioned in blazoning a coat of arms, and it is not at all neceſſary to do it.

Having

Having thus compleated our *escutcheon*, we must proceed to the *blazoning* it; which is deciphering it, and naming all the parts thereof in their proper and particular terms; and which cannot be done without having regard to the following rules.

1. The metal, or colour of the field must be named first. — As *or*, *argent*, or *gules*, &c. 2. The manner of the division of the escutcheon by line, whether downright or bendwise, and also the difference of the line, whether it be indented, ingrailed, *&c.* 3. The charge which is on the field. 4. Having thus expressed the field, the division, and the charge, if there be more parts of the field occupied by the charge than one, you are to name the principal part of the field first. 5. If there be more than one kind of charge in a field, that in the chief part is to be named first. 6. No iteration or repetition of words is to be used in blazoning a coat, especially of any of these four words, *of*, *or*, *and*, *with*. 7. That there are but two forms of blazon, *viz.* metals and colours. 8. That metal upon metal, and colour upon colour is false Heraldry; which admits of no exception but in the arms of *Jerusalem*, which are, *argent*, a cross potent between four croslets, *or*.

These previously considered, we will begin by *blazoning* the most simple escutcheon, which is always accounted the noblest; for the great quantity of different pieces an escutcheon is charged with, is not a greater mark of the nobility of the family who bears it.

The arms of the kings of *England*, as kings of *England* only, are very simple, and are blazoned, *gules three lions passant gardant in pale, or.*

The arms of *Ireland* are but *azure a harp or, strung argent.*

From these simple escutcheons, I'll pass to those which are charged with more pieces.

The arms of the duke of *Norfolk*, first duke, and hereditary earl marshal of *England*, are blazoned thus in *English*.—*Gules a band between six cross-croslets, fitchee argent, with an augmentation*, viz. *in the middle of the bend an inescutcheon, or, charged with a demi-lion rampant, pierced through the mouth with an arrow, within a double tressure contre-fleury gules*,—Or thus; *Gules a band argent. charged encœur with a lion rampant, arrowed in the mouth, within a tressure contre-fleury gules, the band accompanied with six cross-croslets argent, three and three.*

As the different alliances contracted between noble houses, seldom fail making some addition to their escutcheons, and engage a family to quarter their arms with those of another, or several houses, according as they judge those quarters more capable to honour their own, we must give here some instructions or rules relating to quartering escutcheons.

Quartering, in the *French* manner, is to divide the escutcheon into four equal parts, by drawing first a line perpendicularly from top to bottom, which divides it exactly into two equal parts, and another a-cross which divides it into two other equal parts, which together make four equal parts or quarters, which is told thus, 1, 2, 3, 4. The quarter on the left, a-top, being the first *quarter*; the next to it the second; the quarter on the left at bottom, the third; and the next to it the fourth, or last.

If the first and the last quarter are the same coat, they are blazon'd together first; and the second and third together, if they be likewise the same coat; which always happens if there be but two coats in the fourth quarter. For example, in the *French* escutcheon, where the arms of *France* are only quartered with those of *Navarre*, the *French* escutcheon is the first and last; and that of *Navarre* the second and third; therefore we blazon it, quartered in the first and last of *France*; and in the second and third of *Navarre*; naming, if we please, the different colours and pieces of the escutcheon; though there is much more skill to blazon an escutcheon, which contains several quarters, in naming the family to which the quarter belongs, than in blazoning the pieces. For example, I suppose that the arms of the duke of *Norfolk* were quartered with those of that excellent nobleman the viscount *Montacute Brown*, I would say, quartered in the first and last of *Norfolk*; and in the second and third of *Montacute.*

But perhaps the escutcheon thus quartered, contains four different coat of arms; that of the duke of *Norfolk*, of the duke of *Montague*, of the earl of *Harrington*, and of the viscount *Montacute*; I'll say, quartered in the first of *Norfolk*, in the second of *Montague*, in the third of *Harrington*, and in the last of *Montacute*.

To divide the escutcheon into six quarters, we draw two perpendicular lines, which divide it into three equal parts, then draw another a-cross, which divides those three parts into six, which parts are told (beginning at the first on the left a-top, proceeding to the next to it, from thence to the next to that, which is that on the right a-top, then to the first on the left at bottom, from it to the next, ending at that on the right at bottom) 1, 2, 3, 4, 5, 6. This the *French* heralds do not call quartered, but *coupe of three pieces*; for example, the duke of *Lediguieres*, in *France*, bears *coupe of three pieces in chief supported with three in point*. In the first, *or* a chequier *gules*, which

which is of *Crequi*. In the second, *or* two lions leoparded *gules*, which is of *Blanche fort*. In the third, *or* a wolf hauriant *azure*, armed *gules*, which is of *Sault agoult*. In the fourth (which is the first of the point) *azure* three towers *or*, which is of *Montauban*. In the fifth, *azure* three pales *or*, a chief of the same, which is of *Vesc*. In the sixth, and last, *or* two leopards *azure*, which is of *Montlaur*. And over all of *bonne*, which is *gules*, a lion *or*, the chief cousu *azure*, charged with three roses *argent*.

The *French* have but this kind of *parti*, which is the same as the *English parti per pale*; the *English* Heralds applying the word to all the sorts of partitioning, and never use it without some addition to specify the particular one intended. Thus they have *parti*, or *parted per cross*, *per chief*, *per pale*, *per fess*, *per bend dexter*, *per bend sinister*, *per chevron*, &c.

Parti per pale, is when the chief is divided perpendicularly into two halves, by a cut in the middle from top to bottom. This, and this only, the *French* call *parti*.

Parti per fess, is when the cut is a-cross the middle, from side to side; which the *French* call *coupé*.

Parti per bend dexter, is when the cut comes from the upper corner of the shield on the right hand, and descends a-thwart to the opposite lower corner; called by the *French*, *tranché*.

Parti per bend sinister, is when the cut coming from the upper left corner, descends a-cross to the opposite lower corner one, called by the *French* *taillé*.

When the shield is *parti* and *coupé*, it is said to be quartered, or *ecartele*.

It is said to be *parti* one from the other, when the whole shield is charged with some honourable bearing, divided by the same line that parts the shield. Here it is a rule, the one side be of metal, and the other of colour.

When the quarters are quartered over again, sub-divided each into four, this is called by the *French*, *contre-ecartele*, and by the *English*, *counter-quartered*.

There are counter-quartered coats, which have twenty or twenty-five quarters.

When the quartering is by a saltier (which is sometimes used in the *English* Heraldry) the chief and point are the first and second quarters, the right side the third, the left the fourth.

In the middle of a *quarter shield*, is almost always placed the *proper coat* of the *family*, who quarters it with others, which is blazoned over all in *English*, and *sur le tout* in *French*, because it covers the two lowermost inward corners of the two uppermost quarters, and the two uppermost inward corners of the lowermost quarters.

There has been a great dispute among the learned, about the origin of arms. *Favyn* will have them to have been from the beginning of the world; *Segoin* from the time of *Noah*; others from that of *Osiris*, which is supported by some passages in *Diodorus Siculus*; others from the time of the *Hebrews*, in regard arms were given to *Moses*, *Joshua*, the twelve tribes, *David*, &c.

Others will have them to have taken their rise in the heroical age, and under the empires of the *Assyrians*, *Medes*, and *Persians*; building upon *Philostratus*, *Xenophon*, and *Quintus Curtius*.

Some pretend that the use of arms, and the rules of blazon, were regulated by *Alexander*. Others will have them to have had their original under the empire of *Augustus*; others during the inundations of the *Goths*; and others under the empire of *Charlemaigne*.

Chorier observes, that among the antient *Gauls*, each man bore a mark on his buckler, by the sight whereof he might be known to his fellows; and hence he refers the original of the arms of noble families. *Camden* has observed something like this of the antient *Picts* and *Britons*, who going naked to the wars, painted their bodies with blazons, and figures of divers colours, which he supposes to have been different in different families, as they fought divided by kindreds. Yet *Spleman* says, that the *Saxons*, *Danes*, and *Normans* first brought arms from the north into *England*, and thence into *France*.

Upon the whole, it is certain, that from time immemorial, there have been symbolical marks in use among men, to distinguish them in armies, and to serve as ornaments of shields and ensigns; but these marks were used arbitrarily as devices, emblems, hieroglyphicks, &c. and were not regular armories like ours, which should be hereditary marks of the nobility of a house, regulated according to the rules of *Heraldry*, and authorized by princes.

Before *Marius*, even the eagle was not the constant ensign of the *Roman* army, but they bore in their standards a wolf, leopard, or eagle indifferently, according to the fancy of the generals.

The same diversity has been observed with regard to the *French* and *English*; on which account authors are divided, when they speak of the antient arms of those countries. In effect, it appears from all the best authors, that the armories of houses, as well as the double names of families, were not known before the year 1000; and several

ral have even endeavoured to prove, that the uſe of arms did not begin, till the time of the firſt croiſades of the *chriſtians*, for the conqueſt of the *Holy Land*.

The truth is, it appears to have been the antient tournaments, that occaſioned the fixing of armories. *Henry the fowler*, who regulated the tournaments in *Germany*, was the firſt who introduced theſe marks of honour, which appear to be of an older ſtanding in *Germany*, than any other part of *Europe*. It was then that coats of arms were firſt inſtituted, which were a kind of livery, compoſed of ſeveral bars, fillets, and colours; whence came the feſſe, pale, bend, and lozenge, which were ſome of the firſt elements of armories. Thoſe who had never been concerned in any tournament had no arms, tho' they were gentlemen.

Such of the nobility and gentry as croſſed the ſea, in the expeditions to the *Holy Land*, alſo aſſumed theſe tokens of honour to diſtinguiſh themſelves.

Before theſe times, we find nothing upon antient tombs but croſſes, with *Gothick* inſcriptions and repreſentations of the perſons deceaſed. The tomb of pope *Clement* IV. who died in 1268, is the firſt whereon we find any arms; nor do they appear on any coins ſtruck before the year 1336. We meet with figures, it is true, much more antient, both in ſtandards and on medals; but neither princes nor cities ever had arms in form; nor does any author make mention of blazoning before that time.

Originally none but the nobility had right of bearing arms; but *Charles* V. king of *France*, having enobled the *Pariſians* by his charter, in 1371, permitted them to bear arms: From whoſe example, the moſt eminent citizens of other places did the like.

Camden refers the original of hereditary arms in *England*, to the time of the firſt *Norman* kings. He ſays their uſe was not eſtabliſhed till the reign of king *Henry* III. and inſtances in ſeveral of the moſt conſiderable families in *England*, wherein, till that time, the ſon bore always different arms from the father. About the ſame time it became the cuſtom here in *England*, for private gentlemen to bear arms; borrowing them from the lords of whom they held in fee, or to whom they were the moſt devoted.

Arms, at preſent, follow the nature of titles, which being made hereditary, theſe are alſo become ſo; being the ſeveral marks for diſtinguiſhing of families and kindred, as names are of perſons and individuals.

What relates to the making out arms; the rectifying of abuſes committed therein, *&c.* is chiefly committed to the *king at arms*, whoſe buſineſs beſides is to direct the heralds, preſide at their chapter, *&c.*

There are three *kings at arms* in *England*, viz. *Garter*, *Clarencieux*, and *Norroy*.

GARTER is the principal *king at arms*. — As principal *king at arms*, he has power to make arms, *&c.* And as *garter* he is to attend the ſervice of the order of the *garter*; for which he is allowed a mantle and badge, a houſe in *Windſor* caſtle, and penſions both from the ſovereign and knights; laſtly he has fees. He carries the rod and ſcepter at every feaſt of St. *George*, when the ſovereign is preſent; notifies the election of ſuch as are new choſen; attends the ſolemnity of their inſtallations, and takes care of placing their arms over their ſeats; carries the *garter* to foreign kings and princes; for which ſervice it has been uſual to join him in commiſſion with ſome peer, or other perſon of diſtinction.

Garter's oath relates only to ſervices to be performed within the order; and is taken in chapter before the ſovereign and knights.—His oath as *king at arms*, is taken before the earl marſhal. — This office was inſtituted by *Henry* V.

CLARENCIEUX is the ſecond *king at arms*, thus called from the duke of *Clarence*, to whom it firſt belonged.—His office is to diſpoſe and marſhal the funerals of all the inferior nobility, as Baronets, Knights, Eſquires, and Gentlemen, on the ſouth ſide of the *Trent*.

NORROY, the laſt *king at arms*, is to do the ſame on the north ſide of the river *Trent*.

Theſe two laſt are alſo called *Provincial Heralds*, in regard they divide the kingdom between them into two provinces.

Theſe by charter have power to viſit noblemen's families, to ſet down their pedigrees, diſtinguiſh their arms, *&c.*

Antiently the *king at arms* was created, and ſolemnly crowned by the kings of *England* themſelves; but of later days the Earl Marſhal has a ſpecial commiſſion at every creation, to perſonate the king.

To theſe may be added *Lyon king at arms*, for *Scotland*, who is the ſecond *king at arms* for *Great Britain*; he is inveſted and crown'd with great ſolemnity. To him belongs the publiſhing the King's proclamations, marſhalling funerals, reverſing arms, *&c.*

In *England* they have ſix heralds, *viz. Richmond*, *Lancaſter*, *Cheſter*, *Windſor*, *Somerſet*, and *York*; to which may be added a ſeventh, or *Brunſwick Herald*, inſtituted by King *George* I.

Antiently none could arrive at the dignity of herald, without having been ſeven years purſuivant, who is a gentleman whoſe buſineſs is to attend

attend with the heralds in marfhalling and ordering publick folemnities.

Of the great number of purfuivants antiently on foot, there are now only four remaining, *viz.* *Blue-Mantle*, *Rouge Croix*, *Rouge-Dragon*, and *Portcullice*. Who are the loweft order of officers belonging to the college of arms.

The heralds, with the *Kings at arms*, and the four purfuivants are a college or corporation erected into fuch by a charter of *Richard* III. who granted them divers privileges; as to be free from fubfidies, tolls, and all troublefome offices.

HIEROGLYPHICKS.

HIEROGLYPLICK, a *Greek* compound, which literally imports a facred or holy impreffion or character, is that myftical figure or fcience, ufed by the *Egyptian* priefthood to conceal, and to convey the fecrets of their divinity. So that *hieroglyplicks* are general accepted to be the figns of divine, facred, and fupernatural things: and *fymbols* are confined to fenfible and natural things.

The Hieroglyphicks moft remarkable in the *Egyptian* theology, I have collected in the *copper plate* annexed, and are thus explained: with fome others.

The *Sun* (Fig. 1) has been often ufed both by the *Pagans* and *Chriftians*, to fignify a fupreme being, and fome of the *Pagans* have even adored him as fuch; efpecially the *Perfians*.

St. *John*, St. *Paul*, St. *Denis* the *Areopagite*, make often a comparifon between God and the fun.

The *Sun* was alfo the *hieroglypick* of *truth*; nothing more proper than the *fun* to fignify *light*, fince himfelf is the fource of light.

He was a *hieroglyphick* among the *Romans* of the fovereign majefty of the empire.

Archimedes, *lib.* 1. *c.* 36. fays that he was the *hieroglyphick* of the *human life*: That to fhew the *tranquility* of that life, he was reprefented in his *full glory*; darken'd and cloudy, to fignify troubles and inquietude.

The *Sun* was alfo a *hieroglyphick* of the revolution of the whole year, as regulating the feafons by his courfe.

When the *Egyptians* wanted to fignify a woman with child, or lying in, they reprefented the *fun* divided in two, with a *Star* in the middle of the divifion, for a *hieroglyphick* of the child in the womb of its mother; not only becaufe they compared the belly fituated in the middle of the body to the fun; but, likewife, becaufe they were of opinion that he vivifies all forts of conceptions; imagining befides, that a *ftar* borrows it lights from the fun, as a child receives its aliments from its mother.

The *Moon*, (Fig. 2.) was a *hieroglyphick* of *human life*; becaufe its face changes every day, like that of the humane life.

The *Moon* was among the *Pagans*, a *hieroglyphick* likewife of *eternity*; becaufe it feems to have a perpetual rotation.

For a *hieroglyphick* of the *month*, the *Egyptians* painted the *moon* with her horns downwards.

The *Egyptians* made a *Star* one of the *hieroglypicks*, to fignify God; becaufe they imagined that the fixed ftars gave the motion to the inferior heavens, as God does to all created beings.

The parts of the human body have been ufed *hieroglyphically*.

The principal *hieroglyphick* of the *Head* has always been to fignify the *beginning* of fomething.

A *Head* with a diadem is the *hieroglyphick* of fovereignty: It is likewife the *hieroglyphick* of riches, fecurity, profperity, and providence.

The city of *Rome* was reprefented by the head of a woman, with a helmet.

The *Egyptians* fignified watching, by *two heads*, one of a man looking inwards, and the other of a woman looking outwards, whereby they pretend that the devil had no power to offend them. (*Fig.* 5.)

By the *double head* of *Janus*, prudence and popularity were reprefented.

Some imagine, that the *Janus*'s found in feveral places, with two heads, without hands or feet, mounted on a quadrangular column, large a-top, and always going in diminifhing to the bottom, is the *hieroglyphick* of conftancy. (*Fig.* 5)

The interpreters of *Hefiod* are of opinion, that the *Gerion* with *the heads*, fignify the moon: others the month divided into *nones*, *ides*, and *calends*. Fig. 6.

The *Head* of an *Afs* on a human body, was the *hieroglyphick* of ignorance.

The *Back* was a *hieroglyphick* of flight.

The *Egyptians* made the *Eye* the *hieroglyphick* of juftice.

The

The *Eye* was alſo the *hieroglyphick* of our conceptions.

Eyes without eye-laſhes, was the *hieroglyphick* of a laſcivious perſon.

The *Right-eye open*, ſignified *life*, and the *eye ſhut*, repreſented *death*.

The *eye-brows* ſignified ſeverity.

An *Ear open* ſignified obedience; and an *ear ſtopt* obſtinacy.

A *Tongue*, guided by a hand, repreſented eloquence.

A *Tongue*, on an altar, repreſented ſleep.

Tongues cut, ſignified ſilence. *Iliad.* 3.

Ariſtander, ſays, the *mouth* is a *hieroglyphick* of a houſe, the *teeth* repreſenting the inhabitants.

A *Heart* hanging on the neck ſignified ſincerity.

The *Egyptians*, to ſignify the *inundation* of the *Nile*, repreſented a *heart*, with a *tongue* fixed to it, and repreſented *rage* or *indignation* by a *heart* placed on a *gridiron*.

By a *Back-bone* they ſignified a ſtrong inclination to luxury.

By the *Penis*, repreſented on ſo many pyramids or obeliſks, they gave to underſtand, the valour or courage of the perſons buried under, or near thoſe huge maſſes of ſtones.

The *Matrice*, ſignified a coward.

The antients repreſented *continency*, by a *man* holding his *teſticles* in his *hand*.

The *Navel* was, on ſome medals, a *hieroglyhick* of *Jupiter*.

The *Hand* was an *hieroglyphick* of architecture

The *Waſhing of Hands* (Fig. 8.) ſignified innocence.

The *Hand* extended, ſignified authority and power.

Both *Hands* in one's boſom, ſignified idleneſs.

The *Hands* tied behind the back, ſignified captivity.

Two *Right Hands joined*, ſignified felicity.

A *Statue without Hands* repreſented a judge, to ſignify that judges ſhould have no hands for bribery or corruption.

The *Feet walking upon the Water*, ſhew'd the impoſſibility of a project.

The *Feet ſet firm on the ground*, indicated a ſtrong foundation.

The *Egyptian* prieſts repreſented the *winter ſolſtice*, by *two feet in fetters*, to ſhew that then the ſun walks ſlower.

Lame, or *diſtorted Feet*, ſignified iniquity.

The *Right Foot* extended, and wrapt up, was an *hieroglyphick* of retreat, or return.

A *Hand* on the *head*, and playing with its fingers, is a *hieroglyphick* of laſciviouſneſs and effeminacy.

The *Thumb* extended downwards, was, among the *Romans*, an *hieroglyphick* of peace. Extended upwards, an *hyeroglyphick* of favour.

The *Index* on the *Mouth*, was a *hieroglyphick* of ſilence.

The *Egyptian* prieſts repreſented the ſtomach by the *middle finger*.

The *Middle Finger* alſo denoted infamy.

The *Annularis* was a *hieroglyphick* of the heart, and for that reaſon the *Egyptian* prieſts uſed to adorn it with a ring, and perfume it. It alſo indicated marriage, ſlavery, and impetration when put to the ear.

I'll paſs to the *animals* which were uſed for hieroglyphick figures, beginning with the *lion*.

The *Lion* alone was among the *Egyptians*, a *hieroglyphick* of the ſtrength of the body.—By the *head of a lion* they underſtood *vigilancy* and *watchfulneſs*.—To ſignify an exceſſive rage, they repreſented a *lion* tearing his own progeny into pieces.

The *Lioneſs* was moſt commonly the *hieroglyphick* of a proſtitute.

A *Lion*'s *Skin*, repreſented virtue.

A *Lion rampant* (Fig 9.) is the *hieroglyphick* of magnanimity.—*Regardant* (Fig 10.) of circumſpection and caution.—*Saliant* (Fig. 11.) of expedition, or celerity.—*Sejant* (Fig. 12.) of council. *Paſſant* (Fig. 13.) of prudence.—*Gardant* (Fig. 14.) of defence.

The *Sphinx* (which was ſeen at the entrance of ſeveral temples of the antients) with the head of a woman, and the reſt of the body of a *lion*, was a *hieroglyphick* that ſignified, that human nature ſurpaſſes, in excellency, all other animals.

The figure of an *Elephant* (Fig. 15.) was among the *Egyptians*, a *hieroglyphick* to ſignify a king; becauſe perhaps when thoſe animals travel in droves, the eldeſt marches always at the head.

The *Egyptians* repreſented in *hieroglyphick* terms, an *elephant* and a *goat*, to ſignify that a prudent man avoids with care, all that has the leaſt appearance of folly. They painted an *elephant* and a *hog*, to inſinuate that one muſt fly the company of tatlers, as the *elephant* flies the grunting of a *hog*.—To ſignify a king who paſſes his life in luxury and indolence, they painted an *elephant* hunting rats; an occupation very little becoming a body ſo large and ſo heavy.

The *Egyptian* prieſts repreſented a *bull* crowned with the leaves of a fig-tree, for a *hieroglyphick* of modeſty.

The *Athenians* had repreſented a *horſe* on one of their coins, with this legend, ΓΈΡΩΝΟΣ, which was a *hieroglyphick* to ſignify the valour and experience of a hero, in the command of the cavalry.

By a *horſe*, the *Egyptian* prieſts ſignified a profane man.

The *Egyptians* ſignified by a *dog*, a divine, and ſagacity.

Macrobius, *Saturn*. *c*. 20. ſays, that the figure of a *dog*, was a *hieroglyphick* to ſignify the remembrance of things paſt.

A *Dog* is likewiſe the *hieroglyphick* of fidelity.

The *Egyptians* repreſented under the figure of a *dog*, their God *Anubis*.

They likewiſe underſtood by the *hieroglyphick* of a *dog*, with a diadem or coronet, a prince or legiſlator. A *dog* with a *leading-laſh*, was the *hieroglyphick* of a ſoldier; the *laſh* ſignifying the oath of a ſoldier, and the *dog* his duty.

The figure of a *Man* with the head of a *dog* (Fig. 16) is a *hieroglyphick* of impudence.

A *Hart* chewing the cud (*Fig*. 17.) is a *hieroglyphick* of a man perfectly accompliſhed.

The *Ant* was the *hieroglyphick* of care and induſtry; of foreſight; of conſtancy in toils and labours; of mutual compaſſion; of different offices and manners; of opulence; of vain-glory.

By the *Ant*, and a ſmall bundle of *origan*, the *Egyptian* prieſts ſignified devaſtation.

The *Egyptian* prieſts underſtood by the figure of a *hog*, a dangerous and brutiſh man; by a *hog* wallowing in the mud, an uncivil and ill-bred man, luxury and gluttony.

The *Egyptians* by the figure of a *ſheep*, underſtood folly: likewiſe innocence, good-nature, and meekneſs.

The *Aſs* was a *hieroglyphick* of ſtupidity, and of uncleanneſs.

A *Running Aſs*, was a *hieroglyphick* of a fine enterprize begun, but ſoon neglected; becauſe the galloping of an *aſs* is but ſhort.

The *Egyptians* repreſented the *Mule* to ſignify ſterility.

The *Egyptian* prieſts underſtood by the figure of the *Hare*, vigilancy; and quickneſs of hearing

The *Hare* was alſo a *hieroglyphick* of fecundity; and of ſolitude.

The *Fox* ſignified a deceitful, cunning, treacherous, and malicious man.

By the figure of this animal, the *Egyptians* ſignified a man who had inſulted a woman; becauſe this animal, ſeeing himſelf cloſely purſued, cuts his genitals, and throws them far from him.

The *Mole* is the common *hieroglyphick* of blindneſs; of a quick hearing, and of futurity.

The *Rat* was an *hieroglyphick* of ruin and deſtruction; becauſe they are always gnawing ſomething night and day.

The *Egyptian* prieſts by the *rat*, ſignified choice and option, becauſe of ſeveral eatables, he always chuſes the beſt.

The *Egyptian* prieſts, to ſignify the world, repreſented a *ſpott d ſerpent* biting its tail; pretending thereby to ſhew the immortality of things created, whoſe beginning tends towards its end, and the end returns to the beginning.

By a *Serpent* which had caſt off his ſkin, was ſignified an old man, reſtored to his priſtine juvenility.—By one the tail under his throat, was underſtood time, comparing the revolution of the ſeaſons, to the circumvolutions of the ſerpent.

The figure of a *ſerpent*, with the head of a ſaker, within a braſs hoop, almoſt in the form of the *Greek* letter Θ, ſignified the maſs of the world.

By the figure of the *Baſiliſk*, the *Egyptian* prieſts underſtood a century and eternity.

The figure of the *Baſiliſk* ſignified likewiſe a calumniator.

The *Egyptian* prieſts repreſented the *Viper* to ſignify children who conſpire againſt their parents.

To ſignify a prince inclinable to clemency, they repreſented a *Serpent* in his circumvolutions, and biting his tail. And to ſignify one who had taken a particular care of his people, they repreſented a *ſerpent* with his eyes open, his neck erect, and raiſing up his breaſt.

By the *Caducee*, which is a rod, garniſhed with two ſerpents, male and female, they underſtood the birth of man, and concord and amity.

The *Cornucopia* joined to the *caducee*, ſignified felicity.

The figure of the *Vulture* was made uſe of by the *Egyptian* prieſts, to ſignify the year.

By the *vulture* tearing her thighs to feed her young withal, they repreſented pity and commiſeration.

Plunder is alſo repreſented by the figure of the *vulture*.

The principal ſignification of the *Eagle* was proſperity.

Pindarus deſigns by the *Eagle*, a quick wit.

By the figure of the *Phœnix*, the *Egyptian* prieſts underſtood a reſtoration; becauſe the *phœnix* was ſuppoſed to revive from his own aſhes.

The *Egyptian* prieſts ſignified by the figure of the *Pelican*, an extreme folly; becauſe, when as that bird could build his neſt on the higher places, he builds it on the lower, where his young can be ſtolen away. Likewiſe compaſſion and paternal love; becauſe he is ſuppoſed to open his breaſt, and feed his young with his own blood.

By the figure of an *Owl* placed on an altar, was underſtood *Minerva*; and conſequently wiſdom.

The *Egyptian* prieſts, by the figure of an *owl*, ſignified death.

By the *owl* was likewiſe repreſented tyranny.

By the figure of the *Lanner*, the *Egyptian* prieſts underſtood the ſun. *Zoroaſter* ſays, that God has the head of a *lanner* (Fig. 20.)

By the figure of a *lanner* flying, the *Egyptians* underſtood the ſublimity of thoughts, and likewiſe wit, celerity and quickneſs.

The chriſtians by the figure of a *Dove* underſtood the Holy Ghoſt and divine love, otherwiſe called charity.

The *Egyptian* prieſts underſtood by the figure of the *Swan*, an old man who delights in *muſick*, becauſe the ſwan is ſuppoſed to ſing better the nearer he approaches his end.

The figure of a *Swan* ſignified likewiſe, a man who oppreſſed his countrymen and fellow citizens, (*Fig.* 21.) For the *ſwans* have this peculiar to themſelves, that they fight and eat one another.

There is in the cabinet of curioſities of the great duke of *Tuſcany*, an *Apollo* on marble, who plays on the violin, which he holds in his left-hand, and reſting it on the back of a *ſwan*, which ſeems to touch gently the chords with his beak, as it were to heighten the harmony. This was made for a *hieroglyphick* of muſick, (*Fig.* 22.)

By the figure of the *Parrot* is underſtood *eloquence*, becauſe no other animal imitates ſo well the human voice, (*Fig.* 24.)

The figure of the *Peacock* ſignified *Juno*, becauſe that bird was conſecrated to her. The ridicule and vanity of riches was alſo figured by the feet of the *peacock*, which are deſpicable when compared with the reſt of his body. By the tail of the *peacock*, was ſignified the viciſſitude of fortune, becauſe its fine feathers fall every year at the fall of the leaves, and they begin to ſprout anew in the ſpring following.

The figure of a *Syren* or *Mermaid*, with the feet of a *hen*, ſignified misfortunes, (*Fig.* 25.)

A *Hen* ſignified fecundity, health, and ſecurity.

By the figure of a *Cock* is underſtood the *French* nation.

The *Cock* is alſo the *hieroglyphick* of impiety, becauſe he treads his mother and beats his father.

By the figure of a *Gooſe* holding a pebble in her bill, the *Egyptians* underſtood ſilence kept a propos, and alſo a falſe accuſer.

In ſcripture *irreſolution* is ſignified by the *Oſtrich*.

The *Egyptian* prieſts wanting to repreſent good and loyal ſubjects who loved their prince, painted a *bee*.

By the *Bee* is alſo underſtood chaſtity.

By a *Fly*, the *Egyptians* underſtood importunity, impudence, and obſtinacy.

By a *Spider* i ſignified a needleſs work.

The *Egyp ian* prieſts to ſignify *impiety*, *ingratitude*, and *injuſtice*, painted a *Sea horſe*, and ſignified that piety was preferable to impiety, by the head of a *Caſſowary* fixed on the foot of a *ſea-horſe*, (Fig. 27.)

The *Egyptians* to ſignify a perſon without ſhame painted a *Frog*, becauſe it is ſuppoſed that ſhe has blood no where elſe but in the eyes; and alſo underſtood thereby a needleſs or criminal curioſity.

There was ſeen at *Sais*, on the portal of a temple dedicated to *Minerva*, a *child*, an old *man*, a *falcon*, a *fiſh*, and a *ſea-horſe*, (Fig. 28.) which ſignified the condition and fragility of human life: which from its infancy tends towards old age, and returned again to infancy. By the *Falcon* was underſtood our intellectual faculty, which is a participation of the divinity; death by the *fiſh*, by reaſon of the ſea, which the *Egyptians* called ruin and deſtruction; and voilence by the *ſea-horſe*, becauſe he does not even ſpare his own father, whom he kills to enjoy his mother.

The *Egyptian* prieſts, with regard to that beginning and end, which is inviſible, underſtood *God* by the figure of the *circle*.

By the figure of a *circle* we underſtood the courſe of a year, in conſideration of the gold circle which *Cambyſes* carried off from the ſepulchre of *Simond*, and which had in circumference 365 cubits, and a cubit in breadth, each day of the year being engraved on each cubit, according to the diurnal courſe of the planets.

The *winged Sphere* wreathed about with *Serpents*, was the *hieroglyphick* of the ſpirit and ſoul of the univerſe, (*Fig.* 29.)

The *Egyptian* prieſt, by a quadrangular figure, underſtood wiſdom; becauſe they ſuppoſe that form the moſt ſecure foundation.

By the figure of a triangular *Pyramid* or *Obeliſk*, the antients underſtood the *Divinity*; as conſidering the number *three* the moſt perfect number.

The figure of a *Helmet* ſignified war.

By the figure of a *Girdle* the *Greeks*, *Latins*, and *Hebrews* underſtood virginity; alſo ſtrength and virtue.

The figure of a *Ring* was a *hieroglyphick* of faith and honour, and among the *Romans* of nobility.

The *Diadem* ſignified royal power, authority, and victory.

The *Scepter* ſignified a kingdom.

A *Necklace* or gold chain, ſignified a ſolid virtue.

The *Egyptians* to expreſs fame, they painted a *thunder-bolt*. By the figure of a *thunder-bolt*, was alſo underſtood celerity.

An *Anchor*, environ'd with a *Dolphin*, ſignified haſte.

By the figure of a *Ship at anchor*, the *Egyptian* prieſts underſtood a profound ſecurity.

By the figure of a *Rudder* of a ſhip, was underſtood the government of a ſtate.

Yokes, *Chains*, and *Fetters*, ſignify moſt properly the ſtate of marriage, (*Fig.* 30.)

Among the ſeveral *hieroglyphick* ſignifications of the *Palm-Tree*; the following are the four principal; which are, that it ſignifies year, month, juſtice or impartiality, and victory.

Among the ſacred *hieroglyphicks*, by the figure of a *palm-tree* is underſtood innocency and a good life.

The *Laurel* is an *hieroglyphick* of prophecy, health, or preſervation, and of victory.

By the figure of an *Oak*, was ſignified ſometimes the ſtrength of body, and ſometimes length of time.

The figure of a *Cypreſs* ſignified *Words without Deeds*; becauſe the *Cypreſs*, tho' a beautiful tree, produces no fruit.

We ſee on ſeveral antient coins and medals, that the *olive-tree* with a *caduceus*, is an *hieroglyphick* of felicity.

In ſeveral places of the ſcripture, by the *olive-tree* is underſtood alms; it alſo ſignifies clemency, abundance, or plenty, hope, and peace.

By the figure of the *Vine*, the *Egyptians*, and other nations, underſtood joy and mirth, and likewiſe liberty.

HORSEMANSHIP.

HORSEMANSHIP, as a ſcience, inſtructs us in whatever relates to the make, colour, age, temper, and qualities of *horſes*, and their reſpective countries and climates. Likewiſe the knowledge of the defects and diſeaſes of horſes, and the remedies proper for the ſame; with the ſeveral operations relating thereunto, as *docking*, *gelding*, *ſhoeing*, &c.

A Horse is a domeſtick quadruped, of great uſe in agriculture, commerce, war, ſporting, *&c.* and is the ſubject of the art of *horſemanſhip*.

Horſes are diſtinguiſhed into divers kinds, and differently denominated; either with regard to their *ſtrain*, or *country*, or to their *colour*; or to the *uſes*, or *offices* they are reſerved for.

They are diſtinguiſhed with regard to their *ſtrain*, or *country*; as the *Neapolitan*, known by his hawk noſe; the *Spaniſh Jennet*, known by his ſmall limbs; the *Barbe*, by his fine head and deep hoof; the *Dutch*, by the roughneſs of his legs; the *Engliſh*, by his ſtrong knitting together, *&c.*

With regard to their *colours*; as a *bay*, which admits of divers ſhades or caſts, *viz.* a black *bay*, brown *bay*, dappled *bay*; all which have conſtantly black manes and tails. *Dun*, and *mouſe-dun*, having frequently a black liſt along the back, which denominates them *flea-backed*. *Flea-bitten*, which is white ſpotted with red. *Gray*, dappled *gray*, ſilver *gray*, ſad or powder'd *gray*, black *gray*, ſandy *gray*, and iron *gray*. *Griſſel* or *rount*, a light fleſh-colour, intermixed with white. *Peach-colour*, or *bloſſom-colour*. *Pye-bald*, which conſiſts of two colours, one of them white. *Roan*, a bay, black, or ſorrel, intermixed with white hairs. *Rubican*, black, or ſorrel, with white hairs ſcattered about his body. *Sorrel*, common *ſorrel*, red or cow-colour'd *ſorrel*, bright or light-coloured *ſorrel*, burnt *ſorrel*, all chiefly diſtinguiſhed by the colour of their Manes. *Starling-colour*, reſembling a browniſh, or blackiſh grey, only more freckled, or intermixed with white. *Tyger-colour*, much the ſame with the branded grey, only the ſpots ſmaller. *Wolf-colour.*—*Deer-colour.*—*Black.*—*White*, &c.

The colours are generally conſidered as ſymbolical of the nature, qualities, *&c.* of the beaſts; and accordingly their value is much influenced thereby. The *dapple gray*, is prized for *beauty*; the *brown bay*, for *ſervice*; the *black*, with ſilver hairs, for *courage*; the *roan*, for *countenance*; the *ſorrel*, black with white, and iron-gray, are reputed *hot* and *fiery*; the *bright-gray*, *flea-bitten*, and *black* with white ſpots, are *ſanguine*; the *white*, *dun*, and *pye-bald*, *phlegmatick* and *heavy*; the *mouſe-dun*, *red bay*, and *blue gray*, are *dull*: the *peach-colour* rarely proves obedient to the ſpur; the *ſorrel* ſeldom fails of being good, eſpecially if their legs, tails, and manes are black; and the ſame may be ſaid of the *flea-bitten*, at leaſt thoſe ſo marked in the foreparts, or over the whole body; for when only behind, it is an ill ſign.

Yet it is hard laying down any univerſal rules. The *white*, which promiſes the leaſt, proves good, when black about the eyes and noſtrils; and there are excellent *iron-greys*, though they are not reputed a good colour.

With regard to the *uſes* or *offices* they are reſerved for, horſes are diſtinguiſhed into *coach-horſe*, *war-horſe*, *hunting-horſe*, *running-horſe*, *pack horſe*, &c.

The two former diſtinctions contribute much towards the knowledge of a horſe; but one of the moſt eſſential points of that knowledge, conſiſts in the age; the horſe being an animal, that remarkably ſhews the progreſs of his years, by correſpondent alterations in his body.

We have characteriſticks from his teeth, hoofs, coat, tail, and eyes.

The

The *firſt year* he has his foal's teeth, which are only grinders and gatherers: the *ſecond*, the four foremoſt change, and appear browner and bigger than the reſt: the *third*, he changes the teeth next to theſe; leaving no apparent foal's teeth, but two on each ſide above, and two below: the *fourth*, the teeth next to theſe are changed, and no foal's teeth are left, but one on each ſide, above and below: At *five years*, his foremoſt teeth are changed, and the tuſhes on each ſide are compleat: thoſe which come in the places of the laſt foal's teeth, being hollow, and having a little black ſpeck in the midſt; which is called, *the mark in a horſe's mouth*, and continues till eight years of age: at *ſix years*, he puts up new tuſhes; near which appears a little circle of young fleſh, at the bottom of the tuſh; the tuſhes withal being white, ſmall, ſhort, and ſharp: at *ſeven years*, the teeth are all in their growth, and the mark in the mouth appears very plain: at *eight* years, all his teeth are full, ſmooth, and plain, and the mark ſcarcely diſcernable; the tuſhes looking yellowiſh: at *nine years*, the foremoſt teeth ſhew longer, yellower, and fouler than before; and the tuſhes become bluntiſh: at *ten years*, no holes are felt on the inſide of the upper tuſhes; which till then are very ſenſible: add that the temples begin to be crooked and hollow: at *eleven years*, his teeth are very long, yellow, black, and foul; but he will cut even, and his teeth ſtand directly oppoſite to one another: at *twelve years*, the upper teeth hang over the lower: at *thirteen*, the tuſhes are worn cloſe to his chaps, if he has been much rode; otherwiſe they will be black, foul, and long.

As to the *hoof*; if it be ſmooth, moiſt, hollow, and well-ſounding, it is a ſign of youth: on the contrary, if rugged, and as it were ſeamed, one ſeam over another, and withal dry, foul, and ruſty, it is a mark of old age.

For the *tail*; taking him by the ſtern thereof, cloſe at the ſetting on to the buttock, and griping it between the finger and thumb; if the joint be felt to ſtick out more than the reſt, the bigneſs of a nut, the horſe is under ten; but if the joints be all plain be may be fifteen.

The *eyes* being round, full, and ſtaring; the pits that are over them filled, ſmooth, and even with his temples; and no wrinkles to be ſeen, either under or above, is a mark of youth.

The *ſkin* being plucked up in any part betwixt the finger and thumb, and let go again; if it returns ſuddenly to its place, and remains without wrinkles, he may be accounted young.

A dark coloured horſe, growing grizzly above the eye brows, or under the mane; or a whitiſh horſe growing mackled, either white or black, all over, may be infallibly concluded extremely aged.

Laſtly; a horſe being young, the bars of his mouth are ſoft and hollow; otherwiſe they are deep and feel hard, and rough.

The maſters in this art lay it down, that a horſe to be good and well made. muſt have three parts like thoſe of a woman, *viz.* the breaſt, which is to be broad, the hips round, and the mane long: three of a lion, *viz.* countenaace, intrepidity, and fire: three of a bullock, *viz.* the eye, noſtril, and joint: three of a ſheep, *viz.* the noſe, gentleneſs, and patience: three of a mule, ſtrength, conſtancy, and foot: three of a deer, head, leg, and hair ſhort: three of a wolf, throat, neck, and hearing: three of a fox, ear, tail, and trot: three of a ſerpent, memory, ſight, and turning: three of a hare or cat, running, walking, and ſuppleneſs

The ſkin and coat of the horſe, is the *hair*: the long hair on the neck, the *mane*: the fore-top, the *topping* or *tuke*: the hair behind, on the feet, the *fetlock* or *fetter*: that growing over the top of the hoof, the *coronet* or *cornet*: that on the eye-lids, the *brills*. The ridge whereon the mane grows, is called the *creſt* or *criſt*: the fore-part, from the neck to the fore legs, the *briſket* or *cheſt*: the mark frequently running down his face, the *rath*; and that in the forehead, the *ſtar*. The top of the ſhoulder, at the ſetting on of the neck, is called the *withers*: the place where the ſaddle is ſet, the *dock*; and a bruiſe or hurt thereon, a *navel gall*: the middle of the back, from the mane to the hips, the *reins*: the extremity of the reins above the hips, the *croupe*: the tail, the *dock* or *runt*: the hollow or ſinking of the back-bone, the *ſway*: the hind part of the belly, next the genital, the *flank*: that nearer the thighs, the *groin*: the looſe ſkin wherein the yard is, the *ſheath*; and the fore-part of the ſhoulders, next the breaſt, the *fillets*; the uppermoſt part of the hind leg, next the buttock, is called the *ſtiffle* or *ſtiffle joint*: the after-joint, or bending of the hind-leg, the *chambrel* or *elbow*: the inner, the *ham*, or *hough*: the joint at the fetlock, the *paſtern*, *ankle* or *fetlock joint*: the foot, above the hoof of the ankle joint, the *coronet*. The part from the withers to the top joint of the thigh, is called the *ſhoulder*: the middle joint of the fore leg, the *knee*: the right leg before, the *farther leg*; and the left, the *nearer*. The hoof is called the *horn*: the hollow of the hoof, the *coffin*: the tender part of the hoof, next the heel, the *fruſh*: the ball of the foot, the *frog*: the part to be pared, or cut off the hoof, when over-grown, the *rift*: the fore-part of the hoof, the *toes*: the hind-part, where there is a riſing in the middle of the ſole, the *heel*; and the inſide, meeting on the heel, the *quarters*.

The

The principal article of the art of *breeding horſes*, conſiſts in the choice of the *ſtallion* and *mare*; ſince on this depends chiefly the goodneſs of the breed.

It is the common opinion, that the beſt *ſtallion* is either an *Arabian* horſe, a *Spaniſh*, a *Turk*, or a *Barbary*, that is well ſhaped, and of a good colour.

The fitteſt *mare* to breed out of (according to the duke of *Newcaſtle*) is one that has been bred of an *Engliſh* mare, and a *ſtallion* of the above mentioned races; but if ſuch a *mare* is not to be got, choice muſt be made of a right bred *Engliſh* mare, by ſire and dam, that is well fore-handed, well underlaid, and ſtrong put together in general; and in particular, ſee that ſhe has a clean head, wide noſtrils, open chaul, a big weaſand, and the windpipe ſtrait and looſe; and chuſe her about five or ſix years old; taking care, likewiſe, that the *ſtallion* be not too old.

A *ſtallion* muſt be kept as high as poſſible, for four or five months, before the time of covering, with old clean oats, and ſplit beans well hulled; to which you may add, if you pleaſe, bread; and now and then, for change of diet, you may give him a handful of wheat or oats waſhed in ſtrong ale. Mr. *Morgan*, in his perfection of *horſemanſhip*, adviſes to mix bay-ſalt and anniſeed with his provender; which others think needleſs, while the horſe is in health; but he muſt have plenty of good old ſweet hay, well cleanſed from duſt; and good wheat ſtraw to lie on; watering him twice every day, at ſome fair running ſpring, or elſe a clear ſtanding pond-water, near ſome meadow or level piece of ground, where you may gallop him after he has drank. When you have brought him to the water, do not ſuffer him to drink his fill at firſt, but after his firſt draught, gallop and ſkip him up and down a little, to warm him; and then bring him to the water again, and let him drink as much as he pleaſes, after which gallop him as before, never leaving the water till you will find he will drink no more. By this means, new crudities are prevented, which the coldneſs of the water would produce to the detriment of the ſtomach, if he had been permitted to drink his fill at firſt; whereas, in allowing him his fill at laſt, thus by degrees, his body is kept from drying too faſt.

When the *ſtallion* is in his luſt, and the time for covering is come, which is beſt in *May*, that the foals may fall in *April* following (otherwiſe they will have little or no graſs, if they ſhould be put together, according to *Markham*'s opinion, in *March*, though he holds that a foal falling in *March*, is worth two falling in *May*, 'becauſe, ſays he, 'he poſſeſſes, as it were, two winters in a year, and 'is thereby ſo hardened, that nothing afterwards 'can almoſt impair him.') The time, ſays I, being come to put your *ſtallion* and *mares* together, you muſt pull off his hind ſhoes, and lead him to the place where the ſtudd of the *mares* is, which you intend for covering. You ought not to give him above ten or twelve *mares* in a ſeaſon, to the utmoſt; otherwiſe you will ſcarce recover him againſt the next year covering-time.

When your *ſtallion* is paſt this uſe, then buy another; never making uſe of a horſe of your own breed, otherwiſe the beſt kind would in time degenerate; but you cannot do better, ſays the duke of *Newcaſtle*, than to let your own *mares* be cover'd by their ſire; and by this means they are nearer, one degree, to the purity and head of the fountain, from which they are derived, ſince a fine horſe got them, and the ſame fine horſe covers them again.

The method of covering in hand is moſt approved, and which is this:—When they have brought both their *horſe* and *mare* by art and good feeding, to a proper condition for breed, they ſet ſome ordinary ſtoned nag by her, for a day or two to woo her, and by that ſhe will be ſo proned to luſt, that ſhe will readily receive their *ſtallion*; which they preſent to her, either early in the morning, or late in an evening, for a day or two together, and let him cover in hand once or twice, if they think proper, at each time, obſerving always to give the horſe the advantage of ground, having ſomebody ready with a bucket of cold water, to throw on the mare's ſhape, immediately on the diſmounting of the horſe, which will make her retain better the ſeed received; for which purpoſe, they get on her back and trot her for about a quarter of an hour, avoiding, at the ſame time, from heating or ſtraining her; and taking care, after every act, to let them faſt two hours, and then giving each of them a warm maſh.

As to the manner of keeping the *mares*, during the time of their being with foal, and at their foaling, you muſt take care to houſe them all the winter, and to keep them well, their colts will prove the better. When they are foaled, let them run with their dams till *Martinmaſs*, then wean them, and keep them in a convenient houſe, with a low rack, and manger on purpoſe: litter them well, and feed them with good hay, and oats and wheaten-bran mixed, which will make them drink and belly well. The firſt year, you may put them all together, but afterwards they muſt be ſeparated, the ſtone-colts from the fillies; and if you have choice of horſes, you may put yearings together, two years old.

In a warm fair day, you may grant them liberty to run and ſkip, in ſome incloſed court or backſide, taking care to put them up again carefully, that

that they be not hurt. When summer is come, and there is plenty of grass, put them out in some dry ground, that has convenient watering, and so let them run till *Martinmass* again: then house them as before, and order them in all points as older horses, till they are full five years old; then take them up for good, and let your groom back them, if he has skill, or else some skilful rider. You may, if you please, break your fillies, at two years and a half old, and let them be cover'd at three; and by that means they will be so tame and gentle, as not to injure themselves, or their foals. But in case of sickness, or any other accident, as lameness, &c. you must then commit them to the Farrier's care.

The reason why it is proposed to house them every winter, with dry feeding and lodging, is, that they may be the more like their sire in beauty and shape. For the primary cause of the fineness of the shape and beauty in horses, is heat, and dry feeding. And this is proved from the several races already mentioned, *viz.* the *Spanish*, *Barb*, and *Turkish* horse, all which countries are under a hot climate, and by consequence afford little grass: therefore in our more moderate and cold countries, we are to assist nature by art, and to supply the want of heat by warm housing, and dry feeding.

A stone-horse is seldom kept entire, but to serve for a stallion. He is most commonly gelt, when designed for any other use.

In *gelding* of horses, regard must be had to their age, the season of the year, and the state of the moon.—For the first, if it be a colt, the operation may be performed at nine or fifteen days old, if the testicle be come down; in regard the sooner he is gelt, the better it will be for his growth, shape, and courage; though the horse may be gelt at any age if care be taken in the cure. As for the second, the best time is about *April* or *May*; or else about the latter end of *September*. For the third, the wane of the moon is the fittest time.

The manner of *gelding* is thus: the beast being cast on some soft place, the operator takes the testicles between his fore and great finger, slits the cod, and presses out the stones; then with a pair of nippers, made very smooth, either of steel, box, or brasil, claps the string of the stones between them, very near to where the stones are set on; and presses them so hard, that there may be no flux of the blood; then sears away the stone with a thin, drawing cauterizing iron, made red-hot.

This done, he takes a hard plaister, made of wax, rosin, and wash turpentine melted together, and melts it on the head of the strings with the hot iron; and afterwards sears the strings, and melts more of the salve, till there is a good thickness of it laid on the strings.

This being done to one stone, the nippers are loosened, and the like is done to the other; and the two slits of the cod filled with white salt; and the outside of the cod anointed with hog's grease; and thus they let him rise, and keep him in a warm stable, without tying him up.

If he swells much in his cod, or sheath, they chase him up and down, and make him trot an hour in a day, and he soon recovers.

A *hunter* should have a lean, large, and long head; a thin and open chawl; small and pricked ears, or if they be somewhat long, provided they stand upright, like those of a fox, it is usually a sign of mettle and toughness; a long and broad forehead, not flat, and as we term it, mare-face, but rising in the midst like that of a hare, the feather being placed above the top of his eye, the contrary being thought by some to be a token of blindness. His eyes ought to be full, large, and bright; his nostrils wide and red within, for an open nostril betokens a good wind; his mouth large, deep in the wykes and hairy; his thropple, weasand, or wind-pipe big, loose, and strait, when he is rein'd in by the bridle; for if when he bridles, it bends in like a bow (which is called cock thropple) it very much hinders the passage of his wind. His head must be set on to his neck, that there may be a space felt between his neck and his chawl; for to be bull-necked is uncomely to sight, and prejudicial to the horse's wind. His crest should be firm, thin, and well rais'd; his neck long, and strait, yet not loose and pliant, which the northern men term withy-cragged; his breast strong and broad, his chest deep, his chine short, his body large, and close shut up to the huckle-bone; his ribs round like a barrel, his belly being hid within them; his fillets large, his buttocks rather oval than broad, being well let down to the gascoins; his chambrels upright, and not bending, which is called by some feckle-houghed, though some hold it a sign of toughness and speed. His legs clean, flat, and strait; his joints short, well knit and upright, especially betwixt the pasterns and the hoofs, having but little hairs on his fetlocks; his hoofs black, strong, and hollow, and rather long and narrow, than big and flat. And lastly, his main and tail should be long and thin, rather than thick, which is counted by some a mark of dulness.

As to the colour and marks, some are rather inclined to believe them grateful to the eye, than an infallible sign of goodness. Yet one may for ornament sake, and to please one's eye, make choice of a horse that is either a brown bay, dapple bay, black, sad-chesnut, with flaxen mane and tail, so that they have either a white star, blaze, or snip, with a white foot; dapple grey, or white lyard with

with black muzzle, eye, and ear. Any of theſe are reputed by moſt men, to give a grace to ſhape, though in themſelves they are no perfect ſigns of goodneſs,

No doubt but the internal qualities of a horſe, are preferable to all the external ones. Thoſe internal qualities are, his being of a gentle diſpoſition to his keeper, tractable and docile, free from thoſe ill qualities of biting, ſtriking, reſtiffneſs, lying down in the water, ſtarting, running away with his rider, plunging, leaping, *&c.* Not but that moſt, if not all theſe ill habits may be rectified by art.

Therefore ſince art was invented to perfect nature, if, notwithſtanding your care, you have a horſe ſubject to any bad qualities, you muſt ſearch into the cauſes of it, which art will help you to recover and remove; and then the cauſe being taken away, the effect will ceaſe.

It is proper your horſe ſhould be five years old, and well weighed before you begin to hunt him; for though it be a general cuſtom, even among the moſt noted horſemen, to train their horſes up to hunting at four years old, and ſome ſooner; yet at that age, his joints not being full knit, nor he arrived at his full ſtrength and courage, he is diſabled from performing any matter of ſpeed and toughneſs; and indeed being put to ſore labour and toil ſo young, he runs a very great hazard of ſtrains, and the putting out of ſplents, ſpavins, curbs, and windgalls, beſides the daunting of his ſpirit, and abating his natural courage; inſomuch that he will grow melancholy, ſtiff, and rheumatick, and have all the diſtempers of old age, when it might be expected he ſhould be in his prime.

Your horſe then being full five, you may, if you pleaſe, put him to graſs, from the middle of *May* to *Bartholomew-tide*, or at leaſt from the middle of ſummer to that time. Take care to provide a good ſtable for his reception, at his taking up; and a good groom to look after him.

The *ſtable* muſt be ſituated, if poſſible, in a very good air, and upon hard, dry, and firm ground, that, in winter, the horſe may go out, and come in clean. It ſhould alſo be ſeated on an aſcent, that the urine, foul water, or any wet, may run thro' trenches, or ſinks cut for that purpoſe. No hen-houſes, hog-ſties, houſes of eaſe, or any other filthy ſmell, is to be ſuffered near it; for hen-dung or feathers ſwallowed, often prove mortal, and the bad air of a jakes is as often the cauſe of blindneſs. Likewiſe the very ſmell of ſwine will frequently breed the farcy; and no animal delights more in cleanlineſs, or is more offended at unwholſome ſavours, than the horſe. The floor (meaning that part on which the horſe is to ſtand or lie down) is to be made of oaken planks not pitched, being eaſier and warmer for him to lie on boards than on ſtones; laying thoſe planks level, for if they were laid higher before than behind, his hind legs would ſwell, and he could never lie at eaſe, his hind parts ſtill ſlipping down. The planks are alſo to be laid croſs-ways, and not at length, and underneath them a trench is to be ſunk, which receiving the urine through the holes bored on purpoſe in the planks, may convey it into ſome common receptacle. The ground behind him ought to be raiſed even with the planks, that he may continually ſtand on a level; the floor behind him well paved with pebble, and that part of the ſtable where the rack ſtands well wainſcotted.

If the ſtable is to contain ſeveral horſes, it muſt be divided into as many ſtands or ſtalls as it will contain horſes, raiſing each partition, which is to be of boards to that height towards the manger, that one horſe may not moleſt the other, and leaving to each horſe room enough to turn about in, and lie down at pleaſure.

The ſtable ſhould likewiſe have preſſes with pegs in them to hang up ſaddles, bridles, houſing-cloaths, *&c.* and alſo ſhelves to place curry-combs, bruſhes, duſting-cloaths, ointments, waters, or any other neceſſaries.

The ſtable muſt have a cieling, that no duſt from above fall upon your horſes: it muſt likewiſe be fitted with a dung-yard, pump, and a conduit, and have, if poſſible, a pond, or running river near at hand. Never leaving the front of the ſtable without litter, that by frequent practice the horſes may learn to empty their bladder when they come from airing.

A *groom* ſhould have the following good qualities:—Firſt, he muſt love his horſes, and endeavour, by good uſage, to make himſelf loved and obeyed by them. He muſt beſides be patient, for nothing is more tractable than a horſe, if uſed kindly. He muſt keep his ſtable clean and in order, and alſo his ſaddles, houſing-cloaths, ſtirrups, leathers, and girts; but above all, his horſes, by dreſſing and rubbing them often. Diligence is abſolutely requiſite in the diſcharge of his duty, and he muſt obſerve even the ſmalleſt alteration, either in his horſe's countenance, as ſymptoms of ſickneſs, or in his limbs and gait, as lameneſs; or in his appetite, as forſaking his meat, and immediately upon any ſuch diſcovery to ſeek out for remedy.

The firſt buſineſs of the groom, after the hunter is ſtabled, is in the morning to water him, and then rub over his body with a hard whiſp a little moiſtened, and afterwards with a woollen cloth; then to clean his ſheath with his wet hand from all the duſt it had contracted during his running, and to waſh

his

his ... with water, then he may trim him according to the manner other horses are trimmed, except the inside of his ears, which ought not to be meddled with, for fear of making him catch cold.

This done, he must send for the farrier, who is to get him a set of shoes fitted to the shape of his feet, without paring, leaving it well open between the quarter and the thrush, to prevent hoof-bindt ing, taking care that the opening be strait and no-side-ways, for by that means in two or three shoeings his heels, in which consists the strength of his feet, will be cut quite away. His foot must be pared as hollow as possible, to hinder the shoe from pressing upon it. The shoes must come near the heel, yet not be set so close as to bruise it, nor yet so open as to catch in his shoe, if at any time he happens to over-reach, and so hazard the pulling them off, the breaking of the hoof, or the bruising of the heel. The webs of his shoes must be neither too broad nor too narrow, but of a middle size, about the breadth of an inch, with sloped spunges, and even with his foot; for tho' it would be for the advantage of the travelling horse's heel, to have the shoe a little wider than the hoof on both sides, that the shoe might bear his weight, and not his foot touch the ground; yet the *hunter* being often forced to gallop on rotten spungy earth, to have them large would hazard laming, and pulling off his shoes.

The farrier must take a particular care that he pricks not the horse, but leave a space at the heel of the fore-feet, and a space between the nails at the toe. When the shoe is set according to this direction, you'll find a great deal of his hoof left to be cut off at his toe. When that is cut off, and his feet smoothen'd with a file, he will stand so firm, and his feet will be so strong, that he'll tread as boldly on stones as on carpet-ground.

There are several sorts of *horse-shoes*, as the *planch shoe*, which is said to make a good foot and a bad leg; as causing the foot to grow beyond the measure of the leg. It is chose for a weak heel, and will last longer than any other shoe, being borrowed from the moil, which has weak heels, and frushes to keep the feet from stones and gravel.

Shoes with calkings, which, though intended to secure the horse from sliding, yet are reputed by many to do him more harm than good, in that he cannot tread evenly upon the ground, whereby many times he wrenches his foot, or strains some sinew, especially upon stony ways, where stones will not suffer the calkins to enter. *Double calkins* are less hurtful, as he treads evener with them than on the single calkins; but then they must not be over-long or sharp-pointed, but rather short and flat.

Shoes with rings, first invented to make the horse lift his feet up high; though such shoes are more painful than helpful, besides the unhandsomeness of the sight. This defect is most incident to horses that have not sound hoofs; for tender feet fear to touch the ground that is hard: but what is intended for remedy proves a prejudice to the horse, by adding high calkins or rings to his *shoes*, as by that means his heels are made weaker than before.

Shoes with swelling welts, or *borders* round about them, are used in *Germany*, &c. which being higher than the heads of the nails, save them from wearing.—These are the best sort of lasting shoes, if made of well-temper'd stuff, as they wear equally in all parts, and the horse treads evenly upon them. —Others who use to pass mountains, and places where smiths are not so easily met with, carry shoes about them, with vices, whereby they fasten them to the horse's hoofs, without the help of the hammer or nail; yet this is more for shew than service; for though such shoe may save a horse's feet from stones, yet it so pinches his hoof, that he goes with pain, and perhaps injures it more than the stones do. — On such emergent occasions, therefore, it were better to make use of the *Joint shoe*, which is made of two pieces, with a flat rivet nail joining them together in the toe, so that it may be taken both wide, or narrow, to serve any foot.

Panton, or *pantable shoe*, which opens the heels, and helps hoof binding.—To which may be added the *half panton shoe*.

Patten shoe, is used for a horse that is burnt in the hip, stifle, or shoulder, as it causes him to bear upon that leg the grief is on, and consequently makes him use it the better.

When the horse has evacuated all his grass, and his shoes are so well settled to his feet, that he may be fit to be rid abroad without danger of surbating, you must visit him early in the morning, that is to say, by five a clock in summer, and six in winter; and having put up his litter under his stall, and cleansed the stable, the next thing to be done is to feel his ribs, his chaul, and his flank, whereby the good or bad state of his body is discernible. If by laying your hands on the lower part of his short ribs, near the flank, you feel his fat to be exceeding soft and tender, and to yield, as it were, under your hand, you may be sure that it is not sound, and that the least violent labour or travel will dissolve it; and when dissolved, before it be hardened by good diet, if it be not then removed by scouring, the fat or grease belonging to the outward parts of the body will fall down into his heels, and so cause goutiness and swelling; which distempers are both to be prevented and cured. For, if by feeling his ribs you have found his fat ſoft, you muſt likewiſe feel his chaul, and if you find any fleſhy ſubſtance, or big round kernels, or knots, you may be ſure that as his outward fat is not ſound, ſo inwardly he is full of glut, and purſive, occaſioned by groſs and tough humours cleaving to the concavities of the lungs, and ſtopping his wind-pipe in ſuch a manner, that his wind cannot find a free paſſage, nor his body be capable of much labour. Theſe diſtempers are remedied by feeding him with wholſome food to harden his fat, by moderate exerciſe, warm cloathing, and gentle phyſick, to cleanſe away his inward glut, that his wind and other parts being freed from all groſs humours, his courage, and activity may be thereby heightened.

Till your horſe be thoroughly purged, his flank will likewiſe feel thick to your gripe; otherwiſe it feels but like two thin ſkins.

Theſe remarks made, the groom muſt ſift his horſe a handful or two of good old oats. When he has eaten them, he muſt pull off his collar, and rub his head, face, ears, and nape of the neck with a clean rubbing cloth, which helps towards diſperſing all the humours which often gather in thoſe parts: then waſhing a ſmall ſnaffle in fair water, he will put it on his head, drawing the reins through the headſtall, to prevent ſlipping it over his head. Then taking in his right-hand a curry-comb, ſuitable to the ſkin of his horſe; (*i. e.* if the coat of his horſe be ſhort and ſmooth, the curry-comb muſt be blunt; but if long and rough, then its teeth muſt be long and ſharp) he ſtands with his face oppoſite to the horſe's face, and holding the left cheek of his head-ſtall in his left-hand, curries him hard, from the root of his ears, all along his neck to his ſhoulders: then goes over all his body with a more moderate hand, currying his buttocks down to the lower cambrel, with a hard hand again: then changing hand, and laying his right-arm over his back, he joins his right ſide to the left of the horſe, and curries him gently from the top of his withers to the lower part of his ſhoulder, every now and then fetching his ſtroke over the left ſide of his breaſt, and ſo currying him down to the knee, but no further; then he curries him all under his belly near his fore-bowels; and, in a word, very well over, except his legs under the knees, and his cambrels.

If your horſe, while you are currying him, keeps wriggling up and down, biting the rack-ſtaffs, and now and then offering to ſnap at you, or lifting up his leg to ſtrike you, it is a ſign that he is not pleaſed, either by reaſon of the ſharpneſs of the comb, the teeth whereof muſt on that occaſion be blunted; or through wantonneſs, and the pleaſure he takes in the friction; then he muſt be gently corrected with the whip.

As this currying is only to raiſe the duſt, when it is over, the groom muſt take either a horſe's tail, or a clean duſting-cloth, and with it ſtrike off the looſe duſt raiſed by his comb: then dreſs him all over with the *French* bruſh, both head, body, and legs, to the very fetlocks, obſerving ways to clean the bruſh from the filth it gathers from the bottom of the hair, by the rubbing it on the curry-comb; and duſting the horſe a ſecond time. Which done, he dips his hand in water, and with it rubs his horſe's body all over, leaving if poſſible no looſe hair behind him; and with the ſame wet hand picking and cleaning his eyes, ears, noſtrils, ſheath, cods, and tuel; rubbing thus till he be as dry as he was at firſt; then he rubs his body all over with a hair-patch, but eſpecially his fore bowels under his belly, his flank, and between his hind thighs; and laſtly, wiping him over with a fine white linen rubber.

When he has thus dreſſed him, he takes a large ſaddle-cloth, that may reach down to the ſpurring-place, and laps it about his body, then claps on his ſaddle, and throws a cloth over him for fear of his catching cold. Which done, he rubs and chafes his legs from the knees and cambrels downwards to the ground, with two ropes of ſtraw twiſted hard together, picking his fetlock-joints from duſt, filth, and ſcabs; rubbing and dreſſing his legs afterwards with another hair-patch.

This done, his feet muſt be picked clean with an iron picker, to hinder them from taking up ſtones, and his mane and tail combed down with a wet mane-comb; and having ſpirted ſome beer or wine into his mouth, and brought him out of the ſtable, the groom ſhould mount him, in order to take or walk him to ſome running river, or freſh clear ſpring, a mile or two diſtant from the ſtable, where he is ſuffered to drink half his draught at firſt, bringing him afterwards calmly out of the water, and riding him gently for awhile; for thruſting him then into a ſwift gallop, not only hazards the breaking of his wind, but endangers the uncording or burſting him, begets in him an ill habit of running away as ſoon as he has done drinking; and the foreſight he has of ſuch violent exerciſe, makes him often refuſe to quench his thirſt. When he has walked gently a little way, he may be put into a gentle gallop, for five or ſix ſcore, then take wind. And after he has been raked a pretty ſpace, the rider ſhews him the water again, and lets him drink as much as he pleaſes, and then gallops him again; proceeding thus

thus till he will drink no more, avoiding above all things, to gallop him so much as either to chafe or sweat him.

In galloping your horse after water, it is not improper to give him sometimes a watering course sharply, or twelve or twenty score, for then it will quicken his spirits, cause him to gallop more pleasantly, teach him to manage his limbs, and stretch forth his body more largely.

When your horse has done drinking, air him a foot-pace an hour, so long as you'll think sufficient for the state of his body, and afterwards ride him home.

Airing brings several advantages to the horse; first, it purifies the blood, purges the body from many gross and suffocating humours, and so hardens and enseams the horse's fat, that it is not so liable to be dissolved by ordinary exercise. Secondly, it teaches him how to let his wind rake equally, and keep time with the other actions, or motions of his body. Thirdly, it sharpens the appetite, and provokes the stomach; which is of great advantage both to hunters and gallopers, which are apt to lose their stomach through excess or want of exercise: For the sharpness of the air will drive the horse's natural heat, from the exterior to the interior parts, which heat, by helping the digestion creates an appetite. Lastly, it encreases lust and courage in him, provided he be not too early aired; though Mr. *Markham*'s directions are different on this article; for he will have a horse aired before sun rising, and after sun-setting; and the gentleman's jockey says, that nothing is wholsomer than early and late airing, but experience proves the contrary; for in this art all things that any ways weaken nature, or hinder it from growing strong and courageous, are to be avoided; such as cold, which is always greater early in the morning, and in the evening, than it is in the other parts of the day; which is evidently apparent in horses that run abroad all the winter, which however hardy bred, and kept with the best care and food, yet cannot by any means be advanced to so good case in winter, as an indifferent pasture will raise them to in summer. And this holding true of the nocturnal cold, must needs be verified in some measure of the morning and evening dew. Besides, that the dews, and moist rimes, do as much injury to a horse, as the sharpest colds or frosts; since a horse any ways inclinable to catarrhs, rheums, or any other cold distempers, is apt to have the humours augmented, and the disease must sensibly increase by the early and late airings. But if he be not brought forth to air, till the sun be risen, his spirits will be cheared up and comforted. Horses, besides naturally desiring to enjoy the sun's warmth, as well as almost all other creatures. Besides the benefit of the sun, the air is so mild and temperate, that it rather invigorates than preys upon his spirits; and rather increases his strength, than impairs it.

During the time of your horse's airing, you will easily perceive several marks of his satisfaction, and the pleasure he takes in this exercise: For he will gape, yawn, and as it were shrug his body. If he offers to stand still to dung or startle, which his airing will provoke, you must give him leave, as likewise to stare about, neigh, or listen to any noise.

When the groom is returned from airing, and dismounted, he must lead his horse on the straw, which should always lie before the stable-door; and there, by whistling, and stirring up the litter under his belly, will provoke him to stale, which a little practice will bring him to, and is advantageous for the horse's health, and the keeping the stable clean; then leading him into his stall (which should likewise be well littered) and having tied up his head to the empty rack, he takes off his saddle, rubs his body all over with the *French* brush, then with the hair-patch, and lastly with the woollen cloth. This done, he cloaths him with a linen cloth next to his body, and over that a canvass cloth, both made so fit as to cover his breast, and to come pretty low down to his legs; which is the *Turkish* way of cloathing. Over these he must put a body cloth, of six or eight straps, which is better than a sircingle, and pad stuffed with wisps, to keep his belly in shape.

Both the temperature of the climate, and the state of the body, are to be considered in the cloathing of a horse; and that all horses are not to be cloathed alike; for the *Barb*, *Turkish*, *Spanish*, &c. required more cloathing than the *English* common horses, that are bred in a colder climate, and have naturally thicker skins and a longer coat. But however, take this for a general rule, that a rough coat shews want of cloaths, and a smooth one cloathing sufficient; observing, that if by the countenance of your horse, his dung, and other outward marks, he is known to be in health, notwithstanding which his coat stares still, you must add still more till it lies flat; as on the other hand, if it will lie with the assistance of a single linen cloth, he wants no other. But if after your horse has been in keeping some time, you find him apt to sweat in the night, it is a sign that he is over fed and wants exercise: And if he sweats at his first coming from grass, the cloathing allotted at his first housing must rather be increased than diminished; for that sweating proceeds from the foul humours which oppreſs nature; and when by exerciſe they are evacuated, nature will ceaſe working, and he will continue in a temperate ſtate of body all the year after.

The horſe cloathed, his feet muſt be picked with the iron picker, and his hoofs waſhed clean, with a ſpunge dipped in fair water,-and then dried with ſtraw, or a linen cloth, waſhing, likewiſe, his legs, if dirty, provided they be rubbed dry afterwards. Then the horſe is left on his ſnaffle for an hour or more, to ſharpen his appetite. The hour expired, the groom returns to the ſtable, and taking a handful of hay, let his horſe taſte it out of his hand, till he has eaten it; then he pulls off his bridle, and having rubbed his head and neck clean with a cloth as before, he pulls his ears, and ſtops his noſtrils, to make him ſnore, which will help to bring away the moiſt humours which oppreſs his brain; and then put on his collar, and give him a quartern of oats well ſifted. While he is eating his corn, his cloaths muſt be turned up, his fillets, buttocks, and gaſcoins rubbed over with the hair-patch; and after that with a woollen cloth: Then a clean flannel fillet-cloth i ſpread over his fillets and buttocks, to make his coat lie ſmooth, and his houſing-cloth turn'd down upon it; anointing his hoofs round, from the cornet to the toe, with an ointment made for the purpoſe, picking his feet with an iron picker, and covering them with cow-dung; by which time (if he be not a very ſlow feeder) he will have eaten his oats, which if he does with a good appetite, he muſt have another quart; feeding him thus by little and little, whilſt he eats with an appetite; but if he fumbles with his corn, he muſt have no more.

This done, a ſufficient quantity of hay, well duſted, muſt be thrown down to him on his litter, and then ſhutting up the windows and ſtable-door, he is left till one o'clock in the afternoon, at which time the groom returns to him, and having rubbed over his head, neck, fillets, buttocks, and legs, as before, with the hair-patch, and woollen cloth, he'll feed him as before, leaving him afterwards till the time of his evening watering, which ſhould be about three in the winter, and four in the ſummer; when he'll come to him, dreſs and ſaddle him as before, and having mounted him, ſhall take him to the water, and after drinking, and galloping, ſhall air him along by the river ſide, till he thinks it time to go home; then order him in all points, as to rubbing, feeding, ſtopping his feet, *&c.* as he did in the morning; and having fed him at ſix, he muſt feed him again about nine; littering him then well, and throwing him hay enough to ſerve him all night, and leaving him till the next morning.

This exerciſe of a groom muſt be repeated every day, and in the very ſame manner: Though as to that of feeding him, he muſt ſharpen his ſtomach by change of meat; giving him one meal clean oats; another oats and ſplit beans; and when he has brought him to eat bread, he may give another meal of bread, always obſerving to give him oftneſt what he likes beſt. Some horſes are of ſo hot a conſtitution, that without they may drink at every bit, they cannot eat, and thoſe horſes uſually carry no belly; in this caſe, a pale of water muſt ſtand continually before them, or at leaſt, water muſt be offered them at noon, beſides what they fetch abroad at their ordinary time. The habit of the body of a horſe, is alſo diſcovered by his digeſtion; whether he retains his food long, which is the ſign of a bad digeſtion; or whether nature expels the dung oftener, which if it does, and his dung be looſe and bright, it is a ſign of a good habit of body; but if he dungs hard and ſeldom, it is, on the contrary, a ſign of a dry body; and therefore, to remedy this a handful or two of oats, well waſhed in ale, ought to be given him once a day, whereby his body will be looſen'd and kept moiſt, ſerving likewiſe to expel winds.

During this fortnight's keeping, you are to make ſeveral obſervations, as to the nature and diſpoſitions of your horſe, temper of his body, *&c.* and order him accordingly. 1. If he be of a churliſh diſpoſition, you muſt reclaim him by ſeverity: if of a loving temper, win him by kindneſs. 2. You muſt obſerve whether he be a foul feeder, or of a nice ſtomach; if he be quick at his meat, and retain a good ſtomach, then four times of full feeding in the ſpace of a day and night, is ſufficient; but if he be a ſlender feeder, and ſlow at his meat, then you muſt give but little at once, and often, as about every two hours; for freſh meat will draw on his appetite; leaving always a little meat in his locker, for him to eat at his own leiſure, and when you find any left, you muſt ſweep it away, give him freſh, and expoſe that to the ſun and air, which will prevent its growing muſty, and reſtore it to its former ſweetneſs.

By that time the firſt fortnight is expir'd, the *hunter* will be in a pretty good ſtate of body, and fit for a moderate *hunting match*; but how to proceed in this exerciſe, meets with ſome difficulties; for ſome would have a horſe which is deſigned either for a *buck-hunter* or *fox-hunter*, uſed from the beginning to the chace they are deſigned for. Others think thoſe chaces too violent for a young horſe, and therefore chuſe to train him for harriers; which laſt opinion, ſeems to be founded on experience; and which may be confirmed by taking a ſlight

ſlight view of the ſeveral chaces the moſt in vogue here in *England*, viz. the *ſtag*, *buck*, *hind*, *fox*, *otter*, and *hare*.

There is very little difference in the three fore-mentioned chaces, and the inconveniences of each of them are, in a manner, the ſame; for they are all, either in covert, or at force. Now if *deer* be hunted in a park, they uſually chuſe the moſt woody part of it, as a refuge from the purſuit of their enemies, which is both unpleaſant to the rider, and troubleſome to the horſe to follow the dogs through the thick buſhes; and beſides, the ground in parks is uſually full of mole-banks, trenches, &c. which is dangerous for a young horſe to gallop on, till he has attained to ſome perfection in his ſtroke. But if they be turned out of the park, and be hunted at force, you'll find that as ſoon as you have unharboured, or rouzed them, they will immediately make out endways, before the hounds, five or ſix, nay ſometimes ten miles, they following in full cry ſo ſwiftly, that a horſe muſt be compelled to run up and down hill without any intermiſſion; leaping hedge, ditch, and dale, nay often croſſing rivers, to the great danger of the rider, as well as of the horſe. So that it is altogether improper to put a young horſe to ſuch violent labour at firſt, till by practice and degrees he has been made acquainted with hard ſervice. Beſides the ſwiftneſs and violence of this chace, the danger of cracking his wind, and burſting his belly, of ſtraining his limbs, and of creating in a young horſe a loathſomeneſs to his labour; the ſeaſon for theſe chaces beginning about *Midſummer*, and ending about *Holy Rood-Tide*, during which the heat of the ſun is exceſſive, and ſo ſcorches the earth, a violent chace would hazard the melting his greaſe; and the weight of the rider, by reaſon of the hardneſs of the ground, would occaſion foundering, ſplints, and wind-galls, inſomuch that in a ſhort time, the horſe would prove altogether uſeleſs.

However there is not the ſame danger for all ſorts of horſes, without diſtinction, but none ſhould be employed in this chace but thoſe of ſtayed years, which by long practice and experience, have been trained to hunting. Young horſes (as the Duke of *Newcaſtle* obſerves) being as ſubject to diſeaſes, as young children, and therefore he adviſes any man who would buy a horſe for his uſe, either for a journey, hawking, and hunting, never to buy him, till the mark be out of his mouth; for if he be found of wind, limb, and ſight, he will laſt eight or nine years with good keeping, and never fails his rider. An old nag, in his Grace's opinion, of ſome huntſman, or falconer, that is found, is the beſt; for he gallops on all grounds, leaps over hedges and ditches, and never fails his rider in a journey, nor any where elſe.

Fox-hunting is not at all proper for the training of a young horſe, ſince it is ſwift without reſpite, and of long continuance, both which are diſtaſteful to him. When a fox is unkennelled, he ſeldom or never betakes himſelf to a champaign country, but remains in the ſtrongeſt coverts, and in the thickeſt woods; ſo that a horſe can but ſeldom enjoy the pleaſure of accompanying the hounds, without hazarding being ſtubbed, or other accidents equally dangerous. The fitteſt horſes for this chaſe, are horſes of ſtrength and hability; ſince it begins at *Chriſtmas*, which is the worſt time for riding, and ends at *Lady-Day*, when the ground is fitteſt for it.

Neither is the chace of the *Otters* convenient for a horſe; for he that will truly purſue this *amphibious ſport*, muſt often ſwim his horſe, which cannot be done without running ſome danger.

The chace of the *Hare* is not ſo contrary to the training of young horſes; becauſe hares, commonly running the champaign country, and their ſcent being not ſo hot as that of the *Foxes*, the dogs are oftener at default, the horſe has by that means many ſobs, whereby he recovers wind, and regains new ſtrength.

The beſt dogs to bring your horſe to perfection of wind and ſpeed, are the fleet northern hounds; for they, by means of their hard running, will draw him up to that extraordinary ſpeed, that he will not have time to loiter; and by continual practice will be ſo inured, and uſed to the violence of their ſpeed, that, in a ſhort time, he will be able to ride on all ſorts of ground, and be of ſuch command upon the hand, that he will ſtrike at what rate you pleaſe, and three quarters ſpeed will be leſs troubleſome to him, than a *Canterbury* gallop.

The day being fixed for your horſe's firſt going abroad after the dogs; the preceding day he muſt be ordered after this manner. In the morning proceed in your uſual manner, as to dreſſing, feeding, watering, &c. only abſtaining that day from giving him beans, becauſe they are hard of digeſtion, inſtead of which you'll give him moſt bread, if he can eat it, becauſe more nouriſhing than oats; and after the evening watering, which ought to be ſomewhat earlier than at other times, give him only a little hay out of your hand, and no more till the next day, at his return from hunting; and to prevent his eating his litter, or any thing elſe, but what you give him, you muſt, inſtead of a muzzle,

muzzle, put on a caverone, join'd to a head-ſtall of a bridle, being lined with double leather for fear of hurting him, and tying it ſo ſtrait as to hinder his eating; and this will prevent ſickneſs in your horſe, incident to ſome horſes, when their muzzle is ſet on, notwithſtanding the invention of the lattice window, at preſent ſo much in uſe: but this way your horſe's noſtrils are at full liberty, and he will never prove ſick. But as to his corn, give him his meals, both after his watering, and at nine o'clock; at which time he ought to be littered very well, that he may the better take his reſt, and leave him for that time.

About four o'clock the next morning, he muſt have a quarter of a peck of clean oats, mixed with a quart of ſtrong ale, and while he is eating it, his litter and dung muſt be put back, and the ſtable cleanſed. When he has done eating, he muſt be bridled and dreſſed; when dreſſed, ſaddle him, throwing afterwards his cloaths over him, and letting him ſtand till the hounds be ready to go forth, forbearing the drawing the ſaddle girt ſtrait, till you are ready to mount, leſt otherwiſe he ſhould grow ſick. But generally old horſes are ſo crafty, that when an ignorant groom goes to gird them up hard, they will ſtretch out their body to ſuch a bigneſs, by holding up their wind (on purpoſe to gain eaſe after they are girt) that it will appear difficult to girt them; but afterwards they let go their wind, and their body falls again.

When the hounds are unkennelled (which ought not to be till ſun riſing) you muſt go up and down the field along with them, and rake your horſe up and down gently till a hare be ſtarted, always obſerving to let him ſmell at other horſes dung (if he wants to do it) which will provoke him to empty himſelf, and let him ſtand ſtill while he does it. And if you meet with any dead frog, ruſhes, or the like, ride him upon them, and by whiſtling provoke him to empty his bladder.

When the hare is ſtarted, you are to follow the hounds as the other hunters do, only obſerving that this being the firſt time of your horſe's hunting, he is not ſo well acquainted with the different ſorts of ground, as to know how to gallop ſmoothly and with eaſe on them: Therefore you are not to put him as yet to above half his ſpeed, that he may learn to carry a ſtaid body, and to manage his legs both as to fallow, and greenſod; neither are you to gallop him often, nor any long time together, for fear of diſcouraging him, and breeding in him a diſlike to the ſport; but obſerving to croſs the field ſtill to your beſt advantage, you ſhall make into the hounds at every default, and ſtill keep your horſe as much as poſſible within the cry of the dogs, that he may be uſed to it, and you'll find that in a very ſhort time he'll take ſuch delight and pleaſure in it as to be eager to follow them. If at any time the chace be led over a carpet-ground, or ſandy highway, on which your horſe may lay out his body ſmoothly, you may there gallop him for a quarter or half a mile, to teach him to lay out his body and to gather up his legs, to enlargen and ſhorten his ſtroke, according to the different earths he gallops on, as if on a green, ſwarth, meadow, moor, heath, *&c.* then to ſtoop and run more on the ſhoulders: if among mole-hills, or over high ridges and furrows, then to gallop more roundly, and in leſs compaſs, or according to the vulgar phraſe, two up and two down, that thereby he may ſtrike his furrow clear, and avoid ſetting his fore feet in the bottom of it, and by that means fall over, but by this way of galloping, though he ſhould happen to ſet his feet in a furrow, yet carrying his body ſo round, and reſting on the hand in his gallop, would prevent his falling; and nothing but uſe and ſuch moderate exerciſe can bring him to his perfection.

About three o'clock in the afternoon you muſt have your horſe home in a foot pace, as you came out in the morning, but he ſhould be cool before he comes out of the field, and if he has not ſweated a little you muſt gallop him gently on ſome ſkelping earth, till he ſweats at the root of his ears, a little on his neck, and in his flank, which muſt be done of his own voluntary motion, without the compulſion of whip and ſpur: and then when he is cool, have him home and ſtable him, avoiding walking him in hand to cool him, leſt he ſhould cool too faſt.

When ſet in his ſtall, which ſhould be well littered againſt his coming home, his head muſt be tied up to the ring, with the bridle, rubbing him well afterwards with dry ſtraw, both head, neck, fore-bowels, belly, flank, buttocks, and legs, and then his body over with a dry cloth, till there be not a wet hair left about him. This done, his ſaddle is taken off, and the place where the ſaddle ſtood rubbed dry, cloathing him immediately after with his ordinary cloaths leſt he ſhould catch cold, unleſs he be too hot, for then a ſpare cloth muſt be thrown over him for fear he ſhould cool too faſt; and leaving him afterwards to ſtand on his ſnaffle two hours or more, ſtirring him now and then with the whip, in his ſtall, to keep his legs and joints from growing ſtiff.

When thoroughly cold he muſt be unbridled, have his head rubbed, and his feet picked from dirt and gravel, which he may have gathered abroad; and then his collar is put on, and a quart,

or

or three pints of oats mixed with a handful of clean dusted hempseed given him: after which the spare cloth is removed for fear of keeping him hot too long; and when he has eaten his corn, he must be left to rest two or three hours, with a sufficient quantity of clean hay before him.

Whilst you are absent from him, you shall prepare him a good mash, made of half a peck of malt well ground, and boiling hot water, observing to put no more water than your malt will sweeten, and your horse will drink, and having stirred them together with a stick, you'll cover it over with a cloth, till the water has extracted the strength of the malt. Then when it is cold, that you can scarce perceive it to smoak, offer it to your horse, and when he has drank the water, let him, if he will, eat the malt also; but if he refuses to drink, yet you must give him no other water that night, but by placing it in one corner at the head of the stall, in such a manner that he may not throw it down, let him stand by it all night that he may drink at his pleasure.

When he has eaten his mash, strip him of his cloaths, and run him over with your curry-comb, *French* brush, hair-patch, and woollen cloth, and cloath him up again, cleaning his legs as well as his body of all dirt and filth; then remove him into another stall, and bathe his legs all over from the knees, with a quart of warm urine, in which four ounces of salt-petre have been dissolved; then having rubbed his legs dry, set him into his stall, and give him a good home-feeding of oats, or bread, or both, and having shook a good deal of litter under him, that he may rest the better, and thrown him hay enough for all night, shut up your stable close, and leave him to his rest till morning; at which time you must come to him betwixt six and seven o'clock. If he be laid, disturb him not, but stay till he rises of his own accord; but if he be risen then go to him, and begin by putting back his dung from his litter, then proceed to order him as in his days of rest, *i. e.* to give him a handful or two of oats before water, then to dress, water, air, feed, &c.

The next day after he has rested you shall hunt him again; hunting him thus three times a week, for a fortnight together, observing to give him his full feeding, and no other scowring but mashes and hempseed, which is equal in virtue to any other, and only carries off superfluous humours.

By this time your horse will be drawn so clean, his flesh will be so unseamed, and his wind so improved, that he will be able to ride a chace of three or four miles without much blowing or sweating, and you'll find by his chaul and flank, as well as by his ribs, that he is in an indifferent state of body; and therefore, the next fortnight following, you must increase his labour, by which means you will come to a true knowledge of what he is able to do; and whether or no he will ever be fit for plates, or a match.

When your horse is set over night, and fed early in the morning, then go into the field with him, and when he is empty, as he will be by that time you have started your game, you shall follow the dogs at a good round rate, as at half speed, and so continue till you have killed or lost your first hare. This will so rack your horse's mind, and by this time he will have so emptied himself, that he will be fit to be rid the next chace briskly: which as soon as begun, you shall follow the dogs, at three quarters speed, as near to them as is consistent with the discretion of a good *horseman*, and a true huntsman, who will always take care not to strain him.

During this day's riding you'll observe your horse's sweat under his saddle and fore-bowels; if it appears white like froth or soap-suds, it is a sign of inward glut and foulness, and that your day's sport was fully sufficient, and therefore you must have him home, and order him as before directed.

When you unbridle your horse, give him instead of hempseed and oats, a handsome quantity of rye-bread, which being cold and moist, will assist in cooling his body after his labour, and prevent costiveness, to which you'll find him addicted; then give him hay, and afterwards a mash, and afterwards order him in all points as formerly.

The day following you may hunt your horse again, but not so severely as you did the day before, till the afternoon, then ride him after the hounds briskly, and if that does not make him sweat thoroughly, make another train-scent, and follow the dogs three quarters speed that he may sweat heartily. When you have a little cooled him, have him home, and upon his first entrance into the stable, give him two or three balls as big as walnuts of the following scowring.

Take butter four ounces, lenitive electuary two ounces, granwel broom and parsley-seeds of each one ounce, jalap an ounce; put the seeds into powder, and stir them into a paste, with the electuary and the butter, knead it well, and keep it close in a pot for use.

As soon as you have given your horse these balls, rub him dry, then dress him, and cloath him up warm, and let him stand two or three hours on the snaffle; then give him two or three handfuls of rye-bread, and order him as you did before, as to hay, provender, mash, &c. and so leave him till the morning. Then come to him, and first observe his dung, whether it keeps the true colour, or whether it appears dark or black, or red and high

high colour; next, whether it be looſe and thin, or hard and dry. If it be of the right colour, I mean of pale yellow, it is a ſign of health, ſtrength, and cleanneſs; if it be dark or black, then it is a ſign there is greaſe and other ill humours ſtirred up, which are not yet evacuated; if it be red and high coloured, then it is a token that his blood is feveriſh and diſtempered through inward heat; if it be looſe and thin it is a ſign of weakneſs; if hard and dry, it ſhews the horſe to be hot inwardly, or elſe that he is a foul feeder; but if his dung carries a medium betwixt hard and ſoft, and ſmell ſtrong, it is a ſign of health and vigour.

Theſe obſervations made with regard to his dung, he muſt be fed, dreſſed, watered, *&c.* as in his former days of reſt; obſerving always to give variety, and his belly full of corn and bread. Next, have him abroad in the fields again, but by no means put him to any labour further than to take him from hill to hill after the dogs, to keep him within ſound of their cry; for the deſign of this day's exerciſe is only to keep him in breath, and get him an appetite. Obſerve as you ride that you let him ſtand ſtill to dung. When the day is near ſpent, bring him home without the leaſt ſweat, and order him as at other times, abſtaining only from giving him ſcowrings, or rye-bread. You may, if you will, water your horſe this day, both at your going into the field, and at your coming home, obſerving to gallop after it, to warm the water in his belly.—The next is a day of reſt.

To order a *horſe* for a *match* or a *plate*, there are ſeveral other neceſſary rules to be obſerved.

Firſt, keep him for a whole month carefully, and without any violent exerciſe, in order to draw his body perfectly clean, and to refine his wind to that degree of perfection it can attain to; which to accompliſh, we muſt obſerve whether our horſe be low or high in fleſh, or whether he be dull and heavy when abroad, and this occaſioned through too much hard riding, or through ſome greaſe that has been diſſolved by hunting, and has not been removed for want of a ſcowering. If he appears ſluggiſh and melancholy from either of theſe cauſes, we muſt give him half an ounce of *diapente* in a pint of good old *Malaga* ſack, which will both cleanſe his body and revive his ſpirits; and then feed him for the firſt week continually with bread, oats, and ſplit beans, giving him ſometimes one and ſometimes the other, according as he likes, always leaving ſome in his locker, to eat at his own leiſure; obſerving at the ſame time, that the oats muſt have been well dried in the ſun, and afterwards hulled, before they are given our horſe: that the beans muſt alſo be hulled, and that he muſt have none but the crumb of the bread, becauſe the cruſt is hard of digeſtion, and apt to dry and heat his body. This bread muſt be made of an equal quantity of beans and wheat, kneaded with new ale-barm, and the whites of new-laid eggs. Thus a horſe is to be fed till we have made him wanton and gameſome.

But if on the contrary the horſe be briſk and lively, we muſt abſtain from giving him any ſort of ſcowring whatſoever; for there being no foul humours, or any other ſuperfluous matter left in his body for the phyſick to work upon, it will prey upon the ſtrength of his body, and by that means weaken it.

He ſhould be kept near the place where he is to run, that he may be acquainted with the ground; regulating the number of heats according to the articles ſtipulated for the match, and the ſharpneſs of them according to the temper of his ſtrength, and the purity of his wind; providing when we heat him, ſome horſes upon the courſe to run at him, which will quicken his ſpirits, and encourage him, when he finds he can command them at his pleaſure, abſtaining always from giving our horſe a bloody heat for ten days, or a fortnight before the day the plate is to be run for; giving him his laſt heat before the day of trial in all his cloaths, only ſkelping it over, which will make him run the next time much more vigorouſly, when he ſhall be ſtript naked, and feel the cold air pierce him.

During this month, both on his reſting days, and after his ſweats on heating days, we are to obſerve the ſame rules taught in the firſt week of our third fortnight's keeping, omitting only all ſcowrings but rye-bread and maſhes, ſince our horſe be in ſo perfect a ſtate of body as not to need any; only if we think there may be any occaſion, and our horſe proves thirſty, we may give him about eight or nine o'clock at night, to cool him, and quench his thirſt, two quarts of barley-water, mixed with three ounces of ſyrup of violets, and two ounces of ſyrup of lemons. If he refuſes this mixture, it muſt be left to ſtand by him all night.

During the laſt fortnight, his oats muſt not only be dried and hulled, but likewiſe half a ſtrike of it ſhould be waſhed in the whites of a dozen or twenty eggs, which muſt be left to ſoak ſpreading them in the ſun, the next morning, till they be as dry as they were at firſt, and then be given to the horſe to ſtrengthen his wind.

If he will eat his oats without beans, there is no neceſſity to give him any; and this fortnight his bread ought to be three parts wheat to one of beans. If he be inclined to be coſtive, we muſt relieve nature, by giving him oats waſhed in two or three whites of eggs, and all beat together.

During the laſt week, inſtead of a maſh, he ſhould have the barley-water; giving him hay, as much as he will eat, till a day before he is to ride his

his match, when we muſt be pretty ſparing of it, that he may have time to digeſt that he has eaten, muzzling him then with our cavezone; and feeding him that day, till the next morning he is led out, as much as poſſible. That morning, an hour before we are to lead out, we'll give him a toaſt or two of white bread ſteeped in ſack, and ſo lead him into the field.

But if we are to run for a plate, which uſually is not till three o'clock in the afternoon, our horſe muſt be had out early in the morning to air, that he may empty his body; and at his return from airing, we'll feed him with toaſts in ſack. When he has eaten what we think fit to give him, we put on his cavezone; then chaſe his legs ſoundly with train oil, and brandy warmed together, ſhake up his litter, ſhut up our ſtable cloſe, and leave him to his reſt, till the hour of his going into the field.

The perſon who is to ride him, ſhould always be the ſame that has trained him, and the firſt thing requiſite in a *rider*, next to the faithfulneſs in his truſt, is to have a good cloſe ſeat, keeping his knees firm to his ſaddle ſkirts, his toes turn'd inward, and his ſpurs outward from the horſe's ſides; his left-hand governing his mouth, and his right commanding his whip, taking care throughout the whole trial, to ſit firm on his ſaddle, without waving, or ſtanding up in his ſtirrups, which very much incommodes the horſe. When he ſpurs his horſe, he muſt not ſtrike him hard with the calf of his leg, as if he would beat the wind out of his body, but juſt turn his toes outwards, and bring the ſpurs quick to his ſides; and ſuch a ſharp ſtroke will be more ſerviceable to the quickening of his horſe, and ſooner draw blood, never ſpurring his horſe but when there is occaſion, and avoiding ſpurring him under the fore-bowels, between his ſhoulders and his girts, near the heart, till the laſt extremity. When he whips his horſe, it muſt be over the ſhoulder on the near ſide, except upon hard running; and when he is at all, then he muſt be ſtruck in the flank with a ſtrong jirk, for there the ſkin is tendereſt, and moſt ſenſible of the laſh. Taking care when he whips, or ſpurs his horſe, and he is certain that he is at the top of his ſpeed, if then he claps his ears on his pole, or whiſks his tail, to bear him hard, and to give him as much comfort as ever he can, by ſhaking his ſnaffle to and fro in his mouth, and by that means forcing him to open his mouth, which will comfort him, and give him wind.

If while he rides, there be any high wind ſtirring, and that wind be in his face, he muſt ſuffer his adverſary to lead and hold hard behind him, till he ſees his opportunity of giving a looſe; taking care, notwithſtanding, to ride ſo cloſe to him, that his horſe may break the wind from his own; and that he, by ſtooping low in his ſeat, may ſhelter himſelf under him, which will aſſiſt the ſtrength of his horſe. But if the wind be in his back, he muſt ride exactly behind his adverſary, that his horſe may alone enjoy the benefit of the wind, by being as it were blown forward.

He muſt obſerve next, what ground his horſe delights to run beſt on, bearing him, as much as his adverſary will give him leave, on level carpet-ground; becauſe his horſe naturally will be deſirous to ſpend himſelf more freely thereon. But on deep earth, &c. he muſt give him more liberty, becauſe he will naturally favour himſelf thereupon. In running up a hill, he ought to favour his horſe, and bear him for fear of running him out of wind; but down hill (if his horſe's feet and ſhoulders will endure it, and he dares venture his own neck) he muſt always give him a looſe. Taking this for a general rule, that if he finds his horſe to have the heels of the other, he be careful to preſerve his ſpeed till the laſt train-ſcent, if he is not to run a ſtrait courſe; but if he is, then till the courſe, and ſo huſband it then too, that he may be able to make a puſh for it at the laſt poſt.

He muſt next obſerve his oppoſite's horſe, and if he be fiery, run juſt behind, or juſt ſide by ſide, and with his whip make as much noiſe as he can, to force him on faſter than his rider would have him, and thereby ſpend him the ſooner. Or elſe keep juſt before him upon ſuch a ſlow gallop, that he may either over-reach, or by treading on his horſe's heels, endanger falling over. He ſhould likewiſe take notice on what ground the contrary horſe runs worſt, and on that ground give his a looſe, that the adverſary's being forc'd to follow, may hazard ſtumbling, or clapping on the back ſinews. Minding, beſides, in his riding, the correction of the hand, the whip and the ſpur of the oppoſite rider, and when, and how often he makes uſe of them; and when he perceives that his horſe begins to be blown, by any of the aforementioned ſymptoms, as whiſking his tail, clapping down his ears, holding out his noſe like a pig, &c. he muſt take it for granted that he is at the top of what he can do; therefore he ought to obſerve, in this caſe, how his own rides, and if he runs chearfully and ſtrongly without ſpurring, he ſhould keep his adverſary to the ſame ſpeed, without giving him eaſe, and by that means will ſoon bring him to give out, or diſtance him.

At the end of every train-ſcent, notice ſhould be taken of the condition the other horſe is in, and how he holds in his labour; which may be eaſily diſcovered by his looks, the working of his flank, and the ſlackneſs of his girts. For if he looks dull,

dull, it is a ſign his ſpirits fail him, as well as his wind, if his flanks beat much, and conſequently his ſtrength. If his wind fails him, his body will grow thin, and appear tucked up, which will make his girts appear ſlack to the eye; which is the greateſt ſign of a horſe's weakneſs; and the ſureſt that he'll loſe the wager.

When each train-ſcent is ended, or after every heat for a plate; the groom muſt, with an old piece of a ſword blade (called by the Duke of *Newcaſtle*, a *knife of heat)* ſcrape off all the ſweat from the horſe's neck, body, *&c.* rubbing him afterwards all over, firſt with ſtraw, and then with dry cloaths, both linen and woollen (which have been ſteeped in urine and ſalt-petre a day or two, and then dried in the ſun) while others are employed about his legs; which after they have been rubbed dry, muſt be chafed with wet cloaths, ſteeped likewiſe in urine and ſalt-petre, never giving over till the horſes are called by the judges to ſtart again.

The next thing to be conſidered, is the office of the *judges* or *triers*, which is to ſee that all things are ordered according to the articles, which to that end, are to be publickly read before the horſes ſtart.

Therefore each *trier*, on whoſe ſide the train is to be led, according to the articles, gives direction for its leading, according to the advice of the rider, or his knowledge of the nature and diſpoſition of that horſe on whoſe ſide he is choſe.—Each trier ought to be ſo advantageouſly mounted, as to ride up behind the horſes all day; and to obſerve that the oppoſite horſe rides his true ground, and keeps to the articles in every point, or elſe not permit him to proceed.—After each train-ſcent is ended, each trier is to look to that horſe, againſt whom he is choſen, and take care that he be no ways relieved but with rubbing, except liberty on both ſides be given to the contrary. As ſoon as the time allowed for rubbing is expired, which is generally half an hour, they ſhall command the riders to mount, and if either rider refuſes, it may be lawful for the other to ſtart without him, and having beat him the diſtance agreed on, the wager is to be adjudged on his ſide.

The triers muſt keep off all other horſes from croſſing the riders, or leading them; only they themſelves may be allowed to inſtruct the riders by word of mouth how to ride, whether ſlow or faſt, according to the advantages he perceives may be gain'd by his directions. If there be any weight agreed on, they ſhall ſee that both horſes bring their true weight to the ſtarting place, and carry it to the end of the train, on penalty of loſing the wager.—The ſame rules are to be obſerved, eſpecially this laſt, by thoſe who are choſen to be judges at a race for a plate; only they uſually ſtay in the ſtand, that they may the better ſee which horſe wins the heat.

If you know your horſe to be tough at bottom, and that he will ſtick at mark, to ride him each heat, according to the beſt of his performance, and avoid as much as poſſible either riding at any particular horſe, or ſtaying for any, but to ride each heat throughout with the beſt ſpeed you can. But if you have a fiery horſe to manage, or one that is hard-mouth'd, and difficult to be held, then ſtart behind the reſt of the horſes, with all the coolneſs and gentleneſs imaginable; and when you find your horſe to begin to ride at ſome command, then put up to the other horſes, and if you find they ride at their eaſe, and are hard held, then endeavour to draw them on faſter; but if you find their wind begins to rake hot, and that they want a ſob, if your own horſe be in wind, and you have a looſe in your hand, keep them up to their ſpeed, till you come within three quarters of a mile of the end of the heat; and then give a looſe and a puſh for it, and leave to fortune, and your horſe's goodneſs, the event of your ſucceſs. Avoiding all foul play, as croſſing, hanging on the poſts, leaning on the other horſeman, yoking, *&c.* which are to be abhorred by all honeſt horſemen.

When your trial for the plate is ended, as ſoon as you have rubbed your horſe dry, you muſt cloath him up, and ride him home, where you muſt give him firſt, a pint and a half of ſweet milk, with three yolks of eggs beaten into it, which muſt be made lukewarm, adding to it afterwards, three-penny worth of ſaffron, and three ſpoonfuls of ſallad oil; which mixture ought to be given him in a horn.

This done, dreſs him ſlightly over with your curry-comb, bruſh, and woollen cloth; and then bathe the place where the ſaddle ſtood with warm ſack, to prevent warbles, and waſh the ſpurring places with piſs and ſalt, anointing them afterwards with turpentine, and powder of jet mixed together, littering well the ſtable, and then cloathing him up quickly. And after he has ſtood for two hours, he muſt be fed with rye-bread, after that with a very good maſh; then giving him his belly full of hay, and what corn and bread he'll eat. And laſtly, bathing his legs well with urine and ſalt-petre, leaving corn in his locker, without diſturbing him any more till next morning.

Horſes employed in other ſervices, as in the army, coach-horſes, pack-horſes, *&c.* need not ſo much care and attendance; and every groom knows how to dreſs them, feed them, *&c.* to keep them in a good ſtate of body; and render them thereby capable of doing the ſervice they are deſign'd for.

Horſes are ſubject to an infinite number of *diſeaſes*, or *infirmities*. The moſt dangerous are the FARCY, or FASHIONS. This diſeaſe in horſes is infectious, and ſpreads a true plague. It conſiſts in a corruption of the blood, which ſhews itſelf in eruptions of hard puſtules, knots or ſtrings along the veins, and in ulcers; occaſioned by over heats and colds, ſometimes by ſpur-galling with ruſty ſpurs, ſnaffle-bit, or the like; or by the bite of another horſe infected with it; or if in the leg, by cutting or interfering.

This diſeaſe is commonly divided into theſe kinds, *viz. button*, or *knotted farcy*, the *running farcy*, the *water farcy*, and the *pockey farcy*; which are all the ſame, only differing in degrees of malignity.

The beſt method of curing this diſeaſe is, by correcting and carrying off the humours the blood is vitiated with, in order to reſtore it to its priſtine ſtate, and this muſt be done ſoon; otherwiſe, if the *farcy* be too far gone, and has ſiezed the horſe's lungs, or ſome other noble parts, it is not to be attempted with any great hope of ſucceſs.

The firſt remedy to be adminiſtered, in this caſe, is a purging maſh, to mitigate the venom, and carry off a great deal of thoſe humours from the vital and noble parts; repeating the ſame remedy twice, thrice, or four times, at due intervals, *i. e.* as ſoon as his ſtrength will permit.—The following is an excellent purge for this purpoſe.

Take four ounces of aloes ſuccotrine, reduced into powder, and pour upon it half a pint of ſpring-water, wherein has been diſſolved, over a gentle fire, an ounce of *Spaniſh* liquorice juice; put them in an earthen pan, over a gentle fire, ſtirring it continually, that the aloes may not burn at the bottom, and till about half the water be evaporated. Which done, there muſt be added to it jalap, colocynthus, tartar, agarick, all in powder, of each half an ounce; mercurius dulcis half an ounce; and oil of anniſeed one drachm and a half, mixing well all together in a mortar, to be formed into balls. Of which one ounce, or ten drachms, is a doſe ſufficient to purge any horſe, or at moſt one ounce and a half.

After your horſe has done taking this purge, you muſt give him at a time, mixed in his oats and beans, three or four ounces of the following digeſtive powder.

Take one pound of antimony in powder, half a pound of *lignum vitæ* in powder, three ounces of cinnaber of antimony; powder of liquorice four ounces; powder of elecampane four ounces; anniſeed three ounces; all which muſt be mixed together, and kept in a bottle well cork'd for uſe.

While your horſe is under cure, he muſt drink no water without a quart, three pints, or more, of the following diet-drink, put in his pail adding to it as much cold water as you think he will drink at a time, and if he refuſes at firſt, let him be without water till he drinks it.

Take one pound of antimony in powder, one pound of quickſilver, grind them well together in an iron mortar for about three or four hours, then boil them in a new iron pot being firſt tied up in a piece of cloth, with theſe following ingredients tied up in a rag likewiſe, *viz.* raſpings of guaiacum, three pounds; the bark of guaiacum bruiſed, two pounds; raiſins ſlit, one pound and a half; figs ſlit, one pound; carraway-ſeeds, half a pound; fennel-ſeeds, half a pound; liquoriſh cut and ſlit, half a pound; boil all theſe in eight or ten gallons of running water, till it be reduced to half; to which add three quarts of lime-water.

Laſtly, if you perceive that any of the knots or ſwellings are ripened, you muſt open them with a lancet to let out the corruption, and then waſh them with the following green water.

Take one ounce of verdigreaſe, one ounce and a half of roch allum, two ounces of copperas, one ounce and a half of Roman vitriol, all in powder; put them into a quart bottle, upon which pour one quart of the beſt and ſtrongeſt white wine vinegar; put this bottle into a kettle full of water, on a rowl of hay, to hinder it from touching the bottom of the kettle, and make it ſtand upright, ſo that two or three inches of its neck may remain above the water: the bottle being corked, with a cork with two or three notches for vents leſt the bottle ſhould break, put the kettle over a fire, or let it boil till the vinegar has diſſolved the powders, helping to do it, by often ſhaking the bottle. When diſſolved, take the liquor from the fire, and keep it in a bottle well corked.—Half a pint or more of this vinegar is mixed with a quart of old chamber-lye, when one wants to uſe it.

Beſides the *knotted farcy*, which this green water cures effectually, it cures likewiſe, at once or twice dreſſing the *mellander*, the *rat tails*, *ſcratches*, *gourd* or *ſwell'd legs* and *heels*; it prevents and cures the greaſe fallen into the legs and heels, cleanſes and heals all ulcers and wounds, prevents the breeding of *worms* and *proud fleſh*, expelling beſides or driving away any flux of humours from any part; alſo *clifts* and *cracks* in the heels, pains, &c. preventing of wind-galls, &c. the green water alone, without the chamber-lye, is the beſt remedy to cure all fiſtula's, cankers, and galled backs.

Horſes are alſo ſubject to *colds*, *coughs*, &c. which to cure, especially *new cold*, *cough*, or *grass cold*, the following pectoral drench is excellent.

Take one pound of raisins of the sun, two ounces of slic'd liquorice, two ounces of sugar-candy, one pound of treacle, three ounces of sallad-oil, three ounces of horse spice, two or three heads of garlick pounded with raisins, two spoonfuls of honey, and three quarts of ale; boil it till it be reduced to two quarts, and give about a pint of it in the morning, fasting one or two hours after it; and repeating it every morning as occasion requires. Twice is enough for a cold, and the whole will do in most of the other cases. — It is good for a *surfeit*, *short winded*, *hide bound*, and to make a lean horse thrive.

As horses are very subject to *swellings*, the following poultice is very good to dissolve them.

Take of our garden green orris roots, and white lilly roots, of each an ounce, marsh mallows pellitory, pennyroyal, origan, calamint, rue, of each a handful, camomile, melilot, and elder flowers, of each half a handful, green anniseeds, common fennel and cuminseeds, of each half an ounce; boil them to a mash in water and white-wine vinegar, then bruise them into an even smooth mash in a stone mortar, adding to them of the meal of lupins and of beans, of each one ounce and a half, an ounce and a half of oil of camomile, one ounce and a half of oil of orris; mix them well in the mortar, heating them again afterwards, and applying more or less of this poultice hot on the part affected.

But if the swelling cannot be dissolved, they ought to be ripened as soon as possible, and the following poultice is very proper for that purpose.

Take white lilly, and marsh-mallow roots, of each four ounces; the leaves of common mallows, marsh mallows, groundsel, violet plants, brank ursin, of every one a handful; the meal of linseed and fenugreek seeds, goose fat and oil of lillies, of each three ounces. The roots when washed and sliced, are to be boiled in water, and the leaves being added some time after, the boiling is to be continued till the whole mash becomes perfectly tender and soft; when having strained the decoction, you'll beat the remaining gross substance in a stone mortar with a wooden pestle to a pulp; then let the decoction and pulp be put into a skillet, and having mixed the meals of lint-seeds and fenugreek seeds, goose fat and oil of lillies, let them boil together over a gentle fire, stirring the ingredients from time to time, till they all be sufficiently thickened for a poultice.

Horses being also very subject to worms, the following remedy is accounted very good to kill them.

Take half a pound of the best antimony in powder, and two ounces of quicksilver, boil them in four pales of water till they be reduced to three; of which mix half a pailful with as much water as your horse will drink, having first strained it, and continue thus till it is all gone.

It sometimes happens that a horse is bitten by a mad dog, which if not immediately remedied, may be attended with very dangerous consequences; and which to perform with hopes of success, all the bitten parts must be seared as soon as possible with a hot iron; with this caution, that you sear not, nor let the hot iron touch either nerve or tendon, the eyes, or any member whereby the horse may receive any damage from the operation; applying afterwards a strong blistering plaister, as well to every part touched with the hot iron, as to those which you could not attempt to sear, though bitten likewise.—That blistering plaister must be composed in the following manner.

Take an ounce of *Burgundy* pitch, ship pitch, and common rosin, of each half an ounce; of the common *lapis infernalis*, or caustic stone, one dracnm, cantharides or *Spanish* flies in powder, six drachms, or one ounce. Putting first the *Burgundy* pitch, ship pitch, and rosin in a pipkin, to melt over a slow fire, stirring them to make them incorporate; when melted, put in the *lapis infernalis* in powder, stirring it all the while that it may equally mix: lastly, put in by degrees the ounce of cantharides in powder, stirring them likewise as you have done the *lapis infernalis*, and for the same end; but if you perceive that the powders make it too thick, you may at your discretion, add a little of the rankest oil you can get, taking care that it should not boil after the *Spanish* flies are in, nor remain long on the fire, otherwise it would lose its virtue: therefore about a minute or two after the powder of the *Spanish* flies is all stirred in, take it off the fire and keep it for your use; and when you use it spread it pretty thick upon leather, and apply it to the part, where it must remain ten or twelve hours; then when you dress it, cut all the blisters that are not broken, and wipe them clean, applying to the parts the following plaister.

Take four heads of garlick. one ounce of *Venice* treacle, half an ounce of *Venice* turpentine, half an ounce of the filings of pewter, and one drachm of the powder of *Spanish* flies, half an ounce of honey, and two drachms of verdigrease in powder, pounding all these together in a mortar; when you use it spread it on leather and apply it, binding it on, by reason that it is not very apt to stick. but when the

the bite is on a part the plaister cannot be conveniently bound on, then the leather must be cut something broader than what is necessary for the plaister, in order that the margin may be spread with *Burgundy* pitch; then put the plaister in the middle of the leather, and the *Burgundy* pitch on the margin will make it stick without binding. This plaister must lie on twenty-four hours, and then taken off, and the part cleansed, and the plaister renewed; keeping the sores open as long as possible with this plaister, in order to draw the venom that it get not into the blood, which would kill the horse.

Besides these outward applications for putting a stop to the venom, inward remedies are also used to subdue and drive it out, in case it should have seized the mass of the blood, and also to prevent its getting there. The following diet drink is of great efficacy in those cases.

Take of the leaves of box, the leaves of rue, the leaves and roots of primrose, the leaves of sage, of each two handfuls; three quarters of a pound of fresh roots of the male piony, three ounces of the powder of crabs claws, two ounces of round birthwort roots in powder, three ounces of *Venice* treacle: bruise all these things together in a mortar, then put it in a glass or earthen pot, and pour upon the ingredients four quarts of white *Lisbon* wine, or for want of it, of the best cyder, or strong beer: then stop the glass or pot slightly, putting it to infuse in a kettle of hot water for the space of twelve or fourteen hours, then keep it for use. When you use it, you must strain off about a pint, into which you must put about a drachm of balsam of sulphur, and give it your horse in a drenching horn in the morning, letting the horse fast two hours after, and repeating it thrice.

The *eyes* of horses are also subject to a number of different diseases, as *pin* and *web*, *pearls*, *clouds*, *bloodshot*, *sore* and *running eyes*, *salt*, *hot*, and *sharp rheums*, *ulcers*, *fistula's*, *bruises*, *stripes*, &c. for all which the following *eye-water* is a sovereign remedy.

Take a new earthen pipkin which will hold five pints or three quarts, put into it of the stone called *lapis calaminaris* in powder, of the best bole armenick, also in powder, and of the best white vitriol, of each an ounce and a half; boil them over a gentle fire till it be reduced to a quart, then let it settle, and pour the clear from the *fæces*, adding to the water three drachms of sugar of saturn, three drachms of salt of vitriol, half an ounce of camphire dissolved in spirit of wine, an ounce of tincture of aloes, three drachms of tincture of opium, one quart of rose-water, and half an ounce of prepared tutty; mix all together and keep it in a bottle for use.

If your horse be troubled with any dose in his head, give him mustard-seed among his provender, but if it be a worse cold, which you will perceive by his rattling, then give him the following electuary.

Take honey and treacle, a pound of each, having mixed these together, add to them cumin-seeds in powder, liquorice, bay-berries, anniseeds, of each an ounce; these likewise must be mixed together, and afterwards with the honey and treacle, which will make it of a thick consistence. If your horse has a cold, instead of his oats before water, give him the quantity of a walnut of this lambitive, at the end of a stick or in a spoon, and let him lick it off; doing the same after airing, when first you come in, and your horse will soon be cured.

The *lameness* of a horse is also worthy our notice; which, if it proceeds from old strains, you must cure with the following ointment.

Take fresh butter, oil of bays, dialthea and turpentine, of each two ounces, mix and boil them together on a gentle fire; and when they are well incorporated anoint the horse twice a day with it as hot as he can bear it, and give him exercise, by airing him abroad morning and evening a foot-pace; and you'll find it a sovereign remedy for any strain in the shoulder, clap on the back sinews, or any grief whatsoever that proceeds from strains.

But if you only fear *lameness* from old strains, then you must take care that your exercise be moderate, and always when you return from water, and his legs are rubbed dry, anoint them with such ointments as are accounted good for the limbs, as *linseed*, *train*, *sheep's-foot*, *neat's-foot*, *nerve oil*, and the like; all which may be used on his days of rest, but on his heating days, urine and saltpetre. Some *horsemen* use brandy and sallad oil mixed, and bathe his legs, and afterwards heat it in with a hot iron, and commend it as the best thing for the limbs of an old stiff horse.

But if your horse through negligence or any casualty, happens to have the grease fall into his heels, you must endeavour to remove it by a good sound heat, and a scowering after it, applying to his legs this poultice.

Take a pound of honey, turpentine, common gum, meal of linseed and of fenugreek, of each four ounces, bay-berries in powder, three ounces: mix and boil all these together; then take it off and add to it a pint of white wine, boiling it over again

gain till it be very thick; and with this as hot as the horfe can bear it, lap his legs about, renewing it only once in three days, if your horfe's feet be bad, either furbated or founder'd; then inftead of cow-dung, you may ftop them with blue clay and vinegar tempered together.

HUNTING.

HUNTING is the art, exercife, or diverfion of purfuing beafts of venery, or chace; and certain birds, as pheafants, partridges, *&c.*

There are feveral ftatutes for punifhing offences committed by perfons not qualified by law, to take or deftroy the game.

The antient laws ordain, that no perfon fhall take pheafants or partridges, with engines in another's ground, without his licenfe, on forfeiture of 10 *l.* and perfons killing any pheafant, partridge, pigeon, duck, hare, or other game, forfeits 20 *s.* for every fowl, hare, *&c.* 11 *Hen.* VII. 1 *Jac.* I. c. 17. Conftables having a juftice of peace's warrant, may fearch the houfes of fufpected perfons for game; and in cafe any be there found, and they do not give a good account how they came by it, fuch perfons fhall forfeit for each hare or pheafant, partridge, *&c.* not under 5 *s.* nor exceeding 20 *s.* Likewife by another ftatute, if any higler, chapman, carrier, inn-keeper, or victualler, fhall have in his cuftody any hares, pheafants, partridges, heath-game, *&c.* he forfeits for every hare and fowl, 5 *l.* unlefs the fame be fent by a perfon qualified to kill game. The felling or offering game to fale is made liable to the like penalty; and in that cafe, if any hare, *&c.* be found in a fhop, *&c.* it is deemed expofing it to fale.

Perfons not qualified, keeping dogs, nets, or engines to kill game, on their conviction before a juftice of peace, fhall alfo pay 5 *l.* or be fent to the houfe of correction for three months, 4 and 5 *W.* and *M.* c. 23. 5 *Ann.* c. 14. 9. *Ann.* The penalties for deftroying game, are recoverable by action, as well as before juftices of peace, by 8 *Geo.*I. c. 19. If a perfon hunts any game on the land of another, fuch other cannot juftify the killing of his dogs. Where one in hunting ftarts a hare upon his own land, and then follows and kills fuch hare in another perfon's ground, it is lawful, and the game is his own; but where a man ftarts a hare on another's land, and kills it there, he is fubject to an action of trefpafs.

Hunting is practifed in a different manner, and with a different apparatus, according to the different nature, genius, and addrefs of the particular beaft which is the object thereof. Thefe beafts are, the *hart*, *hind*, *hare*, *boar*, *wolf*, *buck*, *doe*, *fox*, *marten*, and *roe*; the five firft whereof are denominated beafts of the foreft, or venery; and the five latter beafts of the field, or of chace.

Every gentleman, who wants to render himfelf perfect in this noble excercife, muft ftudy thofe terms proper to the diverfion, and learn their true fignification.

Thefe terms are either appropriated to the *beafts*, which are hunted, or the *dogs* employed in hunting them. Thofe peculiar to the different kinds of beafts hunted, are either to exprefs their *names*, *feafons*, *degrees*, and *ages of foreft*, or *venery*, *chace*, *warren*, &c. or to fignify their different *focieties*, their *lodging*, *diflodging*, their *noife* at *rutting-time*, their *copulation*, their *footing* and *treading*, the *different parts* of their bodies, the *flying*, *ftripping*, and cafing them, *&c.* Thus the HART is called the firft year a *hind-calf*, or *calf*; the fecond year, a *knobber*; the third year, a *brock*; the fourth year, a *ftaggar*; the fifth year a *ftag*; the fixth year a *hart*.—If the king or queen happen to chafe him, and he efcapes with his life, he fhall ever after be called a *hart royal*.

The HIND is called, the firft year, a *calf*; the fecond year, a *hearfe*; the third year, a *hind*.

The HARE is called, the firft year, a *leveret*; the fecond year, a *hare*; the third year, a *great hare*.

The WILD BOAR is called, the firft year, a *pig of the founder*; the fecond year, a *hog*; the third year, a *hog's fteer*; the fourth year, a *boar*: at which age, if not before, he leaves the *founder*, and then he is called a *fingler*.

The above mentioned beafts are what we have called already *beafts of foreft*, or *venery*; and that they make their abode all the day-time, in the great coverts and fecret places in the woods; and at night repair to their lawns, meadows, paftures, and pleafant feeding places.

Thefe that follow are *beafts of chace*, viz. the BUCK is called the firft year, a *fawn*; the fecond year, a *pricket*; the third year, a *forrel*; the fourth year, a *fore*; the fifth year, a *buck of the firft head*; the fixth year, a *great buck*.

The DOE is called, the firft year, a *fawn*; the fecond year, a *tegg*; the third year, a *doe*.

The

The Fox is called, the firſt year, a *cub*; the ſecond year, a *fox*; and afterwards an *old fox*.

The MARTEN is called, the firſt year, a *cub*; the ſecond year, a *marten*.

The ROE is called, the firſt year, a *kid*; the ſecond year, a *girl*; the third year, a *hemuſe*; the fourth year, a *roe-buck of the firſt head*; the fifth year, a *fair roe-buck*.

The beaſts of chaſe reſide all the day-time in the fields, or upon hills and mountains, where they may be ſeen afar off, to prevent danger; but when night approaches, they feed, as the reſt in meadows, &c.

The *Hart* or *Buck* ſeaſon begins 15 days after *Midſummer-day*, and laſts till *Holy-Rood-Day*. — The *Fox* at *Chriſtmas*, and laſts till the *Annunciation of the Bleſſed Virgin*. — The *Hind*, or *Doe*, begins at *Holy-Rood-day*, and laſts till *Candlemas*. — The *Roe-buck* begins at *Eaſter* and laſts till *Michaelmas*. —The *Hare* begins at *Michaelmas*, and laſts till the end of *February*.—The ſeaſon of the *Wolf*, is ſaid to be from *Chriſtmas* till the *Lady-Day*.—Laſtly, the *Boar*, begins at *Chriſtmas*, and continues to the *purification*, *Candlemas*.

The terms uſed for beaſts of *venery* and *chace*, as they are *in company*, are theſe. — They ſay a *Herd of Harts*, and of all manner of *Deer*.— A *Bevy of Roes*. A *Sounder of Swine*.—A *Route of Wolves*.—A *Richeſs of Martens*.—A *Brace* or *Leaſh of Bucks, Foxes*, or *Hares*.—A *couple of Rabbits*. — A *couple of Coneys*.

To expreſs their *Lodging*.—A Hart is ſaid to *harbour*. A Buck *lodges*.—A Roe *beddeth*.—A Hare *ſits* or *formeth*.—A Coney *ſitteth*.—A Fox *kennelleth* — A Marten *treeth*.—An Otter *watches*.—A Badger *eartheth*.—A Boar *couches*.

Terms for their *Diſlodging*.—They ſay *unharbour* the Hart. —*Rouſe* the Buck. — *Start* the Hare. — *Bolt* the Coney. — *Unkennel* the Fox. — *Tree* the Marten.—*Vent* the Otter. — *Dig* the Badger. — *Rear* the Boar.

The terms for their *Noiſe* at *Rutting-time*, are as follow.—A Hart *belleth*.—A Buck *groweneth*, or *troatch*.—A Roe *belloweth*.—A Hare *beateth* or *tappeth*. —An Otter *whineth*. — A Boar *freameth*. — A Fox *breeketh*. — A Badger *ſhrieketh*. — A Wolf *howleth*. A Goat *ratleth*.

Terms for their *Copulation*. — A Hart, or Buck, goes to *rut*.—A Roe goes to *turn*.—A Boar goes to *brim*. A Hare and Coney goes to *buck*.—A Fox goes to *clickitting*.—A Wolf goes to *match* or to *make*.—An Otter *huſtles for his kind*.

Terms for the *Footing* and *Treading*. — Of a Hart we ſay the *Slot*—Of a Buck, and all Fallow Deer, the *View*.—Of all Deer, if on the graſs, and ſcarce viſible, the *Foiling*. — Of a Fox, the *Print*: and of other like vermin, the *Footing*. — Of an Otter, the *Marks*.—Of a boar, the *Track*. —The Hare, when in open field, is ſaid to *ſore*; when ſhe winds about to deceive the hounds, ſhe *doubles*; when ſhe beats on the hard highway, and her footing comes to be perceived, ſhe *pricketh*. in ſnow it is called the *trace of the Hare*.

Every part of each beaſt has always its different name, expreſſed by a different term, according to the different kinds of beaſts.

Therefore the *tail* of a Hart, Buck, or other deer, is called the *ſingle*; that of the Boar, the *wreath*; of a Fox, the *bruſh* or *drag*, and the tip at the end is called the *chape*; of a Wolf, the *ſtern*; of a Hare and Coney the *ſcut*.

The terms for the *Attire* of *Deer*—Thoſe of a Stag, if perfect, are the *bur*, the *pearls*, the *little knobs* on it, the *beam*, the *gutter*, the *antler*, the *ſur-antler*, *royal*, *ſur-royal*, and all a-top, the *croches*.

Of a *Buck*, the *bur*, the *beam*, *brow-antler*, *black-antler*, *advancer*, *palm*, and *ſpellers*.

If the *croches* grow in the form of a man's hand, it is called a *palm'd head*. Head bearing not above three or four, and the *croches* placed aloft, all of one height, are called *crown'd heads*. Heads having double *croches*, are called *forked heads*, becauſe the *croches* are planted on the top of the beam like forks.

If you be aſked what a *Stag* bears, you are only to reckon the *croches* he bears, never expreſſing an odd number: As if he has four *croches* on his near horn, and five on his fur, you are to ſay he bears ten, a falſe *right* on his near horn (for all that the beam bears, are called *rights*.) If but four on the near horn, and ſix on the far horn, you muſt ſay he bears twelve, a double falſe *right* on the near horn. For you ought not only to make the number even, but alſo the horns even, with that diſtinction.

The very ordure of the beaſts, is expreſſed by different terms; for,

The *excrement* of a Hart, and all Deer, is called *fewmets*, or *fewmiſhing*. — Of a Hare, *crotiles*, or *crotiſing*. — Of a Boar, *leſſes*. — Of a Fox, the *billeting*; and of other the like vermin, the *fuants*. — Of an Otter, the *ſpraints*.

All kind of *Deers fat*, is called *ſuet*.— Of a Boar, *greaſe*—Of a Roe, *heavy-greaſe*.

They ſay a *litter* of Cubs, a *neſt* of Rabbits, a Squirrel's *dray*.

The terms for *flaying*, *ſtripping*, and *caſing* all manner of chaces, are as follow.—The Hart, and all ſort of Deer, are *ſlain*.—The Hare *ſtripped*, or *caſed*; and ſo is the boar.—The Fox, the Badger, and all manner of vermin, are *caſed*.

Veniſon,

Veniſon, is thus called from the manner of taking the beaſt by *hunting*, called in the *Latin*, *venatio*. No beaſt of the foreſt, that is *Solivagum & nocivum*, is *Veniſon*, as the Fox, the Wolf, the Marten, becauſe they are not meat.

From this we conclude, that whatſoever beaſt of the foreſt is for the food of man, is *Veniſon*; and that any beaſt that is not for the food of man, is not *Veniſon*.

Being ſo far advanced in the dialect of hunting, we may provide dogs, called *Hounds*.

Hounds may be diſtinguiſhed with regard to their manner of *hunting*, into ſuch as find out, and purſue the game by ſight, and the quickneſs and ſwiftneſs of their motion; of which kind are the *Gaze-hound*, *Gray-hound*, the *Terrier*, &c. And thoſe which find and purſue the game by the goodneſs of their ſmell.

The ſpecies of *hunting* dogs may be divided further into *hounds*, ſimply ſo called, and *Blood-hounds*, each whereof admit of ſome diverſity.

1. As to the *Hounds*, ſimply thus called, thoſe which are all of one colour, as white, black, *&c.* are more valued than thoſe ſpotted with red. Thoſe ſpotted with dun are little priz'd, as wanting courage and boldneſs. Fallow *Hounds* are of good ſcent and hardy, not fearing the water. They keep the chace well without change; but not ſo ſwift as the white. They love the Hart above any other chace, having little ſtomach for the Hare, *&c.* whence they are not ſo fit for private gentlemen, beſides that they are apt to run at tame beaſts.

The *dun Hounds* are of a more general uſe, being fit for all chaces. Their ſagacity and fidelity in knowing and ſticking to their maſter's voice and horn, and none elſe, are much admired.

The marks of a good and fair *Hound*, are to be of a middle proportion, rather long than round; the noſtrils wide; back bowed; fillets great; haunches large; the thighs well truſſed; the ham ſtrait; tail big near the reins, and the reſt ſlender to the end; the leg big; the ſole of the foot dry, and form'd like a Fox, and large claws

To chuſe a dog and a bitch for good whelps, you muſt take a bitch that comes of a good kind; ſtrong, and well proportioned in all parts, with large ribs and flanks.—The dog, that lines her, muſt be of a good breed, and likewiſe young, if you'll have light and hot *hounds*; for if the dog be old, the whelps will participate of his dull and heavy nature.—If the bitch does not grow naturally proud, ſo ſoon as you would have her, you may make her ſo by taking two heads of garlick, half a caſtor's ſtone, the juice of creſſes, and about twelve *Spaniſh* flies, boiling theſe together in a pipkin which holds a pint, with ſome mutton to make broth of it; and of this give to the bitch tw thrice, and ſhe will infallibly grow proud. The ſame pottage given to the dog, will make him deſirous of copulation.—When the bitch is lined, and with puppy, ſhe muſt not hunt, otherwiſe ſhe would caſt her whelps; but let her, without being confined, walk up and down the houſe and court, and never lock her up in her kennel; for ſhe is then impatient of food; and therefore you muſt make her ſome hot broth once a day.—If you would ſpay your bitch, it muſt not be done before ſhe ever had a litter of whelps; and in ſpaying her, take not away all the roots or ſtrings of the veins; for if you do, it will much prejudice her reins, and hinder her ſwiftneſs ever after; but by leaving ſome behind, it will make her much the ſtronger and more hardy. Whatever you do, ſpay her not when ſhe is proud; for that would endanger her life: but you may do it fifteen days after. The beſt time of all is when the whelps are ſhaped within her.

To enter a young *hound*, after having taught him to know the hallow, and the ſound of the horn, at about eighteen months old he may be taken into the field. The beſt method to initiate him is, to take a live hare, and trail her upon the ground, this way, then that; and at length hide her at a proper diſtance. Then ſetting the *hound* near the trail, he will take wind, and run to and fro about the fields, woods, paſtures, path ways, and hedges, till he finds which way the hare is gone, but with a ſoft and gentle pace, till coming near the place where ſhe is lodged, he mends it, and at laſt leaps on his prey, which he muſt be ſuffered to kill, and bringing it to his maſter with triumph, muſt be rewarded and encouraged. This done, he may be let run in a pack of old *hounds* to confirm and perfect him.

Whatever young *hounds* are firſt enter'd at, and rewarded with, they will ever after covet moſt; ſo that if they be intended, *v. gr.* for the hart, they muſt not be entered at the hind. And for the better hunting the hart, young *hounds* are not to be entered within a toil; for there a hart does nothing but turn and caſt about, ſince he cannot run endways, and thus they are always in ſight of him.—Neither are the *hounds* to be enter'd or taught in the morning; otherwiſe they will give over in the heat of the day.

2. The *Gray-hound* might deſerve the firſt place, by reaſon of his ſwiftneſs, ſtrength, and ſagacity in purſuing his game; ſuch being the nature of this dog, that he is well ſcented to find out, ſpeedy and quick of foot to follow, fierce and ſtrong to overcome, yet ſilent, coming upon his prey unawares.

The

The make and proportions requir'd in a good *Gray-hound* are, that he have a lean and long head, with a ſharp noſe, ruſh grown from the eye downwards; a full clear eye, with long eye-lids; a ſharp ear, ſhort and cloſe falling; a long neck a little bending, with a looſe hanging weaſand; a broad breaſt, ſtrait forehead, hollow ſide, ſtrait ribs, a ſquare flat back, ſhort and ſtrong fillets, a broad ſpace between the hips, a ſtrong ſtern or tail, a round foot, and good large clefts,

In the breeding of *Gray-hounds*, it is obſerved, that the beſt dog upon an indifferent bitch, will not get ſo good a whelp, as an indifferent dog upon the beſt bitch. That the dogs and bitches muſt be, as near as poſſible, of an equal age, not exceeding four years old; however, the beſt means which can be uſed to produce excellent whelps, is to breed with a young dog and an old bitch. That the dieting of *Gray-hounds* conſiſts in the food, exerciſe, airing, and kennelling. The common food of *Gray-hounds* ought to be raſpings, cruſts of bread, ſoft bones, and griſtles. The raſpings to be ſcalded in beef, mutton, veal, or veniſon broth; and when it is indifferently cold, then make your bread only float with good milk, and give it your *Gray-hounds* morning and evening; which will keep them in good ſtate of body. But if your dog be poor, ſickly, and weak, then take ſheep's heads, wool and all, clean waſhed, and having broken them to pieces, put them into a pot, ſcumming it when it boils, putting in it a good quantity of oatmeal; and making it boil till the fleſh be very tender, then with your meat and broth, feed your dogs morning and evening; this will recover them. As to the exerciſe of a *Gray hound*, it conſiſts in two things, *viz.* in courſing and airing. As to the firſt, he ought to be practis'd twice a week, in ſuch a manner that you uſually reward him with blood, which will animate and encourage him to purſue his game; taking care to give the hare all reaſonable advantage, ſo that ſhe may ſtand long before the *Gray-hound*, that thereby he may ſhew his utmoſt ſtrength and ſkill before he reaps the benefit of his labour. If he kills, do not ſuffer him to brake the hare, but take her from him, and having cleanſed his chaps of the wool of the hare, give him the liver, lights, and heart, and ſo take him in your leaſh, and having led him home, waſh his feet with ſome butter and beer, and then put him in his kennel, and feed him half an hour afterwards.

The huntſman is to lead theſe *hounds* on his left hand, if he be on foot; and on the right, if on horſe-back. The beſt time to try and train them to the game, is at twelve months old, though ſome begin ſooner, with the males at ten, and the females at eight months old, which laſt are generally more ſwift than the dogs: they ſhould be kept in a ſlip while abroad, till they ſee their courſe; neither ſhould you looſen a young dog till the game has been a conſiderable time on foot, being apt, by over-eagerneſs at the prey, to ſtrain his limbs.

3. The *Gaze-hound*, or *Beagle*, is a dog more beholden to the ſharpneſs of ſight, than to his noſe or ſmelling, by virtue whereof he makes excellent ſport with the fox and hare. He is alſo noted as exquiſite in chuſing of one that is not lank or lean, but full, fat, and round, which, if it happens to return, and be mingled again with the reſidue of the herd, he will ſoon ſpy out, and leave the reſt untouched, never ceaſing after he has ſeparated it from its company, till he has worried it to death.

4. There is in *Scotland* a kind of hunting dogs called *Sluth Hounds*, moſt of them of a browniſh colour, or ſandy-ſpotted. Their ſenſe of ſmelling is ſo quick, that they can follow the foot-ſteps of thieves, and purſue them with violence till they overtake them; nay ſhould the thief take the water, they are ſo eager in their purſuit that they will ſwim after them, and are reſtleſs till they find the thing they ſeek after.

5. The *Blood-Hound* differs nothing in quality from the *Scotch* ſluth hound, ſaving that it is longer ſized, and not always of the ſame colour; but ſometimes red, ſanded, black, white, ſpotted, *&c.* though moſt commonly either red or brown.

Their nature is, that being ſet on by the voice and words of their leader, to caſt about for the ſetting of the preſent game, and having found it, they will never ceaſe purſuing it with full cry till it be tired, without changing for any other.

They ſeldom bark, except in their chace, and are very obedient and attentive to the voice of their leader. Thoſe that are really good, when they have found the hare, make ſhew thereof to the huntſman, by running more ſpeedily, and with geſture of head, eyes, ears, and tail, winding to the form or hare's muſe, never giving over proſecution without a gallant noiſe.

They have good and hard feet, and ſtately ſtomachs, and are very properly denominated *blood-hounds*, by reaſon of their extraordinary ſcent; for if their game be only wounded, ſo that it eſcapes the huntſman's hands, or if it be killed and never ſo cleanly carried away, theſe dogs by their exquiſite ſmell will diſcover it, and not be wanting either by nimbleneſs or greedineſs to come at it, provided there be any ſtains of blood. Nay, though by all the cunning and foreſight imaginable, a beaſt be conveyed away without ſpot or blood, yet through the roughеſt and moſt crooked ways and meanders, will this dog find out the deer-ſtealer, and even in the

the thickeſt throng, will by his ſmell ſeparate and pick him out.

The *Terrier* or *Harrier*, only hunts the fox or badger, being thus called, becauſe after the manner of ferrets in ſearching for conies, he leaps into the ground and affrights and attacks the beaſt, either tearing them in pieces, or haling them out by force, or at leaſt driving them out of their harbours, to be taken in a net or otherwiſe.

The huntſmen having commonly a couple of terriers they may put in a freſh one, as occaſion requires, to relieve the other.

The time of entering the terrier, is when he is near a twelvemonth old: if it be not done within that time, they will hardly be brought to take the earth; this entering and fleſhing of them may be performed ſeveral ways. Firſt, when the foxes and badgers have young cubs, take an old terrier, ſet him into the ground, and when he begins to bay, hold the young one at the hole or mouth of the earth, that he may liſten and hear the old one bay.

The old fox or badger being taken, ſo that nothing remains within but the cubs, couple up the old ones, and put in the young ones in their room, encouraging them by crying, *to him*, *to him*. If they take any cub within, let them do with him what they will; not forgetting to give the old terriers their reward, which is blood and liver fried with cheeſe and ſome of their greaſe; ſhewing them head and ſkin to encourage them.

6. The *Leviner* or *Lyemmer*, is ſingular in his ſmell, and in ſwiftneſs incomparable. He is of a middle kind between the terrier and the gray-hound, as well for his kind as for the ſhape of his body. The *French* uſe it in hunting the wolf.

Being provided with *hunting dogs*, we muſt next learn the terms uſed in reſpect of them; therefore of *gray-hounds* two make a *brace*; of hounds a *couple*. Of gray hounds three make a *leaſh*; of hounds *a couple and a half*. — They ſay, *let ſlip* a gray-hound, and *caſt off* a hound. — The ſtring wherein a gray-hound is led, is called a *leaſh*, and that of a hound, a *lyam*. The gray-hound has its *collar*, and the hound his *couples*. They ſay, a *kennel* of hounds, and a *pack* of beagles.

When the hounds or beagles hit the ſcent of their chace contrary, as to hit it up the wind when they ſhould hit it down, we ſay, they *draw amiſs*.

When the hounds or beagles take freſh ſcent, hunting another chace till they ſtick and hit it again, we ſay, they *hunt change*.

When the hounds or beagles hunt it by the heels, we ſay, they *hunt counter*.

When the chace goes off and comes on again, traverſing the ſame ground to deceive the hounds or beagles, we ſay, they *hunt the foil*.

When we ſet hounds in readineſs, where we expect the deer will paſs, and then caſt them off, when the other hounds are paſſed by, we account that *a relay*.

When the hounds or beagles have finiſhed their chace, by the death of what they purſued, and then in requital, are fed by the hands of the huntſman or others, we call that their *reward*.

Huntſmen, when they go drawing in their ſprings at hart's hunting, uſually make due rounds, which we call *ring-walks*.

When any deer is hard hunted, and then betakes himſelf to ſwimming in any river, &c. we ſay, he *takes ſoil*.—When deer caſt their horns, we ſay, *they mew*. The firſt head of a fallow deer is called a *prick*.

When huntſmen endeavour to find a hart by the ſlot, &c. and then mind his ſteps, to know whether he be large and long, they ſay then, that they know him by his *gait*.

When deer rub, and puſh their heads againſt trees, to cauſe the peel of their new horns to come off, we ſay, *they fray*.—When after being hard run, they turn head againſt the hounds, we ſay, *they bay*.

When hounds or beagles run along without opening, or making any cry, we ſay, *they run mute*.

When hounds or beagles at firſt finding the ſcent of their game, open and cry, we ſay, *they challenge*.—When hounds run at a whole herd of deer, we ſay, *they run riot*.—When the hounds touch the ſcent, and draw on till they rouze or put up the chace, we ſay, *they draw on the ſlot*.

When a roe croſſes and doubles, it is called *trajeining*.

When a hare takes the ground like a coney, which ſeldoms happens, we ſay, *ſhe goes to the vault*.

When we beat the buſhes, &c. after the fox, we call it *drawing*.

When a hare runs on rotten ground, or in a froſt, which ſticks to her feet, we ſay, *ſhe carrieth*.

When beagles bark and cry at their prey, we ſay, they *yearn*. A red male hart of a year old, is called a *ſpitter*.

A *rein-deer*, is a beaſt like a hart, but has his head fuller of antlers.

A *pricker*, is a huntſman on horſeback.

Engines to take deer withal, are called *wiles*.

When we ſet hounds or beagles in readineſs, expecting the chace to come by, and then caſt them off before the reſt come in, we call it a *vauntlay*.

When hounds or beagles find where the chace has been, and made a proffer to enter but returned, we ſay, *there is a blemiſh*.

The *call*, is a leſſon blowed on the horn to comfort the hounds.—A *recheat*, is likewiſe a leſſon blown

blown on the horn.—The *mort* or *death*, is a lesson blown at the death of any deer.

A dog is subject to seven sorts of madness, *viz* the *hot burning madness*, *running madness*, *dumb madness*, *falling madness*, *lank madness*, *sleeping madness*, *rheumatick* or *slavering madness*; and the *mange*.

The two first of these *madnesses* are incurable, *viz.* the *burning* and the *running madness*.

The symptoms of the *burning madness* are these: when the dogs run, they raise their tails bolt up right, and run upon any thing that stand before them, having no regard where, nor which way they run; also their mouth will be very black, having no foam in or about it. They will not continue thus above three days, before they die. All dogs they have bitten and drew blood from will be mad likewise.

The *running madness* is less dangerous, though incurable. The dogs afflicted therewith run not on men, but on dogs, and other beasts. The symptoms are, they will smell on other dogs, and having smelt them will shake and bite them, yet shaking their tails, and seeming to offer no harm.

The *dumb madness* is curable, and is thus discovered; the dog that is troubled with it will not feed, but continually hold his mouth wide open, putting often his feet to his mouth, as if he had a bone in his throat. The cure is this; put four ounces of the juice of *spatula putrida* into a pot, taking the like quantity of the juice of black *hellebore*, and as much of the juice of *rue*, straining them all well through a fine cloth, and putting them into a glass; then take two drachms of scammony unprepared, and having mixed it with the juices, put it into a horn or funnel, and convey it down his throat, keeping his head up strait lest he cast it up again; then bleed him in the mouth, cutting three or four veins in his gums, that he may bleed the better. Or you may only take eight drachms of the juice of an herb called hartshorn or dog's-tooth, and you'll find it a most excellent receipt against any madness whatever.

The *falling madness* lies in their heads, which makes them reel as they go, and then fall.—The cure is this: take four ounces of the juice of piony, with the like quantity of the juice of briony, the like of the juice of *cruciata*, and four drachms of stavesacre pulverized; mix these together, and give it your dog or hound as aforesaid, then let him blood in the ears, or the two veins which come down the shoulders; and if he be not cured at first, give him a second or third dose.

The *lank madness*, thus called by reason of the leanness of their bodies, is occasioned by *skummering*.—The cure is thus performed: first purge your dog with this potion; take an ounce and a half of *cassia fistularis* well cleansed, two drachms and a half of stavesacre pulverized, and the like quantity of scammony prepared in white-wine vinegar, and four ounces of oil of olive, temper these and warm them over the fire, and give it your dog. In the morning put him into this bath fasting; put into five pails of water ten handfuls of mugworth, of rosemary, of red sage, the roots or leaves of marshmallows, the roots or leaves of wall-wort, the roots or stalks of fennel, the roots or leaves of elecampane, balm and rue, sorrel, bugloss, and melilot; let these boil together in two thirds of water, and the other of wine, to the consumption of one third; the bath being no hotter than your dog can endure it, bathe him in it for the space of an hour, then taking him out, put him in some warm place for fear of catching cold; which should be repeated four or five times to perfect the cure.

The *sleeping madness*, is caused by some little worms breeding in the entrance of the stomach from corrupt humours, the vapours and fumes whereof ascending into the head make the dog sleep continually, sometimes till he dies sleeping. For the cure, you must take five ounces of the juice of wormwood, with two ounces of burnt hartshorn in powder, and two drachms of agarick; mix them together, and if they be too thick add white-wine, and give it your dog to drink.

The *rheumatick* or *slavering madness*, is thus called, because when a dog is afflicted with it, his head swelleth, his eyes are very yellow, and he commonly slavereth at the mouth. The cure is performed thus; take six ounces of the juice of fennel-roots, and the like quantity of the juice of misseltoe, four ounces of the juice of ivy, four ounces of the roots of polipody in powder; boil these in white-wine, and give it your dog to drink as hot as he can suffer it.

The *mange* frequently proceeds from want of fresh water or drink, when a dog desires it, and sometimes by foul kennelling, sometimes likewise by foundering and melting his grease. To cure this distemper, take two handfuls of wild cresses, two handfuls of elecampane, as much of the leaves and roots of rhubarb and sorrel, and two pounds of the roots of frodels, which must be all well boiled in lie and vinegar: having strained the decoction, put in it two pounds of gray soap, and when it is melted, rub your dog with it four or five days together, and it will cure him.

There are some other terms and descriptions, particularly those relating to *forest* and *forest laws*, which must be learned before we can reckon ourselves perfectly well versed in the art of *hunting*.

A FOREST is a certain territory of woody grounds, and fruitful pastures, privileged for wild beasts, and fowls of forests, chace, and warren, to rest and abide in the same protection of the king, for his princely delight; bounded with unremoveable marks and meers, either known by matter of record or prescription; replenished with wild beasts of venery and chace, and with great coverts of vert, for succour of the said beasts; for preservation and continuance whereof, with the vert and venison, there are certain peculiar laws, privileges, and officers.

All the ground adjoining to forests, is called a *purlieu*, and a purlieu-man is he that hath ground within the purlieu, and 40 *s.* a year freehold, which entitles him to hunt, though with some caution, within his own purlieu.

The officers of a forest are, a forester, regarder, ranger, verderer, agistor, *&c.*

A CHACE is a place appointed to receive deer and beasts of the forests; in this it differs from a *forest*, that it may be in the hands of a subject; but a *forest*, properly speaking, cannot; and from a *park*, in that it is not inclosed like it, and has a larger compass, a greater store of game, and more keepers, and overseers.

The terms peculiar to forests, chaces, parks, *&c.* necessary for the knowledge of huntsmen, are thus explained:

Expeditate, is the cutting off (according to Mr. *Manwood*) the three fore-claws of the foot of a great dog, by the skin; and that the owner of every such dog, unexpeditated in the forest, shall forfeit 3 *s.* 4 *d.*

Fence month, hath 31 days, begins 15 days before *Midsummer*, and ends 15 days after; in which time it is unlawful to hunt in the forest, or to go among the deer to disquiet them; because it is the time of fawning.

Frank chace, is a liberty of free chace in a circuit annexed to a forest, whereby all those that have ground within the circuit, are forbidden to cut down wood, or discover, *&c.* within the view of the forester, though it is his own demesne.

Footgeld, is an amercement on such as live within the forest, for not expeditating their dogs. And to be quit of *footgeld*, is a privilege to keep their dogs unlawed, without any penalty.

With these instructions a sportsman may venture to take the field, on such a horse as he'll find described in the treatise on *horsemanship*; observing the following directions.

In BADGER-HUNTING, you must begin with seeking the earths and burrows where he lies, and in a clear moonshine-night go and stop all the burrows, except one or two, and therein place some sacks, fastened with drawing strings, which may shut him in as soon as he straineth the bag. Some use no more than to set a hoop in the mouth of the sack, and so put it into the hole; and as soon as the badger is in the sack and straineth it, the sack slippeth off the hoop and follows him into the earth, so he lies tumbling therein till he is taken. These sacks or bags being thus set, cast off the hounds, beating about all the woods, coppices, hedges, and tufts, round about, for the compass of a mile or two, and what badgers are abroad, being alarmed by the hounds, will soon betake themselves to their burrows; and observe that he who is placed to watch the sacks, must stand close and upon a clear wind; otherwise the badger will discover him, and will immediately fly some other way into his borrow. But if the hounds can encounter him before he can take his sanctuary, he will then stand at a bay like a boar, and make good sport, grievously biting and clawing the dogs, for the manner of their fighting is lying on their backs, using both teeth and nails; and by blowing up their skins defend themselves against all bites of the dogs, and blows of the men upon their noses as aforesaid. And for the better preservation of your dogs, it is good to put broad collars about their necks made of greys skins.

When the badger perceives the terriers to begin to yearn him in his burrow, he will stop the hole betwixt him and the terriers; and if they still continue baying, he will remove his couch into another chamber, or part of the burrow, and so from one to another, barricading the way before them, as they retreat, until they can go no further. If you intend to dig the badger out of his burrow, you must be provided with the same tools as for digging out a fox; and besides, you should have a pail of water to refresh the terriers, when they come out of the earth to take breath and cool themselves. It will also be necessary to put collars of bells about the necks of your terriers, which making a noise may cause the badger to bolt out. The tools used for digging out of the badger being troublesome to be carried on men's backs, may be brought in a cart. In digging, you must consider the situation of the ground, by which you may judge, where the chief angles are; for else, instead of advancing the work, you will hinder it. In this order you may besiege them in their holds, or castles, and may break their platforms, parapets, casemates, and work to them with mines and countermines, until you have overcome them.

BUCK

Buck-hunting. Here the fame hounds and methods are ufed, as in running the ftag; and, indeed, he that can hunt a hart or ftag well, will not hunt a buck ill.

In order to facilitate the chace, the game-keeper commonly felects a fat buck out of the herd, which he fhoots in order to maim him, and then he is run down by the hounds.

As to the method of hunting the buck: the company generally go out very early for the benefit of the morning. Sometimes they have a deer ready lodged, if not, the coverts are drawn till one is rouz'd; or fometimes in a park a deer is pitched upon, and forced from the herd, then more hounds are laid on to run the chace: if you come to be at a fault, the old ftaunch hounds are only to be relied upon till you recover him again: if he be funk and the hounds thruft him up, it is called an imprime, and the company all found a recheat; when he is run down, every one ftrives to get in to prevent his being torn by the hounds: fallow-deer feldom or never ftanding at bay.

He that firft gets in, cries *hoo-up*, to give notice that he is down and blows a death. When the company are all come in, they paunch him and reward the hounds; and generally the chief perfon of quality amongft them *takes fay*, that is, cuts his belly open, to fee how fat he is. When this is done, every one has a chop at his neck, and the head being cut off is fhewed to the hounds to encourage them to run only at male deer, which they fee by the horns, and to teach them to bite only at the head: then the company all ftanding in a ring, one blows a fingle death, which being done all blow a double recheat, and fo conclude the chace with a general halloo of hoo-up, and depart the field.

Fox-hunting makes a very pleafant exercife, and is either above or below ground.

1. Above ground. To hunt a fox with hounds, you muft draw about groves, thickets, and bufhes near villages. When you find one, it will be neceffary to ftop up his earth the night before you defign to hunt, and that about midnight, at which time he is gone out to prey: this may be done, by laying two white fticks a-crofs in his way, which he will imagine to be fome gin or trap laid for him; or elfe, they may be ftopped up with black thorns and earth mixed together.

At firft, only caft off your fure finders, and as the drag mends, add more as you dare truft them. The hound firft caft off fhould be old and ftaunch, and when you hear fuch a hound call on merrily, you may caft off fome others to him; and when they run it on the full cry, caft of the reft: thus you fhall complete your paftime. The words of comfort are the fame which are ufed in other chaces. The hounds fhould be left to kill the fox themfelves, and to worry and tear him as much as they pleafe.

When he is dead, hang him at the end of a pike-ftaff, and halloo in all your hounds to bay him; but reward them with nothing belonging to the fox, for it is not good, neither will the hounds in common eat it.

2. Under ground. If in cafe a fox does fo far efcape as to earth, countrymen muft be got together with fhovels, fpades, mattocks, pick-axes, &c. to dig him out, if they think the earth not too great. They make their earths as near as they can in ground that is hard to dig, as in clay, ftony ground, or amongft the roots of trees; and their earths have commonly but one hole; and that is ftrait a long way in before you come at their couch. Sometimes craftily they take poffeffion of a badger's old burrow, which hath a variety of chambers, holes, and angles.

Now to facilitate this way of *hunting the fox*: the huntfman muft be provided with one or two terriers to put into the earth after him, that is to fix him into an angle; for the earth often confifts of many angles: the ufe of the terrier is to know where he lies, for as foon as he finds him he continues baying or barking, fo that which way the noife is heard that way dig to him. Your terriers muft be garnifhed with bells hung in collars, to make the fox bolt the fooner; befides the collars will be fome fmall defence to the terriers.

The inftruments to dig withal are thefe; a fharp pointed fpade, which ferves to begin the trench where the ground is hardeft, and broader tools will not fo well enter; the round hollowed fpade, which is ufeful to dig among roots, having very fharp edges; the broad flat fpade to dig withal, when the trench has been pretty well opened, and the ground fofter; mattocks and pick-axes to dig in hard ground, where a fpade will do but little ferve; the coal-rake to cleanfe the hole, and to keep it from ftopping up; clamps, wherewith you may take either fox or badger out alive to make fport with afterwards. And it would be very convenient to have a pail of water to refrefh your terriers with, after they are come out of the earth to take breath.

After this manner you may befiege a fox, &c. in their ftrongeft holes and caftles, and may break their cafements, platforms, parapets, and work to them with mines and counter-mines till you have obtained what you defired.

Hare-hunting. If it be rainy, the hare ufually takes to the high-ways; and if fhe come to the

the ſide of a young grove, or ſpring, ſhe ſeldom enters, but ſquats down till the hounds have overſhot her; and then ſhe will return the very way ſhe came, for fear of the wet and dew that hangs on the boughs. In this caſe, the huntſman ought to ſtay an hundred paces before he comes to the wood-ſide, by which means he will perceive whether ſhe return as aforeſaid; which if ſhe do, he muſt halloo in his hounds, and call them back, and that preſently.

The next thing that is to be obſerved, is the place where the hare ſits, and upon what wind ſhe makes her form, either upon the north or ſouth wind; ſhe will not willingly run into the wind, but run upon a-ſide, or down the wind; but if ſhe form in the water, it is a ſign ſhe is foul and meaſled: if you hunt ſuch a one, have a ſpecial regard all the day to the brook ſides, for there, and near plaſhes, ſhe will make all her croſſings, doublings, &c.

Some hares have been ſo crafty, that as ſoon as they have heard the ſound of a horn, they would inſtantly ſtart out of their form, though it was at the diſtance of a quarter of a mile, and go and ſwim in ſome pool, and reſt upon ſome ruſh bed in the midſt of it; and would not ſtir from thence till they have heard the horn again, and then have ſtarted out again, ſwimming to land, and have ſtood up before the hounds four hours, before they could kill them, ſwimming and uſing all ſubtilties and croſſings in the water. Nay, ſuch is the natural craft and ſubtilty of a hare, that ſometimes, after ſhe has been hunted three hours, ſhe will ſtart a-freſh hare, and ſquat in the ſame form. Others having been hunted a conſiderable time, will creep under the door of a ſheep-coat, and there hide themſelves among the ſheep; or when they have been hard hunted, will run in among a flock of ſheep, and will by no means be gotten out from among them, till the hounds are coupled up and the ſheep driven into their pens. Some of them (and that ſeems ſomewhat ſtrange) will take the ground like a coney, and that is called, *going to the vault*. Some hares will go up one ſide of the hedge, and come down the other, the thickneſs of the hedge being the only diſtance between the courſes. A hare that has been ſorely hunted, has got upon a quickſet hedge, and ran a good way upon the top thereof, and then leapt off upon the ground. And they will frequently betake themſelves to furz buſhes, and will leap from one to the other, whereby the hounds are frequently in default.

Having found where a hare hath relieved in ſome paſture or corn-field, you muſt then conſider the ſeaſon of the year, and what weather it is; for if it be in the ſpring-time or ſummer, a hare will not then ſet in buſhes; becauſe they are frequently infeſted with piſmires, ſnakes, and adders; but will ſet in corn-fields, and open places. In the winter-time, they ſet near towns and villages, in tufts of thorns and brambles, eſpecially when the wind is northerly or ſoutherly. According to the ſeaſon and nature of the place where the hare is accuſtomed to ſit, there beat with your hounds, and ſtart her; which is much better ſport than trayling of her from her relief to her form.

After the hare has been ſtarted, and is on foot, then ſtep in where you ſaw her paſs, and halloo in your hounds, until they have all undertaken it, and go on with it in full cry; then recheat to them with your horn, following fair and ſoftly at firſt, making not too much noiſe either with horn or voice; for at the firſt, hounds are apt to overſhoot the chace thro' too much heat. But when they have run the ſpace of an hour, and you ſee the hounds are well in with it, and ſtick well upon it, then you may come in nearer with the hounds, becauſe by that time their heat will be cooled, and they will hunt more ſoberly. But, above all things, mark the firſt doubling, which muſt be your direction for the whole day; for all the doublings that ſhe ſhall make afterwards will be like the former, and according to the policies that you ſhall ſee her uſe, and the place where you hunt, you muſt make your compaſſes great or little, long or ſhort, to help the defaults, always ſeeking the moiſteſt and moſt commodious places for the hounds to ſcent in.

To conclude; thoſe who delight in hunting the hare, muſt riſe early, leſt they be deprived of the ſcent of her foot-ſteps.

HART *or* STAG-HUNTING. Firſt, encompaſs the beaſt in her own layer, and ſo unharbour her in the view of the dogs, that ſo you may never loſe her ſlot or footing. Neither muſt you ſet upon every one, either of the herd, or thoſe that wander ſolitary alone, or a little one, but partly by ſight, and partly by their footing and fumets, make a judgment of the game, and alſo obſerve the largeneſs of his layer.

The huntſman, having made theſe diſcoveries in order to the chace, takes off the couplings of the dogs, and ſome on horſeback, the others on foot, follow the cry, with the greateſt art, obſervation, and ſpeed, remembring and intercepting him in his ſubtile turnings and headings; with all agility leaping hedges, gates, pales, ditches: neither fearing thorns, down hills, nor woods, but mounting freſh horſe, if the firſt tire; follow the largeſt head of the whole herd, which muſt be ſingled out of the chace; which the dogs perceiving, muſt follow; not following any other. The dogs are animated to the ſport by the winding of horns, and the

the voices of the huntsmen. But sometimes the crafty beast sends forth his little squire to be sacrificed to the dogs and hunters, instead of himself, lying close the mean time. In this case, the huntsman must sound a retreat, break off the dogs, and take them in, that is, leam them again, until they be brought to the fairer game; which riseth with fear, yet still striveth by flight, until he be wearied and breathless. The nobles call the beast a *wise hart*, who, to avoid all his enemies, runneth into the greatest herds, and so brings a cloud of error on the dogs, to obstruct their farther pursuit; sometimes also beating some of the herd into his footings, that so he may the more easily escape, by amusing the dogs. Afterwards he betakes himself to his heels again, still running with the wind, not only for the sake of refreshment, but also because by that means he can the more easily hear the voice of his pursuers, whether they be far from him, or near to him. But at last being again discovered by the hunters and sagacious scent of the dogs, he flies into the herds of cattle, as cows, sheep, &c. leaping on a cow or ox, laying the fore parts of his body thereon, that so touching the earth only with his hinder feet, he may leave a very small or no scent at all behind, for the hounds to discern.

But their usual manner is, when they see themselves hard beset, and every way intercepted, to make force at their enemy with their horns, who first comes upon him, unless they be prevented by spear or sword. When the beast is slain the huntsman with his horn windeth the fall of the beast, and then the whole company comes up, blowing their horns in triumph for such a conquest; among whom, the skilfullest opens the beast, rewards the hounds with what properly belongs to them, for their future encouragement; for which purpose the huntsmen dip bread in the skin and blood of the beast, to give to the hounds.

It is very dangerous to go in to a *Hart at bay*, of which there are two sorts, one on land and the other in water. Now if the Hart be in a deep water, where you cannot well come at him, then couple up your dogs; for should they continue long in the water, it would endanger their surbating or foundering. In this case, get a boat, and swim to him, with dagger drawn, or else with rope that has a noose, and throw it over his horns; for if the water be so deep that the Hart swims, their is no danger in approaching him; otherwise you must be very cautious.

As to a *land-bay*; if a *Hart* be burnished, then you must consider the place; for if it be in a plain and open place, where there is no wood nor covert, it is dangerous and difficult to come in to him; but if he be on a hedge-side, or in a thicket, then, while the *Hart* is staring on the Hounds, you may come softly and covertly behind him, and cut his throat. If you miss your aim, and the *hart* turn head upon you, then take refuge at some tree; and when the *hart* is at bay, couple up your hounds: and when you see the *hart* turn head to fly, gallop in, roundly to him, and kill him with your sword.

Directions at the death of a HART *or* BUCK.

The first ceremony, when the huntsman comes in to the death of a deer, is to cry, *ware haunch*, that the hounds may not break in to the deer; which being done, the next is the cutting his throat, and there blooding the youngest hounds, that they may the better love a deer, and learn to leap at his throat: then the mort having been blown, and all the company come in, the best person, who hath not *taken say* before, is to take up the knife that the keeper or huntsman is to lay across the belly of the deer, some holding by the fore-legs, and the keeper or huntsman drawing down the pizzle, the person who *takes say*, is to draw the edge of the knife leisurely along the middle of the belly, beginning near the brisket, and drawing a little upon it, enough in the length and depth to discover how fat the deer is; then he that is to break up the deer, first slits the skin from the cutting of the throat downwards, making the arber, that so the ordure may not break forth, and then he paunches him, rewarding the hounds with it.

In the next place, he is to present the same person, who *took say*, with a drawn hanger, to cut off the head of the deer. Which being done, and the hounds rewarded, the concluding ceremony is, if it be a stag, to blow a tripple mort; and if a buck, a double one; and then all who have horns, blow a recheat in concert, and immediately a general whoop, whoop.

OTTER-HUNTING is performed with dogs, and also with a sort of instruments, called *otter-spears*, with which, when they find themselves wounded, they make to land, and fight with the dogs, and that most furiously, as if they were sensible that cold water would annoy their green wounds.

There is indeed craft to be used in hunting them; but they may be catched in snares under water, and by river-sides; but great care must be taken, for they bite sorely and venomously; and if they happen to remain long in the snare, they will get themselves free by their teeth.

In hunting them, one man must be on one side of the river, and another on the other, both beating the banks with dogs; and the beast not being able

able to endure the water long, you will ſoon diſcover, if there be an otter, or not, in that quarter; for he muſt come out to make his ſpraints, and in the night ſometimes to feed on graſs and herbs.

If any of the hounds finds out an otter, then view the ſoft grounds and moiſt places, to find out which way he bent his head; if you cannot diſcover this by the marks, you may partly perceive it by the ſpraints; and then follow the hounds, and lodge him as a hart or deer. But if you do not find him quickly, you may imagine he is gone to couch ſomewhere farther off from the river; for ſometimes they will go to feed a conſiderable way from the place of their reſt, chooſing rather to go up the river than down it. The perſons that go a hunting otters, muſt carry their ſpears, to watch his vents, that being the chief advantage; and if they perceive him ſwimming under water, they muſt endeavour to ſtrike him with their ſpears, and if they miſs, muſt purſue him with the hounds, which, if they be ſo good and perfectly entered, will go chanting and trailing along by the riverſide, and will beat every root of a tree, and oſierbed, and tuft of bull-ruſhes; nay, they will ſometimes take water, and bait the beaſt, like a ſpaniel, by which means he will hardly eſcape.

ROE-BUCK-HUNTING is performed divers ways, and very eaſily in the woods.

When chaſed, they uſually run againſt the wind, becauſe the coolneſs of the air refreſhes them in their courſe; therefore the huntſmen place their dogs with the wind: they uſually, when hunted, firſt take a large ring, and afterwards hunt the hounds. They are alſo often taken by counterfeiting their voice, which a ſkilful huntſman knows how to do by means of a leaf in his mouth. When they are hunted, they turn much and often, and come back upon the dogs directly; and when they can no longer endure, they take ſoil, as the hart does, and will hang by a bough in ſuch a manner, that nothing of them ſhall appear above the water but their ſnout, and they will ſuffer the dogs to come juſt upon them before they will ſtir.

The veniſon of a *roe-buck* is never out of ſeaſon, being never fat, and therefore they are hunted at any time; only that ſome favour ought to be ſhewn the *doe*, while ſhe is big with fawn, and afterwards till her fawn is able to ſhift for himſelf. He is not called, by the ſkilful in the art of hunting, a *great* roe-buck, but a *fair* roe-buck; the herd of them is called a bevy: and if he hath not bevy-greaſe upon his tail, when he is broken up, he is more fit to be dog's meat than man's meat.

The hounds muſt be rewarded with the bowels, the blood, and feet ſlit aſunder, and boiled all together.

From thoſe words of God to *Adam*, *Gen.* i. 26, 28. and to *Noah*, *Gen.* ix. 2, 3. *Hunting* was conſidered as a right devolved, or made over to man; and the following ages appear to have been of the ſame ſentiment. Accordingly we find that among the more civilized nations, as the *Perſians*, *Greeks*, and *Romans*, it made one of their genteeler diverſions; and as to the wilder and more barbarous, it ſerved them with food and neceſſaries. The *Roman Juriſprudence*, which was formed on the manners of the firſt ages, made a law of it, and eſtabliſhed it as a maxim, that as the natural right of things which have no maſter, belongs to the firſt profeſſor; wild beaſts, birds, and fiſhes, are the property of whoever can take them firſt. But the northern nations of *Barbarians* who overrun the *Roman* empire, bringing with them a ſtronger taſte for the diverſion; and the people being now poſſeſſed of other and more eaſy means of ſubſiſtence, from the lands and poſſeſſions of thoſe they had vanquiſhed; their chiefs and leaders began to appropriate the right of *Hunting*, and inſtead of a natural right, to make it a royal one. Thus it continues to this day; the right of *hunting* among us belonging only to the king, and thoſe who derive it from him.

H U S B A N D R Y.

IT would be very proper to introduce this treatiſe, with principles of vegetation: but that has been already done in the head of *Gardening*. We ſhall therefore begin with our remarks on *Tillage*.

Tillage is the art of dividing the particles of the natural earth to advantage, or to render it fruitful.

This diviſion is made either by fermentation, *i. e.* by mixing *dung* with the earth, or by breaking the native earth mechanically into parts with a ſpade, a plough, a hoe, or any other inſtrument invented for ſuch a purpoſe.

The moſt profitable method to increaſe the fruitfulneſs of land is, the laſt mentioned; not only, on account of the ſcarcity and price of *dung*, but becauſe the particles of earth may be divided and ſubdivided, *ad infinitum*.

It is alſo worthy our attention, that no grain nor roots, nor pulſe ſown in land, manur'd with *dung*, ever have the fine flavour as thofe produced in a good foil, that has not been dung'd.

Befides *dung* harbours infects, which live upon, and deftroy the plants and grain.

Not that *dung* fhould be totally rejected. It is neceffary in clay lands which have their parts fo clofe: it prevents the parts re-uniting after being divided by tillage: fo that the roots can't penetrate them without great difficulty: and confequently, they muft languifh for want of nourifhment. And it is no lefs neceffary for fuch light lands, as contain but few nutritive parts.

Whenever *dung* is ufed in cultivating of land, prepare the dunghill in this manner. Sprinkle each layer of *dung* with quick-lime. This will kill the infects, deftroy the feeds of weeds, enrich the dung, and warm a cold earth.

Tho' dung be ufed, the hufbandman muft not fpare his labour in the tillage: on the contrary, he will find the moft profit by multiplying the frequent plowings of the earth, and not be content with *rolling* and *harrowing:* for in very moift land, the roller will do it more hurt than good; and to fcratch the earth with a harrow, is not only of little fervice, but when it is moift, the horfes poach and damage it confiderably.

If the ground to be broke up be *wood land*, the earth is fo well broken into particles, by grubbing up the roots of the trees, that you need give it only one plowing in autumn, and another in the fpring.

If it be covered with broom, heath, rufhes, fern, bufhes, and briars, burn them towards the end of fummer, when the plants are wither'd. Then grub up the ftrongeft roots with a pick-ax: and after the autumnal rains, plow the land into high ridges, with a ftrong plough. Another plowing in the fpring prepares it for fowing it with oats. The fecond year will require three thorough plowings, and it will be fit for wheat in the third year,

If it be pafture or meadow land to be tilled, one ploughing in autumn, and another in fpring: if it be not too wet, fits it for oats. But it won't yield a good crop of wheat, till the earth be finely reduced for that grain, which requires more nourifhment than oats.

Lands thus ploughed for eight or ten years fhould then be burnt, that the particles may be better divided.

If the land fhould be marfhy, drain off the water by ditches or trenches, and then treat it as above.

The Manures are the next object of the hufbandman's attention.

Clay, fays Mr. *Evelyn*, p. 22, of his *Terra*, is of all other a curft ftep-dame to almoft all vegetation, as having few or no *meatus's* for the percolation of the alimental fhowers, or expanfion of the roots; whether it be the voracious, hungry, weeping, or cold fort. In thefe cafes *laxatives* are to be prefcribed, fuch as drift *fand*, fmall *gritty gravel*, *fawduft*, with *marle* or *chalk*, and continually vexing it with the fpade or plow; but above all, with *fea-fand*, where it may be procured, and the burning of the ground to *afhes*, and all that it bears, the more the better; for by no lefs feverity will this ill-natur'd mould be fubdued: *rotten wood*, and the bottom of bavine ftacks, are good ingredients to this manure; and if it be a cold and wet fort, ftrewings of *foot* are good; if very ftiff, rubbifh of *brick*, *lime-ftone*, and fuch trafh, may properly be laid at the bottom, and on the upper part *compofts* of *dung*.

Rotten-wood, and *faw-duft* when rotted, fays Mr. *Miller* too, is a very good manure for ftrong lands, becaufe it loofens the parts of the earth, and renders it light.

Mr. *Lifle*, Vol. I. p. 26. advifes, as a good way, to tame harfh, churlifh, obftinate clay, to fling it up in ridges in the winter, and after the firft froft, when it thaws and molders, to fling and temper amongft it *afhes* or *chalk*, or whatfoever you have to qualify it: for the time being nickt, wherein you can catch the clayey corpufcles under the greateft difunion and feparation, is the time for keeping them fo, by mixing thefe other lighter bodies amongft them, which will the longeft prevent them from their re-union.

Sea-fand and *fhells* are ufed to great advantage as a manure, in many places where they can be had without too much expence. Mr. *Miller* advifes them chiefly for cold ftrong land, and *loam* inclining to *clay*. They feparate the parts; and the falts which are contained in them, are a very great improvement of land. Coral, and fuch kind of ftony plants which grow on the rocks, are filled with falts which are very beneficial to land. But as thefe bodies are hard, the improvement is not the firft or fecond year after they are laid on the ground, becaufe they require time to be pulverifed before their falts can mix with the earth to impregnate it. The confequence of this is, that their manure is lafting. *Sand*, and the fmaller kinds of *fea-weeds*, will inrich land for fix or feven years; and *fhells*, *corals*, and other hard bodies, will continue many years longer.

In fome countries, at a great diftance from the fea, great quantities of foffil-fhells have been difcovered, and ufed with fuccefs as manure: but they are not near fo full of falts, as thofe fhells which are taken from the sea-shore; and therefore the latter are always to be preferred.

Sea-sand is much used as manure in *Cornwall*, says Mr. *Borlace* in his *Natural History of that county*. The best is that which is intimately mixed with coral. In places where this excellent manure is found, it is taken up by a large bag of the strongest canvas, to the mouth of which is fitted an iron hoop or frame for keeping it open, and sinking it to the bottom of the sea, so as it may receive the sand and coral as it is dredged along by the bargemen. A barge-load is usually delivered for ten shillings, or less if near the place of dredging: and where the land is good, a barge-load will dress an acre. It is used more for corn, than pasture grounds. It gives the heat of lime, and the fatness of oil, to the land it is laid upon. Being more solid than shells, it conveys a greater quantity of fermenting earth in equal space. Besides, it does not dissolve in the ground so soon as shells, but decaying more gradually, continues longer to impart its warmth to the juices of the earth. It is chiefly found in *Falmouth* harbour, and the shores adjoining. Not only *sea-sand* is used as manure by every one who has it in his reach, but after storms they find the *alga marina*, *fucus conserva*, or ore weed, one of the best manures which nature affords, scattered in great plenty on the shore. Being a sub-marine plant, the wind and sun soon exhale its moisture: the sooner therefore it is taken from the shore, the better; and being spread on old and stiff earth, then covered with sand, it soon dissolves into a salt oily slime.

This is the most approved way of applying it. Some lay it naked and fresh from the sea, upon their barley lands, in the end of *March* and beginning of *April*, and have a good crop of corn: but the weeds grow so plentifully and rank afterwards, that no wholsome grass for pasture is to be expected for that year. Sir *George M'Kenzie* observes (*Phil. Trans.* No. 117.) that lands often used to this manure yield bad oats, and in a small quantity, the husks thicker than ordinary, and more darnel among the corn, than in lands which have not so much ore-weed laid upon them.

The use of *sand*, as Mr. *Miller* observes, is to make the clayey earth fertile, and fit to feed vegetables, &c. for earth alone, we find, is liable to coalesce, and gather into a hard coherent mass, as is apparent in clay; and earth thus embodied, and, as it were, glued together, is no ways disposed to nourish vegetables: but if with such earth, sand, &c. *i. e.* hard crystals, which are not dissolvable in water, and still retain their figure, be intermixed, they will keep the pores of the earth open, and the earth itself loose and incompact, and by that means give room for the juices to ascend, and for plants to be nourished thereby.

Thus, a vegetable, planted either in sand alone, or in a fat glebe, or earth alone, receives no growth or increment at all, but is either starved or suffocated: but mix the two, and the mass becomes fertile. In effect, by means of sand, the earth is rendered, in some manner, organical; pores and interstices being hereby maintained, something analogous to vessels, by which the juices may be conveyed, prepared, digested, circulated, and at length excerned, and thrown off into the roots of plants.

Sea-sand, continues Mr. *Miller*, is accounted a very good compost for stiff ground, for it effects the two things following, *viz.* It makes way for the tree or seed to root in stiff ground, and makes a fume to feed it.

Chalk, lime, rubbish of old houses, or, in short, whatever loosens the body of the *clay*, are good manures.

Shell-Marle, or any *marle*, which, dropt into vinegar, makes a strong effervescence, is a peculiarly good manure for *clay*: for, dissolving easily in water, it gives a freer passage to it, whereby the *clay* is kept dry even in winter; and if the *clay* is of a cold acid quality, the absorbent quality of the *marle* destroys that acidity, and keeps the *clay* warm. Many late experiments prove the truth of this, its effects being much beyond what could have been expected.

In very cold moist land, says Mr. *Miller*, I have frequently seen new *horse-dung* buried as it came from the stable, and always observed that the crops have succeeded better, than where the ground was dressed with very rotten dung.

Sheeps dung and *deers dung* are nearly of the same quality, and are esteemed by some the best of dungs for cold clays. Some recommend beating them into powder, and spreading them very thin over autumn or spring crops, about four or five loads to an acre, in the same manner that *ashes*, *malt-dust*, &c. are strewed. But these light dressings do not last long.

In *Flanders*, and other parts, they house their *sheep* at nights in places spread with clean sand, laid about five or six inches thick; which, being laid on fresh every night, is clear'd out once a week. This mixture of *sand* and *dung*, makes an excellent dressing for strong land; for the *dung* and *urine* of the *sheep* is a very rich manure. Mr. *Quintency* thinks it the greatest promoter of fruitfulness in all sorts of ground. Others recommend *hogs dung*, as the fattest and most beneficial of any.

The

The *dung* of *pigeons* and *poultry* is especially good for cold, wet, clayey lands: but it ought to be dried before it be strewed, because it is naturally apt to clod in wet; and it should be mixed with earth or sand to keep it from clogging together, that it may be strewed thin, being naturally very hot and strong.

Human dung is another great improver of all cold sour lands, and especially if it be mixed with other earths or dungs to give it a fermentation.

But there is not any sort of manure equal to the cleansing of the streets of great cities, for all stubborn clayey soils, the parts of which will be better separated, and in a much less time, with this manure, than with any other compost whatsoever.

SAND. By the same rule that *sand* fertilises strong clayey grounds, *clay* meliorates light and sandy soils. But this manure can never have its due effect, unless it be well broken, and divided into such small particles as to be able to incorporate thoroughly with the light earth.

Arenous and sandy earth, says Mr. *Evelyn*, p. 19. wants ligature; and besides, consisting of sharp and asperous angles, wounds and galls, curls and dwarfs our plants, without extraordinary help, to render the passages more slippery and easy: and therefore relenting *chalks*, or *chalk-marle*, is profitable, with *calcinations* of *turf*, or *sea-wrack*, where it is at hand: and if the soil be exceeding bibulous, spread a layer or couch of *loam*, discreetly mingled at the bottom, to entertain the moisture. — *Sand*, being of an open and loose contexture, is apt to put forth a forward spring, as more easily admitting the solar rays: but it does not continue, and is an infirmity which may be remedied with *loam*, which not only unites it closer for the present, but is capable in time to alter and change its very nature also, so as too hot a *compost* be no ingredient with it. — If the soil be *sandy*, or other light mixed earth, imbody it with something of a fatter nature, as *marle*; and be sure so to stir and lay it (especially if with *loam*) that it may not sink too deep, and suddenly, as 'tis apt to do, and so desert the surface-mould, where it should do the feat, and therefore it is to be the oftner repeated.

Dr. *Lister* divides the *English* sands into two classes: the first, sharp or red sand, consisting of small transparent pebbles, naturally found on the mountains, and not calcinable: the second, soft or smooth.

Mr. *Miller* observes, that grounds which are sandy and gravelly, easily admit both of heat and moisture; but then they are liable to these inconveniences, that they let them pass too soon, and so contract no ligature, or else retain them too long, especially where there is a clay bottom; and by that means they are either parched or chilled too much, and produce nothing but moss and cankerous infirmities; but if the sand happens to have a surface of good mould, and a bottom of gravel or loose stone, though it do not hold the water it may produce a forward sweet grass; and though it may be subject to burn, yet it quickly recovers with the least rain.

Sand indeed is apt to push the plants that grow upon it, early in the spring, and make them germinate near a month sooner than those that grow upon *clay*; because the salts in the sand are at full liberty to be raised and put into motion, upon the least approach of the warmth of the sun: but then, as they are hasty, they are soon exhaled and lost.

Clay is another excellent manure, says the author of the *New System of Husbandry*, p. 124. and easy enough to be found in all places: but you must observe, 'tis only useful upon *sandy* grounds, or any lands of a nature entirely different from its own; among which you may reckon *gravelly* or *pebbly* soils. To these it brings the only part of excellence they naturally want, and consequently changes them, from what they were originally, to an equal fertility with the best and richest.

This will, perhaps, be strange news to many countrymen, who have bought *dung*, all their lifetime, to destroy their land with. 'Tis as great a folly, adds our author, to *dung* grounds which require *cooling*, as 'twould be thought to administer *poison*, to cure a man of a *fever*. Our farmers are not sensible, that the *temper* of the *land* must, as necessarily, be consulted, as the *pulse* of the *patient*. The dunghill only is their universal refuge; they fly to *that* upon all occasions. They miss a crop, by dunging an improper soil; and lay on more dung to remedy the misfortune.

The practice of the *North-Riding* of *Yorkshire*, as related by Dr. *Lister*, *Phil. Transact.* N°. 225. shews to how great advantage *clay* is made use of there, as a manure. The *clay* is of a bluish colour, not sandy at all, but very ponderous. They dry it about *Midsummer*, on the declivity of a hill, and lay 100 loads on an acre of ground of a light sandy soil. They observe, that for three or four years it continues yet in clods upon the land; and that the first year, the land so manured bears rank ill-coloured and broad-grain'd barley, but afterwards a plump round corn like wheat. This clay manuring will, by certain experience, last above forty-years in the ground, and then it must be clayed again. This sandy ground, unless clayed, will bear nothing but rye, whatever other manure they use.

Clay becomes a much better manure when mixed with *lime*, then perhaps either of them are ſingly. The *lime* corrects the bad qualities of the *clay*, by rendering it more friable.

Sea-ouſe, that is, the ſettling of the tides on ſhores, and level places, between low and high-water mark, is a manure of incomparable excellence for many ſorts of lands; but is, on others, to be avoided, as a certain bane to whatever part 'tis mixed with. Looſe ſandy ſoils are peculiarly benefited by it.

The cleaning of ponds and ditches becomes likewiſe here an excellent manure, conſiſting of the putrified animal and vegetable bodies mixed with the rich earth depoſited there by rains, &c. The ſame may be ſaid of the mud in rivers, where, by the ſtagnating, or want of current in the water, the rich particles carried down by it have time to ſubſide.

But of all the manures for ſandy ſoils, none is ſo good as *marle*. There are many different kinds and colours of it, ſeverally diſtinguiſhed by many writers; but their virtue is the ſame; and they may all be uſed upon the ſame ground, without the ſmalleſt difference in their effect.

The colour is, either *red*, *brown*, *yellow*, *blue*, *gray*, or *mix'd*. It is to be known by its pure and uncompounded nature. There are many marks to diſtinguiſh it by; ſuch as its breaking into little ſquare bits; its falling eaſily to pieces, by the force of a blow, or upon being expoſed to the ſun, and the froſt; its feeling fat and oily, and ſhining when 'tis dry.—But the moſt unerring way to judge of *marle*, and know it from any other ſubſtance, which may appear like it, is, to break a piece as big as a large nutmeg, and, when 'tis quite dry, drop it to the bottom of a glaſs of clear water, where, if it be right, it will diſſolve and crumble, as it were to duſt, in a very little time, ſhooting up many ſparkles to the ſurface of the water.

Loam, being free from the too great ſtiffneſs of *clay*, and the too little coheſion of *ſand*, in order to its due culture, ſeems only to ſtand in need of being kept in good tilth, and ſupplied at proper ſeaſons with ſuch ſubſtances as the experience of ages has ſhewn to contain in them matter fit for the nouriſhment of plants, or at leaſt to be endued with the power of rendering the earth fruitful. Such ſubſtances we ſhall therefore call *general manures*. Of theſe, dungs of all kinds, putrid, vegetable and animal ſubſtances, aſhes of vegetables, and even of ſea-coal and peat, ſoot, and lime, are the chief.

Dungs, as Mr. *Miller* obſerves, are deſigned to repair the decays of exhauſted worn out lands, and to cure the defects of land, which are as various in their qualities as the dungs are, that are uſed to meliorate and reſtore them. Some lands abound too much in coldneſs, moiſture, and heavineſs; others again are too light and dry; and ſo, to anſwer this, ſome dungs are hot and light, as that of ſheep, horſes, pigeons, &c. others again are fat and cooling, as that of oxen, cows, hogs, &c. And as the remedies that are to be uſed, muſt be contrary to the diſtempers they are to cure; ſo the dung of oxen, cows, and hogs, muſt be given to lean, dry, light earths, to make them fatter and cloſer; and hot and dry dungs to meliorate cold, moiſt, and heavy lands.

There are, continues he, two peculiar properties in *dung*: the one is to produce a certain ſenſible heat, capable of producing ſome conſiderable effect, which properties are ſeldom found but in the *dung* of horſes and mules, while it is newly made, and a little moiſt: the other property of *dung* is, to fatten the earth, and render it more fruitful.

The *dung* of horſes and mules is an admirable fertilizer: but care muſt be taken not to lay too much of it on corn lands, becauſe it produces abundance of ſtraw.

Horſe *dung*, being of a very hot nature, is beſt for cold lands, and cow dung for hot lands; and being mixed together, may make a very good manure for moſt ſorts of ſoils, and for ſome they may be mixed with earth.

The *dung* of pigeons and fowls is ſo rich, that it is generally uſed for a dreſſing to plants whilſt they are growing. That of pigeons, ſays Mr. *Miller*, is the beſt ſuperficial improvement that can be laid on meadow or corn land: but before it is uſed, it ought to have lain abroad out of the dove-houſe ſome time, that the air may have a little ſweetened it, and mollified the fiery heat that is in theſe *dungs*.

The *dung* of poultry being hot and full of ſalts, tends much to facilitate vegetation: and is abundantly quicker in its operation, than the *dung* of animals which feed on herbs.

To animal ſubſtances belong all parts of their bodies, as fleſh, blood, ſhavings of bones, hoofs, rags of their wooll or hair, &c.

Mr. *Evelyn* ſays, the blood and fleſh of animals is much more powerful for the enriching of land, than their dung and excrements, and is computed at twenty times the advantage; and to the ſame advance above this, is hair and calcined bones. Woollen rags are peculiarly uſed for light ſoils. They ſhould be chopt ſmall, about an inch or two ſquare, and ſcattered on the earth at the ſecond plowing; for being thereby covered, they will begin to rot by ſeed-time. They imbibe the moiſture

of

of dews and rain, and retain it long; and, as Dr. *Home* obſerves, thereby keep light ſoils in a moiſt ſtate. The ſame may be ſaid of the hoofs of cattle, when ſet upright in the earth, as Mr. *Ellis* directs. They hold the rain that drops into them, and it putrifies there, till, being worked out by ſucceeding ſhowers, it falls upon the ſurrounding earth, and communicates a great fertility to it.—Sea-ſhells may likewiſe be included under this head: but we have already ſpoken of them, in the article *clay*.

Vegetables afford great abundance of excellent manure. The cuſtom of plowing in green ſucculent plants, is very antient. All the *Roman* authors ſpeak of it particularly. Buck wheat and vetches are the two plants moſt frequently ſown in *England* for that purpoſe; and the time of plowing them in, is when they are in bloom, being then in their moſt ſucculent ſtate. Some farmers plow in their ſecond crop of clover, to enrich the land for wheat in the autumn. This ſhould be done early enough to give the plants ſufficient time to putrify thoroughly before the grain is ſowed: otherwiſe it might prove prejudicial, by bringing on a heat which would hurt the corn. Sea-weeds of all ſorts are a moſt profitable manure to be plowed in.

Rotten vegetables of moſt ſorts, ſays Mr *Miller*, greatly enrich land: ſo that, where other manure is ſcarce, theſe may be uſed with great ſucceſs. The weeds of ponds, lakes, or ditches, being dragged out before they ſeed, and laid on heaps to rot, will make excellent manure; as will moſt other ſorts of weeds. But wherever any of theſe are employed,t hey ſhould be cut down as ſoon as they begin to flower: for if they are ſuffered to ſtand untill their ſeeds are ripe, the land will be ſtored with weeds, which cannot be deſtroyed in two or three years; nay, ſome kind of weeds, if they are permitted to ſtand ſo long as to form their ſeed, will perfect them after they are cut down, which may be equally prejudicial to the land: therefore the ſureſt way is to cut them down juſt as they begin to flower; at which time moſt ſorts of vegetables are in their greateſt vigour, being then ſtronger and fuller of juice, than when their ſeeds are farther advanced: ſo that at that time they abound moſt with ſalts, and therefore are more proper for the intended purpoſe. In rotting theſe vegetables, it will be proper to mix ſome earth, mud, or any other ſuch like ſubſtances with them, to prevent their taking fire in their fermentation; which they are very ſubject to, when they are laid in large heaps, without any other mixture to prevent it: and it will be proper to cover the heaps over with earth, mud, or dung, to detain the ſalts; otherwiſe many of the finer particles will evaporate in fermenting. When theſe vegetables are thoroughly rotted, they will form a ſolid maſs, which will cut like butter, and be very full of oil, which will greatly enrich the land.

Another manure,greatly,and very properly recommended by this gentleman, is rotten tanner's bark. Oak-bark, ſays he, after the tanners have uſed it for tanning of leather, when laid in a heap, and rotted, is an excellent manure eſpecially for ſtiff cold land; in which one load of this manure will improve the ground more, and laſt longer, than two loads of the richeſt dungs. It is better for cold ſtrong land, than for light hot ground, becauſe it is of a warm nature, and will looſen and ſeparate the earth; ſo that where this manure has been uſed three or four times, it hath made the land very looſe, which before was ſtrong, and not eaſy to be wrought. When this manure is laid on graſs, it ſhould be done ſoon after *Michaelmas*, that the winter rains may waſh it into the ground: for if it is laid on in the ſpring, it will burn the graſs, and, inſtead of improving it, will greatly injure it for that ſeaſon. Where it is uſed for corn land, it ſhould be ſpread on the ſurface before the laſt plowing, that it may be turned down for the fibres of the corn to reach it in the ſpring; for if it lies too near the ſurface, it will forward the growth of corn in winter; but in the ſpring, when the nouriſhment is chiefly wanted to encourage the ſtem, it will be nearly conſumed, and the corn will receive little advantage from it.

Aſhes of all green vegetables contain an alkaline ſalt, of great uſe as a manure, but eaſily diſſolved in water, and carried off. Greater care ſhould therefore be taken to keep ſuch aſhes covered from the air, till uſed.

Peat-aſhes are likewiſe of great ſervice. We ſhall here give Mr. *Ellis*'s account of this manure in his own words, vol. II. p. 68. "If barley, ſays he, is ſown ſo late as the beginning of *May*, lean peat-aſhes in particular may be applied over it, or harrowed in with the grain: but aſhes burnt from fat black peat, ſuch as they dig at *Newbury*, are of ſuch a ſulphurous nature, that they are afraid to lay them on their barley; and they do not dreſs their wheat with them till the ſpring is advanced, and then they are ſown over it.—The great uſe of theſe aſhes was found out about thirty (now fifty) years ago: but in a little time after they were brought into diſreputation, by their imprudently laying on too many at a time, which burnt up the corn. Afterwards they found that ſix or ten buſhels were ſufficient to be ſown over an acre of wheat, peaſe, turneps, clover, rape-ſeed, or St. Foyne, as early as they conveniently could. But, as I ſaid before, they are afraid to ſow it over barley, leſt a dry time ſhould enſue, and burn it up; for theſe aſhes are reckoned to contain three times as much ſulphur in them, as there is in coal aſhes; and this they reaſonably imagine from their great brimſtone ſmell, ſparkling and jumping, when they are ſtirred as they are burning, and drying up the corn by their too great heat. Theſe peat-aſhes, and likewiſe thoſe from wood or coal, will help to keep off the ſlug from peaſe and other grains, by the ſalt and ſulphur contained in them, and very much conduce to their preſervation in cold wet ſeaſons. But there is no ſuch danger to be feared from the aſhes of that peat, which grows as a turf over ſandy bottoms, as great quantities do on *Leghton-heath*, in *Bedfordſhire*; for theſe are as much too lean, as the others are too rank."

Soot, either of vegetables or of coal, is reckon'd a good improver of cold and moiſt grounds. Many find their account in ſtrewing it early over their green wheat and barley: but Mr. *Ellis* ſays, neither of them ought by any means to be footed after the 25th of *April*, becauſe the wheat, and generally the barley, have then done gathering and branching, and are upon the ſpindle. He thinks it likewiſe proper to be ſown over young turneps, that have all juſt appeared. Care ſhould be taken not to ſtrew it too thick; for otherwiſe its hot nature might hurt the plants.

Malt-duſt is a good manure for poor clayey lands; and will oftentimes go farther than dung. It is moſt beneficial when rain falls upon it ſoon after its being ſtrewed, and waſhes it into the earth before it has loſt its ſtrength. In ſome parts of *Berkſhire*, they lay the *malt-duſt* on at the ſame time that they ſow the wheat, and harrow them both in together. This they find turn to good account. Some huſbandmen hold it to be better for ſummer corn, than for wheat, and the reaſon they aſſign is, that the winter corn lies a whole year in the ground, and the *malt-duſt* will have ſpent its ſtrength by the time the winter is over, and not hold up the corn in heart all the ſummer. They ſow with the wheat two quarters of *malt-duſt* to an acre, which makes four quarters of corn meaſure.

This manure is likewiſe a great improvement to cold graſs grounds.

All ſorts of fern, ſtraw, brake, ſtubble, ruſhes, thiſtles, leaves of trees, or any manner of vegetable traſh whatever, ſays Mr. *Worlidge*, either caſt into the yards amongſt the cattle or ſwine, or caſt into pools or places to rot in, or mixed with other ſoils, help very much, and make very good compoſt. The lees of wine and the grounds and ſettlings of beer, ale, &c. have the ſame effect.

Chalk is a laſting manure for lands that it agrees with. *Pliny* tells us it was the cuſtom of the *Britons* to chalk their lands, by which, ſays he, they received a great improvement, which laſted their lives.

It is a general ſaying, that chalking is better for the father than the ſon; but experience often ſhews it to be as good an improvement as *dung*, for twenty years together: and that clay land has been always the better for it.

There are ſeveral ſorts of *chalk*: ſome of ſo hard and indiſſoluble a nature, that it is not fit to lay on lands ſimply as it is, but after it is burnt into *lime*, it becomes an excellent improver. Other ſorts of *chalk*, more unctuous and ſoluble, being laid on lands crude as they are, and let lie till the froſts and rain ſhatter and diſſolve them, prove a very conſiderable advantage to barren lands.—Where any of theſe *chalks* are found, Mr. *Worlidge* adviſes proving their natures, by laying them on ſome ſmall portion of land, crude as they are, or by burning them into *lime*, if fewel be plenty, or to half-burn them; by which, ſays he, you may experimentally know the true effects and benefits that ſubject will yield.—And although, continues he, *chalk*, ſimply of itſelf, either burnt or unburnt, may not prove ſo advantageous as many have reported, yet it is of very great uſe to be mixed with earth and the dungs of animals, by which may be made an admirable, ſure, and natural fruitful compoſition for almoſt any ſort of lands, and raiſeth corn in abundance.

Chalk ought never to be plowed in, either too ſoon or too deep. It ſhould have time to crack and waſte on the ſurface of the earth, and not be turned down to the bottom of the furrow, leſt it ſhould ſubſide there in a maſs, and not be ſtirred by ſubſequent plowings. Twelve or fourteen loads upon an acre will make ſome lands produce extraordinary crops of corn for fourteen or fifteen years together.—In the *Iſle of Wight*, they ſometimes lay twenty-five waggon-loads of it on an acre. Their *chalk* is of a fat ſoapy kind, and they call it *marle*. The farmers in the hundreds of *Eſſex* bring their *chalk* as far as from *Graveſend*, but lay not half ſo much on an acre, as thoſe of the *Iſle of Wight*.—It ſhould always be ſpread as ſoon as poſſible after it is dug, becauſe it is apt to harden and grow ſtoney in the air.

Mr. *Worlidge* ſays, you may deal with chalky land as with clay land, though in a moderate way: for chalky land is naturally cold, and therefore requires warm applications. It is alſo ſad, and will therefore the better bear with light compoſts; which is the reaſon that *chalk* is ſo great an improver of light, hot, and dry grounds, eſpecially after it has ſuffered a calcination.

If *chalk* be laid on *clay*, says Mr. *Lisle*, vol. I. p. 66. it will in time be lost, and the ground again return to its *clay:* and if *clay* be laid on *chalk*, in time the *clay* will be lost, and the ground return again to its chalky substance. Many people, continues he, think the land on which the other is laid for a manure, being predominant, converts the manure into its own soil: but I conceive in both cases the *clay* and *chalk* is, in time, filtrated through the land on which 'tis laid, and being soluble by rain into small corpuscles, is washed thro' the land on which 'tis laid; for neither of these manures is able to unite in its finest corpuscles, with the corpuscles of the land on which it is laid, so as to make so strict an union and texture with it as the land doth with itself, and is therefore liable to be borne downwards with rains, till no sign of it be left.

Chalk, laid upon meadows, will enable them to give a great crop for three or four years, but it is thought afterwards to impoverish them — Mr. *Lisle* is of opinion, that the contrary is the case with respect to pasture lands: because the grass being thereby greatly sweetened and increased, keeps constantly so much the more stock, by which it is maintained always in the same vigour.

The same gentleman assigns the following reasons, why chalk is good for sandy and clayey soils. I do suppose, says he, that *chalk*, laid on sandy or wood-seary ground laid up for pasture, may wash and sink in, and fill up the interstices, and thereby consolidate and mend the texture of such ground, and sweeten it, as it is a great alkali: and tho' by time most of the *chalk* may be washed downwards, so that the ground may lose the virtue, yet I do suppose the strength of the ground may still continue much the better, by reason that such manure having made the sword of the grass come thicker and sweeter, the good pasturage on both accounts enlarges the quantity, and betters the quality of the dung the cattle leave on it, which in return maintains a better coat and surface to the ground: and as *chalk* fills up the vacuities of sandy or wood-seary ground, so on the contrary, it insinuates its particles into obstinate clayey and strong land, and divides it, by making in a manner a scissure, thereby hollowing and mellowing it; so that the two contrary extreams are cured by *chalk*.

As *loam* may be inclined either to *clay* or *sand*, the husbandman may collect his manure accordingly, either of dry opening ingredients, such as *ashes*, *lime*, *dung* of *sheep* and *horses*, rubbish of old houses, &c. for the former; or of things which give cohesion and fatness, such as *dung* of *cows* and *hogs*, putrid, animal and vegetable substances, marle, &c. for the latter.

Our farmers, collecting the manures they find necessary from time to time, as they come to hand, generally heap them together in what they call dung-hills. These dung-hills should be placed where there are no running waters or springs, that their rich juices may not be washed away. They are greatly negligent in this care. Mr. *Evelyn*, and the author of the *New System of Agriculture*, call these aggregates of composts *stercoraries*. Such should by no means have a communication with any of the offices, as advised by the latter; for the vapours arising from the putrid dung, must prove hurtful to the health of horses or other cattle exposed to it in a confined place. Mr. *Evelyn* disapproves of laying dung in heaps in the field, exposed to the sun, rain, and drying winds, whereby all its spirit and strength is carried away; and advises the following, as a better method of managing our dung-hills, or *stercoraries*.— Let the bottom or sides of a pit, says he, be about four feet deep, paved with small chalk or clay at the bottom, that it may hold water like a cistern: direct your channels and gutters about your house and stables to it. The pit must be under covert, so that the down right rains may not fall into it. Lay a bed of dung in it a foot thick, on that a bed of fine mould, on that another bed of cyder-mere, rotten fruit, and garden offal, on this a couch of pigeons and poultry dung, with more litter, and beds of all variety of soil, and upon all this cast water plentifully from time to time.

The directions of the author of the *New System of Agriculture*, for making a *stercorary*, and which we much approve of, barring its being so near the stable as he seems to intend it, are as follow.

Along the back of your stable cause a pit to be dug to the depth of the foundation, or a pretty deal below it: let it be as long as the stable, but its breath should be according to the quantity of dung you have conveniencies for making: let this pit be arched with brick, but very slightly, and an entrance left at one end, which may be shut up, or opened, by a wooden door. let the sides and bottom be firmly lined with stone, and closely plaistered over with a cement, which will by no means admit moisture.

Through the wall of this stable, and about a foot or more from the ground, let there be made square holes, which, opening into the *stercorary*, from within the stable, must be of sufficient largeness for the passage of the dung, that is, from time to time, to be shovell'd through them.

The stable floor should be made as smooth and hard as possible, that the urine of the horses may not soak into it. but descending from them to a little gutter, close along the wall, thence run through

through paſſages, which are purpoſely to be made, into the *ſtercorary*.

Pipes of earth, which coſt but little, ſhould be laid, from this place to the cow-houſe, hog-ſties, and privies, that all urine of man or beaſt, of any kind whatſoever, may immediately be convey'd to mingle with the other. Into which muſt be caſt all ox dung, cow dung, hogs dung, and dung of fowls; all aſhes, whether of wood, or ſea-coal: the duſt and ſweepings of your yard and houſe; all weeds, old litter, rotten ſtraw, and ſpare earth. which you can get; as alſo the waſhing of barrels, all ſoap-ſuds, water which meat has been boil'd in, diſh-water, and every ſuch kind of thing, which is now thrown down the common ſink, and render'd uſeleſs: and for the more convenient performance of all this, there may be left a pretty large ſquare hole, in the outward declivity of the arch which covers the *ſtercorary*. This hole muſt have a wooden door fitted to it, which, lifting up and down, will, as occaſion offers, not only ſerve for taking in the things above-named, but, whenever more moiſture may be thought wanting, it will admit as much as is convenient, by being left open in rainy weather, and, as ſoon as ſhut, forbid the entrance of any more. The other door, which I ſpoke of, in one of the ends, is only to ſerve for carrying out the dung, when it is to be made uſe of.

In ſuch a *ſtercorary* as is here deſcribed, the charge is a trifle, not worth naming, in compariſon with the profit. The dungs and other things, incorporating, and fermenting thus together, mellowed, and enriched by the ſpirit of the urine, and unimpaired by the ſun, rain, or wind, attain an excellence, which is beſt known by the prodigious increaſe they make in your crops; and which demonſtratively proves, that one load thus managed, is of more effect than twenty after the common manner.

We leave to experience to determine, whether a *ſtercorary* with only a ſhade thrown over it, would not nearly anſwer all the ends propoſed by cloſing it up, and have none of the dangers attending the other.

The method of making *lime* is ſufficiently known. It's uſe and application, as a manure, is all that appertains to our ſubject.

Liming of land, ſays the author of the *Engliſh Improver*, is of moſt excellent uſe; many barren parts of this kingdom being thereby brought to ſo fertile a condition for bearing moſt ſorts of grain, that as good wheat, barley, and peaſe, as *England* yields, has, with the help of that manure properly diſtributed, been raiſed upon land, before not worth above a ſhilling or two an acre. He adds, that twelve or fourteen quarters will lime an acre. Another writer ſays 160 buſhels. The difference of the land may require a different proportion.

The moſt natural land for lime, ſays Mr *Worlidge*, is the light and ſandy; the next, mixt and gravelly: wet and cold gravel is not good, and cold clay is the worſt of all

A mixture of *lime*, *earth*, and *dung*, together, adds he, is a very excellent compoſt for land.

Mr. *Evelyn* adviſes, for lands that want heat, to mix *lime* with *turf* and *ſwarth*, laying them alternatively, turf on lime, and lime on turf, in heaps, for ſix months, by which means it will become ſo mellow, and rich in nitrous ſalts, as to diſſolve and run like aſhes, and carry a much more cheriſhing vigour, than if uſed alone in a greater quantity, and without danger of burning out and exhauſting the vegetative virtue which it ſhould preſerve.

Lime, a little ſlack'd, continues he, is excellent for cold wet grounds and ſtiff clays, but it overburns drier ſoils. It is the very deſtroyer of moſs and ruſhes, as quick-lime is of furzes, being firſt extirpated.

Mr. *Liſle* thinks it is beſt, eſpecially in lands that work mellow, to ſpread and plow the lime in, as ſoon as it is ſlacked, rather than to let it lie long covered with the earth in heaps.

Chalk-lime is not, in his opinion, ſo beneficial to land, as *ſtone-lime*; becauſe a greater virtue muſt be attributed to the *ſtone-lime* for its burning quality after it is laid on.

Lime, being laid on meadows or paſtures, ſlacks and cools by ſlow degrees, ſo as not to undergo ſuch a heat and fermentation, as when it is covered with the hillocks of earth flung up in arable; therefore, ſays he, it cannot be of that great advantage to paſture.

The lighter the land is, the more *lime* it will require: the ſtronger, the leſs. In ſome places they lay twenty-four or thirty quarters on an acre. The nature of the ſoil muſt determine the proper quantity.

In *Leiceſterſhire* they ſow or ſcatter the *lime* on wheat-land when they ſow the wheat, but on barley-land the laſt earth but one; and ſo plow it in, leſt, if they ſhould ſow it with the barley in the ſpring, it might burn it. They lay five quarters to an acre of each, according to the meaſure as it comes from the kiln, for after it is ſlack'd thoſe five quarters will make near ten.

As the intent of liming land, is to bind it, Mr. *Liſle* thinks it ſhould not be limed late in the year, becauſe the land being then cold and moiſt, and but a weak ſun to conſolidate it, the deſign of liming is fruſtrated; for if it does not conſolidate at firſt liming, it will not afterwards.

In

In *Shropſhire* they lay dung and lime together, *viz.* about twenty load of dung, and only twenty buſhels of lime on an acre.

Mr. *Liſle* gives it as a rule to all huſbandmen, to be cautious of liming ground, and then plowing out the heart of it. I limed, ſays he, ſome years ago, in *Wiltſhire*, ſeven acres for an experiment, and laid down one acre to its own natural graſs in two years time, the graſs of which is to this day 40 ſhillings an acre. The third year I laid down another acre, which is to this day worth 30 ſhillings per acre. The reſt I plowed five or ſix years farther, which is not worth fifteen groats per acre The like experience, adds he, I have had in burn-beaking ground.

Burning, or, as ſome call it, *burn-beaking* of land, may be reckoned among manures, becauſe it is a very great improvement, and only practiſed upon ſome old paſture, or heathy, ruſhy, broomy, and ſuch like barren grounds, which are conſiderably enriched by it; though, as the author of the *New Syſtem of Agriculture* juſtly remarks, lands ſo improved are, for want of one obſervation, generally ruined, in the common practice of plowing them three or four crops ſucceſſively; by which means their whole fertility is moſt aſſuredly exhauſted. and the ſoil becomes incapable of vegetation, though aſſiſted by the richeſt dung, or other manure, in the world. Nothing but ten or fifteen years repoſe, will reſtore the abuſed vigour of nature; whereas, were theſe grounds ſtrengthened by a little *marle*, *chalk*, or *dung*, between their firſt harveſt and their ſecond feeding, the improvement would be made compleat and laſting. No method would be more eaſy; nothing poſſibly more advantageous.

The manner of burning land is generally known to be a paring off the fibrous turf, to a conſiderable depth, in a hot ſeaſon, which being made into little hills, rais'd hollow, and at equal diſtances, are ſet on fire, as ſoon as they are dry enough to kindle, and ſo burnt to a kind of red aſhes, and thoſe aſhes ſcartered over the whole ſurface: the ground is then plowed up very ſhallow, and the ſeed immediately ſown.

This burning of ground is very coſtly, and not a little tedious, becauſe the turf is raiſed in a laborious manner, by the force of a man's arms and boſom, puſhing againſt a thing they call a *breaſt plow.* — I will preſent you, continues our author, with a much neater invention, and which ſaves, at leaſt, two thirds of the charge.

Let ſome ſmith in your neighbourhood, who is a ready workman, make a hollow plow ſhare, of a double form, that is, one which riſes with a ſharp edge in the middle, from the point to the top, and has a *fin* both ways; which fins muſt alſo begin at the point, and ſo run back to the ſhare end. The dimenſions of this ſhare will be two feet broad, from the extreme points of the fins behind; one foot long, and a foot high, ſomewhat like a three-edg'd ſword, if it were cut off a little above the point. The three fins, or edges, muſt be very well ſteel'd, and the whole made as thin, and as ſmooth, as you can get it done. — Into the hollow of this ſhare muſt be faſtened a light ſtrong piece of aſh, ſharpened *forward*, to fit the boſom of the ſhare, but *behind*, as ſquare and ſturdy as may be. Into this laſt part muſt be fix'd a ſtrong piece of wood, like a *lever*; not perpendicular, but ſomewhat hanging backward. It muſt be about two feet high; and on the upper end, ſhould have a croſs ſtaff, or other contrivance, to which muſt be faſtened the harneſs of ſuch cattle as your team conſiſts of. The handles of the plow, and the *earth-boards* to turn the turf, are alſo fix'd into this ſquare head; and there is no other inſtruction neceſſary for the uſe of this plow, but that, when you begin upon the edge of a field, and turn one turf to the hedge, and the other to the field, the laſt will cover one of the breadths you muſt take at your coming back, and the point of your ſhare muſt, therefore, run cloſe along the edge of this length of turf; by which means one ſide of your plough will raiſe two lengths, and, throwing back the higheſt, lay that uppermoſt, which had before lain under. By this one obſervation, you cannot miſs the manner of plowing.

But, as this would only raiſe a long unwieldly *rope* of turf, which it would be neceſſary to cut into many hundred pieces, before it would be fit for *piling*, you will find the following invention of admirable uſe and expedition.

Chuſe the body of a ſhort thick tree; the heavier, and more ſolid, the better: let it be neatly rounded, and work'd into a *roller*, like thoſe that are uſed for leveling *barley lands.* This roller muſt be hoop'd round, in ſix ſeveral places, each two foot diſtant from another: the hoops muſt be of ſtrong iron, and nail'd very firmly on. — The middle part of every one of theſe hoops muſt riſe into an edge, to about five or ſix inches above the level of the hoop itſelf: theſe edges muſt be very ſharp, ſtrong, and well ſteel'd, that the weight of the roller, as it goes round, may not fail to preſs them all into the earth, as deep as they can go, and yet not damage them, either by blunting, bending. or breaking.

One horſe will very well draw this roller, with which you muſt go over the ground you intend to burn, the contrary or croſs way to that which you deſign to take with your plow, before deſcribed; which

which will by this means turn up the turf in pieces of two foot long, and one broad, the exact size they ought to be to form the little hills above named. — I have nothing to add upon this head, but, that those who practise it had need be careful how they *over-burn* the turf, which would, in that case, be robb'd of much of its fertility. A gentle fire, not flaming out, but mouldering inward, is the surest means of hitting the perfection of this work.

In like manner Mr. *Worlidge* cautions us against over-burning the turf; and the reason is, that, in the burning of any vegetable, a gentle, easy, and smothering fire, does not waste the volatile nitrous spirit so much as a quick fire would do, and causes more of it to fix and remain behind.

Mossy grounds are peculiarly benefited by being burnt. Where much long *moss* grows thick, says Mr. *Lisle* tho' the ground be never so sandy in its nature, yet the ground underneath must be of a most cold and sour nature, by being kept from the sun, and the wet more fogging in it than if it had been solid earth upon it; for nothing retains moisture longer than such a spungy body, nor breaks the rays of the sun more from penetrating. Therefore such ground ought to be burn-beak'd; or the moss harrow'd up before feeding, and burnt in heaps; but rather burn-beak'd, to destroy the seeds of weeds.

Plowing. The *strong* plough is to be used on all hard clays, stiff binding soils, and stony grounds, or any lands of that nature. — It is drawn by two oxen, nor are any more at any time necessary. — The following is his description of it.

Let the length of your share be a foot and a half; the point indifferently sharp, but very strong: let the shelving side be work'd thick, and without a *fin*, but steel'd all along its edge, from the point to the hinder part, where its perpendicular height must not exceed six inches. — The breadth must be just sufficient to carry a furrow seven or eight inches broad In this plough, the place of the breast-board must be supplied by an iron plate, which, joining to the share, and being part of it, is, in a bellying manner, carried back, and gradually brought to *whelm*, as if it would fall upon the furrow. This plate, being made as thin as its use will permit, is supported by a pin from the plough-head, which is, in all respects, the same with that of the plough I before recommended, for paring up the turf of lands to be burnt. — This breast-iron, with all the neatness and facility imaginable, takes the earth, as it rises on the share, and, without labouring under the load of a long furrow, turns it over as it runs along, and neither toils the oxen nor the driver.

One man is enough in all reason to manage this plough. He guides his oxen by a goad, as usual; and holds the handles with a great deal less fatigue than in other ploughs, for they are to be set at a large slope, and their ends standing wide from each other, they have the greater power over the going of the plough. If the share is apt to *bite*, or run too deep into the ground, his leaning a little harder than ordinary, on the handles, will raise the point to what pitch he pleases; as, on the contrary, when he lays no stress upon them, the team will of course draw the point downward.

The *light* plough is properly to be used on sandy mellow grounds, and all such as are directly opposite to those for which the *strong* plough is recommended. It is drawn by two horses, with no manner of difficulty; or with one, if you please, for many have tried it.

The share of this plough, is, in a manner, the share of the *turfing-plough*, divided into two equal parts. The share of the *light* plough shelves only one way, as not being double, and has a *breast-iron* exactly like that of the *strong* plough. In all other respects, it is the very same with the *turfing-plough*, even in dimensions, and therefore needs no farther description.

One man will hold and drive this plough, with more ease than the strong one, because the loads are more manageable. The reins, whereby he turns and checks the horses, pass through two long slits, in each handle one, and being just of length enough to hang down five inches, or more, are prevented from being drawn back through the slits, by two pieces of wood, to which their extreme ends are fastened.

Let us suppose then, that at *Lady-day* you begin your husbandry, and that the quantity of land you are about to break up, is an hundred acres. The first thing necessary is, carefully and judiciously to observe both the *surface* of your ground, and the *depth* of it. If you find it a good deep mould, and covered by a thick, strong, fibrous turf, such as by long lying, is become firmly rooted; in this case it will be much the wisest way to *burn* and spread the ashes, by the rules before given, not, by any means, omitting to manure, between the first *reaping* and the second *sowing*; after which you may proceed in all points, as if the turf had been plow'd in, instead of being burnt.

But if, on the contrary, you find your upper mould shallow, or thin turf'd, it will by no means be proper to burn it: you must, therefore, take notice, whether your soil be of the *light* kind or the *heavy*. If, upon examining it by the marks above-mentioned, you find it of a *heavy* nature, you must prepare your *strong* plough and ox team, and

and take care that, in the firſt breaking up, as they call it, your plowman turns the turf ſide neatly downwards, and lays his furrows ſo ſmooth and cloſe together, that, at a little diſtance, a man can ſcarce ſee where the plow went. An acre and a half may eaſily be plow'd in one day, by the uſe of this plough; ſo that, beginning by the firſt of *April*, and allowing for *Sundays* and accidental hinderances, the hundred acres will be all broke up by the middle of *June* at fartheſt.

Between this firſt plowing and the ſecond, is the only proper time for laying on your *manure* of what kind ſoever. The ſeveral ſorts proper for lands of this nature, are *ſea-ſand*, *common-ſand*, *ſea-owſe* of the lighteſt kind, not ſuch as is black and greaſy; *ſheep's dung*, mix'd with *ſand* under a cover'd fold, as before deſcribed; or, for want of any of theſe, the *compoſt* in your *ſtercorary*.

Which ever of theſe you lie moſt convenient for, you may make uſe of, in the following proportions: of *ſea-ſand* you muſt lay upon every acre five and twenty loads; of *common-ſand* never leſs than a hundred, which quantity you may double, if it lies commodiouſly: twenty load of *ſea-ouſe* is ſufficient; and fifteen of *ſheep's dung* ſo mingled: and if you are obliged to rely upon the aſſiſtance of your *ſtercorary*, you muſt lay about twenty load upon an acre.

According to the manure you are obliged to uſe, your charge will be more or leſs conſiderable in the number of carts and teams neceſſary: for this rule you muſt be ſure to obſerve punctually, that the *manure* be all laid on by the laſt day of *July*; in which time, the plowman, a labourer being employed to ſpread the manure, as it is daily brought on, does, with the ſame plough he uſed before, give the ſecond ſtirring to the ground, in order to turn in the richneſs of thoſe helps you have beſtowed upon it. By this means the ſun, high and powerful in this ſeaſon, will be prevented from exhaling the *virtue* of your manure, as it always does in the common way of letting it lie in little heaps in the field for a great while together.

You may obſerve, that, I allow a ſhorter time for *this* plowing, than for the *firſt*; and the reaſon is, becauſe the ground having been broken up before, and the turf now rotten, it is become more mellow, and the draught ſo much eaſier, that a team may diſpatch almoſt a double quantity in a day.

It is now the time to harrow over your ground, with a heavy wide-tooth'd harrow, and a great weight laid upon it; by which means more mould will be rais'd, the clods broken into ſmaller pieces, and the manure mingled with the ſoil in every part. It is not enough to harrow once and away;—you muſt go over the ſame ground again and again, till you have made it as ſmooth and crumbly as is requiſite; and this work will very well employ your team, from the end of *July*, to the middle of *Auguſt*: about which time ſhould be begun the third and laſt plowing.

I come now to your lands of a *light* temper, and, for method's ſake, will begin at *Lady-day* upon this land alſo. Here the *light* plough is to be uſed, and as to the turning down the turf, and laying ſmooth the furrows, the ſame care is to be obſerved on one land, which is recommended on the other. Of this work, two horſes, with the plough above-mentioned, will conſtantly break up two acres a day; and beginning with *April*, and allowing, as before, for *Sundays*, &c. the hundred acres will be very well plowed, for the firſt time, by the latter end of *May*.

Betwixt the *firſt* arature and the *ſecond*, theſe lands are alſo to receive the annual recruits which you think fit to give them; and that may be either *chalk*, *marle*, *clay*, *ſheep's-dung*, prepared with *earth*, not *ſand*; *ſea owſe* of the cloſeſt, black, fat kind; all ſorts of *mud*, or, for want of either of theſe, your *ſtercorary* may ſupply you.

Five and twenty load of the laſt is the quantity moſt proper; thirty of chalk; of marle, at leaſt a hundred; and of clay, a little more. Twenty load of prepared ſheep's-dung, and as much of ſea-owſe; and if you uſe mud, leſs than forty or fifty load will be too little. Uſe either of theſe manures as your beſt conveniency invites you, and, as was directed before, take care that your plowman turns it in as faſt as it is brought on, and ſpread upon the ſurface.

But here comes a neceſſary caution, that your men begin to bring on the manure on that end of your hundred acres which your plowman firſt began to break up, that the turf may be rotted before it is turned up the ſecond time.—Be regardful of this rule, or you will find the neglect of it produce a great deal of confuſion.

When the manure is all turned in, bring on your heavy harrows, and go over the land ſo often, as till the whole maſs is exquiſitely mingled, and the mould becomes fine and duſty. You muſt be doubly careful in this operation upon your *light* lands, which ought by the harrow to be laid as ſmooth and level as a table.

About the beginning of *Auguſt* will come on your *ſeed plowing*, properly ſo called upon theſe *light* lands, becauſe you muſt here *plow* and *ſow* together.

Mr. *Tull* recommends putting all the horſes length-ways, when a ſoft ground is plowed; that, by their treading all in the furrow, the earth may be leſs poached.

If the land is in good tilth, it may be plowed in dry weather: but the best time is when it has been a little moisten'd by rain, especially for the new plough, which would not easily go deep, if the earth was very dry.

'Tis true that as the four-coulter'd plough enters deep, and turns up a great deal of earth, a greater strength is required to draw it; so that it will be necessary to use three horses instead of two, and four instead of three. But the excellence of this tillage will make ample amends for that additional expence.

The four-coulter'd plough is used only for the first plowings, to break up fresh grounds, or give a good tilth to those that have not been plowed before, or that have been ill plowed for a long time. It is likewise very fit for winter plowings; and I think Mr. *Tull* uses it sometimes to make deep furrows in the middle of the alleys between the rows of corn.

The SEEDS of all plants should not be sown at the same depth. To satisfy myself of this, I dug a trench twelve feet long, sloping it gradually from the surface at one end, to the depth of two feet at the other. I sowed different seeds in this trench; and having put the earth in its place, I observed 1. That hardly any seeds rise when buried deeper than nine inches: 2. That some seeds rise extremely well at the depth of six inches: 3. That other seeds do not rise at all when they are above one or two inches deep. Experience shews that the same seeds may be buried deeper in a light, that a heavier soil; and that seeds which lie too deep in the earth to spring up in a dry year, may rise in a warm moist year. Experience likewise teaches, that seeds which are buried too deep in the earth, will remain there ten or twenty years sound and unaltered; so that if by moving that earth they chance to be brought to the surface, they grow extremely well, and produce their proper plant.

Mr. *Worlidge*'s opinion of MILDEWS, which he holds to be quite different things from *blight*, is, that they are caused from the condensation of a fat and moist exhalation in a hot dry summer, from the blossoms and vegetables of the earth, and also from the earth itself, which by the coolness and serenity of the air in the night, or in the upper serene region of the air, is condensed into a fat glutinous matter, and falls to the earth again; part whereof rests on the leaves of the oak, and some other trees whose leaves are smooth, and do not easily admit the moisture into them, as the elm or other rougher leaves do; which *mildew* becomes the principal food of the industrious bees, being of itself sweet, and easily convertible into honey.

Other part thereof rests on the ears and stalks of wheat, bespotting them with a different colour from what is natural; and, being of a glutinous substance, by the heat of the sun, doth so bind up the young, tender, and close ears of the wheat, that it prevents the growth and compleating of the imperfect grain therein; which occasioneth it to be very light in the harvest, and yield a poor and lean grain in the heap.

But if after this *mildew* falls, a shower succeeds, or the wind blow stiffly, it washeth or shaketh it off, and are the only natural remedies against this sometimes heavy curse.

Some advise in the morning, after the *mildew* is fallen, and before the rising of the sun, that two men go at some convenient distance in the furrows, holding a cord stretch'd strait between them, carrying it so that it may shake off the dew from the tops of the corn, before the heat of the sun hath thickened it.

The sowing of wheat early hath been esteemed, and doubtless is the best remedy against *mildews*, by which means the wheat will be well filled in the ear before they fall, and your increase will be much more. For curiosity sake, wheat was sown in all the months of the year: that sown in *July* produced such an increase as is almost incredible. In *France*, they usually sow before *Michaelmas*.

Bearded-wheat is not so subject to *mildews* as the other, the fibres keeping the dew from the ear.

Whatever weakens the plant, brings the *smut*; for seed-corn which has been pricked or run thro' with a needle, or which is not fully ripe, and that which produces lateral or second ears, is subject to the smut. As a proof that whatever weakens plants, causes the smut, he observes, that it is a frequent custom with them to cut rye as soon as it spindles, for food for their cattle; and that this rye generally produces other ears, which seldom contain any but distemper'd grain.

Mr. *Tull* tells us that the cure of this distemper was first found out by an accident, which he relates thus.

" Brining of wheat, to cure or prevent smuttiness (as I have been credibly informed) was accidentally discovered about seventy years ago, in the following manner, *viz.* A ship-load of wheat was sunk near *Bristol*, in autumn, and afterwards at ebbs all taken up, after it had been soaked in sea-water; but it being unfit for making bread, a farmer sowed some of it in a field; and when it was found to grow very well, the whole cargo was bought

bought at a low price by many farmers, and all of it fown in different places. At the following harveft, all the wheat in *England* happened to be fmutty; except the produce of this brined feed, and that was all clean from fmuttinefs."

We fhall here copy the directions given by the author of the *New Syftem of Agriculture*, for the choice and preparation of feed-corn.

Let your corn be brought into the corner of a large barn floor, or great boarded hall, fuch as few country houfes are without: order a man, with a broad wooden fhovel, to throw the corn, with all his force, towards the oppofite corner of the barn, or hall: the laft is generally the fitteft for it. In this exercife, all light, fmall, fhrivell'd grain, and the feeds of cockle, darnel, and other weeds, not being fo heavy as the folid corn, will fall fhort, and lie neareft to the man who throws them; while fuch as are large, plump, and weighty, out-flying all the reft, are feparated widely, and may eafily be gathered in what quantity you pleafe. Experience only is capable of making men believe the wonderful advantages of fowing feed thus chofen.

Take your corn, when it has been thus obtained, and throw it, by a bufhel at a time, into a large veffel full of water: let a man ftir it with a ftaff, as violently as he can, for a confiderable while together, and then, giving it a little time to fettle, fkim off all that fwims upon the furface; and repeat this labour till no more rifes: after which, take out the corn which is funk to the bottom, and lay it by for feed; proceeding in the fame manner, till you have your intended quantity.

Now make a *brine*, by throwing *bay-falt* into *rain-water*, till it becomes of ftrength enough to bear an egg. In this liquor fteep your *feed corn* for thirty hours: lefs time will have no manner of effect. Obferve this, and regard not the contrary opinions of any men, let them pretend to never fo much fkill.

When you take your corn out of this brine, fpread it upon a fmooth floor, and, fcattering upon it good ftore of the *fine-ground powder of flack'd lime*, fweep it up and down, and mingle it with the corn, till every grain leaves clinging to another, and becomes, as it were, *candied* with the lime: and in this condition let it be fowed, never entertaining a moment's doubt of the infallible increafe of your harveft.

PLANTS that grow in any ground, different from thofe which are intended to be cultivated in it, are called *weeds*.

They exhauft the earth, as much as the moft ufeful plants: nay, they fometimes get the afcendant, and multiply to fo great a degree, that a field will almoft feem never to have been fowed with corn.

The weeds which are feared moft, are, 1. *Cockle* or *darnel*. Its feed is black; but being heavy, and nearly of the fame fize as the grains of wheat, it is not eafily feparated from them. Sifting, and throwing the corn at a diftance on a large floor, are the beft ways of clearing the wheat of it. If ground with the corn, it makes bread look black.

2. *Fox tail*, the feed of which is fomewhat like wheat. This gives bread a bitter tafte.

3 *Wild-poppy*, or *red weed*, the feed of which is very fmall, and fometimes multiplies fo prodigioufly that it choaks the wheat.

4. *Wild-fitch*, which covers the corn when it is laid, hinders it from rifing again, and makes it rot.

5. *Dog's grafs*, and *colt's foot*, which multiply by their feeds, and extend themfelves by their creeping roots, and even by the pieces of their roots which are broke off by the plough.

6. *Melilot*, which gives bread a bad tafte; and,

7. *Thiftles*, and many other weeds which greatly exhauft the earth.

8. *Charlock*, the young plants of which it will be of advantage to the farmer to be able to diftinguifh from young turneps, efpecially in weeding the latter, left they be reared or plucked up indifcriminately. This can fcarcely be done but by the tafte, the charlock being hot and bitter, and the turnep mild.

To prevent the increafe of weeds, it is proper to deftroy them before their feed is ripe.

The fureft way to deftroy weeds, is, to continue plowing whilft the corn grows: but this can be done only in the new hufbandry.

Weeds may be diftinguifhed into four kinds: 1. Into fuch as have creeping perennial roots. 2. Such as grow in cold wet foils. 3. Such as are of a large fucculent body; and 4. Such as having fmall feeds, or that ripening before the corn, fow themfelves. Each of thefe require different methods, to deftroy them.

The firft can only be deftroyed by repeated fummer fallows, by which their roots are cut, and turned up to be withered by the fun and winds; after which they are dragged out by harrows, and fhould be burnt. This repeated as often as the farmer can conveniently during a dry feafon, or repeated another feafon, can fcarcely fail to complete the cure. *Colt's foot*, which is propagated by the root, may likewife be deftroyed by fowing the ground with rye-grafs, on any plant which, coming up early in the fpring, fhadows and fmothers it, whereby it dies in a few years.

The fecond are deftroyed by draining the earth

of

of its superfluous moisture, and by warming it with *lime*, *ashes*, *gravel*, *shelly sea-sand*, &c.

The third are destroyed by cutting them down when in full sap and vigour: for the sudden interruption which this gives to the motion of the sap, causes it to stagnate in the roots, and putrify there. Some few and weak lateral shoots may be made; but they too being cut in the same manner, the roots are entirely putrified by degrees, and, instead of annoying, become a manure.

The fourth can be destroyed only by frequent fallows, and constantly cutting, or rather plowing them down before they run to seed. Some, for instance the wild oats, may be mowed for hay, but it is much more beneficial to the land to have them turned down; for by that means, instead of being exhausted by frequent crops, it is manured by those enemies to useful grain.

Banks and hedges should be preserved free from weeds; not only to preserve their bottoms thicker, but also to prevent the seeds of weeds from being carried into the adjacent fields, by winds, by which means the corn must be constantly pestered with them.

The common *two wheel plough*. (See *Fig.* 1. in the plate) used almost in all the counties in the south of *England*, is commonly divided into two parts, the plough-head, and the plough-tail. The plough-head contains the two wheels A, B, and their axis, or iron-spindle, which passes through the box C, and turns round both in it and in the wheels; the two crow-staves D, D, fastened perpendicularly into the box, having in each two rows of holes, in order to raise or sink the beam, by pinning up or down the pillow E, to increase or diminish the depth of the furrow; the gallows F, through which the crow-staves pass at top, by mortoises into which they are pinned; G the wilds, with its links and crooks of iron, by which the plough is drawn; H the tow-chain, which fastens the plough-tail to the plough head, by the collar I at one end, and by the other end passing thro' a hole in the middle of the box, where it is pinned in by the stake K; L the bridle-chain, one end of which is fastened to the beam with a pin, and the other end to the top of the stake, which stake is held up to the left crow-staff, by the end of the wyth or rope M passing round it above, and under the end of the gallows below, or by the end of the bridle-chain itself, when that is long enough. The plough-tail consists of the beam, N; the coulter, O; the share, P; and the sheat, Q; the hinder sheat, R, passing through the beam near its end; S the short handle, fastened to the top of the hinder sheat by a pin, and to the top of the fore-sheet by another pin; T the drock, which belongs to the right-side of the plough-tail, and to which the ground-wrist V is fastened; as is the earth-board, whose fore-part W, is seen before the sheat; as also the long handle X, whose fore-part Y appears before the sheat, and is fastened to the drock by the pin at *a*, the other end of which pin goes into the beam. Z is the double retch, which holds up the sheat, and passes through the beam to be fastened by its screws and nuts at *b* and *c*.

The structure of the *four-coultered plough*, (*ibid.* Fig. 2.) is in several respects different from this, though in general founded on it. Its beam is ten feet four inches long, whereas that of the common plough is but eight feet: it differs also in shape; for as the other is strait from one end to the other, this is strait only from *a* to *b*, and thence turns up, in the manner shewn in the plate; so that a perpendicular line let down from the corner at *a*, to the even surface on which the plough stands, would be eleven inches and a half, which is its height in that place; and if another line was let down from the turning of the beam at *b*, to the same surface, it would be one foot eight inches and a half, which is the height the beam stands from the ground at that part; and a third line let down to the surface from the bottom of the beam, at that part which bears upon the pillow, will shew the beam to be, in that part, two feet ten inches high above the surface. At the distance of three feet two inches from the end of the beam, at the plough-tail, the first coulter, or that next the share, is let through: and at thirteen inches from this, a second coulter is let through: a third at the same distance from that; and, finally, a fourth at the same distance from the third. The crookedness of the beam is to avoid the too great length of the fore-most coulters, which would be so long if the beam was strait all the way, that they would be apt to bend and be displaced, unless they were vastly thick and clumsy.

The sheat in this plough is to be seven inches broad, and the fixing the sheat in this, as well as in the common plough, is the nicest part, and requires the utmost art of the maker; for supposing the axis of the beam, and the left-side of the share to be both horizontal, they must never be set parallel to each other; but the strait side of the share must make an angle on the left side of the beam, which must be very acute, that the tail of the share may press less against the side of the trench than the point does: this angle is shewn by the pricked lines at the bottom of *Fig.* 1. where the line *e f* is supposed to be the axis of the beam let down to the ground, and the line *g h*, parallel to the left-side

of

of the ſhare. The great thing to be taken care of, is the placing the four coulters, which muſt be ſo ſet that the four imaginary planes deſcribed by the four edges, as the plough moves forwards, may be all parallel to each other, or very nearly ſo; for if any one of them ſhould be very much inclined to, or ſhould recede much from either of the other, then they would not enter the ground together. In order to the placing them thus, the ſecond coulter-hole muſt be two inches and a half more on the right-hand than the firſt; the third muſt be as much more to the right of the ſecond; and the fourth the ſame diſtance to the right of the third; and this two inches and a half muſt be carefully meaſured from the center of one hole to the center of the other. Each of theſe holes is a mortoiſe of an inch and a quarter wide, and is three inches and a half long at the top, and three inches at the bottom. The two oppoſite ſides of the holes are parallel to the top and bottom, but the back is oblique, and determines the obliquity of the ſtanding of the coulter, which is wedged tight up by pieces of wood. The coulters are two feet eight inches long, of which ſixteen inches are allowed for the handles, which is to be thus long, that the coulter may be drawn down as the point wears away. As to the wheels, the left-hand wheel is twenty inches diameter, and that on the right-hand, two feet three inches; and the diſtance the wheels are ſet from each other, is two feet five inches and a half.

The *Lincolnſhire-plough*, proper for fenny lands, ſubject to weeds and ſedges, and remarkable for the largeneſs of its ſhare, which is frequently a foot broad and very ſharp, is thus form'd, (*ibid.* Fig. 3.) At A is a foot, which is ſet higher or lower, by a wedge drove in at B; and which keeps the fore-part of the plough from going deeper than they would have it. At C there are wedges by which the hinder part is ſet. Inſtead of a coulter there is a wheel with a ſharp edge, which cuts the roots of the graſs or ſedge as it turns round, while the broad ſhare cuts them up at the bottom.

The *Caxton* or *trenching-plough*, invented to cut drains about *Caxton* in *Cambridgeſhire*, in ſtiff, miry, clay-ground, (*ibid.* Fig. 4.) is larger and ſtronger than ordinary: to the beam is fixed a piece of wood at A, in which is a coulter ſet at B, and another ſet in the beam at C, which two coulters ſtand bending inwards as at D, to cut each ſide of the trench. The ſhare is very flat and broad, in order to form the bottom of the trench; and the mould board is three times the length of other ploughs, in order to caſt the turf a great way from the trench. This plough cuts a trench a foot wide at the bottom, a foot and a half broad at the top, and a foot deep, and it is drawn with twenty horſes.

But the moſt common plough, ſays *Mortimer*, is the *dray plough*, repreſented Fig. 6. which is beſt for miry clays, when the land is ſoft; but is extremely bad in ſummer, when the land is hard, becauſe its point will be continually flying out of the ground: it is ſet higher or lower, by wedges at *a*. Fig 5. is a *Spaniſh-plough*, with which, and one horſe, they will plow two or three acres of their light lands in a day.

For the *hoe* and *drill ploughs*, invented by *Jethro Tull*, Eſq; ſee his Eſſay on *Horſe-hoeing Huſbandry*.

HYDRAULICKS and HYDROSTATICKS.

HYDRAULICKS, (from the *Greek* υδραυλος, *i. e. ſounding water*) is the ſcience of fluids, particularly of water, with a ſpecial attention to artificial water-works; and to the laws and motion of fluid bodies.

HYDROSTATICKS explain the equilibrium of fluids, or the gravitation of fluids at reſt; upon removing that equilibrium, motion enſues; and here *Hydraulicks* commence.

Hydraulicks, therefore, ſuppoſe *Hydroſtaticks*; which induces me to begin this treatiſe by *Hydroſtaticks*.

HYDROSTATICKS, by proving, againſt the vulgar opinion of the ſchools, that all the ſenſible elements, *viz.* the air, the water, and the earth, and all heavy bodies, are ponderous in their proper places, *i. e.* the water of the ſea, in its bed; and a ſtone, or any other heavy body, placed on the earth, have a gravitating force, or gravity. And ſuch are called proper or natural places of all heavy bodies, which have been aſſigned to them by nature, according to their manner of gravity in that elementary region, which *Ariſtotle, lib.* 4. *de Cœlo, c.* 4. ſeems to inſinuate; and which I prove in the following manner.

Thoſe bodies have a gravitating force in their proper places, which being compreſſed by the ſubtile matter, can ſcarce be removed from that place, in which the ratio of gravity ſeems to be placed.

But

But the ſenſible elements, and all heavy bodies, compreſſed by the ſubtile matter, can ſcarce be removed from their place; as it appears in water, earth, *&c.* which cannot be raiſed upwards without difficulty:—Therefore the ſenſible elements, and all other heavy bodies, have a gravitating force in their proper place. For the water of the ſea, by its gravity, does no leſs compreſs its bed, than water contained in a veſſel, compreſſes by its gravity, the bottom of that veſſel; but it is confirmed by repeated experiments, that water contained in a veſſel, gravitates on its bottom; and that the water, which occupies that bottom, is preſſed by the other water over it. Whence if the ſide of a veſſel full of water be perforated near its baſe, the greater is the quantity of the water contained in that vaſe, the further will it flow through that hole; therefore, *&c.*

To this it will be objected, firſt, that a heavy body, as lead, has leſs weight in water than in the air; ſince water diminiſhes very near a twelfth part of the weight of the lead; and takes off, likewiſe, very near a ninth part of the weight of copper; ſo that if the weight of the body, and that of the water, be equal; that body will be found to have no gravity in the water: and therefore water has no gravity in its proper place.

I anſwer, that what has deceived moſt philoſophers, on this point, is, that they made no diſtinction between an *abſolute* and *relative gravity.*

We call *abſolute gravity*, that whereby a body is heavy in itſelf, or tends downwards: and a *relative* one, that whereby a body is heavy with reſpect to our ſenſes; therefore lead loſes a twelfth part of its *relative gravity* in the water, becauſe we feel it a twelfth part lighter; but it loſes nothing of its *abſolute gravity.*

If I be aſked why lead loſes almoſt a twelfth part of its gravity in the water? I'll anſwer, that the reaſon of this phænomenon is very eaſy, *viz.* that a maſs of lead is almoſt twelve times heavier than a maſs of water of the ſame volume, or magnitude; whence that the water may be in an equilibrium with the lead, its volume muſt be twelve times greater than that of the lead.—Hence if a wooden beam be as ponderous as an equal volume of water, in whatever place it ſhall be put in the water, there it will remain, without riſing higher, or deſcending lower; and will have the effect of a volume of water, which are in an equilibrium, with parts equal and like to it.

But if that wood be much lighter than the water, *v. gr.* twice, thrice, four times, five times, ſix times, *&c.* lighter than the water, it will take up half, a third, a fourth, a fifth, or a ſixth part of its weight of the water. The ſame as a boat only full of air, ſcarce preſſes a ſixth part of its weight of water, but if it be loaded with ſand, ſtones, or men, together with the air, ſo that the whole maſs of the boat, men, air, and ſand, approaches the gravity of an equal volume of water, the boat will be depreſſed lower; but if, at laſt it be too much loaded, and grows heavier than an equal maſs of water, it will be ready to ſink.

The ſame may be ſaid of a glaſs bottle full of air, which repreſents ſometimes a human figure, (*Fig.* 12 in Plate *Hydroſtaticks*) for that bottle being put in a tube or pipe of glaſs, full of water, as it is ſomewhat lighter than a like volume of water, ſome part thereof is ſeen above the water. But its having a very ſmall hole on the ſide; if while it is in the water, ſome of the air be pumped out, to make room for as much water; then, by the ſingle compreſſion of the finger on the orifice of the pipe, it will happen that more water ſhall enter the bottle through the hole on the ſide, and depreſs it more down towards the bottom of the tube: but if the finger be removed, the air left in the figure, will, by its elaſtick virtue, thurſt out the little quantity of water, which had entered through the hole, and the figure being again rendered thereby lighter than an equal volume of water, will return upwards. But if ſo much air be pumped from it, as to make room for a greater quantity of water, then it will deſcend of its own proper weight to the bottom of the tube, and not aſcend to the top but by pumping.

There are alſo other glaſs bottles, from which a greater or leſs quantity of air has been taken out, which being likewiſe incloſed in a tube full of water, where the water grows thicker, by cold, aſcend and deſcend, if the water, thro' heat, be rarified; whereby the degree of heat may be known at any time. But I'll ſpeak of the *Thermometer*, or inſtrument proper to meaſure the degrees of heat, in another place. Therefore, ſo often as a body is much more heavy, as often it is precipitated downwards; but it only loſes as much of its relative gravity, as the like volume of water is ſuſpended over it, *v. gr.* copper, which is nine times heavier than water, loſes a ninth part of its weight, as gold loſes a nineteenth part. Therefore, if you ſuſpend gold in open air, and afterwards put it into water, while it remains of the ſame weight ſuſpended in the air, you may obſerve, that a ninth part of the equality of weight, muſt be taken off, to make it of an equilibrium with the water.

In this manner you'll eaſily diſcover, how much all ſorts of bodies are heavier than water. For gold is nineteen times heavier than the ſame volume of river water; quickſilver almoſt fourteen times; lead almoſt twelve; ſilver

 ten

ten times, and a thirteenth; copper nine times; tin almost seven times and a half; white marble almost three times; common stone almost twice but wine a fifteenth part; wax a twentieth; and lastly, oil a twelfth part less ponderous than water.

From all these it appears, why those bodies, which were of equal weight, while in the air, lose their equilibrium when weighed in water. For if lead and copper, while suspended in the air, are equal in weight; as the volume of the lead must be less than that of the copper, since lead is heavier than copper, if they be put into water, the lead shall occupy a lesser space than copper of the same weight; whence it will be ballanced by a lesser mass of water, and thereby be heavier than copper, though while in the air it was in an equilibrium with it.

It may be objected, that a diver does not feel the weight of the superincumbent water; and that a pail full of water can be easily moved here and there, while it remains in the well; though out of it, it feels very heavy; and therefore, that water does not gravitate in its proper place.

I answer this objection, by observing, that a diver does not feel the weight of the superincumbent water, because all the parts of the water, sustain mutually one another in an equilibrium, not only according to their perpendicular lines, but likewise according to their oblique ones. For, 1. Who would deny, that they are in an equilibrium, according to their perpendicular lines? Since it is the nature of liquids, that, if they be divided by our imagination into several equal columns, all those columns, by reason of the fluidity of their parts, will mutually counterpoise one another; for if one of them descends, the neighbouring, and adjacent ones must ascend; as when a weight put in one side of a ballance descends, that in the other side of the same ballance must ascend; for there is no greater reason that a column should conquer another, than of its being conquer'd by it. 2. By reason of the same fluidity of the water, those parts which are superincumbent on the head of the diver, are counterpoised, according to the oblique lines, by those which are on his sides: likewise those, which environ his body, are supported by others placed round them. Whence it happens, that their weight is felt neither on the head of the diver, nor on his sides.

For the same reason, a pail full of water is easily rais'd from the bottom of a well, as far as the superficies of the water of the well, because it is supported by an equal volume of water, as by a counterpoise placed in another equal column; and not because water has no gravity, otherwise it would not be ponderous in a vessel, because when a hand is plunged into it, it feels no gravity, which, notwithstanding, a daily experience proves to be false.

But what is more surprising in this place, and which no body would believe, if it was not demonstrated by certain and evident experiments, is that, notwithstanding, the whole foundation of *Hydrostaticks*, fluids press upon subject bodies, according to their perpendicular altitude, and according to their latitude or breadth, having, notwithstanding regard to the base; which I prove in the manner following.

The gravity of fluids, is to be estimated according to their altitude, regard being had to their base, if they press more or less the bottom of the vessel in which they are contain'd, according to their greater or lesser perpendicular altitude, whatever the figure of the vessel be; which is the case of fluids: for if several vessels or tubes of the same altitude (*Fig.* 13, 14, 15, 16, *ibid.*) be filled with water, and in the bottom of every one of them should be made an equal aperture, and every aperture stop'd in the same manner; all the corks, which stop those apertures must be equally strong, whether the tubes be placed in a perpendicular manner (as *a b*, *Fig.* 13.) or inclined (as *c d*, *Fig.* 14.) or equally wide in the form of a column or cylinder, as *a b* and *c d*; or broader at one end like a cone or funnel (as *e f*, *Fig.* 15. or *g h*, *Fig.* 16.) So that if there be wanted an hundred pound weight to support the water contained in the greater tubes, 14, or 15, or 16, the same force or weight must be fixed at the beam of a ballance, to support with an iron-wire or small cord, the cork of the narrower tube *a b* *Fig.* 13. which cork serves as a base, which is pressed by the water:—Therefore fluids are ponderous according to their altitude.

My proof is confirmed by this experiment: let the tube ABCD, *Fig.* 17. *ibid.* be wider at bottom, and narrower a top, I say, that the bottom C D is no less pressed by the water contained in that tube, than if the vessel was equally wide every where, as STDC, of the same *Figure*: Which to demonstrate, the sides A *b* B *g*, must be carried into E and F; and afterwards, the part of the base EC is to be divided into the equal parts E *m*, *n p q c*, but in such a manner, that the latitude or breadth of every one should not exceed half the altitude of the tube B A, or E F. Which done, if E *p* be taken equal to the first part E *m*, it may be shewn that the column E *i* presses equally the bottom of the vessel, as the column *p* A; for if you conceive the line *l i*, as a ballance of equal members, *n* being the fulcrum thereof in the right line A E; and at one of its extremities, *l* be suspended, the weight *v*, kept in equilibrium by the point *i* of the side of the vessel, which is the other extremity of the ballance, certainly the fulcrum *n* will ſuſtain both the weight *v*, and the reſiſtance of the point *i* equal to the weight *v*, and conſequently will carry twice the weight of *v*.

Then let it be imagined that the water of the column A *p*, has the ſame effect on the bottom *p* E, as the weight *r* has on the arm *u l*; therefore, as the point *i* of the ſide of the vaſe hinders the weight *r* from deſcending, likewiſe the part *b i* hinders the water of the column A *p*, from forcing upwards the water of the column E *i*, and therefore that column E *i* will by its reſiſtance preſs as much the bottom, as the column A *p* preſſes *p* E in gravitating.

In the ſame manner the part of the baſe *m q*, is as much preſſed by the column *i q*, as the part E *m* by the column E *i*, i. e. as much as the part *p* E is preſſed by the column *p* A: and thus the whole baſe is as much preſſed by the water contained in the vaſe D B A C, as it ſhould be preſſed by the water filling up the whole veſſel STDC, which was to be demonſtrated.

The fluidity of the water is the cauſe that the column A *p* exerciſes its ſtrength on the column E *i*; for if the water ſhould be frozen, thoſe columns ſhould have no power over one another; therefore what we ſay of the water cannot be applied to ice.

To confirm and illuſtrate this doctrine of the preſſure of the fluids, in the ratio of the baſe and altitude, provide a metallick veſſel, ſo contrived as that the bottom may be moveable, and to that end fitted in the cavity of the veſſel with a rim of wet leather, to ſlide without letting any water paſs: then through a hole in the top apply ſucceſſively ſeveral tubes of equal altitudes, but different diameters. Laſtly, faſtening a ſtring to the beam of a ballance, and fixing the other end by a little ring to the moveable bottom: put weights in the other ſcale, till they be ſufficient to raiſe the bottom: then will you not only find that the ſame weight is required, what diameter or magnitude ſoever the tube be of; but even that the weight which will raiſe the bottom, when preſſed by the ſmalleſt tube, will raiſe it when preſſed by the whole cylinder.

The moſt ſolid and ponderous body, which near the ſurface of the water would ſink with great velocity; yet if placed at a greater depth than twenty times its own thickneſs will not ſink, unleſs aſſiſted by the weight of the incumbent water.

Thus immerge the lower end of a ſlender glaſs tube, in a veſſel of mercury; then ſtopping the upper end with your finger, you will by that means keep about half an inch of that ponderous fluid ſuſpended in the tube. Laſtly, keeping the finger thus, immerge the tube in a long glaſs of water, till the little column of mercury be more than thirteen or fourteen times its length under water; then removing the finger, you will find that the mercury will be kept ſuſpended in the tube by the preſſure of the water upwards: but if you raiſe the tube very little above the former ſtation, the mercury will immediately run out; whereof, if before you had removed the finger from the top, you had ſunk the pipe ſo low, as that the mercury were twelve or fourteen inches, &c. below the ſurface of the water, the mercury would be violently forced up, and make ſeveral aſcents and deſcents in the tube, till it had gained its former ſtation, according to the laws of ſpecifick gravity.

We may alſo make uſe in this place, of the experiment of a ſiphon; for if water be put in a ſiphon or inflexed tube (*a b e d c*, *Fig.* 18. *ibid.*) though one limb, *viz.* *a b*, be an hundred times larger than the other, *viz.* *c d*, the water will notwithſtanding remain ſuſpended in both limbs at the ſame altitude; which could not happen unleſs water was ponderous according to its altitude, or ſhould preſs the point *e*. For as there is a greater volume of water in the larger limb, it ſhould force upwards that contained in the ſlenderer limb, which is contrary to experience. Therefore water and other liquors gravitate in the ratio of their altitude.

Now what has been obſerved in the equilibrium of ſolids, the ſame is found in fluids. For then the water muſt be in an equilibrium, ſince on one part its volume, and on the other the ratio of its velocity is reciprocal; which is the caſe of the aforeſaid experiment of the ſiphon, where the volume of the water contained in both limbs, and the ratio of its velocity are reciprocal: for when you'll have poured a hundred times more water into the tube *a b*, than into *c d*, when that will be depreſſed towards *e* to the height of an ounce or inch, then that which is in the ſlenderer tube, or the limb *c d*, will riſe to the altitude of an hundred ounces: ſo that the greater the volume of water is in the larger tube, the greater is its velocity in the leſſer, by reaſon of the amplitude of each tube. Therefore it is neceſſary that the water ſhould be in an equilibrium in both, and gravitate equally every way on the point *e*.

This is ſo very true, that if there be water in a large veſſel (*Fig.* 19. *ibid.*) and the two tubes *a* and *b* be adapted to it, of which *b* be an hundred times thicker than *a*: water put in the tube *a* of a pound, will be equivalent to the weight of an hundred pounds put in the tube *b*. For the force or power is no leſs in the weight of one pound, for it to raiſe the other weight of a hundred pounds of water in the ſpace of one ounce, as it ſhould happen here, than

than it is in the hundred pounds, to raiſe one pound in the ſpace of one ounce.

Hence. if a ſmall tube or pipe be adapted to the orifice of a hog's bladder (*Fig.20.ibid.*) which is an hundred times narrower than the circumference of the bladder, as the wind blows through that ſmall tube into the bladder, has an hundred times a greater velocity of motion in the ſmall tube, than in the bladder, for though the wind or breath conſidered in itſelf, has only the force of one pound, it is notwithſtanding a weight equivalent to a weight of a hundred pounds; and if the bladder be preſſed by a ninety-nine pounds weight, that weight will be lifted up by the ſingle breath of the mouth introduced through that pipe into the bladder. Notwithſtanding this, ſeveral imagine, that the water contained in the tube *a*, *Fig.* 19 *ibid.* and which has the force of one pound, is only ponderous on the part which is immediately under it. For the propriety of *liquids* incloſed in veſſels is ſuch, that if they be compreſſed in any place, the force of the compreſſion inclines on every part of the veſſel wherein they are contained; whence if any of thoſe parts cannot bear that force either upwards or downwards, or on the ſides, it will preſently break. Hence it is, what we have already mentioned, that liquids are not only ponderous according to their perpendicular lines only, but likewiſe according to their oblique ones, by reaſon of the fluidity of their parts. Therefore the water of the tube *a* is ſaid to act, not only on the part *c* of the vaſe ſubject to it, but likewiſe on the orifice of the tube *b*; the ſame as the water of the leſſer tube in the ſiphon *a b e d c*, *Fig.* 18. *ibid.* ſupports in an equilibrium, the other water contained in the larger limbs.

It may be objected to this, that in the ſiphon, one limb whereof is very narrow, and the other very wide, the water in the narrower limb is ſuſtained higher than that contained in the broader; and therefore fluids do not always gravitate according to their altitude.

I anſwer, that the water being raiſed higher in the narrower tube than in the broader, is firſt to be attributed to the texture of the parts, whereby the ſmall fibres of the water being inſerted into the meatus of the glaſs of the narrower tube, adhere to its parietes or ſides, and are raiſed higher. Beſides, there is no doubt that the air ſuper-incumbent on the orifice of the narrower tube, preſſes with a far leſs force the water incloſed in it, than that contained in the larger limb, having a much more free acceſs into the larger tube than into the narrower

So far I have explained the laws of *Hydroſtaticks*, let us now paſs to thoſe of HYDRAULICKS; proceeding afterwards to the application thereof to practice, as to conducting and raiſing of water, with the conſtructing of engines for that purpoſe.

The firſt of the *hydraulick laws of fluids* is, that the velocity of a fluid, as water moved by the preſſure of a ſuperincumbent fluid, as air, is equal at equal depths, and unequal at unequal depths. For, the preſſure being equal at equal depths, the velocity ariſing thence muſt be ſo too, and *vice verſâ*, yet the velocity does not follow the ſame proportion as the depth; notwithſtanding, that the preſſure whence the velocity ariſes, does increaſe in the proportion of the depth. But here the quantity of the matter is concerned; and the quantity of motion which is compounded of the ratio of the quantity and velocity of the matter increaſed in equal times as the ſquares of the velocities.

The ſecond law is, that the velocity of a fluid, ariſing from the preſſure of a ſuperincumbent fluid, at any depth, is the ſame as that, which a body would acquire in falling from a height equal to the depth.

The third law is, that if two tubes of equal diameters full of any fluid, be placed any how, either erect or inclined, provided they be of the ſame altitude, they will diſcharge equal quantities of the fluid in equal times. That tubes every way equal, ſhould under the ſame circumſtances empty themſelves equally is evident; and that the bottom of a perpendicular tube is preſſed with the ſame force as that of an inclined one, when their altitudes are equal, has already been ſhewn; whence it eaſily follows, that they muſt yield equal quantities of water, &c.

The fourth is, that if two tubes of equal altitudes, but unequal apertures, be kept full of water; the quantities of water they yield in the ſame time will be as the diameters; and this whether they be erect or any how inclined. Hence if the apertures be circular, the quantity of water emptied in the ſame time, are in a duplicate ratio of the diameters.

The fifth law is, that if the apertures of two tubes be equal, the quantity of water diſcharged in the ſame time will be as the velocities.

The ſixth is, that if two tubes have equal apertures, and unequal altitudes, the quantity of water diſcharged from the greater tube, will be to that diſcharged from the leſſer in the ſame time in a ſubduplicate ratio of their altitudes. Hence, 1. The altitudes of water diſcharged through equal apertures, will be in a duplicate ratio of the waters diſcharged in the ſame time: and as the quantities of water are as the velocities; the velocities are likewiſe in a ſubduplicate ratio of their altitudes. Hence, 2. The ratio of the waters diſcharged by two tubes, together with the altitude of one of them

them being given, we have a method of finding the altitude of the other, *viz.* by finding a fourth proportional to the three given quantities; which proportional, multiplied by itself, gives the altitude required. Hence also, 3. The ratio of the altitude of two tubes of equal apertures being given, as also the quantity of water discharged by one of them, we have a method of determining the quantity the other shall discharge in the same time. Thus to the given altitudes, and the squares of the quantity of water discharged at one aperture, find a fourth proportional. The square root of this will be the quantity of water required.

Suppose, *e. gr.* the height of the tubes, as 9 to 25, and the quantity of water discharged at one of them three inches; that discharged by the other will be $= \sqrt{}$ (9. 2[illegible] : [illegible]) $= \sqrt{}$ [illegible] $= 5$.

The seventh law is, that if the altitudes of two tubes be unequal, and the apertures likewise unequal, the quantities of water discharged in the same time, will be a ratio compounded of the simple ratio of the apertures, and the subduplicate one of the altitudes. And hence if the quantities of water discharged in the same time by two tubes, whose apertures and altitudes are unequal, be equal; the apertures are reciprocally as the roots of the altitudes, and the altitudes in a reciprocal ratio of the squares of the apertures.

The eighth is, that if the altitudes of two tubes be equal, the water will flow out with equal velocity, however unequal the apertures be.

The ninth, if the altitudes of two tubes, and also their apertures be unequal, the velocity of the waters discharged are in a subduplicate ratio of their altitudes. And hence, 1. As the velocities of waters flowing out at equal apertures, when the altitudes are unequal, are also in a subduplicate ratio of the altitudes, and, as this ratio is equal, if the altitudes be equal; it appears in the general, that the velocities of water flowing out of tubes, are in a subduplicate ratio of the altitudes. Hence also, 2. The squares of the velocities are as the altitudes.

Mariotte found from repeated experiments, that if a vessel has a tube fitted to it, there will be more water evacuated through the tube, than there could have been in the same time, through the aperture of the vessel without the tube: and that the motion of the fluid is accelerated so much the more, as the tube is the longer, *e. gr.* the altitude of a vessel being one foot, that of the tube three feet, and the diameter of the aperture three lines; $6\frac{1}{2}$ septiers of water were discharged in the space of one minute, whereof, upon taking off the tube, only four septiers were discharged. Again, when the length of the tube was six feet, and the diameter of the aperture an inch, the whole quantity of water run out in thirty-seven seconds; but cutting off half the tube, the vessel was not evacuated in less than forty-five seconds; and taking it quite away, in less than ninety-five seconds.

The tenth law is, that the altitudes and apertures of two cylinders full of water being the same; one of them will discharge double the quantity of water discharged in the same time by the other; if the first be kept continually full, while the other runs itself empty. For the velocity of the full vessel will be equable, and that of the other continually retarded. Now it is demonstrated, that if two bodies be impelled by the same force, and the one proceeds equably, and the second is equably retarded; by that time they have lost all their motion, the one has moved double the space of the other.

The eleventh, if two tubes have the same altitudes and equal apertures, the time wherein they will empty themselves will be in the ratio of their cases.

The twelfth, cylindrick and prismatick vessels empty themselves by this law, that the quantities of water discharged in equal times, decrease according to the uneven numbers. 1, 3, 5, 7, 9, &c. taken backwards. For the velocity of the descending level, is continually decreasing in the subduplicate ratio of the decreasing altitudes: but the velocity of a heavy body descending, increases in the subduplicate ratio of the increasing altitudes.

The thirteenth is, that if water descending through a tube, spouts upon an aperture, whose direction is vertical; it will rise to the same altitude, at which the level of the water in the vessel does stand; for since the direction of the aperture is vertical, the direction of the water spouting through it will be so too; consequently the water must rise to the height of the level of the water in the vessel.

The fourteenth law is, that water descending through an inclined tube, or a tube bent in any manner, will spout up through a perpendicular aperture to the height at which the level of the water in the vessel stands,

The fifteenth law is, that the length or distances, to which water will spout, either through an inclined, or a horizontal aperture, are in a subduplicate ratio of the altitudes in the vessel or tube. For since water spouted out through the aperture, endeavours to proceed in an horizontal line; and at the same time by the power of gravity, tends downwards in lines perpendicular to the same; nor can the one power hinder the other, inasmuch as the directions are not contrary: it follows, that the water will arrive at the line proposed, in the same time wherein it would have arrived at it, had

there

there been no horizontal impulse at all. Hence, as every body projected, either horizontally, or obliquely, in an unresisting medium, describes a parabola; water projected either through a vertical or inclined spout, will describe a parabola. Hence we have a way of making a delightful kind of water arbours or arches, *viz.* by placing several inclined tubes in the same right lines.

On these principles, we'll form several *hydraulick* engines, for the raising, &c. of fluids, as *pumps*, *siphons*, *fountains*, or *jets d'eaus*, &c. beginning with *pumps*,

A *Pump* is a machine formed on the model of a syringe, for the raising of water.

Pumps are distinguished into several kinds, with regard to the several manners of their acting, as the *common*, or *sucking pump*, *forcing pump*, *Ctesebes's pump*, *chain pump*, *are pump*, *bur pump*, &c.

The *common* or *sucking pump*, (*Fig.* 23. *ibid.*) is that which acts by the pressure of the air, and whereby water is raised out of a lower into a higher place, not exceeding 32 feet. This *pump* is made of a hollow cylinder, or barrel, provided of any solid matter, usually wood, and erected perpendicularly in a spring, or other source of water. the lower part of the cylinder being first fitted with a valve † *d*, which opens upwards. — A Piston, * or embolus *b*, called the sucker, furnish'd with a valve *c*, which likewise opens upwards, is let down the cylinder; and for the more easy working upwards and downwards, furnished with a level or handle *a*. Now the embolus being drawn up, will leave a space void of air, at least in a great measure so: the pressure, therefore, of the air on the surface of the stagnant water prevailing, will, by the laws of *hydrostaticks*, lift up the valve *d*, first mentioned, and raise it to fill the cavity supposed void of air. — If then the embolus be again let down. the lower valve being now fast closed with the weight of the incumbent water, upon pressing the piston. the water must open the upper valve *c*, and get into the embolus, by which it is raised up and discharged out of the spout. — Thus is the embolus alternately raised and depressed.

This ascent of the water, the ancients, who supposed a *plenum*, attributed to nature, abhorrent of a *vacuum*; but the moderns, more reasonably, as well as more intelligibly, attribute it to the pressure of the atmosphere, on the surface of the fluid. For, by drawing up the embolus, the air left in the cavity of the cylinder, must be exceedingly rarified; so that being no longer a counter-ballance to the air incumbent on the surface of the fluid; that prevails and forces the water thro' the little tube into the body of the *pump*.

The *forcing pump* (*Fig.* 24. *ibid.*) acts by mere impulse or protrusion and raises water to any height at pleasure. This *pump* is made in this manner: a cylinder is divided by a diaphragm, or transverse piece, fitted with a valve, opening upwards *d*, and thus immerged in water: an embolus *b*, furnished with a valve, is so fitted to an iron-rod *f*, moveable on a hinge at each end, as that it may be conveniently raised, and depressed by the hand. Now, upon pressing the embolus, the water will open the valve, and thus ascend into the cavity of the cylinder. But upon raising it again, the valve is shut, so that there is no passage for it that way; the other valve therefore becomes open'd, and the water mounts through it; and by repeating the agitation of the embolus, it is at length driven out thro' the spout.

The great difficulty of rectifying this *pump*, when out of order, on account of the chief seat of action being under water, makes people decline the use of it when they can do well without it, notwithstanding its advantage of raising the water to any given height.

Ctesebes's pump (*Fig.* 25. *ibid.*) is the first and finest of all the kinds and acts both by friction and compulsion. Its structure and action is as follows. A brass cylinder furnished with a valve *c*, is placed in the water. In this is fitted the embolus *b*, made of green wood, which will not swell in the water, and adjusted to the aperture of the cylinder, with a covering of leather; but without any valve. Another tube *e*, is fitted on with a valve that opens upwards. Now the embolus being raised, the water opens the first valve *c*, and rises into the

† A valve in *hydraulicks*, is a kind of lid, or cover, of a tube or vessel, so contrived, as to open one way; but which, the more forcibly it is pressed the other way, the closer it shuts the aperture So that it either admits the entrance of a fluid into the tube, or vessel, or prevents its re entrance. In *hydraulick* engines, they are frequently of leather; their figure round; and are fitted to the bottom, or other part of the barrel, &c. to shut the apertures. Sometimes they are made of two round pieces of leather, inclosed between two others of brass, having divers perforations, which are covered with another piece of brass, moveable upwards and downwards, on a kind of axis, which goes thro' the middle of them all — Sometimes they are made of brass, covered with leather, and furnished with a fine spring, which gives way upon a force applied against it: but upon the ceasing of that, returns the valve over the aperture.

* The *piston* or *embolus*, is a short cylinder of metal, fitted exactly to the cavity of the barrel or body of the pump; and which being worked up and down alternately therein, raises the water; and when raised, presses it again, so as to make it force up the valve wherewith it is furnished, and so escape through the nose of the pump.

cavity

cavity of the cylinder: and when the ſame embolus is again depreſſed, the laſt valve is opened *c*, and the water driven out thro' the tube.

This is the *pump* uſed among the antients, and that from which both the others are deduced. Sir *S. Morland* has endeavoured to increaſe its force, by leſſening the friction, which he has done to good effect, inſomuch as to make it work without almoſt any friction at all.

Note, That the other pumps I have mentioned, are only uſed in ſhips; and therefore I'll give their deſcription in the treatiſe of *Naval Architecture*, under the letter *N*.

From the *pump* we'll paſs to the SIPHON; which is a crooked tube, one branch or leg whereof is longer than the other; uſed in the raiſing of fluids, emptying of veſſels, and in various *hydroſtatical* experiments.

The word in the original *Greek* σιφων, ſignifies ſimply *tube*; whence ſome apply it to common tubes or pipes. *Wolfius* particularly deſcribes two veſſels, under the name of *ſiphons*; the one cylindrical in the middle, and conical at the two extremes; the other globular in the middle, with two narrow tubes fitted to it, axis-wiſe; both ſerving to take up a quantity of water, *&c.* and to retain it when up.

There is not a more uſeful and celebrated *ſiphon* than this. A crooked tube is provided of ſuch a length, and with ſuch an angle, that as when the orifice is placed on an horizontal plane, the height may not exceed 30 foot. For common uſes, a foot, or half a foot high ſuffices. If now the leſſer arm be immerged in water, or any other liquid, and the air be ſucked out of it by an aperture made for that purpoſe, till the liquor follow; the liquor will continue to flow out of the veſſel, through the tube, as long as the aperture is under the ſurface of the liquor. Inſtead of ſucking out the air, the event will be the ſame, if the *ſiphon* be at firſt filled with the fluid, and the upper aperture ſtopped with the finger, till the lower be immerged.

In ſucking, the air in the tube is rarified, and the equilibrium deſtroyed, conſequently the water muſt be raiſed into the leſſer leg, by the preponderating preſſure of the atmoſphere.

The *ſiphon* being thus filled, the atmoſphere preſſes equally on each extremity thereof; ſo as to ſuſtain an equal quantity of water in each leg: but the air not being able to ſuſtain all the water in the longer leg, unleſs it exceeds 32 feet in height; it will be more than able to ſuſtain that in the ſhorter leg: with the exceſs of force, therefore it will raiſe new water into the ſhorter leg; which new water cannot make its way, but by protruding the firſt before it. By this means the water is continually driven out at the longer leg, as it is continually raiſed by the ſhorter.

If a filled *ſiphon* be ſo diſpoſed as that both orifices be in the ſame horizontal line, the fluid will remain pendant in each leg, how unequal ſoever the length of the legs may be. Fluids, therefore, in *ſiphons*, ſeem, as it were to form one continued body; ſo that the heavier part deſcending like a chain, pulls the lighter after it. Obſerving, beſides, that the water will flow out even thro' a *ſiphon* that is interrupted, by having the legs join'd together, by a much bigger tube full of air.

The moſt conſiderable machine of *hydraulicks*; the moſt agreeable to the ſight, and moſt diverting, is the *artificial fountain*.

The *artificial fountain*, is a machine, or contrivance, whereby water is ſpouted or darted up, called alſo *jet d'eau*.

M. *Mariotte* ſhews, that a *jet d'eau* will never raiſe water ſo high as its reſervoir, but always fall ſhort of it by a ſpace, which is a ſubduplicate ratio of that height. He ſhews, likewiſe, that if a greater *jet* branch out into many ſmaller ones, or be diſtributed thro' ſeveral *jets*, the ſquare of the diameter of the main pipe, muſt be proportioned to the ſum of all the expences of its branches; and that if the reſervoir be 52 feet high, and the adjutage half an inch in diameter, the pipe ought to be three inches in diameter.

There are divers kinds of *artificial fountains*, ſome founded on the ſpring, or elaſticity of the air; and others on the preſſure or weight of the water, *&c.* the ſtructure of each hereof, being entertaining and curious, and affording a good illuſtration of the doctrine of *hydraulicks*, ſhall be here explained; beginning by the conſtruction of an *artificial fountain, playing by the ſpring, or elaſticity of the air.*

For the conſtruction of that kind of *artificial fountain*, a veſſel proper for a reſervoir as A B, of metal, glaſs, or the like, is provided; ending in a ſmall neck *c* a top. Through a thick neck a tube is put *c a*, traverſing the neck of the veſſel, till its lower orifice *d*, nearly, but not abſolutely, reach the bottom of the veſſel; the veſſel being firſt half filled with water. The neck is ſo contrived, as that a ſyringe, or condenſing pipe may be ſcrewed upon the tube, by means whereof a large quantity of air may be intruded through the tube into the water, out of which it will diſengage itſelf, and emerge into the vacant part of the veſſel, and lie over the ſurface of the water C D. See *Fig.* 30. *Hydraulicks.*

Now the water here contain'd, being thus preſſed by the air, which is, *e. gr.* twice as denſe as the external air; and the elaſtick force of air being equal to its gravitating force, the effect will be the ſame as if the weight of the column of air over the ſurface of the water, were double that of the column preſſing in the tube; ſo that the water muſt of neceſſity ſpout up through the tube, with a force equal the exceſs of preſſure of the included, above that of the external air.

But if our *artifical fountain* is to play *by the preſſure of the water*, we muſt ſearch a reſervoir of water in a place conſiderably higher than that where the fountain is to be, (whether that reverſoir have been placed there by nature; or whether it have been raiſed for the purpoſe by a proper engine; as a pump, ſiphon, ſpiral ſcrew, or the like) having found ſuch reſervoir, we'll lay vertical tubes for the water to deſcend through; and to theſe vertical tubes, fit other horizontal ones under ground, to carry the water to the place where the fountain is to play. Laſtly, from theſe horizontal tubes, we'll erect other vertical ones, by way of adjutages, jets, or ſpouts; their altitude being much leſs than that of the tubes, whereby the water was carried to the horizontal ones. Then will the water, by the preſſure of the ſuperincumbent column, be ſpouted up at theſe jets; and that to the height or level of the water in the reſervoir, and thus howſoever any of the tubes be bent or incurvated.

Thus may water be ſpouted to any given height at pleaſure: the tubes may be ſo proportioned, as to yield any given quantity of water, in a given time: or ſeveral tubes of the ſame *fountain*, may be made to yield water in any given ratio; or laſtly, different tubes may project the water to different altitudes

Theſe aerial or aquatick *fountains*, may be applied in various manners; ſo as to exhibit various appearances; and from theſe alone ariſes the greateſt part of our artificial water-works, which ſo agreeably ſtrike the ſight that the deſcription of ſome of them, muſt be very entertaining, therefore,

I'll begin by the deſcription of an *artificial fountain, which ſpouts the water in various directions* Suppoſing, firſt, the vertical tube or ſpout in which the water raiſes. to be I L (*Fig.* 31. *ibid.*) into this are to be fitted ſeveral other tubes; ſome horizontal, others oblique; ſome inclining, others reclining, as M N, O P, Q R *&c.* Then all the water will retain the direction of the aperture through which it is ſpouted, that iſſuing through I, will riſe perpendicularly; and that through M N, O P, Q R, will deſcribe arches of different magnitudes, and tending different ways.

Or thus; ſuppoſe the vertical tube M N, (*Fig.* 32. *ibid.*) through which the water riſes, to be ſtopped a-top, as in M; and inſtead of pipes or jets, let it be only perforated with little holes all round, or only half its ſurface, then will the water ſpin forth in all directions, through the little apertures, and to a diſtance proportional to the height of the fall of the water: and hence if the tube M N, be ſuppoſed the height of a man, and be furniſhed with an epiſtonium, or cock, at P; upon opening the cock, the ſpectators dreaming of no ſuch matter, will be covered with a ſhower, obſerving, however, that the diameter of the apertures through which the water is emitted, muſt be conſiderably leſs than thoſe tubes in which the water is brought; leſt the reſiſtance of the air, and other impediments, break the force of the water.

We'll exhibit next, a *fountain playing by the draught of the breath*; in ſuppoſing R S (*Fig.* 32. *ibid.*) to be a glaſs. or metalline ſphere, wherein is fitted a tube T V, having a little orifice in T, and reaching almoſt to V, the bottom of the ſphere; if now the air be ſucked out of the tube T V, and the orifice T be immediately immerged under cold water, the water will aſcend thro' the tube into the ſphere. Thus proceeding by repeated exſuctions till the veſſel be above half full of water, and then applying the mouth to T, and blowing air into the tube; upon removing the mouth, the water will ſpout forth. Or, if the ſphere be put into water, the air being thereby rarified, will make the water ſpout as before. This fountain is called *Pila Heronis*, or *Hero*'s *ball*, from the name of its inventer.

To make a *fountain, the ſtream whereof riſes, and plays thro' a braſs ball*; we muſt provide a hollow braſs ball B (*Fig* 33. *ibid*) made of thin plate, that its weight may not be too great for the force of the water; and make the tube D E, through which the water riſes, exactly perpendicular to the horizon. Then the ball being laid in the bottom of the cup or baſon F, will be taken up in the ſtream, and ſuſtain'd at a conſiderable height, as B; alternately vibrating, or playing up and down. Hence as the figure of the ball contributes nothing to its repriprocal riſe and fall; any other body, not too heavy, may be ſubſtituted in lieu thereof, *e. gr.* a bird with its wings ſtretched forth.

It is neceſſary the ball when on the deſcent. ſhould keep the ſame preciſe perpendicular, wherein it roſe, (ſince otherwiſe it would miſs the ſtream, and fall downright) and that ſuch a *fountain* ſhould only be played in a place free from wind.

For the conſtruction of a *fountain, which ſpouts water in the form of a ſhower*; to the tube wherein the

the water is to rise, we must fit a spherical, or lenticular head, 1, 2, (*Fig*, 34. *ibid*) made of a plate of metal, and perforated a top with a great number of little holes: the water rising with vehemence towards 1, 2, will be there divided into innumerable little threads, and afterwards break, and disperse into the finest drops.

To make a *fountain, which spreads the water in form of a table cloth*; we must solder to the tube H I, (*Fig.* 35. *ibid.*) two spherical segments K L, almost touching each other; with a screw M, to contract or amplify the interstice or chink at pleasure. Others chuse to make a smooth, even cleft, in a spherical or lenticular head fitted upon the tube. The water spouting through the chink, or cleft, will expand itself in manner of a cloth.

Since water may be derived or conveyed by tubes in any situation, and always retains the direction of the apertures, *artificial fountains* may be made wherein the *water spouts out of the figures of men and other animals*; by inclosing tubes within the figures of men or other animals, having their orifices in those parts, whence the waters are to spout forth.

From the principles hitherto laid down, it will be very easy to deduce whatever relates to the furniture of *fountains*; and the various forms water may be put into by their means; all depending on the magnitude, figure, and direction of the adjutages or apertures.

To make a *fountain, which, when it has done spouting, may be turned like an hour-glass*; we must provide two vessels, P Q and R S (*Fig.* 36. *ibid.*) which should be so much the bigger, as the *fountain* is to play the longer; and placed at so much the greater distance from each other T V, as the water is desired to spout the higher. Then X Y Z, which is a crooked tube, must be furnished with a cock in Z; and A B C, another bent tube, furnished with a cock in B. In F G, are to be other lesser tubes, open at both ends, and reaching near the bottom of the vessel R S, and P Q, to which the tubes T V and Q S, are likewise to reach. If now the vessel P Q be filled with water, it will descend through the tube I X, and upon opening the cock Z, will spout up near to the height of G: and after its fall again, will sink through the little tube F, into the vessel R S, and expel the air through the tube E D. At length, when all the water is emptied out of the vessels P Q; by turning the machine upside down the vessel R D will be the reservoir, and make the water spout up thro' the cock Z. Hence if the vessels P Q and R S, contain just as much water as will be spouted up in an hour's time, we shall have a spouting clepsydra, or water clock, which may be divided or graduated into quarters, minutes, &c.

To this treatise we should add certain engines and instruments of modern invention, and great use.

Engine *for extinguishing fires*, a machine for raising a considerable quantity of water, in one continued stream, for the extinguishing accidental fires.

The best engine of this kind is that of Mr. *Newsham*, an engine-maker of *London*, which is so contrived that part of the men who work it, exert their strength by treading, the very best way of working such engines; the whole weight of the body being successively thrown on the forces of the pumps, and every part of a man's strength may be added to the weight, by means of horizontal pieces, to which he may apply his hands when treading. This is the reason why, with the same number of men, his engine will throw water farther, higher, and in greater quantities than any engines of the same size, hitherto contrived. See a perspective view of the whole engine, ready for working, N° 1. in *Plate* facing *Husbandry*.

The nature and effect of this engine will be easily understood from a perpendicular section of it represented *ibid*. N° 2.

The water is raised by the pressure of the atmosphere, by the force of the pistons, and by the spring of condensed air, in the following manner: thus, when the piston R is raised, a vacuum would be made in the barrel TV, did not the water follow it from the inferior canal E M (through the valve H) which rises through the brass tube E F, immersed in the water of a vessel, by the pressure of the atmosphere on the surface thereof. By the depression of the piston R, the water in the barrel TV is forced through the superior canal ON, to enter by the valve I, into the air-vessel *a b c d*; and the like being done alternately by the other barrel W X, and its piston S, the air-vessel is by this means continually filling with water, which greatly compresses the air above the surface of the water in the vessel, and thereby proportionably augments its spring, which is at length so far increased, as to re-act with great force on the surface Y Z of the subjacent water; which ascending through the small tube *e f*, to the stop cock *e g*, is there, upon turning the cock *p*, suffered to pass through a pipe *h*, fixed to a ball and socket, from the orifice of which it issues with a great velocity, to a very great height or distance, in a small continued stream, directed every way, or to any particular place, by means of the ball and socket.

The greatest artifice of this engine is its contrivance to produce a continued stream, which is done by compression, and the consequent increased elasticity

ticity of the air in the barrel *a b c d*, called the air-vessel.

When, therefore, the air vessel is half filled with water, and the air thereby compressed into half its first space, its spring will be equal to twice the pressure of the atmosphere; so that, on turning the stop cock *p*, the air within pressing on the subjacent water with twice the force it meets with from the external air in the pipe *e f*, will cause the water to spout out of the engine to the height of 32 or 33 feet, if the friction be not too great.

When the air-vessel is $\frac{2}{3}$ full of water, the space which the air takes up is only $\frac{1}{3}$ of its first space; whence its spring being three times as great as that of the common air, it will project the water with twice the force of the atmosphere, or throw it to the height of 64 or 66 feet. In the same manner, when the air-vessel is $\frac{3}{4}$ full of water, the air will project it to the height of 96 or 99 feet; and when $\frac{4}{5}$ full of water, to the height of 132 feet. Hence it is easy to calculate the different heights to which the water will rise, as in the following table.

Height of the water.	Heighth of the compressed air.	Proportion of the air's spring.	Height to which the water will rise.
$\frac{1}{2}$	$\frac{1}{2}$	2	33 feet.
$\frac{2}{3}$	$\frac{1}{3}$	3	66
$\frac{3}{4}$	$\frac{1}{4}$	4	99
$\frac{4}{5}$	$\frac{1}{5}$	5	132
$\frac{5}{6}$	$\frac{1}{6}$	6	165
$\frac{6}{7}$	$\frac{1}{7}$	7	198
$\frac{7}{8}$	$\frac{1}{8}$	8	231
$\frac{8}{9}$	$\frac{1}{9}$	9	264
$\frac{9}{10}$	$\frac{1}{10}$	10	297

As the air-vessel is the cause of the continued stream, we may naturally infer, that if such an air-vessel were adapted to the common house pump, it would become a useful engine for extinguishing accidental fires. Now this may be effected in the following or some other analogous manner: let A B C D (*ibid.* N° 3.) be the barrel of the pump, P H the rod and piston, CW the pipe going down to the water of the well at W. Towards the lower part of the barrel is a shot tube, by which the air-vessel FE is fixed to, and communicates with the barrel of the pump. A M N L is a collar of leather, so fixed on the top of the barrel, and adapted to the rod, that it may move freely in the leathers, without permitting the air to pass in or out between. The nozzle or spout D, has a stop-cock S, to let out or keep in the water at pleasure. Q is a piece screwed on, to direct the stream, by a small leather-pipe at the end. When the piston is raised from the bottom of the pump-barrel, the water above will be forced into the air-vessel, and there compress the air; it will also compress the air on the top of the barrel, for the water will not be higher than the spout D at first, when the stop-cock is shut; but afterwards, as the air is confined, it will be compressed at top, the water rising to I. This compressed air, in each place, will act upon the water by its spring, and, upon turning the stop-cock, will force it out in a continued stream thro' the pipe at Q, and that with a greater or lesser degree of force, as occasion requires, that being absolutely in the power of the person working the pump.

Steam-Engine, a machine to raise water by fire, or rather by the force of water turned into steam.

The following is a description of this engine in its first state, and original simplicity. ABC (Plate *Hydraulick Engines*, Fig. 1.) is a copper vessel, partly filled with water to D E, which, being set over a fire and made to boil, will fill the upper part DBE with an elastic vapour, the sufficient strength whereof is known by its forcing open a valve at *e*: this heated elastic steam is, by turning a cock at F, let into the barrel *a b c d*, where, by its elastic force, it raises the piston G, which drives the air above it through a proper clack at the top. After this, that the piston may by its weight descend, a little cold water from the cistern *f g h i*, is let in at the bottom by turning a cock at *k*, which, in form of a jet, condenses the hot steam in the barrel into 13000 times less space than before it took up, which make a sufficient vacuum for the piston to descend in. The piston G, and lever H I being thus put into motion, do accordingly raise and depress the piston K in the barrel of the forcing pump L M, on the other side; which, by the pipe N, draws the water from the depth W, and forces it to rise and spout through the tube O, continued to any height at pleasure.

Thus is the *Steam-Engine* a very simple and plain machine, where a very powerful stroke for working of pumps is performed by only turning two cocks alternately; and yet a person who knows nothing of it, would imagine it to be very complex, by the number of parts that offer themselves to view. But here we must distinguish between what performs the material operations of the engine, and what serves for conveniency and the just regulation of the said operations; for not above the hundredth part of the power of this engine is employed to turn the cocks and regulate all the motions, as will appear from what follows.

The structure of the *Steam-engine*, as used at present, is represented in N° 2. concerning which we are to observe.

1. That there may be always water in the ciſtern *g*, to inject into the ſteam to condenſe it, there is an arch *x*, fixed near the arch H, at the pump end, from whence another pump-rod *k*, with its piſton, draws water from a ſmall ciſtern near the mouth of the pit, ſupplied from the water raiſed at *p*, and forces it up the pipe *m m m*, to keep the injecting ciſtern *g* always full.

2. As the piſton C which moves up and down the cylinder ought to be air-tight, a ring of leather, or a piece of match, which lies upon its circumference next to the inſide of the cylinder, muſt be kept moiſt and ſwelled with water; this is ſupplied from the injecting ciſtern by a ſmall pipe *z*, always running down upon the piſton, but in a very ſmall quantity, if the work be well performed. L is a leaden cup, whoſe office is to hold the water that lies on the piſton, leſt it ſhould flow over when the piſton is arrived at its greateſt height in the cylinder, as W, at which time if the cup is too full, the water will run down the pipe L V, into the waſte-well at Y.

3. As the water, in the boiler B, muſt waſte by degrees, as it is conſtantly producing ſteam, and that ſteam continually let out for working the engine, there ought to be a conſtant ſupply of the water to boil: this is performed by means of the pipe F *f*, about three feet long, going down a foot under the ſurface of the water in the boiler, with a funnel F, at top, always open, and ſupplied by the pipe W, with water from the top of the ciſtern, which has the advantage of being always warm, and, therefore, not apt to check the boiling of the water in the copper.

4. That the boiler may not have the ſurface of the water too low (which would endanger burſting) or too high (which would not leave room enough for ſteam) there are two guage-pipes at G, one going a little below the ſurface of the water when at a proper height, and the other ſtanding a little above it: when every thing is right, the ſtop-cock of the ſhorter pipe being opened gives only ſteam, and that of the long one water; but if otherwiſe, both cocks will give ſteam when the ſurface is too low, and both give water when it is too high; and hence the cock which feeds the boiler at F may be opened to ſuch a degree as always to keep the ſurface of water to its due heighth.

5. As cold water is injected into the cylinder at every ſtroke, and as that water might in time fill the cylinder, and hinder the operation of the engine, there is a pipe coming from the bottom of the cylinder *d* T Y, called the eduction pipe, thro' which the water that has been injected, comes down every time the ſteam is let into the cylinder. This eduction pipe goes an inch or two under water in the waſte well Y, and having its end turned up is ſhut with a valve Y to keep out the air from preſſing up the pipe, but permitting the injected air coming the other way to be diſcharged; by which means the cylinder is kept empty.

6. Leſt the ſteam ſhould grow too ſtrong for the boiler, and burſt it, there is a valve fixed at *b* with a perpendicular wire ſtanding up from the middle of it, to put weights of lead upon, by which to examine the ſtrength of the ſteam puſhing againſt it from within. Thus the ſteam is known to be as ſtrong as the air, if it will raiſe up ſo much weight on the valve as is at the rate of 15 *lb.* to an inch ſquare; becauſe that is the weight of the air, nearly, on every inch ſquare. When the ſteam becomes ſtronger than what is required, it will lift up the valve and go out. This valve is called the puppet clack.

7. The ſteam is always in a fluctuating condition, yet never $\frac{1}{10}$ ſtronger or weaker than common air. For it has been found that the engine will work well, when there is the weight of one pound on every ſquare inch of the valve *b*. This ſhews that the ſteam is then $\frac{1}{15}$ part ſtronger than the common air. Now as the heighth of the feeding pipe from the funnel F to the ſurface of the water S *s* is not above three feet, and $3\frac{1}{2}$ feet of water is $\frac{1}{10}$ of the preſſure of air; if the ſteam were $\frac{1}{10}$ part ſtronger than air, it would puſh the water out at E; which ſince it does not do, it cannot be ſtronger than air, even in this caſe, where the regulator being ſhut, it is moſt of all confined.

8. When the regulator is open, the ſteam gives the piſton a puſh on the underſide, then occupying more ſpace, the ſteam comes to be a ballance only for the outward air, and ſo only ſuſtains the piſton; but the over weight of the pump-rods, at the contrary end of the beam *h* 2, draws up the piſton beyond C as far as W. The ſteam, then expanded ſo as to fill up all the cylinder, would not quite ſupport it, if it was not for the over weight abovementioned. If this was not true, when the end *h* 2 is down as low as it can go, and reſts upon the beams that bear its center, the chain LH above the piſton would grow ſlack, and the piſton might ſometimes be puſhed out of the cylinder, which never happens.

Again, when firſt the ſteam is let into the cylinder, the injected water is puſhed out at the eduction pipe *d* T Y, and is all out of the cylinder by that time the piſton is got up to C. If then the ſteam was ſtronger than air, it would fly out at Y after the water, the valve Y not being loaded. If it were exactly equal to the ſtrength of the air, it would juſt drive all the water out at Y, but could not follow itſelf, the preſſure being equal on each ſide of the valve by ſuppoſition. If it be weaker than the air, it will not force all the water out of the pipe *d* TY, but the ſurface will ſtand, ſuppoſe at T, where the column of water T Y added to the ſtrength of the ſteam, is equal to the preſſure of the air. When the ſtream is $\frac{1}{10}$ weaker than the air, the height TY is equal $3\frac{1}{2}$ feet.

Now ſince the whole perpendicular diſtance from *d* to Y is but four feet, and the ſteam is always ſufficient to expel the water; it is plain it can never be more than $\frac{1}{10}$ part weaker than the air, when weakeſt.

9. As there is air in all the water injected, and that air cannot be taken out, or condenſed with the ſteam by the jet of cold water coming in at *n*, the whole operation would be diſturbed, and only a very imperfect vacuum made, were it not for the following contrivance.

We are to remember that when ſteam is become as ſtrong as air, it is above ſixteen times rarer; ſo that air will precipitate in ſteam, as quickſilver would in water. Therefore all the air extricated from the injected water, lies at the bottom of the cylinder, over the ſurface of ſo much of the injected water as is come down to *d n*. Now there is without the cylinder at 4, a little cup with a valve, and from under the valve, a pipe going laterally into the cylinder above its bottom to receive the air into the cup. When, therefore, the ſteam firſt ruſhes into the cylinder, and is a little ſtronger than the outward air, it will force the precipitated air to open the valve at 4, and make its eſcape; but the ſteam cannot follow, becauſe it is weaker than the external air, as the piſton, by aſcending, gives it room to expand. This valve from the noiſe it makes is called the ſnifting clack.

10. But amongſt the greateſt improvements of this engine, we may reckon that contrivance by which the engine itſelf is made to open and ſhut the regulator and injection-cock, and that more nicely than any perſon attending could poſſibly do it. For if the man who turns the regulator at E, and the injection-cock N, when the piſton is coming down, opens the regulator and lets in the ſteam too ſoon to raiſe the piſton again, the ſtroak will be ſhorter than it ought to be; and if he does not open the regulator ſoon enough, the piſton coming down with a prodigious force, will very probably ſtrike againſt the throat pipe D *d* at *d*, and cruſh it to pieces.

Likewiſe when the regulator is open, the ſteam going into the cylinder, and the piſton riſing, the ſtroke will not have its full length, if the ſteam is turned off, and the cold water injected too ſoon; and if injected too late, the ſteam may throw the piſton quite out of the cylinder's top at L.

To prevent, therefore all ſuch accidents, there is fixed to an arch Z, at a proper diſtance from the arch P, a chain, from which hangs a perpendicular piece, or working beam QQ, which comes down quite to the floor, and goes through it in a hole which it fits very exactly. This piece has a long ſlit in it, and ſeveral pin holes and pins for the movement of ſeveral levers deſtined to the office of opening and ſhutting the cocks after the following manner,

11. Between two perpendicular pieces of wood on each ſide of P, there is a ſquare axis AB (*ibid.* N° 3.) which has upon it ſeveral iron pieces of the lever kind. The firſt is the piece CED called the Y, from its repreſenting that letter inverted by its two ſhanks, E and D; on the upper part is a weight F, to be raiſed higher and lower, and fixed as occaſion requires. This Y is fixed very faſt upon the ſaid iron axle A B.

12. From the axle hangs a ſort of an iron ſtirrup, IKLH, by its two hooks IG, and having on the lower part two holes K L, through which paſſes a long iron pin L K, and keyed in the ſame. When this pin is put in, it is alſo paſſed through the two holes in the ends E N of the horizontal fork or ſpanner E QN, joined at its end Q to the handle of the regulator V 10. From Q to O are ſeveral holes, by which the ſaid handle may be fixed to that part of the end which is moſt convenient.

13. Upon the axis A B is fixed at right angles to the Y an handle or lever G 4, which goes on the outſide of the piece QQ, and lies between the pins. Another handle is alſo faſtened upon the ſame axle, *viz.* H 5, and placed at half a right angle to the former G 4: this paſſes through the ſlit of the piece Q Q, lying on one of its pins. Hence we ſee that when the working beam goes up, its pin in the ſlit lifts up the ſpanner H 5, which turns about the axle ſo faſt, as to throw the Y with its weight F from C to 6, in which direction it would continue to move after it paſſed the perpendicular, were it not prevented by a ſtrap of leather fixed to it at *æ*, and made faſt at the ends *m* and *n*, in ſuch manner as to allow the Y to vibrate backwards and forwards about a quarter of a circle, at equal diſtance on this ſide and that of the perpendicular.

14. As things are repreſented in the figure, the regulator is open, its plate TY being ſhewn on one ſide of the pipe S, which joins the cylinder and boiler. The piſton is now up, and alſo the working beam near its greateſt height, the pin in the ſlit has ſo far raiſed the ſpanner H 5, that the weight F on the head of the Y is brought ſo far from *n*, as to be paſt the perpendicular and ready to fall

X 2 over

over towards *m*, which when it does, it will by its ſhank E, ſtrike the iron pin K L with a ſmart blow, and drawing the fork O N horizontally towards the beam Q, will draw the end 10 of the regulator towards *t*, and thereby ſhut it, by ſlipping the plate Y under the holes of the throat-pipe S.

15. Immediately after the regulator is ſhut, the beam riſing a little higher with its pin *S* on the outſide upon the lower part, lifts up the end *i* of the handle of the injecting-cock, and opens it by the turning of the two parts with teeth. The jet immediately making a vacuum, the beam again deſcends, and the pin *r* depreſſing the handle *k i*, ſhuts the injection cock; and the beam continuing to deſcend, the pin *p* bears down the handle G 4, and throwing back the Y, its ſhank D throws forward the fork NQ, and again opens the regulator to receive freſh ſteam. After this very thing returns as before, and thus is the engine moſt wonderfully contrived to work itſelf.

16. Many years after the engine had been made, as above deſcribed, it received another improvement of very great advantage, and that was, inſtead of feeding the boiler with warm water, from the top of the cylinder (*ibid Fig.* 3.) by the pipe W above, and F *f* below, they contrived to ſupply it with the ſcalding hot water which came out of the eduction-pipe *d* TY, which now, inſtead of going into the waſte well at Y, was turned into the boiler on the top, and as the eduction pipe before went out at the ſide of the cylinder, it was now inſerted in the bottom of it; and though the preſſure of the ſteam in the boiler be ſomewhat ſtronger than in the cylinder, yet the weight of water in the eduction-pipe being added to the force of ſteam in the cylinder will carry the water down continually, by overcoming the reſiſtance in the boiler.

This is the *lever engine* with the improvements of Mr. *Newcomen* and others; but as Captain *Savary*'s, or rather the Marquis of *Worceſter*'s, is very cheap in reſpect of this machine, and as it is alſo applicable with great advantage when the heighth to which the water is to be raiſed does not exceed 100 or 150 feet, we ſhall here ſubjoin a view of that engine, with the improvements of Dr. *Deſaguliers*.

The boiler B B (*Fig.* 4.) is a large copper body of a globular form, which will beſt of all withſtand the very great force of ſteam that in this caſe is neceſſary. Round the body of this boiler the fire and flame are conducted as ſhewn at TTT. It has a copper-cover ſcrewed on, which contains the ſteam pipe C D, and two gage-pipes *n*, *o*, which by turning their cocks, ſhew the height of the water within as in the other engine. On the ſame cover P is a valve, over which lies a ſteel-yard, with its weight Q to keep it down, the ſtrength of the vapour being this way moſt exactly eſtimated. For being in the nature of a lever of the third ſort, it is plain, if the beam of the lever be divided into ten equal parts, and the firſt of them being upon the middle of the valve, and the weight Q hangs at the 2d, 3d, 4th, &c. diviſions, that then the force of the ſteam which can raiſe up the valve will be 2, 3, 4, &c. times as great as the weight. If the area of the valve be a ſquare inch, and Q = 15 *lib.* hanging at the ſecond diviſion is raiſed by a ſteam puſhing up the valve, it will ſhew that the ſteam will then preſs with the force of two atmoſpheres, and ſo on to ten atmoſpheres; but great care muſt be then taken that the ſteam ſo very ſtrong burſt not the boiler to pieces.

The ſteam is carried from the boiler to a copper-veſſel A, by means of the pipe CD, and is let into it by turning the handle K of the ſteam-cock DI. The key of this cock is kept down by the ſcrew L, held up by the gibbet D L. The handle turned from K to *k* admits a paſſage to the ſteam into the copper-receiver A.

This receiver A communicates at bottom with the ſucking-pipe Z H going down to the water H in the well X, and above with the forcing-pipe EE, which goes up a little above the water of the reſervoir R, and between theſe pipes are two valves F and G both opening upwards.

The ſteam being let in upon the water of the receiver A, forces it up through the valve F, and the pipe EE to the reſervoir, and then the receiver is full of hot ſteam. This ſteam in the receiver is condenſed by a jet of cold water coming from the forcing-pipe by the ſmall pipe MI, being let in and ſhut off by the cock at M. The ſteam being condenſed by this jet will be reduced within a very ſmall ſpace, and ſo make a vacuum, upon which the water in the well will ruſh up the forcing-pipe to reſtore the equilibrium, and thus again fill the receiver A, the little air being compaſſed within a ſmall compaſs at the top above *b c*. That there may be always water in the force-pipe for the jet, there is a little pipe which brings the water to it from the reſervoir with the ſmall ſtop-cock Y, to ſhut it off upon occaſion.

The valves at F and G are examined at any time by unſcrewing the pin 1, to looſen the ſtrap 2, and let down the flanch 3, all which parts are ſhewn larger in the figures Nº 5. By the particular contrivance of the cock at DI, and its key, the water is made to paſs from the force-pipe to the boiler to ſupply the waſte in ſteam.

This is plainly ſhewn in the ſections of the cock and key, where 5 is the top of the key, 6 is a

 hole

hole on one fide, which goes down to the bottom to convey the fteam, or jet of water alternately to the receiver; 7 is a notch on the other fide to take in the water from the force-pipe, and conduct it to the boiler B.

How this is done is eafy to conceive from a view of the two fections of the cock and key, in two pofitions within it. The boiler may hold about five or fix hogfheads, and the receiver one hogfhead. It will work four or five hours without recruiting: about four ftrokes a minute will produce upwards of 200 hogfheads per hour. This fteam makes a vacuum fo effectually, as to raife water from the well to the height of twenty nine or thirty feet: and fuppofe the fteam able to lift up the fteel yard with its weight hanging on the 6th divifion, it will then be able to raife a column of water above fifty yards high, as being then fix times ftronger than the preffure of the atmofphere, as is eafily underftood from what has been faid upon the *fire-engine*, the water being raifed in a fimilar manner in both machines, there by the preffure of condenfed elaftic ai, and here by the preffure of rarefied elaftic fteam.

In the philofophical tranfactions there is an account of an improvement made in the *fteam-engine* by Mr. *Payne*, as follows. He has contrived two iron-pots or veffels of a conical form inverted as reprefented by A B E F N° 6.) on the upper part of which is fixed a globular copper-head, of about $5\frac{1}{2}$ feet diameter, as LMN. Then there is placed on the infide a fmall machine H, called the difpenfer, with fpouts *a b c de*, &c. round the fides fixed to it, and the bottom thereof refts on a center pin O. In this machine is fixed an upright tube G with holes at the bottom, and a funnel P on the top, to receive a fpout of water from a conduit-pipe Q, by the ftop-cock R. Two or more of thefe veffels are placed in a reverberatory arch for conveying the intenfe heat of a ftrong fire, the flame whereof encompaffes the iron-veffels, and keeps them in a red heat during the time of their ufe, at which time the cog-wheel I, being turned by proper machinery, whirls the difpenfer about with great velocity, and caufes the water in it to fly through the fpouts againft the fides of the red hot pots. By this means, the greateft part of the water is converted into vapour or elaftic fteam, which is conveyed by a common pipe and cock to the barrel of the engine to put the pifton in motion, and the wafte water is conveyed away at bottom by means of a pipe CD, with a valve at D to keep out the air.

In *Hydroftaticks* our modern philofophers have given us the following inftruments,

The HYDROMETER, an inftrument to meafure the gravity, denfity, velocity, force, &c. of water and other fluids. is one of the moft ufeful inftruments of the philofophic kind; for tho' the *hydroftatic ballance* be the moft general inftrument for finding the fpecific gravities of all forts of bodies, yet the *hydrometer* is beft fuited to find thofe of fluids in particular, both as to eafe and expedition.

This inftrument fhould be made of copper; for ivory imbibes fpirituous liquors, and thereby alters its gravity; and glafs is apt to break. The moft fimple kind, ufed for finding the ftrength of fpirits, confifts of a copper-ball B *b* (plate *Hydroftatick Inftruments*, *Fig.* 1. N° 1.) with a brafs wire, A B, $\frac{1}{4}$ of an inch thick, foldered into it. The upper part of this wire being filed flat on one fide, is marked proof at *m*, becaufe it finks exactly to this mark in proof-fpirits. There are other two marks at A and B, to fhew whether the liquor be $\frac{1}{10}$ above or below proof, according as the hydrometer finks to A, or emerges to B, when a brafs weight as C or K has been fcrewed on at the bottom *c*. There are alfo weights to be fcrewed on, for fhewing the fpecific gravities of fluids quite to common water. The round part of the wire above the ball, may be marked fo as to reprefent river-water when it finks to R W, (*ibid.* N° 2.) the weight which fits the inftrument for river-water being fcrewed on at *c*: alfo when put into fpring-water, mineral-water, fea-water, and water of falt-fprings, it will emerge or rife gradually to the marks S P, M I, S E, S A; and on the contrary, when put into briftol-water, rain-water, port-wine, and mountain-wine, it will fucceffively fink to the marks *b r*, *r a*, *p o*, *m o*..

Another kind, which ferves to diftinguifh the fpecific differences of fluids to great nicety, confifts of a large hollow ball B. (*ibid.* N° 3.) with a fmaller ball *b* under it, partly filled with quickfilver or fmall fhot, and fcrewed on to the lower part of the former, in order to render it but little fpecifically lighter than water: it has alfo a fmall fhort neck at C, into which is fcrewed the graduated brafs-wire A C, which by its weight caufes the body of the inftrument to defcend in the fluid, with part of the ftem.

When this inftrument is fwimming in the liquor, contained in the jar I L M K, the part of the fluid, difplaced by it, will be equal in bulk to the part of the inftrument under water, and equal in weight to that of the whole inftrument. Suppofe the weight of the whole were 4000 grains, then it is evident we can by this means compare together the different bulks of 4000 grains of va-

rious

rious ſorts of fluids. For if the weight A, be ſuch as ſhall cauſe the aræometer to ſink in rain-water, till its ſurface comes to the middle point of the ſtem 20, and if, after this, it be immerſed in common ſpring-water, and the ſurface is obſerved to ſtand $\frac{1}{10}$ of an inch below the middle point 20; it is evident that the ſame weight of each water differs in bulk only by the magnitude of $\frac{1}{10}$ of an inch in the ſtem.

Now ſuppoſe the ſtem were ten inches long, and weighed 100 grains, then every tenth of an inch would be one grain weight; and ſince the ſtem of braſs, and braſs is about eight times heavier than water, the ſame bulk of water will be equal to $\frac{1}{8}$ of a grain; and conſequently to the $\frac{1}{8}$ of $\frac{1}{4000}$ part, that is, a 32000th part of the whole bulk, which is a degree of exactneſs as great as can be deſired. Yet the inſtrument is capable of ſtill greater exactneſs, by making the ſtem or neck conſiſt of a flat thin ſlip of braſs, inſtead of one that is round or cylindrical: by this means we increaſe the ſurface, which is the moſt requiſite thing; and diminiſh the ſolidity, by which the inſtrument is rendered more exact.

In order to adapt this inſtrument to all ſorts of uſes, there ought to be two different ſtems to ſcrew on and off in a ſmall hole at *a*. One ſtem ſhould be ſuch a nice thin ſlip of braſs, or rather of ſteel, like a watch-ſpring ſet ſtrait, as we have juſt mentioned, on one ſide of which ought to be the ſeveral marks or diviſions, to which it will ſink in various ſorts of waters, as rain-water, river-water, ſpring-water, ſea-water, ſalt ſpring-water, *&c.* And on the other ſide you mark the diviſion to which it ſinks in various lighter fluids, as hot bath-water, *Briſtol* water, *Lincomb*-water, *Chelten*-water, *port* wine, *mountain*, *Madeira*, and various other ſorts of wine. But in this caſe the weight A on the top muſt be a little leſs than before, when it was uſed for the heavier waters.

But in caſe of trying the ſtrength of ſpirituous liquors, a common cylindric ſtem will do beſt, becauſe of its ſtrength and ſteadineſs; and this ought to be ſo contrived, that when immerſed in what is called *proof-ſpirit*, the ſurface of the ſpirit may be upon the middle point 20; which is eaſily done by duly adjuſting the ſmall weight A on the top, and making the ſtem of ſuch a length, that when immerſed in water, it may juſt cover the ball, and riſe to *a*; but, when immerſed in pure ſpirit, it may riſe to the top at A; then by dividing the upper and lower parts *a* 20, A 20, into ten equal parts each; when the inſtrument is immerſed in any ſort of ſpirituous liquor, it will immediately ſhew how much it is above or below proof.

This *proof-ſpirit* conſiſts of half water and half alcohol, or pure ſpirit, that is, ſuch as when poured upon gunpowder, and ſet on fire, will burn all away, and permit the powder to take fire, which it will, and flaſh as in the open air. But if the ſpirit be not ſo highly rectified, there will remain ſome phlegm or water, which will make the powder wet, and unfit to take fire. This *proof-ſpirit* of any kind, weighs ſeven pounds twelve ounces per gallon.

The common method of ſhaking the ſpirits in a vial, and by raiſing a crown of bubbles, to judge by the manner of their riſing or breaking away whether the ſpirit be proof or near it, is very precarious, and capable of great fallacy. There is no way ſo eaſy, quick, certain, and philoſophical, as this by the aræometer, which will demonſtrate infallibly the difference of bulks, and conſequently ſpecific gravities, in equal weights of ſpirits, to the 30 40, or 50 thouſandth part of the whole, which is a degree of accuracy, beyond which nothing can be deſired.

The Hydrostatic Ballance, contrived for the eaſy and exact finding the ſpecific gravities of bodies, both liquid and ſolid, is of a conſiderable uſe in eſtimating the degree of purity of bodies of all kinds; the quality and richneſs of metals, ores, minerals, *&c.* The proportion in any mixture, adulteration, or the like: of all which the ſpecific weight is the only adequate meaſure.

The doctrine of the *hydroſtatical ballance* is founded on this theorem of *Archimedes*, that a body heavier than water, weighs leſs in water than in air, by the weight of as much water as is equal to it in bulk.

We have a new *hydroſtatical ballance*, the parts of which are as follow: A B (*ibid.* N° 4.) is the foot on which it ſtands; C D is a pillar ſupporting a moveable braſs plate F, faſtened thereto by the ſcrew in the knob *e*. In the end of this plate is fixed an upright piece I K, ſupporting another plate G H, which ſlides backwards and forwards thereon, and is moveable every way about it. In the end of this plate, at H, is fixed (by a nut beneath) a wire L M, taped with a fine thread from one end to the other; upon this moves the ſwan-neck ſlip of braſs N O, to which a very exact ballance is hung at the point N; to one of whoſe ſcales P is appended the heavy body R, by a fine horſe-hair or piece of ſilk S: the weight of the ſaid body R in the air, is expreſſed by the weight put into the ſcale Q to make an equilibrium therewith, which being deſtroyed by immerging the ſolid in the fluid T V, contained in the glaſs W V, is again reſtored by weights put into the ſcale P. So that the weights in the ſcale Q compared with thoſe

thoſe in the ſcale P, ſhew at once the ſpecific gravity of the ſolid R to that of the fluid T V.

The ſpecific gravity of fluids is readily determined by weighing one and the ſame ſolid body in them ſeverally; for ſince we ſuppoſe the ballance in equilibrio with the body ſuſpended in the air, the equilibrium will be deſtroyed when the ſolid is immerſed in the fluid, and muſt be then reſtored by weights put into that ſcale, to which the body is appended. Theſe weights will ſeverally expreſs the gravities of an equal bulk of the reſpective fluids; and conſequently they may be thus compared with each other, or all of them with the gravity of common water, as uſual, and diſpoſed in a proper table; making water 1.000,

In the ſame manner, if divers ſolids are firſt weighed in air, and then afterwards immerſed in the ſame fluid, as water; for inſtance, the equilibrium will be deſtroyed; which will be reſtored, as before, by putting in ſo much weight as is equal to the weight of the ſame bulk of water: the gravity, therefore, of every ſolid is thus compared with water, and conſequently with each other.

But in this, and many other caſes, it is required to be very exact in weighing bodies, even beyond what is attainable by the niceſt mechaniſm of this inſtrument. We ſhall therefore give the reader an account of an improvement of the common ballance in this reſpect; and it is the more pertinent in this place, as this inſtrument ſerves equally for exactneſs in common, as in *hydroſtatical* matters.

The figure of the machine repreſents the ballance in its hydroſtatic uſe, (*ibid.* N° 5.) We ſhall firſt deſcribe the machine, then ſhew the new contrived artifice for exactneſs; and laſtly, give an inſtance of its univerſal uſe. V C G is the ſtand or pillar fixed in the table; From the top at A hangs, by two ſilken ſtrings, the horizontal piece or bar B B; from which is ſuſpended, by a ring at *i*, the fine beam of a ballance *b*, which is kept from deſcending too low on either ſide by the gentle ſpringing piece *t x y z*, fixed on the ſupporter M. The harneſs is annulated at *o*, to ſhew diſtinctly the perpendicular poſition of the examen, by the ſmall pointed index fixed above it.

The ſtrings by which the ballance is ſuſpended paſſing over two pullies, one on each ſide the piece at A, go down to the bottom on the other ſide, and are hung over the hook at *v*; which hook by means of a ſcrew P, is moveable about $1\frac{1}{4}$ inches backwards and forwards, and therefore the ballance may be raiſed or depreſſed ſo much. But if a greater elevation or depreſſion be required, the ſliding piece S, which carries the ſcrew P, is readily moved to any part of the ſquare braſs rod V K, and fixed by means of a ſcrew.

The motion of the ballance being thus provided for, the reſt of the apparatus is as follows: H H is a ſmall table fixed upon a piece D, under the ſcales *d* and *e*, and is moveable up and down in a long ſlit in the pillar above C, and faſtened at any part with a ſcrew behind. At the point in the middle of the bottom of each ſcale is hung by a fine hook a braſs-wire *a d*, *a c*. Theſe paſs through two holes *m*, *m* in the table; and to the wire *a d* is ſuſpended a curious cylindric wire *r s*, perforated at each end for that purpoſe. This wire *r s* is covered with graduated by equal diviſions, and is about five inches long.

In the cornet of the table at E, is fixed a braſs-tube in which a round wire *h l* is ſo adapted as to move neither too hard nor too freely by its flat head I. Upon the lower part of this moves another tube Q, which has friction enough to cauſe it to remain in any poſition required; to this is fixed an index T, moving horizontally when the wire *h l* is turned about, and therefore may be eaſily ſet to the graduated wire *r s*.

To the lower end of the wire *r s* hangs a weight L, and to that a wire *p n* with a ſmall braſs ball *g*, about $\frac{1}{4}$ of an inch in diameter. On the other ſide to the wire *ac*, hangs a large glaſs bubble R by a horſe hair. Let us at preſent ſuppoſe the weight L taken away, and the wire *p n* ſuſpended from S: and on the other ſide let the bubble R be taken away, and the weight F ſuſpended in its room at *c*. This weight F we ſuppoſe to be ſuch as will keep in equilibrio with the ſeveral parts appended to the other ſcale, at the ſame time that the middle point of the wire *p n* is in the ſurface of the water in the veſſel N. The wire *p n* is to be of ſuch a ſize, that the length of one inch ſhall weigh four grains. Hence it is evident, ſince braſs is eight times heavier than water, that for every inch the wire ſinks in the water, it will become half a grain lighter, and half a grain heavier for every inch it riſes out of the water: conſequently, by ſinking two inches below the middle point, or raiſing two inches above it, the wire will become one grain lighter or heavier. And therefore, if when the middle point is at the ſurface of the water in equilibrio, the index T be ſet to the middle point *a* of the graduated wire *r s*, and the diſtance on each ſide *a r* and *a s* contains a hundred equal parts; then, when in weighing bodies the weight is deſired to the hundredth part of a grain, it may be eaſily had by proceeding in the following manner.

Let the body to be weighed be placed in the ſcale *d*, and put the weight X in the ſcale *e*; and let this be ſo determined, that one grain more ſhall be too much, and one grain leſs too little. Then the ballance being gently moved up or down by the

ſcrew

ſcrew P, till the equilibrium be nicely ſhewn at *o*; and then if the index T be at the middle point *a* of the wire *rs*, it ſhews that the weights put into the ſcale *e*, are juſt equal to the weight of the body. By this method we find the abſolute weight of the body; the relative weight is found by weighing it *hydroſtatically* in water, as follows.

Inſtead of putting the body into the ſcale *e*, as before, let it be appended with the weight F at the hook *c*, by a horſe-hair as at R, ſuppoſing the veſſel of water O were away; then the equilibrium being made, the index T ſtanding between *a* and *r*, at the 36th diviſion, ſhews the weight of the body put in 1095.36 grains. As it thus hangs, let it be immerſed in the water of the veſſel O, and it will become lighter by much; the ſcale *e* will deſcend till the beam of the ballance reſts on the ſupporter *z*. Then ſuppoſe 100 grains put into the ſcale *d* reſtores the equilibrium preciſely, ſo that the index T ſtands at the 36th diviſion above *a*; it is plain the weight of an equal bulk of water would, in this caſe, be exactly 100 grains.

After a like manner may this ballance be applied to find the ſpecific gravities of fluids, which will not be difficult from what has been ſaid.

The HYGROMETER is a machine, or inſtrument whereby to meaſure the degrees of drineſs, or moiſture of the air, or rather of the atmoſphere.

There are divers ſorts of hygrometers; for whatever body either ſwells or ſhrinks, by drineſs or moiſture, is capable of being formed into an hygrometer. Such are woods of moſt kinds, particularly aſh, deal, poplar, *&c.* Such alſo is catgut, the beard of a wild oat, *&c.* Stretch an hempen-cord or lute-ſtring, as A B. (*ibid.* N° 6.) along a wall, bringing it over a pulley, B; and to the other end D, fix a weight E; into which fit an index G. On the ſame wall fit a plate of metal H I, divided into any number of equal parts, and the hygrometer is compleat. For it is known from experience that moiſture ſenſibly ſhortens the length of cords or fiddle-ſtrings; and that as the moiſture evaporates, they return to their former length. The weight, therefore in the preſent caſe, upon an increaſe of the moiſture of the air, will aſcend; and upon a diminution of the ſame, it will deſcend.

Hence, as the index G will ſhew the ſpaces of aſcent and deſcent; and thoſe ſpaces are equal to the increments and decrements of the length of cord, or gut, A B D; the inſtrument will diſcover whether the air be more or leſs humid now, than it was at another given time.

But if a more ſenſible and accurate hydrometer be required, ſtrain a whip-cord or fiddle-ſtring, over ſeveral pullies B, C, D, E, F, and G. (*ibid.* N° 7.) and proceed as in the former example. Nor does it matter whether the ſeveral parts of the cord A B, B C, C D, *&c.* be parallel to the horizon as expreſſed in the figure or perpendicular to the ſame.

The advantage of this above the former hygrometer, is, that we have a greater length of cord in the ſame compaſs; and conſequently greater contraction or dilatation.

Another method of conſtruction, which is more ſimple, is thus. Faſten a hempen-cord or fiddle-ſtring, A B, (*ibid.* N° 8.) to an iron hook; and let the other end B, deſcend upon the middle of a horizontal board, or table, E F; near B, hang a leaden weight or ball of a pound, C, and fit an index C G. Laſtly, from the center B deſcribe a circle, which divide into any number of equal parts. Or, inſtead of the table or board, draw two concentric circles on the ball K from I. (N° 9.) and divide them into any number of equal parts, and fix an index N O, to any proper ſupport N. So that it may almoſt touch the diviſions of the ball. Here the côrd or gut twiſting or untwiſting will ſhew the change of moiſture, *&c.* by the ſucceſſive application of the index to the diviſions of the circle.

Or thus: provide two wooden frames, A B and C D. (N° 10.) with grooves therein; and between theſe grooves fit two thin leaves of aſh, A E F C, and G B D H, ſo as they may eaſily ſlide either way. At the extremes of the frames A, B, C, D, confine the leaves with nails, leaving between them the ſpace E G H F, about an inch wide. On I faſten a ſlip of braſs dented, I K; and in L a little dented wheel, upon whoſe axis, on the other ſide of the machine an index is to be put. Laſtly, from the center of the axis, on the ſame ſide, draw a circle, and divide it into any number of equal parts.

Now, it is found from experience, that aſhen wood readily imbibes the moiſture of the air, and ſwells therewith; and as that moiſture ſlackens, ſhrinks again; upon any increaſe of the moiſture of the air, the two leaves A F and B H growing turgid, will approach nearer each other: and, again, as the moiſture abates, they will ſhrink, and again recede. Hence, as the diſtance can neither be increaſed nor diminiſhed without turning the wheel L, the index will point out the changes in reſpect of humidity, or ſiccity.

All the hygrometers above deſcribed become by degrees leſs and leſs accurate, and at length undergo no ſenſible alteration at all from the humidity of the air.

The

The following is much more lasting. Take a nice ballance (*ibid.* N° 11.) and place in it a ſponge, or other body, which eaſily imbibes moiſture; and let it be in equilibrio, with a weight hung at the other end of the beam. Now if the air become moiſt, the ſponge becoming heavier, will preponderate; if dry, the ſponge will be raiſed up. This ballance may be contrived two ways; by either having the pin in the middle of the beam, with a ſlender tongue a foot and a half long, pointing to the diviſions on an arched plate fitted to it; or the other extremity of the beam may be made ſo long as to deſcribe a large arch on a board placed for the purpoſe, as is repreſented in the figure.

To prepare the ſponge, it may be neceſſary to waſh it in water; and when dry again, in water or vinegar, wherein ſal ammoniac, or ſalt of tartar, has been diſſolved, and let it dry again, then it is fit to be uſed.

In the laſt mentioned hygrometer, Mr. *Gould*, in the *Philoſophical Tranſactions*, inſtead of a ſponge, recommends oil of vitriol, which is found to grow ſenſibly lighter or heavier, in proportion to the leſſer or greater quantity of moiſture it imbibes from the air; ſo that being ſatiated in the moiſteſt weather, it afterwards retains or loſes its acquired weight, as the air proves more or leſs moiſt. The alteration in this liquor is ſo great, that in the ſpace of fifty-ſeven days, it has been known to change its weight from three drachms to nine; and has ſhifted an index or tongue of a ballance thirty degrees. A ſingle grain, after its full increaſe, has varied its equilibrium ſo ſenſibly, that the tongue of a ballance, only an inch and a half long, has deſcribed an arch one third of an inch in compaſs, (which arch would have been almoſt three inches if the tongue had been one foot) even with ſo ſmall a quantity of liquor; conſequently, if more liquor, expanded under a large ſurface, were uſed, a pair of ſcales might afford as nice an hygrometer as any kind yet invented. The ſame author ſuggeſts, that oil of ſulphur per campanum, or oil of tartar per deliquium, or the liquor of fixed nitre, might be ſubſtituted in lieu of the oil of vitriol.

But among all the inventions the following ſeems beſt calculated both for diſpatch and accuracy. A (*ibid.* N° 12.) repreſents a thin piece of ſponge, ſo cut as to contain as large a ſuperficies as poſſible. This hangs by a fine thread of ſilk, upon the beam B, and is exactly ballanced from another thread of ſilk at D, ſtrung with the ſmalleſt lead ſhot, at equal diſtances, and ſo adjuſted as to cauſe the index E to point at G, in the middle of the graduated arch F G H, when the air is in a middle ſtate between the greateſt moiſture and the greateſt dryneſs. I, ſhews a little table or ſhelf for that part of the ſilk and ſhot which is not ſuſpended to reſt upon.

JAPANNING.

JAPANNING, is the art of imitating the *Japanneſe* in *varniſhing* and *drawing* figures on wood and other materials.

The colours uſed in this art for a fair *red*, are the *Spaniſh* vermilion, with a fourth part of *Venice* lacquer; though *carmine* is far preferable. For *blue*, *ultramarine*, and only twice as much varniſh as colours; the *Pruſſian* blue has the ſame effect, and is not ſo chargeable. The *black* is made of ivory calcined between two crucibles. *Green* is ſeldom uſed in *japanning*, becauſe it is difficult to make it fair and lively.

The *varniſh* is made by taking a pint of *ſpirit of wine*, well deflegmated, and four ounces of *gum lacca*, which after it has been broke from the ſticks and rubbiſh, and roughly bruiſed in a mortar, muſt be tied up in a bag of coarſe linen, together with a little *Caſtile* ſoap, and put to ſteep in ſpring water for the ſpace of twelve hours. This done, all the tincture muſt be rubbed out, adding to it a little *allum*, and reſerving it apart: then muſt be added as much *maſtic* and *white amber*, diſtilled in a matraſs, with ſpirit of wine, by a two days digeſtion, frequently ſtirring it, that it do not ſtick to the glaſs; then ſtraining and preſſing it out into another veſſel.

This done, the wood to be *japanned* muſt be covered with a layer of this varniſh, till it be ſufficiently drenched with it; then taking ſome of the colours the figures are to be of, it muſt be incorporated with ſeven times as much of the varniſh, and applied with a pencil, going over each part three ſeveral times, each a quarter of an hour after the other: two hours after this it muſt be poliſhed with a peſtle or *Dutch* reeds.

What they call *night japanning*, is performed by applying three or four layers, with the colours firſt; then two of pure varniſh uncoloured. Before it is dry, ſome venturine or gold wire reduced to powder, muſt be ſifted over it; then covering it over with as many layers of pure varniſh to render it like poliſhed glaſs; and laſtly, rubbing it over with tripoli, oil of olive, or hatters felt.

JEWELLER.

THE art of the *Jeweller* consists in setting diamonds, rubies, emeralds, and other precious stones, in gold, silver, or other metals, that they may appear with a full lustre, and hide their defects, as much as possible.

To heighten the lustre of a stone, they put commonly under it a leaf of the same colour of the stone, but livelier, which they call *foyl.*

To proceed in this operation, they begin by putting the ring, or other piece which is to be set with jewels, into cement; then they put the foyl, and over it the stone, which they fasten in the callet by approaching the metal near it, with their setting tool as close as possible, without breaking or scratching the stone; this done, they file and polish the metal.

This art must be very antient, and ought to be considered as having been invented in heaven, since God, *Exodus* xxviii. gives these directions for the breast-plate, ver. 17. *And thou shalt set in it settings of stones.*

LAPIDARY.

LAPIDARY cuts precious stones.—There are various machines used in the cutting of precious stones, according to the quality of the matter to be cut.

To cut and form a *diamond*, the *lapidaries* use a wheel of soft steel, turned by a kind of mill, with diamond dust, tempered in oil of olives; which serves likewise to polish it.

From the different manner of cutting them, *diamonds* borrow their different appellations of *roses*, *brilliants*, *table*, &c.

To give to a *diamond* the form of a rose, it must be made quite flat underneath, and its upper part cut into divers little faces, usually triangles, the uppermost whereof must terminate in a point.

A *brilliant diamond* is formed by cutting it in faces both a-top and bottom, making its table, or principal face a-top, flat.

The *table diamond* is that which has a large square face a-top.

The whole secret of the art consists in observing a just symmetry in the formation of the faces, whereby the lustre of the stone is more or less heightened; for if they are too large, that lustre is dull or languishing, and if too small, it is too confuse, and the stone does not play, by so agreeable a variety of colours. It consists likewise in the polishing, that there should be neither clouds, flaws, nor scratches on the stone.

Oriental *rubies*, *saphires*, and *topazes* are cut, and formed on a copper wheel with oil of olive, and diamond-dust: they are polished on another copper wheel with tripoly and water.

Emeralds, *hyacinths*, *amethysts*, *garnets*, *agates*, and other stones less hard, are cut on a leaden wheel with smalt and water, and polished on a tin wheel with tripoly.

These wheels are fixed on a table, with a handle to them, by means whereof the artist turns the wheel round with his left-hand, holding with the right the stone upon it, having before besmeared it over with his composition. The stone is fixed with cement, at the end of a sort of scewer, that the artist may easier lay hold of it.

Turquois, of the old and new rock, *lapis*, *girasole*, and *opal*, are cut and polished on a wooden wheel with tripoly.

LAPIDARY is also used for one skilled in the nature, kinds, &c. of precious stones, or a merchant who deals in them.

A rough *diamond*, must be chosen uniform, of a good shape, transparent, not quite white, and free of flaws and shivers. Black, rugged, dirty, flawey, veiny stones, and all such as are not fit for cutting, are most commonly pounded in a steel mortar for that purpose; and when pulverized they serve to saw, cut, and polish the rest.

The goodness of *diamonds* consists in their water, or colour, lustre and weight. The most perfect colour, and most esteemed at present, is the white. The yellow has been a long while in vogue, and our ancestors esteemed a black cast, which they imagined contributed much to heighten the lustre of the stone.

The water called *cœlestis* is the worth of all, and yet is somewhat difficult to discover in a rough *diamond.* The only infallible way is to examine it in the shade of some tufted tree.

In *Europe* the *Lapidaries* examine the goodness of their rough *diamonds*, their water, points, &c. by day-

day light; in the *Indies* they do it by night; in order to which, a hole is made in the wall a foot ſquare, and therein a lamp placed with a thick wick, by the light whereof they judge of the ſtone, holding it in their fingers.

As to their diſtinguiſhing of *diamonds* from other ſtones, Dr. *Wall* in the *Philoſophical Tranſactions*, ſeems to have found an infallible method. A *diamond* with an eaſy ſlight friction in the dark, with any ſoft animal ſubſtance, as the finger, woollen, ſilk, &c. appears luminous in its whole body: nay, if you keep rubbing for ſome time, and then expoſe it to the eye, it will remain ſo for ſome time. If the ſun be 18 degrees below the horizon, holding up a piece of bays, or flannel ſtretched tight between both hands, at ſome diſtance from the eye; and another rubbing the other ſide of the bays or flannel pretty briſkly with a *diamond*, the light is much more vivid and pleaſant than any other way. But what Dr. *Wall* judges moſt ſurprizing is, that a *diamond* being expoſed to the open air in view of the ſky, gives almoſt the ſame light of itſelf, without rubbing, as if rubbed in a dark room: but, if in the open air you put the hand, or any thing a little over it, to prevent its immediate communication with the ſky, it gives no light, which is a diſtinguiſhing criterion of a diamond.

The following is a rate, or manner of eſtimating the value of *diamonds*, drawn up by a perſon well verſed in ſuch matters, and which for its curioſity, as well as the uſe it may be of to perſons who deal in *diamonds*, we judge will not be unacceptable.

TABLE *of* DIAMONDS.
DUTCH CUT.

A diamond *weighing one grain is worth from,*

Grains.		*l.*	*s.*		*l.*	*s.* *Ster.*
1	—	1	0	to	1	1
1½	—	1	16	to	1	17
2	—	2	15	to	3	0
2½	—	3	12	to	3	15
3	—	4	15	to	5	0
4	—	7	17	to	8	0
5	—	15	0	to	15	15
6	—	22	0	to	25	0
7	—	30	0	to	34	0
8	—	42	0	to	45	0
9	—	60	0			
10	—	75	0			
12	—	112	0	to	120	0
15	—	187	0	to	220	
19	—	330	0	to	380	0
24	—	450	0			
30	—	700	0	to	735	0
40	—	1500	0	to	1800	0
50	—	3500	0	to	4500	0
60	—	4500	0	to	5620	0

It muſt be obſerved, however, that defects in the water, or ſhape, red, or black ſpots, ſhivers, and other failings, frequently found in theſe ſtones, reduce the price by one third, and ſometimes more.

As to *brilliant diamonds* of very ſmall cut, the price is always leſs by one third, than that of *diamonds* of a larger cut, though the weight is the ſame: the reaſon is, that the latter ſhew themſelves a great deal more, when ſet in their collets, than the former.

Lapidaries uſually diſtinguiſh three kinds of RUBIES, the *roky*, *balaſs*, and *ſpinell*; ſome add a fourth kind, *viz.* the *rabecelle*. It is the different degree of colour which makes their different value and beauty. The *balaſs ruby* is of a crimſon colour with a caſt of purple: the *ſpinell ruby* is of a bright roſy red.

The *ruby* is formed in a ſtony ſubſtance, or marcaſite of a roſe colour, called *mothe of ruby*; it has not all its colour and luſtre at once; but comes to it by degrees. At firſt it grows whitiſh, and as it approaches to maturity, becomes red. Hence we have white *rubies*, others half white, half red, and others blue and red, called *ſaphire rubies*.

When a *ruby* exceeds 20 carats, it may be called a *carbuncle*, the name of an imaginary ſtone.

They have ſeveral manners of counterfeiting *rubies*; and have carried this imitation to that length, that the moſt able *Lapidaries* are ſometimes over-ſeen.

The value of *rubies*, from one carat, or four grains, to ten carats, is thus given us in the *Dictionaire de Commerce*, from a good hand.

	l.	*s.*	*d.*
A *ruby* of one carat, is worth	1	15	0
—— of two carats, — —	9	00	0
—— of three carats, ——	22	10	0
—— of four carats, — —	33	15	0
—— of five carats, — ——	45	00	0
—— of ſix carats, —— —	67	10	0
—— of ſeven carats, — ——	84	00	0
—— of eight carats, ——	106	00	0
—— of nine carats, — —	150	00	0
—— of ten carats, ——	216	00	0

The SAPHIRE is tranſparent, yet exceedingly hard, ſo as ſcarce to bear being engraven.

Different colours bear different kinds thereof; the deepeſt blues being eſteemed males, and the whiteſt females. The *ſaphires* of *Pegu* are the moſt eſteemed.

The ſoft *water-ſaphires* of *Bohemia* and *Sileſia*, are of ſome account, tho' far inferior to the oriental ones, both in the brightneſs of their blue, and the firmneſs of their texture.

The Topaz is tranſparent, its colour a beautiful yellow, or gold colour: it is very hard, and takes a fine poliſh. It is the true chryſolite of the antients, and is found in ſeveral parts of the *Indies*, in *Ethiopia*, *Arabia*, *Peru*, and *Bohemia*.

The oriental *topazes* are moſt eſteemed; their colour borders on the orange.

The *topaz* is eaſily counterfeited; and there are fictitious ones, which to the eye do not come behind the natural ones.

The Emerald is a very green and tranſparent ſtone, and as to hardneſs, next to the ruby.

The *oriental emerald* is harder, more brilliant, and tranſparent than the *Peruvian*; which has generally clouds found in it, and ſparkles leſs.

The *emerald* is ſuppoſed to grow more and more perfect in the mine like the ruby; and to arrive at its greenneſs by ſlow degrees, as the fruit comes to maturity by degrees. It is a common opinion that the *emerald* grows in the jaſper; and it is certain there are ſome jaſpers ſo perfectly green, that many have taken them for *emeralds*.

But the proper matrix, or marcaſite of this ſtone, is the *preme*, which is held among the coarſer precious ſtones; being hard, tranſparent, half opake, and uſually intermix'd with yellow, green, white, blue, &c.

The firſt and coarſeſt ſort of rough *emeralds*, called *plaſmes*, for grinding, are worth 27 ſhillings ſterling, the *mark*, or 8 ounces. The demimorillons, 8 *l.* ſterling, *per* mark. Good morillons, which are only little pieces, but of fine colour, from 13 *l.* to 15 *l. per* mark. *Emeralds*, larger then morillons, and called *of the third colour*, or *ſort*, are valued at from 50 *l.* to 60 *l. per* mark. *Emeralds*, called *of the ſecond ſort*, which are in larger and finer pieces than the preceding, are worth, from 65 *l.* to 75 *l. per* mark.—Laſtly, thoſe of the firſt colour, otherwiſe called *negres cartes*, are worth from 110 *l.* to 115 *l.*

Emeralds ready cut, or poliſhed and not cut, being of good ſtone, and a fine colour, are worth,

	l.	*s.*	*d.*
Thoſe weighing one carat, or four grains, —— —	0	10	0
—— of two carats, — ——	1	7	0
—— of three carats, ———	2	5	0
—— of four carats, — —	3	10	0
—— of five carats, ———	4	10	0
—— of ſix carats, —— —	7	10	0
—— of ſeven carats, ———	15	00	0
—— of eight carats, — —	19	00	0
—— of nine carts, ———	23	00	0
—— of ten carats, —— —	33	00	0

Hyacinth is thus called from its reſemblance of the purple flower, named *hyacinth*, or the violet.

There are four ſorts of *hyacinths*; thoſe intermixed with a vermillion colour, thoſe of a ſaffron colour; thoſe of an amber colour, and laſtly thoſe of a white, intermixed with a ſlight red.

Hyacinths, again, are diſtinguiſhed into *oriental* and *occidental*

The ſtone graves or cuts fine, and would be more uſed for ſeals, &c. but that the graving frequently coſts more than the ſtone.

Amethyst is a precious ſtone of a violet colour, bordering on purple.

There are divers ſorts of *amethyſts*; the *oriental* which is the hardeſt, the ſcarceſt, and moſt valuable, is of a dove colour; the *German* which is of a violet colour; and the *Spaniſh* which has the colour of a panſy.

There are ſome *oriental*, alſo, of a purple colour, and others white, and like the *diamond*.

The *amethyſt* is not extremely hard, but may be cut with a leaden wheel, ſmeared with emery moiſtened in water. It is poliſhed on a pewter wheel with tripoli; it is eaſily engraven on, either in creux or relievo.

The Beryl is a tranſparent ſtone or gem, brought from *India* of a light or pale green colour, inſomuch that ſome have repreſented it as of two colours, the one green, the other pale.

The *beril* differs from the *chryſoberil*, which is ſomewhat paler, and partakes more of the yellow, and from the *chryſoprуſus*, which partakes more of the green.

Some authors take the *beryl* for the diamond of the antients; this is certain, the ableſt modern jewellers have ſometimes miſtaken the one for the other.

The Cornelian is a precious ſtone ordinarily red, bordering on orange, called alſo *ſardius*, or the *ſardian ſtone*. It is but little tranſparent, cuts eaſily; and we find moſt of the fine gravings of antiquity, whether in relievo, or indented, are on this ſtone. It bears the fire admirably.

The fineſt *cornelians* are thoſe brought from near *Babylon*, the next are thoſe of *Sardinia*, the laſt thoſe of the *Rhine*, *Bohemia*, and *Sileſia*. To give theſe ſtones the greater luſtre, in ſetting them they lay a piece of ſilver leaf underneath.

The principal uſe made of *cornelians* is in ſeals, by reaſon they grave well, and take a fine poliſh.

Granate, popularly called *Garnate*, is a precious ſtone of a high red colour, thus called from the

the resemblance it bears of the kernel of a pomegranate.

Granates are either *oriental* or *occidental*; the first are brought from divers parts of the *East Indies*, the second from *Spain*, *Silesia*, and *Bohemia*.

Those from the *East* are distinguished by their colour into three kinds; the first of a deep brownish red, like black clotted blood; of which kind there are some as big as an hen's egg. The second are nearly of the colour of a hyacinth, with which it were easy to confound them, but for their superior redness. The last, having a mixture of a violet with their red, are called by the *Italians*, *rubini della rocha*.

The *occidental granates* are of divers reds, according to the places they are found in. Those of *Spain* imitate the colour of the kernels of a pomegranate: those of *Bohemia* have a golden cast with their red glittering like a live coal: those of *Silesia* are the darkest of all, and seldom thoroughly transparent.

Of the *occidental granates* those of *Bohemia* are the most valued: some even give them the preference to the oriental kind. They are found near *Prague*; not in any particular mines, but are picked up by the peasants in the fields from among the sands and pebbles.

The AGATE is a precious stone, partly transparent, and partly opake, usually diversified with a variety of colours, veins, spots, &c. sometimes exhibiting figures, or appearances of natural objects.

There are various kinds of *agates*; which according to their different colours, degrees of transparency, &c. have different names. The principal may be reduced to these four, *viz.* the *onyx*, *calcedony*, the *black*, and the *German* agates.

The *agate* has ordinarily a reddish teint, but is finely variegated with spots, and stains, many of which seem very naturally to represent woods, rivers, trees, animals, fruits, flowers, &c.

The *sardians*, and *sardonyx agates* are very valuable; the latter is of a sanguine colour, and is divided into zones, which seem to have been painted by art.

Agates have always been esteemed for seals, as being a stone that no wax will stick to.

The ONYX is a kind of precious stone, accounted a species of opake *agate*. It is of a dark horny colour, in which is a plate of a bluish white, and sometimes of red; the several colours appearing as distinct as if laid on by art.

White zones or girdles, are essential to an *onyx*.

The SARDONYX is a kind of precious stone partaking partly of the *sardian*, and partly of the *onyx*.

It is semi-transparent, and reddish bordering on white, somewhat like the nail of the hand: in some the red inclines to a yellow.

The TURCOIS, or TURQUOIS, is a precious stone of a blue colour, ordinarily opake, but sometimes a little transparent.

There are *turcoises* both oriental and occidental, of the new rock and the old. The oriental partakes more of the blue tincture than the green, and the occidental more of the green than the blue. Those of the old rock are a deep blue, and those of the new rock more whitish, and do not keep their colour.

The oriental ones come from *Persia*, the *Indies*, and some parts of *Turky*; and some even suppose that it is hence they derive their modern name *turcois*. The occidental are found in various parts of *Europe*, particularly *Germany*, *Bohemia*, *Silesia*, *Spain*, and *France*.

Turcoises all grow of a round or oval figure.

The *turcois* is easily counterfeited, and that so perfectly that it is impossible to discover the deceit, without taking it out of the collet.

The great defect of all *turcoises* is, that in time they lose their blue colour, and become green, and then cease to be of any value.

The OPAL is a precious stone of various colours, changeable according to the different position of the stone to the light.

In it are seen the red of the ruby, the purple of the amethyst, the green of the emerald; besides yellow, blue, and sometimes black and white. When the stone is broke, most of these colours disappear; which shews that they arise by reflection from one or two principal ones.

Its form is always either round, or oval; its prevailing colour white. Its diversity of colours makes it almost of equal value with a saphire or ruby.

L A W.

THE etymology of *law* is either from *legendo*, reading; or from *eligendo*, chuſing; or from *ligando*, tying, obligating. — It may be deduced from *legendo*, reading; for though it is not eſſential to the *law* that it ſhould be written, according to *Juſtinian's* inſtitutions, *c*. 25. *q*. 2. and to *Ariſtotle*, *lib*. 10. *Eth*. *c*. 9. where he expreſſes himſelf in theſe words; *whether the laws be written, or not written, it does not ſeem to matter much*: the *law*, notwithſtanding, is moſt commonly written, that every body may read in it what he is to do, or to avoid. — It may alſo be derived from *eligendo*, chuſing; becauſe *law* is like a certain choſen rule, or form of living. This etymology is that of *Tully*, *lib*. *de leg*. Laſtly, it may be derived from *ligando*, tying or obliging; becauſe it obliges the ſubjects to its obſervance.

All *law* is either *natural*, or *poſitive* — The *natural law* is conſidered either in God or in us. In God it is called *eternal law* or *eternal order*. In us it is either called *right reaſon* or *natural light*; or retains ſimply the name of *natural law* or *order*.

The *poſitive law*, is that eſtabliſhed by the free-will of a legiſlator; and ſubject to alterations or changes thereof, are called by different names by the *Roman* Juriſconſultes. For among them the law is defined, *lex rogatur*, when it is made, becauſe there was no law made unleſs aſked by the people. It is *abrogated*, *abrogatur*, when entirely aboliſhed; *derogated*, *derogatur*, when part thereof was taken off: *ſubrogated*, *ſubrogatur*, when additions were made thereunto; and *abrogated*, *abrogatur*, when ſome changes were made in it.

The *poſitive law* is either divine or human; the firſt is from God, and the latter from men.

The *divine law* is contained in the Old and New Teſtament; whence it is either antient or new.

The *old* or *antient law*, is that given to the *Hebrews*, by the miniſtry of *Moſes*, or as the Apoſtle expreſſes himſelf, *Gal*. iii. 19. *It was ordained by Angels in the hand of a Mediator*.

The *new law* is called the *law of the Goſpel*, or of the New Teſtament, is that brought to all men by Chriſt, author of the *New Teſtament*.

The *human law*, is that made and eſtabliſhed by men; and this is either *eccleſiaſtical* or *civil*.

The *eccleſiaſtical law*, conſiſts in the canons of the general councils, the ſentiments of the fathers, and the conſtitution of the Popes, called decretal, amongſt thoſe in communion with the church of *Rome*; and in ſuch antient conſtitutions and privileges as the clergy are entitled to in *England*, by the laws of the land.

The *civil law* conſiſts in the conſtitutions of a republick, or in the edicts of emperors, and kings, in the deciſions of a ſenate, or of the canons, in the anſwers of prudent men, and in a long cuſtom, approved by the unanimous conſent of the people. This ſeems to be the general diviſion of all *laws*.

As to the matter ſubject to *law*, it is the *right itſelf*, or what is juſt, or what is acted or omitted juſtly.

Thus much concerning *law* in general, of the different diviſions and ſubdiviſions thereof, are as follow.

Every body agrees, that the *eternal law* is the ſource of all others, and the firſt rule of all our actions. For the *eternal law*, ſays St. *Auguſtin*, *lib*. 22. *cont*. *Fauſt*. *c*. 27. *is the divine reaſon, or God's will commanding to preſerve the natural order, and forbidding to diſturb it*. Natural order, in this place, *is that*, ſays he himſelf, *lib*. 2. *de ordin*. *c*. 10. *whereby all things are done, which God has eſtabliſhed*. Therefore the *eternal law* is an immutable reaſon, to which all that is done rightly and juſtly is agreeable, and all that is done wrong diſagreeable.

Natural law alſo called *right reaſon*, *natural light*, and *natural order*, is the *eternal law* itſelf, or a certain participation of the *eternal law*, in a rational being, whereby he is made capable to diſtinguiſh between good and evil.

Lawyers call *natural law*, that, which nature has taught all kinds of animals without diſtinction, ſuch as their *conſervation*, *procreation*, the *education* of children, &c. But the Divines call *natural law*, that which God has imprinted on man's mind.

That this *natural law* is imprinted in our minds, is evident from that every body underſtands what is good, and what is bad.

We'll paſs to the *law of nations*, and aſk firſt, *what is the law of nations, and whether it pertains to the natural law?*

I anſwer, 1. That *the law of nations is that which natural reaſon has eſtabliſhed among men, and which is obſerved almoſt by all men.*

1. It is called *law*, becauſe it has the property of a *law*, which is that it ſhould be entirely juſt.

2. *Which the natural reaſon or light has eſtabliſhed among men*, becauſe through the exigency of their affairs,

affairs, men of almoſt all nations have eſtabliſhed it.

3. *And which is obſerved by almoſt all men*; becauſe almoſt all nations obſerve that *law* to which they have almoſt all given a ſanction.

If I be aſked, which are thoſe precepts which have been made, and are kept by almoſt all nations? I'll anſwer, that the principal of them are *manumiſſions*, *war*, the difference *made between nations*, *the condition of kingdoms*, *the differenee of government*, *the partitions of lands*, *buildings*, *commerce*, *emptions*, *venditions*, *loeations*, *conductions*, &c.

I anſwer, 2. *That the law of nations pertains rather to the poſitive than to the natural law*; becauſe eſtabliſhed and calculated by men for the ſecurity of the civil ſociety; for it differs from the natural law, in that the inſtitution of the natural law does not depend of men, and is not ſaid to be in force among almoſt all men, but among all without reſtriction.

Divine law is that rule given by GOD to his people, the *Hebrews*, for their guide in his worſhip, and their lives, conduct, and government which was from time to time revealed to the world by *Moſes*, and the prophets, from the beginning of the world, till it was fully completed by a *new Revelation*, delivered to us by JESUS CHRIST the *Sun of Righteouſneſs*. See *Hebrews* i.

The *old law* conſiſted of *moral*, *judicial*, and *ceremonial* precepts, ſtatutes and conſtitutions, which are chiefly contained in the books of *Exodus* and *Leviticus*. The *ceremonial*, otherwiſe called the *levitical law*, was abrogated by the *new law* delivered by CHRIST.

With regard to this new law we'll aſk, *what it is, and how many precepts it has?*

I anſwer, 1. That the *new law*, or the *law of the Goſpel*, is defined *a divine poſitive law, given to all men by their legiſlator Chriſt*.

It is called *law*, becauſe the definition of law is proper to it.

It is called *poſitive*, to diſtinguiſh it from the eternal and natural law.

It is ſaid *given to all men*, to diſtinguiſh it from the old law given only to *Abraham* and his poſterity.

It is ſaid by *Chriſt*, becauſe Chriſt himſelf calls his precepts in ſeveral places of the ſcripture, the precepts of the new law.

I anſwer, 2. *That there are three ſorts of precepts of the new law*, viz. *moral precepts*, *the precepts of faith*, *and the precepts of the ſacraments*; which can be proved by the ſcripture. For *Matt.* v. vi. Chriſt explains the moral precepts of the decalogue. And *Matt.* ix. forbids divorce, and the libel of repudiation, and decrees that the conjugal knot ſhould be indiſſoluble.

As to the *precepts of the ſacraments*, it is ſaid, *John* iii. *Except a man be born of water and of the ſpirit, he cannot enter into the kingdom of God.* And *John* vi. *Except you eat the fleſh of the ſon of man, and drink his blood, you have no life in you.*

As to the *precept of faith*, it is ſaid *Mark* xvi *But he that believes not ſhall be damned.*

There is this difference between theſe three kinds of precepts; that the *moral* ones being of the natural law, were not inſtituted by CHRIST, but only explained, and vindicated from the errors they had been involved in by men's malice. But that the *ſacramental* were inſtituted by Chriſt, to ſupply the place of the old ones abrogated by him. That the precepts of *faith* were not inſtituted anew, but only, from implicit, were made more clear; ſo that we are obliged at preſent to believe ſome precepts explicitly, which, in the old law they believed only implicitly; ſuch as the *Nativity*, *Paſſion*, and *Death* of *Chriſt*, and all the other myſteries, which are only believed obſcurely by the *Jews*, and are at preſent believed expreſly by the *Chriſtians*.

The *human law*, next to the *divine*, falls under our conſideration.

Men's minds being agitated by various affections, and darkned by errors, deviate from the right way of reaſon and ſimplicity. Extravagantly infatuated with their own pretended merit, they behave themſelves towards others with haughtineſs and injuſtice, envying their fortune, jealous of their merit, and great and noble actions, rejoicing at their adverſities, perfidious, calumniators, plunderers, falſe, always ready to offend them, and almoſt never to do them good: therefore *human laws* were neceſſary, which eſtabliſhing puniſhments ſhould maintain the natural and divine law, correct the delinquents, keep rebels in awe, and contain all in their duties; for if there was no fear of puniſhment, the moſt ſacred and wholeſome laws would be neglected by the indolent, infringed by the wicked, and deſpiſed by the audacious.

Therefore the human laws are eſtabliſhed to give a greater authority to the *natural law*, that no-body ſhould either omit it, or violate unpuniſhed.

HUMAN LAWS are divided into *eccleſiaſtical* and the *civil*.

The *eccleſiaſtical law* is that eſtabliſhed by, or for the uſe of the church, or religious conſtitution in every nation. This is alſo commonly called the *canon law*. The power of making *laws* has been granted to the church.

In the firſt council, *viz.* that of *Jeruſalem*, *Act.* xv. a law was made, that the Gentiles converted to the chriſtian faith, ſhould abſtain from blood, and from fleſh ſuffocated. St. *Paul*, 1 *Tim.* iii. 2. forbids that the *Bigames* ſhould be promoted to *epiſcopacy*, and by their example ſeveral things have been eſtabliſhed in the church, by the canons of the Apoſtles, general councils, and by the conſtitutions of different churches; and theſe laws have been collected and digeſted by authors, in ſeveral nations and languages: as the *Decretum Gratiani*, the *Gregorian Collection*, by *Pope Gregory* IX. The *Clementines*, the *Extravagantes*, the *Concordats*, &c.

In *England*, ſince the reformation, the *canon law* has been much abridged and reſtrained; only ſo much of it obtaining, as is conſiſtent with the common and ſtatute laws of the realm, and the doctrine of the eſtabliſhed church.

The CIVIL LAW is that made by either a prince or a republick, and which all the ſubjects of that prince or republick are obliged to obey.

They who command others, have a right to call to an account thoſe, who deſpiſe their laws; which is confirmed by the Apoſtle, *Rom.* xiii. 1. *Let every one be obedient to the ſuperior power; for there is no power but from God:* therefore he who reſiſts power, reſiſts God's ordinance.

From which expreſſions it is eaſy to underſtand, that the *civil law* is political, and temporal with regard to the object and the things commanded; but that the obligation ariſing from it, is internal and ſpiritual; and that the obſervance thereof cannot be deſpiſed with a ſafe conſcience.

Firſt, God himſelf dictated civil precepts to the *Jews*. The moſt antient people, and particularly the *Greeks*, digeſted and reduced into writings their civil laws, ſuch were thoſe of *Solon*, *Lycurgus*, and others, which all flow from the natural law; and perhaps are taken in part from the law of *Moſes*. But the *Romans* have excelled in that all other nations.

Beſides the laws of *Romulus*, and of the other kings, which were in force while the royal authority laſted; they took care, after the expulſion of the king, to make laws agreeable to the republican government they had eſtabliſhed among them, to keep the citizens under a juſt and reaſonable ſubjection, to compoſe their differences, *&c.* To that effect, they ſent about the year 300 of the foundation of *Rome*, three deputies to *Athens*, and to the other cities of *Greece*, to collect the laws of thoſe people, and bring them to *Rome*. Theſe being return'd three years afterwards, ſeven other men, eminent for their extraordinary merit, were joined to them, to make a choice of thoſe laws, and who digeſted them into *ten tables*, to which ſoon after, by reaſon that ſome of thoſe laws were defective, were added two more tables: ſo that thoſe *twelve tables* became afterwards the ſource of all the private and publick laws. Thoſe compilers were called *decemviri*; whence the laws of the *twelve tables* we alſo called *decemviral laws*.

Next to theſe *tables*, amongſt thoſe properly called *laws*, were the *plebiſcita*, made by the *Plebeians*; the *ſenatuſconſulta*, by the ſenate; the *edicts* of the pretors, whence proceeded a right called the *honorary right*: and theſe *edicts* having been collected into one body, that body was called the *perpetual edict*.

The face of the republick being changed, and the empire deferred to one perſon only; there enſued ſeveral conſtitutions of the emperors, which during very near 500 years, *i. e.* from *Auguſtus* to *Juſtinian*, increaſed in a ſurprizing manner.

Of theſe conſtitutions of the emperors, from *Adrian* to *Conſtantine*, were compoſed two codex's, in the time of *Diocleſian*, one by *Gregory*, and the other by *Hermogenes*, both private perſons. The emperor *Theodoſius* the younger, gave the third codex, digeſted by eight prudent perſons, in which he included the conſtitutions of the emperors, from *Conſtantine* to himſelf.

At laſt the emperor *Juſtinian* perfected quite the *Roman* juriſprudence. For in the year of Chriſt 528, he appointed ſome illuſtrious perſons to free the *Gregorian*, *Hermogenian*, and *Theodoſian* codex's of their too tedious prolixity, and to compoſe of them another under the name of *Juſtinian*. Agreeable to the emperor's expectations they perfected the *Juſtinian* codex, which he approved and confirmed by an imperial conſtitution, given in the year 529.

Afterwards, he cauſed to be compriſed into a ſingle work, all the antient laws divided into fifty books, which work was called the *digeſt*, or *pandects*.

Then he publiſhed an epitome of the *civil law*, diſtributed into four books, for the uſe of young ſtudents in the law, and which he called, *The Epitome of the Inſtitutions of the Civil Law*.

But as he found that ſeveral things were omitted in the codex, or not treated with that accuracy he deſir'd, he cauſed it to be corrected in ſeveral places, and would afterwards give a ſecond edition thereof more correct than the firſt, and this is, *Repetitæ prælectionis codex*; which we read in the body of the civil law.

The *novellæ* were ſoon added to it, or 168 new conſtitutions. So that the whole body of the civil law conſiſts of four collections, *viz.* the four books of *inſtitutions*, fifty books of *digeſts* or *pandects*, twelve books of the *codex*, and 186 novels. From which novels were extracted ſhort ſentences, which in the diviſion of the *codex*, were inſerted in ſeveral places thereof, and are called *Authenticæ*, becauſe confirmed by the authority of the emperor.

But

But as the fifty books of *digeſts* or *pandects*, with the *gloſſa*, could not be contained in one volume, bookſellers have divided them into three, calling the firſt volume the *antient Digeſt*; becauſe it was publiſhed firſt, the ſecond *Infortiate*, becauſe it gives a clearer, and more ample knowledge of the law; and the third the *new digeſt*, becauſe publiſhed laſt.

Each book of the *pandex* and *codex* is divided into titles, and the titles into laws, and the laws into paragraphs. Therefore, when ſome law of the *digeſts* or *pandects* is quoted, the name of the digeſt is ſignified by the majuſcule lettter D. And of the *pandects*, by a *Greek* $\tilde{\pi}$ with a circumflex, in place whereof the printers ſubſtitute a double *ff*. For example, if any body wants to quote the third paragraph of the firſt law of the firſt title of the *digeſts* or *pandects*, which has for title *de Juſtitiâ & Jure*, he'll ſay, the *natural right is what nature has taught all animals*, from *lib* 1. *paragra.* 3. *D.* or *ff. de Juſtitiâ & Jure*, i. e. the firſt law, third paragraph of the *digeſt* or *pandect*, title *de Juſtitiâ & Jure*.

And in the codex, *L. nemo* 2. *cod. de Sacroſanct. Ec.* i. e. the law which begins at this word *nemo*, which is the ſecond law in the codex, title *de Sacroſanctis eccleſiis*. This title is the ſecond of the firſt book. If the *Authentica* is quoted, it muſt be ſaid, *Authen. caſſa, cod. de Sacroſanctis Eccleſiis*, &c. The *novels* are quoted by their proper names, and the chapters thereof are indicated. The inſtitutions of the civil law are commonly quoted by paragraphs and titles.

The *Roman* civil law thus compoſed with ſo much art and care, is of great authority in almoſt all *Europe*; where it is ſimply called *law*.

For though there be ſcarce any kingdom or province in *Europe* which has not its particular uſe and cuſtoms; in them notwithſtanding the *written law*, i. e. the *Roman law* is a rule whenever the cuſtomary, or common law is deficient. Which is rightly obſerved by *Obertus de Orto*, a lawyer, of *Milan*, *lib.* 2. *de Feudis. Tit.* 1. in theſe words, *An experienced lawyer, if a caſe ariſes, which is not contained in the common law, can very well have recourſe to the written law.*

The *law of England* conſiſts of three parts: 1. The *common law*, which is the moſt antient and *general law* of the realm. 2. *Statutes*, or acts of parliament. 3. *Particular cuſtoms*.

The *common law of England* is derived from the *Engliſh*, *Saxons*, and *Danes*, and was antiently divided into three parts, *viz.* the *Mercian law*, the *Weſt-Saxon law*, and the *Daniſh law*.

Thoſe called *Mercian laws*, are commonly ſaid to have been compoſed by *Martia*, queen of the *Britons*, from whom there was a province called *Provincia Merciorum*. Many laws were alſo publiſhed by *Ethelred*, king of *Kent*, by king *Ina*, and *Offa*; but *Alfred*, who ſubdued the whole kingdom, having reviſed all the laws of his predeceſſors, retained thoſe which he thought proper, and aboliſhed the reſt; whence he is called *Anglicarum Legum Conditor*; and theſe laws were called *Weſt-Saxene-laga*.

But the kingdom being afterwards ſubdued by the *Danes*, they introduced another law, called *Dane-laga*, by which their people were governed; and they being afterwards deſtroyed, *Edward the Confeſſor*, out of the former laws, compoſed that, now called the *common law*; for which reaſon he is called by *Engliſh* hiſtorians, *Anglicarum Legum Reſtitutor*.

Theſe laws were only general cuſtoms, obſerved thro' the nation, and for that reaſon, were called *common*; and perhaps alſo, *Leges omnibus in commune reddidit*: to be obſerved by all, with ſuch amendments as were afterwards to be made.

William the Conqueror did not exact many new laws, but confirmed the old, *viz.* St. *Edward's* laws; and abrogated none that any ways concern'd compoſitions, or mulcts of delinquents: but unfortunately brought along with him from *Normandy*, the litigious ſpirit of that nation; which has been ſince cultivated, and much improved in this land, to the oppreſſion of its inhabitants.

The *common law* is alſo called *lex non ſcripta* (not but moſt of them are wrote in the old *Norman* dialect) but becauſe it cannot be made by charter, or parliament; for thoſe are always matters of record, whereas *cuſtoms* are only matters of fact, and are no where but in the memory of the people, and of all laws, are the beſt for the *Engliſh*; for the written laws, made by king and parliament, are impoſed upon the ſubjects before any probation or trial, whether they are beneficial to the nation, or agreeable to the nature of the people, except where they are firſt made temporary, and for their experienced uſefulneſs afterwards, made perpetual; but cuſtoms bind not till they have been try'd and approved time out of mind.

Beſides the *common law of England*, in general, there are in ſeveral parts of it, certain cuſtoms and common uſages, which have the force of *common law* among thoſe people, to whoſe property they belong; as *Borayn Engliſh*, a cuſtom ſo called, as not being in uſe out of *England*; where the youngeſt ſon, or for want of ſons, the youngeſt brother is to inherit; the eldeſt being ſuppoſed to have learned the father's trade, and the youngeſt the leaſt able to ſhift for himſelf.

Where the *common law* is ſilent, there are *ſtatute laws*, made by the ſeveral kings of *England*, with

with the advice and conſent of both houſes of parliament.

For the adminiſtration of theſe laws, there are ſeveral courts of judicature, *viz.* the *chancery*, *exchequer*, *king's bench*, and the court of *common pleas*.

The CHANCERY is the grand court of equity and conſcience, inſtituted to moderate the rigour of the other courts, that are tied to the ſtrict letter of the law; for as far as I can underſtand, and know by experience, law is not always founded on juſtice, equity, and conſcience; and what's law, is often very unjuſt.

The judge of this court is the lord high-chancellor, who is the firſt perſon of the realm, next after the king and princes of the blood, in all civil affairs. He is the chief adminiſtrator of juſtice next the ſovereign.

All other juſtices are tied to the ſtrict law, but the chancellor has an abſolute power to moderate the rigour of the written law, to govern his judgment by the law of nature and conſcience, and to order all things *ſecundum æquum & bonum*. Accordingly, *Stanmford* ſays, the chancellor has two powers, the one abſolute, the other ordinary; meaning, that though by his ordinary power he muſt obſerve the ſame form of procedure as other judges; yet in his abſolute power he is not limited by any written law, but by conſcience and equity.

The offices of *lord-chancellor* and *lord-keeper*, are by the ſtatute 5 *Eliz.* make the ſame thing; till that time they were different, and frequently ſubſiſted at the ſame time in different perſons.

The *keeper* was created *per traditionem magni ſigilli*; but the lord-chancellor by patent; though now that he has the keeper's office, he is created in like manner by giving him the ſeal. The chancellor is likewiſe ſpeaker of the houſe of lords.

Though the lord-chancellor be the ſole judge of the court of *chancery*, yet in matters of much difficulty he ſometimes conſults the other judges; ſo that this office may be diſcharged by one who is not a profeſſed lawyer, as antiently it commonly was. He has twelve aſſiſtants, or coadjutors, antiently called *clerici*, as being in holy orders, now maſters in *chancery*, the firſt whereof is the maſter of the rolls.

The maſter of the rolls, is a patent officer for life; who has the cuſtody of the rolls and patents, which paſs the great ſeal, and of the records of the chancery.

In the abſence of the lord-chancellor or keeper, he alſo ſits as judge in the court of *chancery*, and is called by Sir *Edward Coke*, his aſſiſtant.

At other times he hears cauſes in the Rolls-chapel, and makes orders and decrees. He likewiſe has the aſſiſtance of the other maſters in *chancery*; but all hearings before him are appealable to the lord-chancellor.

He has alſo his writ of ſummons to parliament, and ſits next to the lord chief-juſtice of *England*, on the ſecond woolpack. He has the keeping of the parliament's rolls, and the rolls houſe for his habitation; has alſo the cuſtody of all charters, patents, commiſſions, deeds, recognizances, which being made of rolls of parchment, gave riſe to the name. Antiently he was called *clerk of the rolls.*

In his gift are the ſix clerks in *chancery*, the examiners, three clerks of the petty-bag, and the ſix clerks of the rolls chapel, where the rolls are kept.

The maſters of *chancery* are uſually choſen out of the barriſters of the common law, and ſit in *chancery*, or at the rolls, as aſſiſtants to the lord chancellor, and maſter of the rolls.

To them is alſo committed interlocutory reports, ſtating of accompts, taxing coſts, &c. and ſometimes by way of reference, they are empower'd to make a final determination of cauſes.

They have, time out of mind, had the honour to ſit in the houſe of lords, though they have neither writs nor patents to empower them, but as aſſiſtants to the lord chancellor, and maſter of the rolls. They had antiently the care of inſpecting all writs of ſummons, which is now perform'd by the clerk of the petty-bag. When any meſſage is ſent from the lotds to the commons, it is carried by the maſters of *chancery*. Before them affidavits are made, and deeds and recognizances acknowledged.

Beſides theſe, who may be called *maſters of chancery ordinary* (being twelve in number, whereof the maſter of the rolls is reputed the chief) there are alſo *maſters of chancery extraordinary*, appointed to act in the ſeveral counties of *England*, beyond ten miles diſtance from *London*, by taking affidavits, recognizances, &c. for the eaſe of the ſuitors of the court.

For the equity part of the court of *chancery* are ſix clerks, who have each under him about fifteen more, in the nature of attorneys of the court; two chief examiners, for examining witneſſes, who have each five or ſix clerks apiece, one principal regiſter, who has four or five deputies; clerk of the crown, who makes out writs, commiſſions, &c. warden of the fleet; ſerjeant at arms, who bears the mace before the chancellor, and the uſher and crier of the court.

The *ſix clerks* are officers of great account, next in degree below the twelve maſters, whoſe buſineſs is to enroll commiſſions, pardons, patents, warrants, &c. which paſs the great ſeal. They are attornies

attornies for parties in fuits depending in the court of chancery.

Under them were formerly fixty clerks, who with the under-clerks did the bufinefs of the office; which number was afterwards increafed to ninety. At prefent the number is indefinite; an order having been made, for reducing them to their antient number of fixty; by not filling up the vacancies that may happen by death, &c. till they are fallen to that ftandard.

The *examiners* are two officers, whofe bufinefs is to examine on oath, the witneffes produced on both fides, upon fuch interrogatories, as the parties to the fuit do exhibit for the purpofe.

The *clerk of the crown*, is an officer, who by himfelf, or deputy, is continually to attend the lord-chancellor or lord-keeper, for fpecial matters of ftate, by commiffion, or the like, either immediately from his majefty, or by order of his council, as well ordinary as extraordinary. All general pardons, upon grant of them at the king's coronation, or in parliament; the writs of parliament, with the names of the knights, citizens, and burgeffes, are alfo returned into his office; befides which he has the making of fpecial pardons, and writs of executions upon bonds of ftatute-ftaple forfeited.

To the common law part, in *chancery*, belongs the twenty-four curfitors, and their clerks, who make out original writs; clerks of the petty-bag; clerks of the hanaper; comptroller of the hanaper; clerk of appeals; clerk of the faculties; fealer; chafe-wax; clerks of the patents, of prefentations, difmiffions, licenfes to alienate, enrollments, protections, fubpæna's, affidavits, &c.

The *curfitors*, alfo called *clerks of the courfe*, are twenty-four in number; making a corporation of themfelves. To each of them are alloted feveral fhires; in which fhires they make out fuch original writs, as are by the fubject required.

Clerk of the hanaper, is an officer, whofe bufinefs is to receive all money due to the king for the feals of charters, patents, commiffions, and writs: as alfo fees due to the officers for enrolling and examining the fame. He is obliged to attend on the lord-chancellor, or lord-keeper, daily in term-time, and at all times of fealing.

Comptroller of the hanaper, is an officer attending the lord-chancellor daily in term and feal-time. He is to take all things fealed from the clerk of the hanaper, inclofed in bags of leather, and to note the juft number and effect thereof; to enter them in a book, with all the duties belonging to the king and other officers for the fame, and fo charge the clerk of the hanaper with them.

The *court of* EXCHEQUER is a court wherein are tried all caufes relating to the king's treafury or revenue; as touching accounts, difburfements, cuftoms, fines, &c.

It confifts of feven judges, *viz.* the lord-treafurer, the chancellor of the *exchequer*, the lord chief baron, and three other barons of the *exchequer*, with one curfitor baron.

The *chancellor of the exchequer* is an officer fuppofed by fome to have been created for qualifying extremities in the *exchequer*. He fometimes fets in that court and the exchequer-chamber, and with the reft of the court orders things to the king's beft benefit. He is always in commiffion with the lord-treafurer, for letting lands accruing to the crown by diffolution of abbies, and otherwife: he has power with others to compound for forfeitures on penal ftatutes, bonds, and recognizances entered into by the king. He has a great authority in managing the royal revenue, and in matters of firft-fruits.

The barons of the *exchequer* are judges, to whom the adminiftration of juftice is committed in caufes between the king and his fubjects, touching matters belonging to the *exchequer*, and the king's revenue.

They are called barons, becaufe barons of the realm were ufed to be employ'd in that office.

Their office is alfo to look to the accompts of the king; to which end they have auditors under them, as well as to decide caufes relating to the revenue, brought by any means into the *exchequer*. So that of late they have been conftantly perfons learned in the law; whereas formerly they were *majores & difcretiores in regno, five de clero effent five de curiâ*. The lord chief baron is the principal judge of the court.

The court of *exchequer* is divided into two; the one of law, the other of equity.

All judicial proceedings, according to *law*, are ftiled *coram baronibus* only; but the court of equity held in the exchequer-chamber, is *coram thefaurario, cancellario & baronibus*, before the treafurer, chancellor, and barons.

For a long time after the conqueft, there fet in the *exchequer* both fpiritual and temporal barons of the realm, but of latter times there have fate in their places other judges, who, though no peers of the realm, yet retain the original denomination.

The common opinion of *Englifh* hiftorians is, that this court was erected by *William the Conqueror*, foon after his having obtained the kingdom: that the *Englifh* exchequer was a court of the higheft jurifdiction; that the acts thereof were not to be examined by any of the ordinary courts; that it was the repofitory of the records of all the other courts, and that it was to be held in the king's court, and before him; and that it was concerned in the prerogative as well as the revenue of the crown.

 The

The immediate profits of the crown, as of franchiſes, lands, tenements, hereditaments, debts, duties, accounts, goods, chattels, all diſburſements, ſeizures, and fines impoſed on the ſubjects, *&c.* are within the juriſdiction of the *exchequer*. And the king's attorney may exhibit bills for any matter concerning the king in inheritance or profits; ſo alſo may any perſon who finds himſelf aggrieved in any cauſe proſecuted againſt him, on behalf of the king, or any patent by grant of the king, exhibit his bill againſt the king's attorney, to be relieved by equity in this court.

To this court belong two officers, the king's *remembrancer* office, and that of the lord treaſurer's *remembrancer*; whoſe buſineſs is to put the lord treaſurer and juſtices of the court in remembrance of ſuch things as are to be called upon, and dealt in for the king's benefit.

There is a third *Remembrancer*, called *of the firſt-fruits*, who takes all compoſitions and bonds for firſt-fruits and tenths; and makes proceſs againſt ſuch as do not pay the ſame.

The two *Chamberlains* keep a controulment of the pells, of the precepts and exitus, and have certain keys of the treaſury and records; they alſo keep the keys of that treaſury, where the leagues of the king's predeceſſors and divers antient books, as *domeſday-book*, and the *black book* of the *Exchequer* remain.

Domeſday or *domeſ-day-book*, *liber judiciarius vel ſenſualis Angliæ*, the judicial book, or book of the ſurvey of *England*, is a moſt antient record made in the time of *William the conqueror*, upon a ſurvey or inquiſition of ſeveral counties, hundreds, tithings, *&c.* Its name is formed from the Saxon *Dom*, doom, judgment, ſentence, and *day*, which has the ſame force, ſo that *domeſday* is no more than a reduplicative, importing judgment.—The drift or deſign of the book is to ſerve as a Regiſter, by which ſentence may be given in the tenures of eſtates; and from which that noted queſtion, whether lands by antient demeſne or not, is ſtill decided; its contents are ſummed up in the following verſes:

Quid deberet fiſco, quæ quanta tributa,
Nomine qui l cenſus, quæ vectigalia quantum
Quiſque tenetur feodali ſolvere jure,
Qui ſunt exempti, vel quos angaria damnat,
Qui ſunt vel glebæ ſervi, vel conditionis,
Quove manumiſſus patrono jure ligatur.

This book is ſtill remaining in the *Exchequer* fair and legible, conſiſting of two volumes, a greater and a leſs; the greater comprehending all the counties of *England*, except *Northumberland*, *Cumberland*, *Weſtmoreland*, *Durham*, and part of *Lancaſhire*, which were never ſurveyed: and except *Eſſex*, *Suffolk*, and *Norfolk*, which are comprehended in the leſſer volume, which concludes with theſe words: *Anno milleſſimo octogeſimo ſexto ab Incarnatione Domini, vigeſimo vero Regis Wilhelmi, facta eſt deſcriptio non ſolum per hos tres comitatus, ſed etiam alios.* It is called *Liber Judicialis*, by reaſon a juſt and accurate deſcription of the whole kingdom is contained therein; with the value of the ſeveral inheritances, *&c.* It was begun by five juſtices aſſigned for that purpoſe in each county, in the year 1081, and finiſhed in 1086. *Camden* calls it *Gulielmi librum Cenſualium*, King *William*'s tax-book.

KING'S BENCH, is a court or judgment-ſeat, ſo called, in regard the king is ſuppoſed to ſit in perſon as judge of the court, and may do ſo whenever he pleaſes; for which reaſon, all writs and other proceſſes in this court, are made returnable *coram nobis*, i. e. before the king himſelf; and not *coram juſticiariis noſtris*, as in the form in the *common pleas*.

The judges of this court, are the Lord chief juſtice, and three other puiſne juſtices.

The chief juſtice is conſtituted by writ, and is to hold *quamdiu ſe bene geſſerit*. He preſides under his Majeſty in this court, but when the court divides, in giving judgment upon any ſpecial argument he hath but one voice; ſo that if the opinion of the court ſhould be equally divided, the matter muſt reſt till one of the judges ſhall ſee juſt reaſon to alter his opinion. He is to attend the Lords in Parliament, though he has no vote, unleſs he be a Peer himſelf, but is to give his opinion and advice to the houſe by virtue of a writ of aſſiſtance; and is frequently, therefore, conſulted by them, both in making and repealing laws, and in altering or explaining them. He makes a return of all writs of error in Parliament, directed to this court, and with his own hand delivers the writ of error, and a tranſcript of the proceedings in the cauſe into the houſe of Lords.

The three *puiſne* or *inferior judges* of this court, go the circuits, and are in commiſſion of *Oyer* and *Terminer* at the *Old Bailey*.

There are ſeveral officers belonging to this court, as two chief clerks or prothonotaries, who are ſuppoſed to enter all the pleadings and judgments between party and party; although this is done by an entring-clerk under them; and all writs of *Latitat*, *Non Omittas*, bills of *Middleſex*, *Habeas Corpus*, &c. are ſubſcribed with the names of theſe chief clerks.

The

The fecondary acts as mafter of the office on the pleas fide, and is the chief clerk's deputy; his bufinefs is to examine any perfon, who is to be fworn an entring clerk, or attorney at large, whether he be duly qualified, and to prefent him to the chief juftice. He alfo figns all judgments, and gives cofts upon them; and the court upon any motion, in relation to the irregular practice of any clerk or attorney, generally refers the examination thereof to him. He alfo takes all affidavits in court (unlefs on the crown fide) and the acknowledgment of all deeds in court.

The chief clerk, or prothonotary, has alfo a deputy, who keeps the ftamp for figning all writs and proceffes of this court; and with him are kept the remembrances of all records, whereby any record may be eafily found, if the term wherein it was enter'd be known, *&c.* Likewife all common writs return'd, pofteas and writs of error, and common or fpecial bails, after they are accepted, are filed in his office.

The office of the *Cuftos Brevium* is to file all original and other writs, whereon you proceed to outlawry. He examines and feals all records of *nifi prius*, for trials at the affizes in feveral counties, and hath feveral clerks under him for making up records throughout *England*; but many times the plantiff's attorney, *&c.* difpatches this bufinefs, paying a fee of 6 *s.* 6 *d.* for every prefs of fixty-fix lines. This officer alfo files all warrants of attorney, is clerk of the effoins, and of the treafury.

The two clerks of the papers receive all fpecial pleas, demurs, and other pleadings, and make up the paper-books thereof; which the attorney for the plaintiff moft commonly fpeaks for, and afterwards gives a rule on the fide of the book, for the defendant's attorney to bring them again, to be entered within four days, or judgment to go by default: they read in court affidavits, records, and proceedings.

The clerk of the declarations, is an officer of the court, who files all declarations after they are engroffed in parchment, and continues them on the back from the term you declare, till iffue is joined, *&c.*

The figner and fealer of bills, keeps a book of entry of the names of the plaintiffs and defendants, in all bills of *Middlefex*, &c. and the defendants therein enter their appearance with him; in whofe office fearch may be made for any writ or appearance.

The clerk of the rules takes notes of all rules and orders made in court on the plea-fide, and afterwards draws them up, and enters them in a book at large, for which he has 8 *d.* fee, and for the copy of each rule 4 *d.* if in term, and double out of term; and he, or the clerk of the papers, files all affidavits ufed in court, and makes copies of them at 4 *d.* *per* fheet; alfo with him are given all rules of courfe, as on a *Cepi Corpus*, *Habeas Corpus*, for procedendo's, poftea's, writs of inquiry, *&c.*

The clerk of the bails and poftea's, files the bail pieces, and marks the poftea's, *&c.* and he, or his deputy, attends in the king's bench office for that purpofe. With this officer you file all affidavits of fervice, of procefs for common bail, when the defendant does not appear.

The clerk of the errors allows all writs of error, and makes fuperfedeas's, whereupon and into what county you pleafe. He likewife makes tranfcripts of records, to be carried into the exchequer-chamber or the houfe of lords.

The clerk of the docquets enters the judgments, iffues, and proceedings, and keeps docquets of them, fo that with him you may find if any judgment be enter'd, *&c.* and he keeps a book for entering commitments and furrenders, and another for general iffues.

The *Filazers* in this court, which ought to be one for each county, make the mefne procefs after the original, in fuing to the outlawry, and have the benefit of all copies thereof, and entries made thereupon. There has of late been but one perfon chiefly concern'd in this office, who is *Filazer* and *Exigenter* for *London* and *Middlefex*; and when you fue by original, affidavit of your debt is to be filed with him, and here you enter the appearance, give bail, *&c.*

The Marfhal of the *King's-bench*, has the cuftody of all prifoners, who are fued in *Banco Regis*, and by himfelf or deputy, ought always to attend in court to receive fuch prifoners as are committed. And every perfon fued here, is fuppofed, by the declaration to be in his cuftody; for till the *Stat.* 4. and 5. *W.* and *M.* if one was arrefted in the country, and remain'd in prifon there for want of bail, he was firft to be removed by *Habeas Corpus* to the cuftody of the Marfhal, before the plaintiff could declare againft him.

The cryer of the court, makes proclamations of fummoning and adjourning the court, calls nonfuits, and fwears jurymen, witneffes, *&c.*

For managing, conducting, and pleading caufes in the court of *King's bench*, are appointed follicitors, attorneys, and counfellors at law.

An *Attorney* is a perfon appointed by another to do fomething in his ftead, particularly to follicit and carry on a law-fuit.

Attorneys are fometimes guilty of *barratry* and *champarty*. A *barrator* in law is a common mover, or maintainer of fuits, quarrels, or parties, either in in court or elsewhere.—*Barrators* are punished by fine and imprisonment, bound to their good behaviour, &c. and being of the profession of the law, shall be disabled to practise, 34 *Edw.* III.—An attorney is in danger of being convicted of *barratry*, for maintaining another in a groundless action, to the commencing whereof he was no way privy, &c. and a common sollicitor who sollicits suits, is a common *barrator*, and may be indicted. By statute no person shall take upon him any business in suit, to have part of the land or thing sued for, which is called *champarty*; nor shall any one upon any covenant give up his right to another in such case, on pain that the taken shall forfeit to the king so much of his lands and goods as amounts to the value of the part of the purchased, &c. for such maintenance, *Stat.* 28. *Edw.* I. *c.* 11.—And attorneys convicted of *champarty*, shall suffer three years imprisonment, and be fined at the king's pleasure, by 33 *Edw.* I. If any attorney undertakes or follows a cause to be paid in gross, when the thing in suit is recovered, if he prevail therein, this has been held *champarty*.—Persons as move pleas and suits as their own, are *champarters*.

Counsellor at *Law*, is a person learned in the law, retained by the client to plead his cause in a court of judicature.

Counsellors at *Law*, may alledge any thing which is informed them by their clients, if pertinent to the matter; and need not examine whether it be true or false; for it is at the peril of him who informs them: but after the court hath delivered their opinion of the matter depending before them, the council at the bar ought not to urge any thing further in that cause.

The fee of a Counsellor is *honorarium quiddam*, not *mercenarium*, as that of an attorney, or sollicitor; should be paid according to the ability of the client who employs him: since on his learning and eloquence, depends almost the whole success of the cause.

No *Counsellor* shall set his hand to a frivolous plea, &c. And as counsellors have a special privilege to practise the law, they are punishable for misbehaviour by attachment.

In *England* there are three sorts of trials, *viz.* one by *parliament*, another by *battle*, and a third by *assize*, or *jury*.

The trial by *assize* (let the action be civil or criminal, publick or private, personal or real) is referred for the fact to a jury, and as they find it, so passes the judgment.

In the *general assize*, there are usually many juries, because there are a great many causes, both civil and criminal, commonly to be tried; whereof one is called the *grand jury*, and the rest the *petit-juries*; of which it seems there should be one in every hundred.

Grand Jury consists of twenty-four good and substantial gentlemen, or some of the better sort of yeomen, chosen indifferently by the sheriff of the whole Shire, to consider of all bills of indictment, preferred to the court; which they do either approve, by writing upon them *billa vera*; or disallow by endorsing *ignoramus*.

Such as they do approve, if they touch life and death, are further referred to another jury, to be considered of, because the case is of much importance; but others of lighter moment, are upon their allowance, without more ado, fined by the bench; except the party traverses the indictment, or challenge it for insufficiency; or remove the cause to a higher court by *Certiorari*; in which two former cases, it is referred to another jury, and in the latter, transmitted to a higher bar. And presently upon the allowance of this bill, by the grand inquest, a man is said to be *indicted*. Such as they disallow, are delivered to the bench, by whom they are forthwith cancelled or torn.

Petit Jury consists of twelve men at least, and are impannelled as well upon criminal, as upon civil causes. Those that pass upon offences of life and death, bring in their verdict, either guilty or not guilty; whereupon the prisoner, if he be found guilty, is said to be *convicted*, and receives judgment or condemnation, or otherwise is acguitted and set free.

Those that pass upon civil causes real, are all, or so many as can conveniently be had, of the same hundred where the land or tenement doth lie, being four at least; and they, upon due examination, bring in their verdict, either for the demandant or tenant.

The answer of the jury given to the court, concerning the matter of fact in any cause, committed by the court to their trial and examination, is called *verdict*, from *vere dictum*, q. d. *dictum veritatis*, the dictate of truth.

A *verdict* is either *general* or *special*.

General verdict, is that which is brought into the court in like general terms, as the general issue: as in action of disseisin, the defendant pleads no wrong, no disseisin.—Then the issue is general, whether the fact be wrong or not; which being committed to the jury, they upon consideration of the evidence, come in and say, either for the plaintiff, *that it is a wrong disseisin*; or for the defendant, *that it is no wrong*, no *disseisin*.

Special verdict, is when they say at large, that such and such a thing they found to be done by the defendant; declaring the course of the fact, as in in their opinion it is proved; and as to the law, upon the fact proving the judgment of the court.

This *ſpecial verdict*, if it contains any ample declaration of the cauſe from the beginning to the end, is called a *verdict at large*.

The *verdict* muſt anſwer the iſſue in all things, or it will not be good; but if the jury find the iſſue and more, it is good for the iſſue, and void for the reſt; and where they find a point in iſſue, and a ſuperfluops matter over, that ſhall not vitiate the *verdict*.

If a juryman withdraws from his fellows, or keeps them from giving their *verdict*, without aſſigning any reaſon, he ſhall be fined; but not if he differs from them in judgment: and if jurors eat or drink at the coſt of him for whom they give their *verdict*, before they are agreed; or caſt lots whether they ſhall find for the plaintiff, or defendant; or if they ſend for a witneſs, after gone from the bar, and he repeats his evidence again; and where a *verdict* is given contrary to the evidence, and againſt the directions of the court, *&c.* in all thoſe caſes the *verdict* may be ſet aſide.

On return of *verdicts*, in all civil caſes, given at the aſſizes, to the courts above, the judges there give judgment for the party for whom it is found.

Sir *Edward Coke* is of opinion, that the COURT OF COMMON PLEAS was conſtituted before the conqueſt.

There are four judges of this court, created by letters patent, of whom the chief is a lord by his office; and is called *dominus juſticiarius communium placitorum, vel dominus juſticiarius de banco.* And the ſeal of the court is committed to the cuſtody of the chief juſtice.

The lord chief juſtice, with his aſſiſtants, hear and determine all common pleas in civil cauſes, as diſtinguiſhed from the king's pleas: and the juriſdiction of this court is general, like that of B. R. and extends itſelf throughout *England*. It holds pleas of civil actions at common law, between ſubject and ſubject, as well actions real, as perſonal and mixed; and it ſeems to have been the only court for all real cauſes: but this court cannot regularly hold plea in any action real or perſonal, *&c.* but by writ out of chancery, returnable here; except it be by bill, for or againſt an officer, or other privileged perſon of the court.

All actions belonging to this court, come thither, either by original, or arreſt, and outlawries; or, by privilege or attachment, for or againſt privileg'd perſons; or out of inferior courts, not of record, by *pone*, *recordare*, *accedas ad curiam*, writ of falſe judgment, *&c.* And actions popular, *decies tantum*, of champarty, maintenance, *&c.* are alſo cognizable by this court; as are actions, penal of debts, *&c.* upon any ſtatute. And beſides juriſdiction for puniſhment of its officers and miniſters; the court of *common pleas*, may grant prohibitions to temporal and eccleſiaſtical courts, *&c.*

The officers of this court are, the *cuſtos brevium*, *prothonotaries*, *ſecundaries*, *clerk of the warrants*, *clerk of the eſſoins*, *filazers*, *clerk of the ſeal*, *exigenters*, *clerk of the outlawries*, *clerk of the juries*, *clerk of the treaſury*, *clerk of the errors*, *chirographer*, *clerk of the king's ſilver*, *clerk of the inrolments*, a *proclamator*, *cryer*, *tipſtaves*, and the *warden* of the *Fleet-priſon*.

The *cuſtos brevium*, is the chief clerk in this court, whoſe office is in the king's gift: he receives and keeps all writs, and puts them upon files; every return by itſelf; and at the end of each term receives of the prothonotaries all the records of the *niſi prius*, called *poſteas*.

The writs are firſt brought in by the clerks of the aſſize of every county to the prothonotary, who attend the iſſue in that matter, to enter judgment. Four days after the return the prothonotary enters the verdict and judgment thereupon, into the rolls of the court, and then delivers them over to the *cuſtos brevium*.

The *cuſtos brevium* alſo makes entry of writs of covenant, and concords on fines; and makes copies and exemplifications of all writs and records in his office, and of all fines levied; the fines, when engroſſed, are divided between the *cuſtos brevium* and chirographer, the former keeping the writ of covenant and the note, the latter the concord and foot of the fine.

The *prothonotaries* enter and inrol all declarations, pleadings, aſſizes, judgments, and actions; they alſo make out all judicial writs, as the *venire facias* after iſſue joined; *habeas corpus* for bringing in of the jury; *diſtringas jurator*, writs of execution and ſeiſin, of ſuperſedeas, of privilege, *&c.* They inrol all recognizances acknowledged in that court, all common recoveries; make exemplifications of record, *&c.*

The *ſecondaries* are aſſiſtant to the prothonotaries in the execution of their offices; and they take minutes, and draw up all orders and rules of court. Here are three *clerks of the judgments*, one under each prothonotary.

The *clerk of the warrants* enters all warrants of attorney for the plaintiffs and defendants in ſuits; and inrolls all deeds of indenture of bargain and ſale; which are acknowledged in court, or before any judge out of the court: and it is his office to eſtreat into the exchequer all iſſues, fines, and amercement, which grow due to the king in this court, for which he has a ſtanding fee, or allowance from the crown.

The

The *clerk of the eſſoins* keeps the *eſſoin roll*, or enters *eſſoins*: he alſo provides parchment, cuts it into rolls, marks the number on them, delivers out all the rolls to every officer, and receives them again when written.

The *filazers* are officers in the court of common pleas, ſo called, becauſe they file the writs, whereon they make out proceſs.

There are fourteen *filazers* in the ſeveral diviſions, and counties of *England*. They make out all writs and proceſs upon original writs, iſſuing out of the chancery, as well real, as perſonal and mixed, returnable in that court.

The *filazers* likewiſe make out all writs of view in real actions, where the view is prayed, and upon replevin's and recordari's writs of *retorn habendo*, ſecond deliverance, and writs of withernam.—In real actions, writs of *grand* and *petit cape* before appearance.

They enter all appearances and ſpecial bail, upon any proceſs made by them: they make the firſt *ſcire facias* upon ſpecial bails, writs of habeas corpus, *diſtringas nuper vicecomitem vel balivum*, and *duces tecum*; and all ſuperſedeas's upon ſpecial bail or appearance, *&c.* Writs of habeas corpus *cum cauſa*, upon the ſheriff's return that the defendant is detained with other actions; writs of adjournment of a term, in caſe of peſtilence, war, or publick diſturbance.

The *clerk of the ſeal* is an officer that ſeals all writs, judicial and miniſterial, and alſo of meſne proceſs made by the filazers; likewiſe writs of outlawry and ſuperſedeas, and all patents and exemplifications, and takes certain fees for the ſame, for which he is accountable to the maſter of this office, and the lord chief juſtice of the court.

The *exigenters* are four officers, who make out all exigents and proclamations. in all actions where the proceſs of outlawry lies, and have for every common *exigent* 1 *s.* and for every ordinary proclamation 6 *d.* but if longer than ordinary, they take in proportion to their length.

The *clerk of the outlawries* is ſervant to the attorney-general, for making out the *capias utlagatum*, on return of the exigent after outlawry, and the name of the attorney-general is to be to every one of theſe writs; and 1 *d.* only is paid for ſealing this writ, becauſe it is ſuppoſed to be at the king's ſuit; whereas 7 *d.* is paid for the ſeal of every other writ.

The *clerk of the juries* is an officer who makes out the writs called *habeas corpus*, and *diſtringas*, for the appearance of juries, either in court or at the aſſizes; after the pannel is returned upon the *venire facias*.

The *clerk of the treaſury* has the charge of keeping the records of the court, and makes up and ſeals all records of *niſi prius*: he makes all exemplifications of records lodged in the treaſury, and copies of iſſues, imparlances and judgments, and of all informations and recognizances on record there; and he has the fees due for all ſearches. He is ſervant to the chief juſtice, and is ſaid to be removeable at pleaſure; but all other officers of this court are for life: and there is an under-clerk of the treaſury for aſſiſtance, who hath ſome fees and allowances; alſo an under-keeper that keeps the keys of the treaſury-door, *&c.*

The *clerk of the errors* tranſcribes and certifies into the king's-bench the tenor of the records of the cauſe or action, upon which the writ of error, made by the curſitor, is brought there to be determined.

The *chirographer* is an officer who engroſſes fines, acknowledged in that court, into a perpetual record (after they have been examined, and paſſed by other officers) and writes and delivers the indentures thereof to the party. He makes two indentures, one for the buyer, the other for the ſeller; and a third indented piece, containing the effect of the fine, and called *the foot of the fine*; and delivers it to the *cuſtos brevium*. The ſame officer alſo, or his deputy, proclaims all fines in court every term, and endorſes the proclamations on the back-ſide of the foot; keeping withal the writ of covenant, and the note of the fine.

The *clerk of the king's ſilver* is an officer to whom every fine is brought, after it has been with the *cuſtos brevium*, and by whom the effect of the writ of covenant is entered in a paper-book; and according to that note all the fines of that term are alſo recorded in the rolls of the court.

The *clerk of the enrollments* is an officer under the three elder judges of the court of common pleas, and removable at their pleaſure.

As to the *practice* or manner of *proſecuting* ſuits in theſe ſeveral courts, they that require more knowledge thereof, may be well furniſhed by the books which are in the hands of all gentlemen practitioners in the law; it being foreign to this treatiſe to enter into the manner of proceeding upon actions in *Weſtminſter-hall*.

LOGICK.

L O G I C K.

LOGICK is the art of thinking, and reasoning justly; and it consists in *perception*, *judgment*, *ratiocination*, and *method*.

Perception, or *apprehension*, is the simple view of things, which offer themselves to our mind, or whereby we only conceive a thing, without affirmation or negation; as, when we conceive the sun, the earth, a tree, a round or square, the thought, a being, without forming any express judgment thereof.

Judgment is the act of our mind, whereby the ideas, which agree together, are joined by an affirmation; and those, which disagree are separated by a negation, or whereby one is affirmed, or denied of the other; as, when I have the idea of God, the idea of good, and the idea of liar, I can join the idea of goodness with the idea of God, and remove from him the idea of a liar; in judging that God is good, and that God is not a liar.

Ratiocination is the act of our mind, whereby a judgment is formed of several preceding ones; as having judged that *true virtue* must be referred to God, and that the virtue of the Pagans was not referred to God; we conclude that the virtue of the Pagans was *not a true virtue*.

Method is the action of our mind, whereby having on the same subject, *viz.* the human body, various ideas, various judgments, and various reasonings, it disposes them in the most proper manner, to discover that subject.

From all we have said on this subject, it follows, that *Logick* can be very well divided into four parts; the first of which contains *reflections on ideas*, or on *the first act of the mind called conception.* The second *the reflections, which men have made on their judgments.* The third, *ratiocination.* The fourth, *method.*

The First Part. Of Simple Apprehension, or Perception.

If we attend carefully to what passes in our own minds, we shall observe two inlets of knowledge, from whence, as from two fountains, the understanding is supplied with all the materials of thinking.

First, outward objects, acting upon our senses, rouze in us a variety of perceptions, according to the different manner in which they affect us. It is thus that we come by the ideas of light and darkness, heat and cold, sweet and bitter, and all those other impressions which we term sensible qualities. This great source and inlet of knowledge is commonly distinguished by the name of *Sensation*, as comprehending all the notices conveyed into the mind, by impulses made upon the organs of sense.

But these ideas, numerous as they be, are wholly derived to us from without; there is therefore yet another source of impressions, arising from the mind's attention to its own acts, when turning inwards upon itself, it takes a view of the *perceptions* that are lodged there, and the various ways in which it employs itself about them. For the ideas furnished by the senses, give the mind an opportunity of exerting its several powers; and as all our thoughts, under whatever form they appear, are attended with consciousness, hence the impressions they leave, when we come to turn the eye of the soul upon them, enrich the understanding with a new set of *perceptions*, no less distinct than those conveyed in by the senses. Thus it is that we get ideas of thinking, doubting, believing, willing, *&c.* which are the different acts and workings of our minds, represented to us by our own consciousness. This second source of ideas is called *reflection*, and evidently presupposes sensation, as the impressions, it furnishes, are only of the various powers of the understanding, employed about perceptions already in the mind.

These considerations, if we duly attend to them, will give us a clear and distinct view of the natural procedure of the human intellect, in its advances to knowledge. We can have no perception of the operations of our own minds until they are exerted; nor can they be exerted before the understanding is furnished with ideas, about which to employ them; and as these ideas, that give the first employment to our faculties, are evidently the perceptions of sense, it is plain, that all our knowledge must begin here. This then is the first capacity of the human mind, that it is fitted to receive the impressions made upon it by outward objects affecting the senses; which impressions thus derived into the understanding, and *there lodged*, for the view of the soul, employ it in various acts of perceiving, remembering, considering, *&c.* all which are attended with an internal feeling and consciousness. And this leads us to the second step the mind takes in its progress towards knowledge, *viz.* that it can by its own consciousness represent

repreſent to itſelf theſe its ſeveral workings and operations, and thereby furniſh the underſtanding with a new ſtock of ideas. From theſe ſimple beginnings, all our diſcoveries take their riſe; for the mind thus provided with its original characters and notices of things, has a power of combining, modifying, and examining them in an infinite variety of lights, by which means it is enabled to enlarge the objects of its perception, and finds itſelf poſſeſſed of an inexhauſtable ſtock of materials. It is in the various compariſon of theſe ideas, according to ſuch combinations of them as ſeem beſt to ſuit its ends, that the underſtanding exerts itſelf in the acts of judging and reaſoning, by which the capacious mind of man puſhes on its views of things, adds diſcovery to diſcovery, and often extends its thoughts beyond the utmoſt bounds of the univerſe.

It is evident from hence, that they all fall naturally under theſe two heads. *Firſt*, thoſe original impreſſions that are conveyed into the mind by *ſenſation* and *reflection*, and which exiſt there ſimple, uniform, and without any ſhadow of variety. *Secondly*, thoſe more complex notions of things that reſult from the various combinations of our *ſimple ideas*, whether they are conceived to co-exiſt of themſelves in any particular ſubject, or are united and joined together by the mind, enlarging its conceptions of things, and purſuing the ends and purpoſes of knowledge. Theſe two claſſes comprehend our whole ſtock of ideas.

The firſt claſs of our *ideas* are thoſe, which I diſtinguiſh by the name of *ſimple perception*; becauſe they exiſt in the mind under one uniform appearance, without variety or compoſition. For, tho' external objects convey at once into the underſtanding, many different ideas all united together, and making as it were one whole; yet the impreſſions themſelves are evidently dinſtinct, and are conceived by the mind, each under a form peculiar to itſelf. Thus the ideas of colour, extenſion, and motion, may be taken in at one and the ſame time, from the ſame body; yet theſe three perceptions are as diſtinct in themſelves, as if they all proceeded from different objects, or were exhibited to our notice at different times. We are therefore carefully to diſtinguiſh between our *ſimple* and *primitive conceptions*, and thoſe *different combinations* of them, which are often ſuggeſted to the mind, by ſingle objects acting upon it. The firſt conſtitute our original notices of things, and are not diſtinguiſhable into different ideas, but enter by the ſenſes ſimple and unmixed. They are alſo the materials out of which all the others, how complex and complicated ſoever, are formed; and therefore ought deſervedly to be looked on as the foundation and ground-work of our knowledge.

Now if we take a ſurvey of theſe ideas, and their ſeveral diviſions and claſſes, we ſhall find them all ſuggeſted to us, either by our ſenſes, or the attention of the mind to what paſſes within itſelf. Thus, our notices of the different qualities of bodies, are all of the kind we call ſimple ideas, and may be reduced to five general heads, according to the ſeveral organs which are affected by them. Colours, &c. and ſounds are conveyed in by the eyes and ears; taſtes and ſmells by the noſe and palate; and heat, cold, and ſolidity, &c. by the touch. Beſides theſe, there are others which make impreſſions on ſeveral of our ſenſes, as extenſion, figure, reſt and motion, &c. the ideas of which we receive into our minds both by ſeeing and feeling.

If we next turn our view upon what paſſes within ourſelves, we ſhall find another ſet of ſimple ideas, ariſing from our conſciouſneſs of the acts and operations of our own minds. Perception or thinking, and volition or willing, are what every man experiments in himſelf, and cannot avoid being ſenſible of. I ſhall only obſerve farther, that beſides all the above-mentioned perceptions, there are others that come into our minds, by all the ways of ſenſation and reflection; ſuch are the ideas of pleaſure and pain, power, exiſtence, unity, ſucceſſion. &c. which are derived into our underſtandings, both by the action of objects without us, and the conſciouſneſs of what we feel within. It is true ſome of theſe ideas, as of extenſion and duration, cannot be conceived altogether without parts; nevertheleſs they are juſtly rank'd among our ſimple ideas; becauſe their parts being all of the ſame kind, and without the mixture of any other idea, neither of them can be reſolved into two diſtinct and ſeparate conceptions.

Having traced the progreſs of the mind thro' its original and ſimple ideas, until it begins to enlarge it's conceptions, by uniting and tying them together; it is time to take a ſurvey of it as thus employed in *multiplying* its views.

Whoever attentively conſiders his own thoughts, and takes a view of the ſeveral *complicated ideas*, that, from time to time, offer themſelves to his underſtanding, will readily obſerve that many of them are ſuch, as have been derived from *without*, and ſuggeſted by different objects affecting his perception; others again are formed by the *mind* itſelf, variouſly combining it's ſimple ideas, as ſeems beſt to anſwer thoſe ends and purpoſes it has, for the preſent, in view. Of the firſt kind are all our ideas of ſubſtances, as of a man, a horſe, a ſtone, gold. Of the ſecond are thoſe arbitrary collections of things, which we on many occaſions put together, either for their uſefulneſs in the commerce of life, or to further the purſuit of know-

ledge:

ledge: such are our ideas of stated lengths whether of duration or space, as hours, months, miles, leagues, &c. Many of our ideas of human actions may be also referred to this head, as treason, incest, manslaughter, which complex notions we do not always derive from an actual view of what these words describe, but often from combining the circumstances of them in our own minds, or, which is the most usual way, by hearing their names explained, and the ideas they stand for enumerated. These two classes comprehend all our complex conceptions, it being impossible to conceive any, that are not either suggested to the understanding by some real existences, or formed by the mind itself, arbitrarily uniting and compounding it's ideas.

It has been already observed, that the impressions conveyed into the understanding from external objects, consist for the most part of many different ideas joined together, which all unite to make up one whole. These collections of various ideas, thus co-existing in the same common subject, and held together by some unknown bond of union, have been distinguished by the name of *substances*: a word which implies their subsisting of themselves, without dependence (at least as far as our knowledge reaches) on any other created beings. Such are the ideas we have of gold, iron, water, a man, &c. For if we fix upon any one of these, for instance gold; the notion, under which we represent it to ourselves, is that of a body, yellow, very weighty, hard, fusible, malleable, &c. where we may observe, that the several properties, that go to the composition of gold, are represented to us by clear and evident perceptions; the union too of these properties, and their thereby consisting a distinct species of body, is clearly apprehended by the mind; but when we would push our enquiries farther, and know wherein this union consists, what holds the properties together, and gives them their self-subsistence, here we find ourselves at a loss. However, as we cannot conceive qualities, without at the same time supposing some subject, in which they inhere; hence we are naturally led to form the notion of a support, which serving as a foundation for the co-existence and union of the different properties of things, gives them that separate and independent existence, under which they are represented to our conception. This support we denote by the name *substance*; and as it is an idea applicable to all the different combinations of qualities that exist any where by themselves, they are accordingly all called *substances*. Thus a house, a bowl, a stone, &c. having each their distinguishing properties, and being conceived to exist independent one of another, the idea of *substance* belongs alike to them all.

In substances therefore there are two things to be considered: first the general notion of self subsistence, which, as I have said, belongs equally to them all; and then the several *qualities* or *properties*, by which the different kinds and individuals are distinguished one from another. These *qualities* are otherwise called *modes*, and have been distinguished into *essential* and *accidental*, according as they are conceived to be separable or inseparable from the subject to which they belong. Extension and solidity are *essential modes* of a stone; because it cannot be conceived without them: but roundness is only an *accidental mode*, as a stone may exist under any shape or figure, and yet still retain its nature and other properties.

So that the variety of *material* substances arises wholly from the different configuration, size, texture, and motion of the minute parts. As these happen to be variously combined, and knit together under different forms, bodies put on a diversity of appearances, and convey into the mind by the senses, all those several impressions, by which they are distinguished one from another. This internal constitution or structure of parts, from which the several properties that distinguish any substance flow, is called the *essence* of that *substance*, and is in fact unknown to us, any farther than by the perceivable impressions it makes upon the organs of sense. Gold, as has been said, is a body yellow, very weighty, hard, fusible, malleable, &c. That inward structure and conformation of its minute particles, by which they are so closely linked together, and from which the properties above-mentioned are conceived to flow, is called its *essence*; and the properties themselves are the perceivable marks that make it known to us, and distinguish it from all other substances. For our senses are not acute enough to reach its inward texture and constitution.

But many of the properties derived from this *essence*, make obvious and distinct impressions, as the weight, hardness, and yellow colour, &c. These properties combined together, and conceived, as co-existing in the same common subject, make up our *complex idea* of gold. The same may be said of all the other species of corporeal substances.

This however ought to be observed, that tho' the *essence* or *inward structure* of *bodies*, is altogether *unknown* to us, yet we rightly judge, that in all the *several species* the *essences* are distinct. Thus only is *true knowledge* promoted, when we argue from *known* qualities, and not from a *supposed* internal constitution, which however real in itself, yet comes not within the reach of our faculties; and therefore can never be a ground to us, for any discoveries or improvements.

Material ſubſtances includes the idea of ſolid, cohering, extended parts, and is divided into different claſſes, according to the different impreſſions made upon the organs of ſenſe. But beſides theſe ſenſible ideas received from *without*, we alſo experiment in ourſelves thinking and volition. Theſe actions have no connection with the known properties of body; nay, they ſeem plainly inconſiſtent with ſome of it's moſt eſſential qualities. For the mind, not only diſcovers no relation between thinking, and the motion of arrangement of parts; but it alſo perceives that conſciouſneſs, a ſimple individual act, can never proceed from a compounded ſubſtance, capable of being divided into many.

Finding therefore conſciouſneſs incompatible with the coheſion of ſolid ſeparable parts, we are neceſſarily led to place it in ſome other ſubſtance, of a diſtinct nature and properties, which we call *ſpirit*.

Whatever conſiſts of ſolid extended parts, is called *matter*.

But *ſpirit* is ſomething altogether diſtinct from body, nay and commonly placed in oppoſition to it; for which reaſon, the beings of this claſs are called *immaterial*, a word that implies not any thing of their nature, but merely denotes its contrariety to that of matter.

Body and *ſpirit* therefore, differ not as ſpecies of the ſame ſubſtance, but are really diſtinct kinds of ſubſtances, and ſerve as general heads, under which to rank all the particular beings that fall within the compaſs of our knowledge. For we having no ways of perception but ſenſe and conſciouſneſs, can have no notices of things, but as derived from theſe two inlets. By our ſenſes we are informed of the exiſtence of ſolid extended ſubſtances, and reflection tells us, that there are thinking conſcious ones. Beyond theſe our conceptions reach not.

If we proceed to enquire into the ideas of the mind, we ſhall diſcover that the mind, in framing *complex ideas*, acts voluntarily and of choice; it combines only ſuch ideas as are ſuppoſed beſt to ſuit its preſent purpoſe, and alters or changes theſe combinations, by inſerting ſome, and throwing out others, according as the circumſtances of things require their being viewed in different lights.

Theſe acts may in the general be all reduced to three, as, 1. *Compoſition*, when we join many ſimple ideas together, and conſider them as one picture or repreſentation. Such are our ideas of beauty, gratitude, &c.

2. The next operation therefore of the mind, about its ideas, is *abſtraction*; when we ſeparate from any of our conceptions, all thoſe circumſtances, that render it *particular*, or the repreſentative of a ſingle determinate object; by which means, inſtead of ſtanding for an individual, it is made to denote a whole rank or claſs of things.

3. The third and laſt act of the mind about its ideas, is the *comparing* them one with another; when we carry our conſideration of things beyond the object themſelves, and examine their *reſpects* and *correſpondencies*, in reference to other things, which the mind brings into view at the ſame time.

Let us now conſider the means of making known our thoughts to others, or to communicate it with the greateſt certainty and advantage. For our ideas, though manifold and various, are nevertheleſs all within our own breaſts, inviſible to others, nor can of themſelves be made appear. But God deſigning us for ſociety, and to have fellowſhip with thoſe of our kind, has provided us with organs fitted to frame articulate ſounds, and given us alſo a capacity of uſing thoſe ſounds, as ſigns of internal conceptions. Hence ſpring words and language; for having once pitched upon any ſound, to ſtand as the mark of an idea in the mind, cuſtom by degrees eſtabliſhes ſuch a connection between them, that the appearance of the idea in the underſtanding, always brings to our remembrance the ſound or name by which it is expreſſed; as in like manner the hearing of the ſound, never fails to excite the idea for which it is made to ſtand. And thus it is eaſy to conceive, how a man may record his own thoughts, and bring them again into view, in any ſucceeding period of life. For this connection being once ſettled, as the ſame ſounds will always ſerve to excite the ſame ideas; if he can but contrive to regiſter his words, in the order and diſpoſition, in which the preſent train of his thoughts preſents them to his imagination; it is evident he will be able to recal theſe thoughts at pleaſure, and that too in the very manner of their firſt appearance.

Beſides the ability of recording our own thoughts, there is this farther advantage in the uſe of external ſigns, that they enable us to communicate our ſentiments to others, and alſo receive information of what paſſes in their breaſts. For any number of men, having agreed to eſtabliſh the ſame ſounds as ſigns of the ſame ideas, it is apparent that the repetition of theſe ſounds muſt excite the like perceptions in each, and create a perfect correſpondence of thoughts. When for inſtance, any train of ideas, ſucceed one another in my mind, if the names by which I am wont to expreſs them, have been annexed by thoſe with whom I converſe, to the very ſame ſet of ideas, nothing is more evident, than that by repeating those names according to the tenor of my present conceptions, I shall raise in their minds the same course of thought as has taken possession of my own. Hence, by barely attending to what passes within themselves, they will also become acquainted with the ideas in my understanding, and have them in a manner laid before their view. So that we here clearly perceive, how a man may communicate his sentiments, knowledge, and discoveries to others, if the language, in which he converses, be extensive enough to mark all the ideas and transactions of his mind. But as this is not always the case, and men are often obliged to invent terms of their own, to express new views and conceptions of things; it may be asked, how in these circumstances we can become acquainted with the thoughts of another, when he makes use of words, to which we have never annexed any ideas, and that of course can raise no perceptions in our minds. Now, to unveil this mystery, and give some little insight into the foundation, growth, and improvement of language, the following observations will, I am apt to think, be found of considerable moment.

First, That no word can be to any man the sign of an idea, till that idea comes to have a real existence in his mind.

The first thing therefore to be consider'd is, how these ideas may be conveyed into the mind; that being there, we may learn to connect them with their appropriated sounds, and so become capable of understanding others, when they make use of these sounds in laying open and communicating their thoughts. Now to comprehend this distinctly, it will be necessary to call to mind, the before-mentioned division of our ideas into simple and complex. And first as for our simple ideas, it has been already observed, that they can find no admission into the mind, but by the two original fountains of *knowledge*, *sensation*, and *reflection*. If therefore any of these have as yet no being in the understanding, it is impossible by words or a description to excite them there. A man who had never felt the impression of *heat*, could not be brought to comprehend that sensation, by any thing we might say to explain it. The case is the same in respect of light and colours. A man born blind, can never be brought to understand the names by which they are expressed. The reason is plain: they stand for ideas that have no existence in his mind; and as the organ appropriated to their reception is wanting, all other contrivances are vain, nor can they by any force of description be raised in his imagination. But it is quite otherwise in our complex notions. For these being no more than certain combinations of simple ideas, put together in various forms, if the original ideas out of which the collections are made, have already got admission into the understanding, and the names serving to express them are known; it will be easy, by enumerating the several ideas concerned in the composition, and marking the order and manner in which they are united, to raise any complex conception in the mind. Thus the idea answering to the word *rainbow*, may be readily excited in the imagination of another, who has never seen the appearance itself, by barely describing the figure, largeness, position, and order of colours; if we suppose these several simple ideas, with their names, sufficiently known to him.

And this naturally leads me to a second observation upon this subject, namely: that words standing for *complex ideas* are all *definable*, but those by which we denote *simple ideas* are *not*. For the perceptions of this latter class, having no other entrance into the mind, than by sensation or reflection, can only be got by experience, from the several objects of nature, proper to produce those perceptions in us. The only method in this case is, to present some object, by looking at which the *perception* itself may be excited, and thus he will learn both the *name* and the *idea* together.

Thus finding, that the name *heat*, is annexed to that impression, which men feel when they approach the fire, I make it also the sign of the idea excited in me by such an approach, nor have any doubt but it denotes the same perception in my mind as in theirs. For we are naturally led to imagine, that the same objects operate alike upon the organs of the human body, and produce an uniformity of sensations.

Being furnished with simple ideas, and the names by which they are expressed, the meaning of terms that stand for *complex ideas* is easily got; because the ideas themselves answering to these terms, may be conveyed into the mind by *Definitions*.

DEFINITIONS are intended to make known the meaning of words standing for complex ideas, and were we always careful to form those ideas exactly in our minds, and copy our definitions from that appearance, much of the confusion and obscurity complained of in languages might be prevented. But unhappily for us we are by no means steady in the application of names, referring them sometimes to one thing, sometimes to another; therefore to render this whole mattter as clear and obvious as possible, we shall first consider, to what it is that names, in the use of language, are most commonly applied; and then from the variety of this applica-

tion,

tion, endeavour to account for the ſeveral methods of defining mentioned in the writings of Logicians.

Words then have manifeſtly a threefold reference. *Firſt*, and more immediately, they denote the ideas in the mind of him, who uſes them; and this is their true and proper ſignification *Secondly*, we conſider our words, as ſigns likewiſe of the ideas in the minds of thoſe, with whom we converſe; and this is the foundation of what is called propriety in language, when men take care to affix ſuch notions to their words, as are commonly applied to them by thoſe of moſt underſtanding in the country where they live. A *third* reference of words, is to things themſelves. For many of our ideas, are taken from the ſeveral objects of nature, wherewith we are ſurrounded; and being conſidered as copies of things really exiſting, the words by which they are expreſſed, are often transferred from the ideas themſelves, to ſignify thoſe objects which they are ſuppoſed to repreſent. Thus the word *ſun*, not only denotes the idea excited in the mind by that ſound, but is alſo frequently made to ſtand for the luminous body itſelf, which inhabits the center of this our planetary ſyſtem. Now according to this threefold application of names, their definitions, and the manner of explaining them, muſt be various; for it is one thing to unfold the ideas in a man's own mind, another to deſcribe them as they are ſuppoſed to make their appearance in the minds of others; and laſtly, it is ſomething ſtill different, to draw images or pictures, that ſhall carry in them a conformity to the being and reality of things.

Firſt then, when we conſider words, as ſigns of the ideas in the mind of him who uſes them; a *definition* is nothing elſe, but ſuch an explication of the meaning of any term, as that the complex idea annexed to it by the ſpeaker, may be excited in the underſtanding of him with whom he converſes. And this is plainly no more than teaching the connection of our words and ideas, that others may underſtand the ſenſe of our expreſſions, and know diſtinctly what notions we affix to the terms we uſe. When we ſay for inſtance, that by the word *ſquare*, we mean a figure bounded by four equal ſides, joined together at right angles; what is this but a declaration, that the idea of a quadrilateral, equilateral, rectangular figure, is that which in diſcourſe or writing, we connect with the term *ſquare?* This is that kind of definition, which Logicians call the *definition of the name*; becauſe it diſcovers the meaning of the words or *names* we make uſe of, by ſhewing the ideas for which they ſtand.

In definitions of the name, we aim at no more, than teaching the connection of words and ideas. Now the ideas we join with our words are of two kinds: either ſuch as we have reaſon to believe are already in the mind of others, though perhaps they know not the names by which they are called; or ſuch as being new and of our own formation, can no otherwiſe be made known than by a deſcription. When we ſay that a *clock is an inſtrument by which we meaſure the hours of the day*; it is plain, that the idea anſwering to the word *clock*, is not here unfolded, but we being before-hand ſuppoſed to have an idea of this inſtrument, are only taught by what name it is called. In this ſenſe, the names of even ſimple ideas may alſo be defined. For, by ſaying that *white* is the colour we obſerve in ſnow, *heat* the ſenſation produced by approaching the fire, we ſufficiently make known what ideas we connect with the terms *white* and *heat*, which is the true purpoſe of a definition of the name.

But where the ideas we join with our words, are new and of our own formation, there they are to be laid open by a deſcription. Becauſe being ſuppoſed unknown to others, we muſt firſt raiſe them in their minds, before they can learn to connect them with any particular names. And here it is, that the *definition of the name* coincides with what Logicians call the *definition of the thing*, as in either caſe we proceed, by unfolding the idea itſelf, for which the term defined ſtands. And indeed this alone is what conſtitutes a definition, in the true and proper ſenſe of the word.

This ſpecies of definitions conſiders words as referred to things themſelves. All definitions of this kind, when juſtly made, are in reality pictures or repreſentations, taken from the being and exiſtence of things. For they are intended to expreſs their nature and properties, ſo as to diſtinguiſh them from all others, and exhibit them clearly to the view of the mind.

And, from what is ſaid, it evidently follows, that a *definition is the unfolding of ſome conception of the mind, anſwering to the word or term made uſe of as the ſign of it.*

Definitions, conſidered as *deſcriptions* of ideas in the mind, are ſteady and invariable, being bounded to the repreſentation of thoſe preciſe ideas. But then in the *application* of *definitions* to particular names, we are altogether left to our own free choice. Becauſe as the connecting of any idea, with any ſound, is a perfectly arbitrary inſtitution; the applying the deſcription of that idea, to that ſound, muſt be ſo too. When therefore Logicians tell us, that the definition of the name is arbitrary, they mean no more than this; that as different ideas may be connected with any term, according to the good pleaſure of him that uſes it, in like manner

manner may different descriptions be applied to that term, suitable to the ideas so connected. But this connection being settled, and the term considered as the sign of some fixed idea in the understanding, we are no longer left to arbitrary explications, but must study such a description, as corresponds with that precise idea Now this alone ought to be accounted a definition.

In *definitions* properly so called, we first consider the *term* we use, as the sign of some inward conception, either annexed to it by custom, or our own free choice; and then the *business* of the definition is, to unfold and explicate that idea.

A definition is then said to be perfect, when it serves distinctly to excite the idea described, in the mind of another, even supposing him before wholly unacquainted with it. This point settled, it is obvious that definitions cannot have place, but where we make use of terms, standing for complex ideas. But perhaps the reader may still expect, that we should enter a little more particularly into the nature of a definition, describe it's parts, and shew by what rules it ought to proceed, in order to the attainment of it's proper end.

Two things are therefore required in every *definition*. *First*, that all the original ideas out of which the complex one is formed, be distinctly enumerated. *Secondly*, that the order and manner of combining them into one conception, be clearly explained. And to arrive at a just and adequate definition; *First*, we are to take an exact view of the idea to be described, trace it to it's original principles, and mark the several simple perceptions, that enter into the composition of it. *Secondly*, we are to consider the particular manner, in which these elementary ideas are combined, in order to the forming of that precise conception, for which the term we make use of stands. When this is done, and the idea wholly unravelled, we have nothing more to do, than fairly transcribe the appearance it makes to our own minds.

All the ideas we receive, from the several objects of nature that surround us, represent distinct individuals. These individuals when compared together, are found in certain particulars to resemble. Hence by collecting the resembling particulars into one conception, we form the notion of a *species*. And here let it be observed, that this last idea is less complicated, than that by which we represent any of the particular objects contained under it. For the idea of the species excludes the peculiarities of the several individuals, and retains only such properties as are common to them all. Again, by comparing several species together, and observing their resemblance, we form the idea of a *genus*; where in the same manner as before, the composition is lessened, because we leave out what is peculiar to the several species compared, and retain only the particulars wherein they agree. It is easy to conceive the mind, proceeding thus from one step to another, and advancing through its several classes of general notions, until at last it comes to the highest genus of all, denoted by the word *being*, where the bare idea of existence is only concerned.

As therefore the first order of our compound notions, or the ideas that constitute the highest genera, in the different scales of perception, are formed, by uniting together a certain number of simple notices; so the terms expressing these genera, are defined, *by enumerating the simple notices so combined*. And as the species comprehended under any genus, or the complex ideas of the second order, arise from superadding the specific difference, to the said general idea; so the definition of the names of the species, is absolved *in a detail of the ideas of the specific difference, connected with the term of the genus*. For the *genus* having been before defined, the term by which it is expressed, stands for a known idea, and may therefore be introduced into all subsequent definitions, in the same manner as the names of simple perceptions. It will now I think be sufficiently obvious, that the definitions of all the succeeding orders of compound notions, will every where consist, *of the term of the nearest genus, join'd with an enumeration of the ideas that constitute the specifick difference*; and that the definition of individuals, *unites the name of the lowest species, with the terms by the which we express the ideas of the numerick difference*.

Here then we have the true and proper form of a definition, in all the various orders of conception. This is that method of defining, which is commonly called *logical*, and which we see is perfect in it's kind, inasmuch as it presents a full and adequate description of the idea, for which the term defined stands. There are still two things worthy of observation, before we take leave of this subject. First that the very frame and contexture of these definitions, points out the order in which they ought to follow one another. For as the name of the genus is admitted into a description, only in consequence of it's having been before defined; it is evident, that we must pass gradually through all the different orders of conception. Accordingly, Logicians lay it down as a rule, that we are to begin always with the highest genus, and carry on the series of definitions regularly, through all the intermediate genera and species, quite down to the individuals.

The

The Second Part. Of Judgment or Intuition.

When the mind is furniſhed with ideas, it's next ſtep in the way to knowledge is, the comparing theſe ideas together, in order to judge of their agreement or diſagreement. In this joint view of our ideas, if the relation is ſuch, as to be immediately diſcoverable by the bare inſpection of the mind, the judgments thence obtained are called *intuitive*, from a word that denotes *to look at* : for in this caſe, a mere attention to the ideas compared, ſuffices to let us ſee, how far they are connected or disjoined. Thus, *that the whole is greater than any of its parts*, is an intuitive judgment, nothing more being required to convince us of its truth, than an attention to the ideas of *whole* and *part*. And this too is the reaſon, why we call the act of the mind forming theſe judgments, *intuition*; as it is indeed no more, than an immediate perception of the agreement or diſagreement of any two ideas.

But our knowledge of this kind reſpects only our ideas, and the relation between them; and therefore can ſerve only as a foundation to ſuch reaſonings, as are employed in inveſtigating theſe relations. Now it ſo happens, that many of our judgments are converſant about facts, and the real exiſtence of things, which cannot be traced by the bare contemplation of our ideas. What then are the grounds of our judgment in relation to facts? I anſwer theſe two: *experience* and *teſtimony*.

By *experience* we know the exiſtence of thoſe objects that ſurround us, and fall under the immediate notice of our ſenſes. When we ſee the ſun, or caſt our eyes towards a building, we not only have ideas of theſe objects within ourſelves, but aſcribe to them a real exiſtence out of the mind. It is alſo by the information of the ſenſes, that we judge of the qualities of bodies; as when we ſay that ſnow is white, fire hot, or ſteel hard. But this is not the only advantage derived from experience, for to that too are we indebted, for all our knowledge regarding the co-exiſtence of ſenſible qualities in objects, and the operations of bodies one upon another. Ivory, for inſtance, is hard and elaſtic; this we know by experience, and indeed by that alone. In like manner with regard to the operations of bodies one upon another, it is evident, that our knowledge this way, is all derived from obſervation. *Aqua regia* diſſolves gold, as has been found by frequent trial, nor is there any other way of arriving at the diſcovery.

But there are many facts that will not allow of an appeal to the ſenſes, and in this caſe *teſtimony* is the true and only foundation of our judgments. All human actions of whatever kind, when conſidered as already paſt, are of the nature here deſcribed; becauſe having now no longer any exiſtence, both the facts themſelves, and the circumſtances attending them, can be known only from the relations of ſuch, as had ſufficient opportunities of arriving at the truth. *Teſtimony*, therefore, is juſtly accounted another ground of human judgment, from which we derive *hiſtorical knowledge*; by which I would be underſtood to mean, not merely a knowledge of the civil tranſactions of ſtates and kingdoms, but of all facts whatſoever, where teſtimony is the ultimate foundation of our belief.

Of affirmative and negative propoſitions. While the comparing of our ideas, is conſidered merely as an act of the mind, aſſembling them together, and joining or disjoining them according to the reſult of it's perceptions, we call it *judgment*; but when our judgments are put into words, they then bear the name of *propoſitions*.

A propoſition therefore is a ſentence expreſſing ſome judgment of the mind, whereby two or more ideas are affirmed to agree or diſagree. Now as our judgments include at leaſt two ideas, one of which is affirmed or denied of the other, ſo muſt a propoſition have terms anſwering to theſe ideas. The idea of which we affirm or deny, and of courſe the term expreſſing that idea, is called the *ſubject* of the propoſition. The idea affirmed or denied, as alſo the term anſwering it, is called the *predicate*. Thus in the propoſition, *God* is *omnipotent* : *God* is the ſubject, it being of him that we affirm omnipotence; and *omnipotent* is the predicate, becauſe we affirm the idea expreſſed by that word to belong to God.

But as in propoſitions, ideas are either joined or disjoined; it is not enough to have terms expreſſing thoſe ideas, unleſs we have alſo ſome words to denote their agreement or diſagreement. That word in a propoſition, which connects two ideas together, is called the *copula*; and if a negative particle be annexed, we thereby underſtand that the ideas are disjoined. The *ſubſtantive verb*, is commonly made uſe of for the *copula*, as in the above mentioned propoſition, *God* is *omnipotent*; where *is* repreſents the *copula*, and ſignifies the agreement of the ideas of *God* and *omnipotence*. But if we mean to ſeparate two ideas; then, beſides the ſubſtantive verb, we muſt alſo uſe ſome particle of negation, to expreſs this repugnance. The propoſition, *man is not perfect*; may ſerve as an example of this kind, where the notion of *perfection*, being removed from the idea of *man*, the negative particle *not* is inſerted after the *copula*, to ſignify the diſagreement between the ſubject and predicate.

Every propofition neceffarily confifts of thefe three parts, but then it is not alike needful that they be all feverally expreffed in words: becaufe the *copula* is often included in the term of the predicate, as when we fay, *he fits*; which imports the fame as *he is fitting*.

When the mind joins two ideas, we call it an *affirmative* judgment; when it feparates them a *negative*; and as any two ideas compared together, muft neceffarily either agree or not agree, it is evident, that all our judgments fall under thefe two divifions. Hence likewife, the propofitions expreffing thefe judgments, are all either affirmative or negative. An affirmative propofition connects the predicate with the fubject, as *a ftone is heavy*; a negative propofition feparates them, as *God is not the author of evil*. *Affirmation* therefore is the fame as joining two ideas together, and this is done by means of the *copula*. *Negation* on the contrary, marks a repugnance between the ideas compared, in which cafe a negative particle muft be called in, to fhew that the connection included in the *copula* does not take place.

Of univerfal and particular propofitions. The next confiderable divifion of propofitions, is into *univerfal* and *particular*.

An *univerfal* propofition is that, wherein the fubject is fome general term, taken in it's full latitude, infomuch that the predicate agrees to all the individuals comprehended under it, if it denotes a proper fpecies; and to all the feveral fpecies, and their individuals, if it marks an idea of a higher order. The words *all*, *every*, *no*, *none*, &c. are the proper figns of this univerfality; and as they feldom fail to accompany general truths, fo they are the moft obvious criterion whereby to diftinguifh them. *All animals have a power of beginning motion.* This is an univerfal propofition; as we know from the word *all*, prefixed to the fubject *animal*, which denotes that it muft be taken in it's full extent. Hence the power of beginning motion, may be affirmed of all the feveral fpecies of animals; as of birds, quadrupeds, infects, fifhes, &c. and of all the individuals of which thefe different claffes confift, as of this hawk, that horfe, and fo for others.

A *particular* propofition has in like manner fome general term for its fubject, but with a mark of limitation added, to denote, that the predicate agrees only to fome of the individuals comprehended under a fpecies, or to one or more of the fpecies belonging to any genus, and not to the whole univerfal idea. Thus *fome ftones are heavier than iron*; *fome men have an uncommon fhare of prudence*. In the laft of thefe propofitions, the fubject *fome men*, implies only a certain number of individuals, comprehended under a fingle fpecies.

We have a fure and infallible mark, whereby to diftinguifh between univerfal and particular propofitions. Where the predicate agrees to all the individuals comprehended under the notion of the fubject, there the propofition is univerfal; where it belongs only to fome of them, or to fome of the fpecies of the general idea, there the propofition is particular. This criterion is of eafy application, and much fafer than to depend upon the common figns of *all*, *every*, *fome*, *none*, &c. becaufe their being different in different languages, and often varying in their fignification, are very apt in many cafes to miflead the judgment.

We fee therefore, that all propofitions are either *affirmative* or *negative*; nor is it lefs evident, that in both cafes, they may be *univerfal* or *particular*. Hence arifes, that celebrated fourfold divifion of them, into *univerfal affirmative*, and *univerfal negative*; *particular affirmative*, and *particular negative*.

Of abfolute and conditional propofitions. The objects about which we are chiefly converfant in this world, are all of a nature liable to change. What may be affirmed of them at one time, cannot often at another.

This confideration gives rife to the divifion of *propofitions* into *abfolute* and *conditional*. *Abfolute* propofitions are thofe, wherein we affirm fome property infeparable from the idea of the fubject, and which therefore belongs to it in all poffible cafes; as *God is infinitely wife*. *Virtue tends to the ultimate happinefs of man*. But where the predicate is not neceffarily connected with the idea of the fubject, unlefs upon fome confideration diftinct from that idea, there the propofition is called *conditional*. The reafon of the name is taken from the fuppofition annexed, which is of the nature of a condition, and may be expreffed as fuch. Thus; *If a ftone is expofed to the rays of the fun, it will contract fome degree of heat. If a river runs in a very declining channel, it's rapidity will conftantly increafe.*

Of fimple and compound propofitions. Hitherto we have treated of propofitions, where only two ideas are compared together. Thefe are in the general called *fimple*; becaufe having but one fubject and one predicate, they are the effect of a fimple judgment, that admits of no fubdivifion. But if it fo happens, that feveral ideas offer themfelves to our thoughts at once, whereby we are led to affirm the fame thing of different objects, or different things of the fame object; the propofitions expreffing thefe judgments are called *compound*: becaufe they may be refolved into as many others, as there are ſubjects or predicates, in the whole complex determination of the mind. Thus; *God is infinitely wiſe, and infinitely powerful.* Here there are two predicates, *infinite wiſdom*, and *infinite power*, both affirmed of the ſame ſubject; and accordingly, the propoſition may be reſolved into two others, affirming theſe predicates ſeverally. In like manner in the propoſition, *neither kings nor people are exempt from death*; the predicate is denied of both ſubjects, and may therefore be ſeparated from them, in diſtinct propoſitions. Nor is it leſs evident, that if a complex judgment conſiſts of ſeveral ſubjects and predicates, it may be reſolved into as many ſimple propoſitions, as are the number of different ideas compared together. *Riches and honours are apt to elate the mind, and increaſe the number of our deſires.* In this judgment, there are two ſubjects and two predicates, and it is at the ſame time apparent, that it may be reſolved into four diſtinct propoſitions. *Riches are apt to elate the mind. Riches are apt to increaſe the number of our deſires.* And ſo of honours.

Logicians have divided theſe compound propoſitions, into a great many different claſſes; but we reduce them to two kinds only, *viz. copulatives* and *disjunctives.*

A *copulative* propoſition is, where the ſubjects and predicates are ſo linked together, that they may be all ſeverally affirmed or denied one of another. Of this nature theſe examples. *Riches and honours are apt to elate the mind, and encreaſe the number of our deſires. Neither kings nor people are exempt from death.* In the firſt of theſe, the two predicates may be affirmed ſeverally of each ſubject, whence we have four diſtinct propoſitions. The other furniſhes an example of the negative kind, where the ſame predicate being disjoined from both ſubjects, may be alſo denied of them in ſeparate propoſitions.

Disjunctive propoſitions are theſe, in which, comparing ſeveral predicates with the ſame ſubject, we affirm that one of them neceſſarily belongs to it, but leave the particular predicate undetermined. If any one, for example, ſays: *this world either exiſts of itſelf, or is the work of ſome all wiſe and powerful cauſe*; it is evident, that one of the two predicates muſt belong to the world; but as the propoſition determines not which, it is therefore of the kind we call *disjunctive.* It is the nature of all propoſitions of this claſs, ſuppoſing them to be exact in point of form; that upon determining the particular predicate, the reſt are of courſe to be removed; or if all the predicates but one are removed, that one neceſſarily takes place.

Of the diviſion of propoſitions into ſelf-evident and demonſtrable. When any propoſition is offered to the view of the mind, if the terms in which it is expreſſed are underſtood; upon comparing the ideas together, the agreement or diſagreement aſſerted is either immediately perceived, or found to lie beyond the preſent reach of the underſtanding. In the firſt caſe the propoſition is ſaid to be *ſelf-evident*, and admits not of any proof; becauſe a bare attention to the ideas themſelves, produces full conviction and certainty; nor is it poſſible to call in any thing more evident, by way of confirmation. But where the connection or repugnance comes not ſo readily under the inſpection of the mind, there we muſt have recourſe to reaſoning; and if by a clear ſeries of proofs we can make out the truth propoſed, inſomuch that ſelf-evidence ſhall accompany every ſtep of the procedure, we are then able to demonſtrate what we aſſert, and the propoſition itſelf is ſaid to be *demonſtrable.* When we affirm for inſtance, *that it is impoſſible for the ſame thing to be and not to be*; whoever underſtands the terms made uſe of, perceives at firſt glance the truth of what is aſſerted; nor can he by any efforts, bring himſelf to believe the contrary. The propoſition therefore is *ſelf-evident*, and ſuch, that it is impoſſible by reaſoning to make it plainer; becauſe there is no truth more obvious, or better known, from which as a conſequence it may be deduced. But if we ſay, *this world had a beginning*; the aſſertion is indeed equally true, but ſhines not forth with the ſame degree of evidence. We find great difficulty in conceiving how the world could be made out of nothing; and are not brought to a free and full conſent, until by reaſoning we arrive at a clear view of the abſurdity involved in the contrary ſuppoſition. Hence this propoſition is of the kind we call *demonſtrable*, in as much as its truth is not immediately perceived by the mind, but yet may be made appear by means of others more known and obvious, whence it follows as an unavoidable conſequence.

In all propoſitions, we either affirm or deny ſome property of the idea that conſtitutes the ſubject of our judgment, or we maintain that ſomething may be done or effected. The firſt ſort are called *ſpeculative* propoſitions, as in the example, *the radii of the ſame circle are all equal one to another.* The others are called *practical*; thus, *that a right line may be drawn from one point to another*, is a practical propoſition, inaſmuch as it expreſſes that ſomething may be done.

The Third Part. Of Ratiocination, or Reasoning.

The great art of *ratiocination* lies in finding out ſuch intermediate ideas, as when compared with the

the others in the question, will furnish evident and known truths; because, as will afterwards appear, it is only by means of them, that we arrive at the knowledge of what is hidden and remote.

Every act of reasoning necessarily includes *three distinct judgments*; two wherein the ideas whose relation we want to discover, are severally compared with the middle idea, and a third wherein they are themselves connected or disjointed, according to the result of that comparison.

The expressions of our reasonings are termed *syllogisms*. And hence it follows, that as every act of reasoning implies three several judgments, so every syllogism must include three distinct propositions. When a reasoning is thus put into words, and appears in form of a syllogism, the intermediate idea made use of to discover the agreement or disagreement we search for, is called the *middle term*; and the two ideas themselves, with which this third is compared, go by the name of the *extremes*.

Let us, for instance, set ourselves to enquire, *whether men are accountable for their actions*. As the relation between the ideas of *man* and *accountableness*, comes not within the immediate view of the mind, our first care must be, to find out some third idea, that will enable us the more easily to discover and trace it. A very small measure of reflection is sufficient to inform us, that no creature can be accountable for his actions, unless we suppose him capable of *distinguishing* the *good* from the *bad*; that is, unless we suppose him possessed of *reason*. Nor is this alone sufficient. For what would it avail him to know good from bad actions, if he had no *freedom of choice*, nor could avoid the one, and pursue the other? Hence it becomes necessary to take in both considerations in the present case. It is at the same time equally apparent, that where-ever there is this ability of distinguishing good from bad actions, and of pursuing the one and avoiding the other, there also a creature is *accountable*. We have then got a third idea, with which *accountableness* is inseparably connected, *viz. reason* and *liberty*; which are here to be considered as making up one complex conception. Let us now take this mild idea, and compare it with the other term in the question, *viz. man*, and we all know by experience, that it may be affirmed of him. Having thus by means of the intermediate idea formed two several judgments, *viz. that man is possessed of reason and liberty*; and, *that reason and liberty imply accountableness*; a third obviously and necessarily follows, *viz. that man is accountable for his actions*. Here then we have a compleat act of reasoning, in which, according to what has been already observed, there are three distinct judgments; two that may be stiled previous, in as much as they lead to the other, and arise from comparing the middle idea, with the two ideas in the question: the third is a consequence of these previous acts, and flows from combining the extreme ideas between themselves. If now we put this reasoning into words, it exhibits what *Logicians* term a *syllogism*, and when proposed in due form, runs thus:

Every creature possessed of reason and liberty is accountable for his actions.

Man is a creature possessed of reason and liberty.

Therefore man is accountable for his actions.

It will be farther necessary to observe, that as the conclusion is made up of the extreme terms of the *syllogism*, so that *extreme*, which serves as the *predicate* of the conclusion, goes by the name of the *major term*: the other *extreme*, which makes the *subject* in the same proposition, is called the *minor term*. From this distinction of the extremes, arises also a distinction between the premisses, where these extremes are severally compared with the *middle* term. That proposition which compares the greater extreme, or the predicate of the conclusion with the middle term, is called the *major proposition*: the other, wherein the same middle term is compared with the subject of the conclusion, or lesser extreme, is called the *minor proposition*. All this is obvious from the syllogism already given, where the conclusion is, *man is accountable for his actions*. For here the predicate *accountable for his actions*, being connected with the middle term in the first of the two premisses; *every creature possessed of reason and liberty is accountable for his actions*, gives what we call the *major proposition*. In the second of the premisses; *man is a creature possessed of reason and liberty*, we find the lesser extreme, or subject of the conclusion, *viz. man*, connected with the same middle term, whence it is known to be the *minor proposition*. I shall only add, that when a syllogism is proposed in due form, the *major* proposition is always placed first, the *minor* next, and the *conclusion* last.

We may in the general define reasoning, *to be an act or operation of the mind, deducing some unknown proposition, from other previous ones that are evident and known*. These previous propositions, in a simple act of reasoning, are only two in number; and it is always required, that they be of themselves apparent to the understanding, insomuch that we assent to and perceive the truth of them as soon as proposed. In the syllogism given above, the premisses are supposed to be self-evident truths, otherwise the conclusion could not be inferred by a single act of reasoning. If for instance in the major, *every creature possessed of reason and liberty is accountable for his actions*, the connection between

between the subject and predicate could not be perceived by a bare attention to the ideas themselves; it is evident, that this proposition would no less require a proof, than the conclusion deduced from it. In this case a new middle term must be sought for, to trace the connection here supposed; and this of course furnishes another syllogism, by which having established the proposition in question, we are then, and not before, at liberty to use it in any succeeding train of reasoning. And should it so happen that in this second Essay, there was still some previous proposition, whose truth did not appear at first sight; we must then have recourse to a third syllogism, in order to lay open that truth to the mind; because so long as the premisses remain uncertain, the conclusion built upon them must be so too. When by conducting our thoughts in this manner, we at last arrive at some syllogism, where the previous propositions are *intuitive* truths; the mind then rests in full security, as perceiving that the several conclusions it has passed thorough, stand upon the immoveable foundation of *self-evidence*, and when traced to their source terminate in it.

The great art lies, in so adjusting our syllogisms one to another, that the propositions severally made use of as premisses, may be manifest consequences of what goes before. For, as by this means, every conclusion is deduced from known and established truths, the very last in the series, how far soever we carry it, will have no less certainty attending it, than the original intuitive perceptions themselves, in which the whole chain of syllogisms takes it's rise.

Of the several kinds of reasoning, and first of that by which we determine the genera and species of things. All the aims of *human reason* may in the general be reduced to these *two*: 1. To rank things under those universal ideas to which they truly belong; and 2. To ascribe to them their several attributes and properties in consequence of that distribution.

First then I say, that one great aim of human reason is, to determine the *genera* and *species* of things. As in universal propositions, we affirm some property of a genus or species, it is plain, that we cannot apply this property to particular objects, till we have first determined, whether they are comprehended under that general idea, of which the property is affirmed. Thus there are certain properties belonging to all *even* numbers, which nevertheless cannot be applied to any particular number, until we have first discovered it to be of the species expressed by that general name. Hence reasoning begins with referring things to their several divisions and classes in the scale of our ideas; and as these divisions are all distinguished by peculiar names, we hereby learn to apply the terms expressing general conceptions, to such particular objects, as come under our immediate observation.

In order to arrive at these conclusions. *First*, we take a view of the idea itself denoted by that general name, and carefully attend to the distinguishing marks which serve to characterize it. *Secondly*, we compare this idea with the object under consideration, observing diligently wherein they agree or differ. If the idea is found to correspond with the particular object, we then, without hesitation, apply the general name; but if no such correspondence intervenes, the conclusion must necessarily take a contrary turn. Let us for instance take the number *eight*, and consider by what steps we are led to pronounce it an *even* number. First then we call to mind the idea signified by the expression *an even number*, viz. that it is *a number divisible into two equal parts*. We then compare this idea with the number *eight*, and finding them manifestly to agree, see at once the necessity of admitting the conclusion. These several judgments therefore, transferred into language, and reduced to the form of a syllogism, appear thus:

Every number that may be divided into two equal parts is an EVEN *number.*

The number EIGHT *may be divided into two equal parts.*

Therefore the number EIGHT *is an* EVEN *number.*

Of Reasoning, *as it regards the* powers *and* properties *of things, and the* relations *of our* general ideas. Here it will be necessary to distinguish between *reasoning* as it regards the *sciences*, and as it concerns *common life*.

In the sciences, our reason is employed chiefly about universal truths, it being by them alone, that the bounds of human knowledge are enlarged. Hence the division of things into various classes, called otherwise *genera* and *species*. For these universal ideas, being set up as the representatives of many particular things, whatever is affirmed of them, may be also affirmed of all the individuals to which they belong. *Murder* for instance is a general idea, representing a certain species of human actions. Reason tells us that the punishment due to it is *death*. Hence every particular action coming under the notion of *murder*, has the punishment of *death* allotted to it. Here then we apply the general truth to some obvious instance, and this is what properly constitutes the reasoning of common life.

The

The steps by which we proceed, in the reasoning of common life, are, *First*, refer the object under consideration to some general idea or class of things; then to recollect the several attributes of that general idea: and lastly, to ascribe all those attributes to the present object. Thus, in considering the character of *Sempronius*, if we find it to be of the kind called *virtuous*; when we at the same time reflect, that a *virtuous* character is deserving of esteem, it naturally and obviously follows, that *Sempronius* is so too. These thoughts put into a *syllogism*, in order to exhibit the form of reasoning here required, run thus.

Every virtuous man is worthy of esteem.
SEMPRONIUS *is a virtuous man.*
Therefore SEMPRONIUS *is worthy of esteem.*

The determining the *genera* and *species* of things, is, as we have said, one exercise of human reason; and here we find, that this exercise is the first in order, and previous to the other, which consists in ascribing to them their powers, properties, and relations. But when we have taken this previous step, and brought particular objects under general names; as the properties we ascribe to them are no other than those of the general idea, it is plain, that in order to a successful progress in this part of knowledge, we must thoroughly acquaint ourselves with the several *relations* and *attributes* of these our general ideas.

The *relations* of our *general ideas* are of two kinds; either such as immediately discover themselves, upon comparing the ideas one with another; or such, as being more remote and distant, require art and contrivance to bring them into view. The relations of the first kind, furnish us with intuitive and self-evident truths: those of the second, are traced by reasoning, and a due application of intermediate ideas. It is evident therefore, that to make a good reasoner, two things are principally required: *First*, an extensive knowledge of those intermediate ideas, by means of which, things may be compared one with another. *Secondly*, the skill and talent of applying them happily, in all particular instances that come under consideration.

Of the FORMS *of* SYLLOGISMS. Hitherto we have contented ourselves with a *general notion* of *syllogisms*, and of the *parts* of which they consist. It is now time to enter a little more particularly into the subject, to examine their various forms, and lay open the rules of argumentation proper to each.

In the syllogisms already mentioned, we may observe, that the *middle term* is the subject of the *major* proposition, and the predicate of the *minor*. This disposition, though the most natural and obvious, is not however necessary; it frequently happening, that the *middle term* is the subject in both the premisses, or the predicate in both; and sometimes, the predicate in the *major*, and the subject in the *minor*.

Hence the distinction of syllogisms into various kinds, called *figures* by *Logicians*. For, *figure*, according to their use of the word, is nothing else, but the order and disposition of the *middle term* in any syllogism. And as this disposition, is *four-fold*, so the figures of syllogisms thence arising, are *four* in number.

When the *middle term* is the subject of the *major* proposition, and the predicate of the *minor*, we have what is called the *first figure*. If on the other hand, it is the predicate of both the premisses, the syllogism is said to be in the *second figure*. Again in the *third figure*, the *middle term* is the subject of the two premisses. And lastly, by making it the predicate of the *major*, and subject of the *minor*, we obtain syllogisms in the *fourth figure*.

But besides this four-fold distinction of syllogisms, there is also a farther subdivision of them in every figure, arising from the *quantity* and *quality* as they are called of the propositions. By *quantity* we mean the consideration of propositions as universal or particular, by *quality* as affirmative or negative.

Now as in all the several dispositions of the *middle term*, the *propositions* of which a syllogism consists, may be either *universal* or *particular*, *affirmative* or *negative*; the due determination of these, and so putting them together, as the laws of argumentation require, constitute what *Logicians* call the *moods* of syllogisms.

Of these *moods* there are a determinate number to every figure, including all the possible ways, in which propositions differing in *quantity* or *quality* can be combined, according to any disposition of the *middle term*, in order to arrive at a just conclusion. See the *Port-Royal art of thinking*, where the *moods* and *figures* of syllogisms are distinctly explained, and the rules proper to each, are very neatly demonstrated.

When in any syllogism, the *major* is a *conditional* proposition, the syllogism itself is termed *conditional*, thus:

If there is a God, he ought to be worshipped.
But there is a God:
Therefore he ought to be worshipped.

In this example, the *major* or first proposition, is, we see, *conditional*, and therefore the syllogism itself is also of the kind, called by that name.

And

And here we are to obſerve, that all conditional propoſitions are made up of two diſtinct parts: one expreſſing the condition upon which the predicate agrees or diſagrees with the ſubject, as in this now before us, *if there is a God*; the other joining or disjoining the ſaid predicate and ſubject, as here, *he ought to be worſhipped.* The firſt of theſe parts, or that which implies the condition, is called the *antecedent*; the ſecond, where we join or disjoin the predicate and ſubject has the name of the *conſequent.*

When any *conditional* propoſition is aſſumed, if we admit the antecedent of that propoſition, we muſt at the ſame time neceſſarily admit the conſequent; but if we reject the conſequent, we are in like manner bound to reject alſo the antecedent. For as the antecedent always expreſſes ſome condition, which neceſſarily implies the truth of the conſequent; by admitting the antecedent we allow of that condition, and therefore ought alſo to admit the conſequent. In like manner if it appears that the conſequent ought to be rejected, the antecedent evidently muſt be ſo too; becauſe as was juſt now demonſtrated, the admitting of the antecedent, would neceſſarily imply the admiſſion alſo of the conſequent,

Hence it appears, that there are two ways of arguing in *hypothetical* ſyllogiſms, which lead to a certain and unavoidable concluſion. For, as the *major* is always a conditional propoſition, conſiſting of an antecedent and a conſequent; if the *minor* admits the antecedent, it is plain that the concluſion muſt admit the conſequent. This is called arguing from the admiſſion of the antecedent, to the admiſſion of the conſequent, and conſtitutes that mood or ſpecies of *hypothetical* ſyllogiſms, which is diſtinguiſhed in the ſchools by the name of the *modus ponens*, in as much as by it, the whole conditional propoſition, both antecedent and conſequent, is eſtabliſhed. Thus:

If God is infinitely wiſe, and acts with perfect freedom, he does nothing but what is beſt.
But God is infinitely wiſe, and acts with perfect freedom.
Therefore he does nothing but what is beſt.

Here we ſee the antecedent or firſt part of the conditional propoſition is eſtabliſhed in the *minor*, and the conſequent or ſecond part in the concluſion; whence the ſyllogiſm itſelf is an example of the *modus ponens.* But if now we on the contrary ſuppoſe, that the *minor* rejects the conſequent, then it is apparent, that the concluſion muſt alſo reject the antecedent. In this caſe we are ſaid to argue from the removal of the conſequent, to the removal of the antecedent, and the particular mood or ſpecies of ſyllogiſms thence ariſing, is called by Logicians the *modus tollens*; becauſe in it, both antecedent and conſequent, are rejected or taken away, as appears by the following example.

If God were not a Being of infinite goodneſs, neither would he conſult the happineſs of his creatures.
But God does conſult the happineſs of his creatures;
Therefore he is a Being of infinite goodneſs.

Theſe two ſpecies take in the whole claſs of *conditional* ſyllogiſms, and include all the poſſible ways of arguing that lead to a legitimate concluſion.

As from the *major*'s being a *conditional* propoſition, we obtain the ſpecies of *conditional* ſyllogiſms; ſo where it is a *disjunctive* propoſition, the ſyllogiſm to which it belongs is alſo called *disjunctive.*

The world is either ſelf-exiſtent, or the work of ſome finite, or of ſome infinite Being.
But it is not ſelf-exiſtent, nor the work of a finite Being.
Therefore it is the work of an infinite Being.

Now a disjunctive propoſition is that, where of ſeveral predicates, we affirm one neceſſarily to belong to the ſubject, to the excluſion of all the reſt, but leave that particular one undetermined. Hence it follows, that as ſoon as we determine the particular predicate, all the reſt are of courſe to be rejected; or if we reject all the predicates but one, that one neceſſarily takes place. When therefore in a *disjunctive* ſyllogiſm, the ſeveral predicates are enumerated in the *major*; if the *minor* eſtabliſhes any one of theſe predicates, the concluſion ought to remove all the reſt; or if in the *minor*, all the predicates but one are removed, the concluſion muſt neceſſarily eſtabliſh that one.

Thus in the *disjunctive* ſyllogiſm given above, the *major* affirms one of three predicates to belong to the earth, *viz. Self-exiſtence*, or that it is *the work of a finite*, or that it is *the work of an infinite Being.* Two of theſe predicates are removed in the *minor, viz. Self-exiſtence*, and *the work of a finite Being.* Hence the concluſion neceſſarily aſcribes to it the third predicate, and affirms, that it is *the work of an infinite Being.* If now we give the ſyllogiſm another turn, inſomuch that the *minor* may eſtabliſh one of the predicates, by affirming the earth to be *the production of an infinite Being*; then the concluſion muſt remove the other two, aſſerting it to be neither *ſelf-exiſtent*, nor *the work of a finite Being.* Theſe are the forms of reaſoning in this ſpecies of ſyllogiſms.

It often happens, that ſome one of the premiſſes is not only an evident truth, but alſo familiar, and in the minds of all men; in which caſe it is uſually omitted, whereby we have an imperfect ſyllogiſm that

that seems to be made up of only two propositions. Should we for instance argue in this manner:

Every man is mortal;
Therefore every king is mortal.

The syllogism appears to be imperfect, as consisting but of two propositions. Yet it is really compleat, only the *minor* [*Every king is a man*] is omitted, and left to the reader to supply, as being a proposition so familiar and evident, that it cannot escape him.

These semingly imperfect syllogisms are called *enthymemes*.

There is another species of reasoning with two propositions, which seems to be compleat in itself, and where we admit the conclusion, without supposing any tacit or suppressed judgment in the mind, from which it follows syllogistically.

Thus by admitting an *universal* proposition, we are forced also to admit of all the *particular* propositions comprehended under it. Whoever allows, for instance, *that things equal to one and the same thing are equal to one another*, must at the same time allow, *that two triangles, each equal to a square whose side is three inches, are also equal between themselves*. This argument therefore,

Things equal to one and the same thing are equal to one another;
Therefore these two triangles, each equal to the square of a line of three inches, are equal between themselves;

is compleat in its kind, and contains all that is necessary towards a just and legitimate conclusion.

The next species of reasoning we shall take notice of, is what is known by the name of a *sorites*; in which a great number of propositions are so linked together, that the predicate of one, becomes continually the subject of the next following, until at last a conclusion is formed, by bringing together the subject of the first proposition, and the predicate of the last. Of this kind is the following argument.

God is omnipotent.
An omnipotent being can do every thing possible.
He that can do every thing possible, can do whatever involves not a contradiction.
Therefore God can do whatever involves not a contradiction.

This particular combination of propositions, may be continued to any length we please, without in the least weakening the ground upon which the conclusion rests. The reason is, because the *sorites* itself may be resolved into as many simple syllogisms as there are middle terms in it; where this is found universally to hold, that when such a resolution is made, and the syllogisms are placed in train, the conclusion of the last in the series, is also the conclusion of the *sorites*.

What is here said of plain *simple* propositions, may be as well applied to those that are *conditional*; that is, any number of them may be so joined together in a series, that the consequent of one, shall become continually the antecedent of the next following; in which case, by establishing the antecedent of the first proposition, we establish the consequent of the last, or by removing the last consequent, remove also the first antecedent. This way of reasoning is exemplified in the following argument.

If we love any person, all emotions of hatred towards him cease.
If all emotions of hatred towards a person cease, we cannot rejoice in his misfortunes.
If we rejoice not in his misfortunes, we certainly wish him no injury.
Therefore if we love a person, we wish him no injury.

I come now to that kind of argument, which Logicians call *induction*; in order to the right understanding of which, it will be necessary to observe, that our *general ideas* are for the most part capable of various *subdivisions*. Thus the idea of the lowest *species*, may be subdivided into its several individuals; the idea of any *genus*, into the different species it comprehends; and so of the rest.

Thus if we suppose the whole tribe of animals, subdivided into men, beasts, birds, insects and fishes, and then reason concerning them after this manner: *All men have a power of beginning motion*; *all beasts, birds, and insects, have a power of beginning motion*; *all fishes have a power of beginning motion*; *therefore all animals have a power of beginning motion*: the argument is an *induction*. When the subdivisions are just, so as to take in the whole general idea, and the enumeration is perfect, that is, extends to all and every of the inferior classes or parts; there the *induction* is compleat, and the manner of reasoning by *induction*, is apparently conclusive.

The last species of syllogisms I shall take notice of, is distinguished by the name of a *dilemma*.

A *dilemma* is an argument, by which we endeavour to prove the absurdity or falshood of some assertion. In order to this we assume a *conditional* proposition, the antecedent of which is the assertion to be disproved, and the consequent a *disjunctive* proposition, enumerating all the possible suppositions, upon which that assertion can take place. If then it appears, that all these several suppositions ought to be rejected, it is plain, that the antecedent or or aſſertion itſelf muſt be ſo too. When therefore ſuch a propoſition, as that before mentioned, is made the *major* of any ſyllogiſm; if the *minor* rejects all the ſuppoſitions contained in the conſequent; it follows neceſſarily, that the concluſion ought to reject the antecedent, which, as we have ſaid, is the very aſſertion to be diſproved. From this account it appears, that we may in the general define it, to be *a hypothetical ſyllogiſm, where the conſequent of the major is a disjunctive propoſition; which is wholly taken away or removed in the minor.* Of this kind is the following:

If God did not create the world perfect in its kind, it muſt either proceed from want of inclination, or from want of power.

But it could not proceed either from want of inclination, or from want of power.

Therefore he created the world perfect in its kind. Or, which is the ſame thing: *'tis abſurd to ſay that he did not create the world perfect in its kind.*

The nature then of a *dilemma.*

The *major* is a conditional propoſition, whoſe conſequent contains all the ſeveral ſuppoſitions upon which the antecedent can take place. As therefore theſe ſuppoſitions are wholly removed in the *minor*, it is evident that the antecedent muſt be ſo too; inſomuch that we here always argue from the removal of the conſequent, to the removal of the antecedent. That is, a *dilemma* is an argument, in the *modus tollens* of hypothetical ſyllogiſms, as Logicians love to ſpeak. Hence it is plain, that if the antecedent of the *major* is an affirmative propoſition, the concluſion of the *dilemma* will be negative; but if it is a negative propoſition, the concluſion will be affirmative.

As to the *fallacy of ſophiſms.* Though when one knows the rules of good reaſoning, it is not difficult to diſcover thoſe which are bad, notwithſtanding as the examples to be avoided make often a greater impreſſion on our mind than thoſe to be imitated, it will not be needleſs to repreſent the principal ſources of bad reaſoning, called *ſophiſms* or *paralogiſms.* I'll reduce them all to eight or nine.

The firſt is *to prove another thing than what is in queſtion. Paſſion*, or want of probity, cauſes one to attribute to his adverſary, what is often very far from his ſentiment, to take occaſion hence to fight him with more advantage, or to impute to him the conſequences he imagines he can draw from his doctrine, though at the ſame time he denies them.

The ſecond is *to ſuppoſe for true what is in queſtion.* This is what *Ariſtotle* calls *petition of principle*, and which we ſee clearly enough, to be contrary to true reaſon; becauſe in all reaſoning what ſerves for proof muſt be clearer and better known than what is to be proved.

Notwithſtanding which *Ariſtotle* is accuſed by *Galileo*, and with juſtice, to have himſelf been guilty of that imperfection, when he wanted to prove by the following argument, that the earth is placed in the center of the world.

The nature of ponderous things is to tend towards the center of the world, and of light things to depart from it.

But experience ſhews us, that ponderous things tend towards the center of the earth, and light things depart from it:

Therefore the center of the earth is the center of the world.

It is clear, that there is in the major of this argument a manifeſt *petition of principle*; for we ſee very well, that ponderous things tend towards the center of the earth: but whence has *Ariſtotle* took, that they tend towards the center of the world; unleſs he ſuppoſes that the center of the earth is the ſame with the center of the world; which is the very concluſion he would prove by that argument.

The third is *to take for a cauſe which is not a cauſe.* This ſophiſm is very common. Philoſophers have attributed a thouſand effects to the fear of the vacuum, which has been proved demonſtratively by very ingenious experiences, to have for cauſe but the ponderoſity of the air.

The fourth is *an imperfect enumeration.* As if any body was to ſay, *Titius is condemned to die, or by his own fault, or by the partiality of the judges*; this enumeration would be imperfect, for it could happen likewiſe, that *Titius* is condemned to die, or by want of probity in the witneſſes, or ſome miſtakes in his defence, or the like.

The fifth is, *to judge of a cauſe by what belongs to it, but by accident.* As if ſome body would exclude *antimony* from among remedies, becauſe having been ſometimes unſkilfully adminiſtred, it has produced bad effects.

The ſixth is *to paſs from a divided ſenſe to a compoſite ſenſe, and from a compoſite ſenſe to a divided ſenſe.*

One of theſe ſophiſms is called *fallacia compoſitionis*, and the other *fallacia diviſionis.* It is what will be eaſier underſtood by examples.

God juſtifies the impious; cannot be ſaid, that he accounts for juſt thoſe, who are impious ſtill, but that he renders juſt, by his grace thoſe, who were impious before.

There are on the contrary propositions, which are not true, but in a ſenſe oppoſite to that which is a divided ſenſe: As when St. *Paul* ſays, that fornicators, *&c.* ſhall not enter into the kingdom of heaven; for this does not ſignify that none of thoſe, who have been guilty of thoſe vices will be ſaved, but only that thoſe, who will *not renounce* them by a ſincere repentance, and their converſion to God, ſhall have no part in the kingdom of heaven.

The ſeventh is *to paſs from what is true in ſome reſpect, to what is ſimply true.* This is called in the ſchools, *a dicto ſecundum quid ad dictum ſimpliciter*; of which I'll give the following examples.

The *Epicureans* wanted to prove, that the gods ſhould have a human form, becauſe there was no handſomer than that, and that all that's handſome muſt be in God; which was a very bad reaſon. For the human form is not abſolutely a beauty, but only with regard to the bodies; and therefore it being a perfection, but in ſome reſpect and not ſimply, it does not follow hence that it muſt be in God, becauſe all perfections are in God; none but thoſe, which are ſimple perfections, *i. e.* which include no imperfections being neceſſarily in God.

The eighth is *to abuſe the ambiguity of words.* To this ſort of *ſophiſm* can be referred all the ſyllogiſms, which are vicious for having four terms; either becauſe the medium is taken twice particularly, or becauſe it is taken in one ſenſe in the firſt propoſition, and in another ſenſe in the ſecond; or, laſtly, becauſe the terms of the concluſion are not taken in the ſame ſenſe in the premiſſes, as in the concluſion.

Such is that found in the words, which ſignify a *whole*, which can be taken collectively for all its parts together, or diſtributively for each of its parts. It is whereby this *ſophiſm* of the *Stoicks* is to be reſolved, who concluded that the world was an animal endued with reaſon; *becauſe what has the uſe of reaſon, is better than that, which has not that uſe; but nothing is better*, ſaid they, *than the world: therefore the world has the uſe of reaſon.* The minor of this argument is falſe, becauſe they attributed to the world what only belongs to God; which is to be ſuch, that nothing can be conceived better and more perfect. But in confining ones ſelf in the creatures, though it can be ſaid that nothing is better than the world, taken collectively for the univerſality of all the beings God has created, all that can be concluded from it, is, that the world has the uſe of reaſon according to ſome of its parts, ſuch as the angels and men; but not that altogether he is an animal which has the uſe of reaſon.

The Fourth Part. Of Method.

It is the true and proper buſineſs of *method* to aſcertain the various diviſions of human knowledge, and ſo to adjuſt and connect the parts in every branch, that they may ſeem to grow one out of another, and form a regular body of ſcience, riſing from firſt principles, and proceeding by an orderly concatenation of truths.

In this view of things we muſt be well acquainted with the truths we are to combine together; otherwiſe how could we diſcern their ſeveral connections and relations, or ſo diſpoſe of them as their mutual dependence may require. But as it often happens, that the underſtanding is employed, not in the arrangement and compoſition of known truths, but in the ſearch and diſcovery of ſuch as are unknown: let us ſuppoſe a watch preſented to us, whoſe ſtructure and compoſition we are as yet unacquainted with, but want if poſſible to diſcover. The manner of proceeding in this caſe is, by taking the whole to pieces, and examining the parts ſeparately one after another. When by ſuch a ſcrutiny we have thoroughly informed ourſelves of the frame and contexture of each, we then compare them together, in order to judge of their mutual action and influence. By this means we gradually trace out the inward make and compoſition of the whole, and come at length to diſcern, how the parts of ſuch a form, and ſo put together as we found, in unraveling and taking them aſunder, conſtitute that particular machine called a watch, and contribute to all the ſeveral motions and phænomena obſervable in it. This diſcovery being made, we can take things the contrary way, and, beginning with the parts, ſo diſpoſe and connect them, as their ſeveral uſes and ſtructures require, until at length we arrive at the whole itſelf, from the unraveling of which theſe parts reſulted.

As it is in tracing and examining the works of art, ſo is it in a great meaſure in unfolding any part of human knowledge. For the relations and mutual habitudes of things do not always immediately appear, upon comparing them one with another. Hence we have recourſe to intermediate ideas, and by means of them are furniſhed with thoſe previous propoſitions, that lead to the concluſion we are in queſt of. And if it ſo happen, that the previous propoſitions themſelves are not ſufficiently evident, we endeavour by new middle terms to aſcertain their truth, ſtill tracing things backward in a continued ſeries, until at length we arrive at ſome ſyllogiſm, where the premiſſes are firſt and ſelf-evident principles.

Hence it appears, that in diſpoſing and putting together our thoughts, either for our own uſe, that the

the diſcoveries we have made may at all times lie open to the review of the mind; or where we mean to communicate and unfold theſe diſcoveries to others, there are two ways of proceeding equally within our choice. For we may ſo propoſe the truths relating to any part of knowledge, as they preſented themſelves to the mind in the manner of inveſtigation, carrying on the ſeries of proofs in a reverſe order, until they at laſt terminate in firſt principles: or beginning with theſe principles, we may take the contrary way, and from them deduce, by a direct train of reaſoning, all the ſeveral propoſitions we want to eſtabliſh.

This diverſity in the manner of arranging our thoughts, gives riſe to the twofold diviſion of method eſtabliſhed among *Logicians*. For, *method*, according to their uſe of the word, is nothing elſe but *the order and diſpoſition of our thoughts relating to any ſubject*. When truths are ſo propoſed and put together, as they were or might have been diſcovered, this is called the *analytick method*, or the *method of reſolution*; in as much as it traces things backward to their ſource, and *reſolves* knowledge into its firſt and original principles. When on the other hand they are deduced from theſe principles, and connected according to their mutual dependance, inſomuch that the truths, firſt in order, tend always to the demonſtration of thoſe that follow, this conſtitutes what we call the *ſynthetick method*, or *method of compoſition*. For here we proceed by gathering together the ſeveral ſcattered parts of knowledge, and *combining* them into one whole or ſyſtem, in ſuch manner, that the underſtanding is enabled diſtinctly to follow truth, thro' all her different ſtages and gradations.

The firſt has alſo obtained the name of the *method of invention*; becauſe it obſerves the order in which our thoughts ſucceed one another in the *invention* or diſcovery of truth. The other is often denominated the *method of doctrine* or *inſtruction*, in as much as in laying our thoughts before others, we generally chuſe to proceed in the *ſynthetic* manner, deducing them from their firſt principles. Hence it is, that we chuſe to diſtinguiſh it by the name of the *method of ſcience*; not only as in the uſe of it we arrive at *ſcience* and certainty; but, becauſe it is in fact the method, in which all thoſe parts of human knowledge, that properly bear the name of *ſciences*, are and ought to be delivered.

Of the method of invention. By the *method of invention* we underſtand ſuch a diſpoſition and arrangement of our thoughts, as follows the natural procedure of the underſtanding, and preſents them in the order in which they ſucceed one another in the inveſtigation and diſcovery of truth. When the mind reſts ſatisfied in a bare contemplation of the rules, and the reaſons on which they are founded, this kind of knowledge is called *ſpeculative*. But if we proceed farther, and endeavour to apply theſe rules to *practice*, ſo as to acquire a habit of exerting them on all proper occaſions, we are then ſaid to be poſſeſſed of the *art* itſelf.

In the exerciſe of invention, two things are of principal conſideration. *Firſt*, an enlarged and comprehenſive underſtanding, able to take in the great multitude of particulars, that frequently come under our notice. *Secondly*, a ſtrong habit of attention, that lets nothing remarkable ſlip its view, and diſtinguiſhes carefully all thoſe circumſtances, which tend to the illuſtrating and clearing the ſubject we are upon. Theſe are the great and preparatory qualifications, without which it were in vain to hope, that any conſiderable advance could be made, in enlarging the bounds of human knowledge.

Furniſhed with theſe two *preparatory qualifications*, the next requiſite to the diſcovery of truth is, a judicious choice of intermediate ideas. Now altho' this happy choice of intermediate ideas, ſo as to furniſh a due train of previous propoſitions, that ſhall lead us ſucceſſively from one diſcovery to another, depends in ſome meaſure upon a natural ſagacity and quickneſs of mind; it is yet certain from experience, that even here much may be effected, by a ſtubborn application and induſtry. In order to this it is in the firſt place neceſſary, that we have an extenſive knowledge of things, and ſome general acquaintance with the whole circle of arts and ſciences. And if to this we join in the ſecond place, a more particular and intimate ſtudy of whatever relates to the ſubject about which our enquiries are employed, we ſeem to bid fair for ſucceſs in our attempts.

Much ſtill depends upon a certain dexterity and addreſs, in ſingling out the moſt proper, and applying them ſkilfully for the diſcovery of truth. This is that talent, which is known by the name of *ſagacity*, and commonly ſuppoſed to be altogether the gift of nature. But yet I think it is beyond diſpute, that practice, experience, and a watchful attention to the procedure of our own minds while employed in the exerciſe of reaſoning, are even here of very great avail. It is a truth well known to thoſe who have made any conſiderable progreſs in the ſtudy of Algebra, that an addreſs and ſkill in managing intricate queſtions, may be very often obtained, by a careful imitation of the beſt models.

Though

Though the capacity of the intellect may be greatly enlarged by use and exercise, yet still our views are confined within certain bounds, beyond which a finite understanding cannot reach. And as it often happens in the investigation of truth, especially where it lies at a considerable distance from first principles, that the number of connections and relations are so great, as not to be taken in at once by the most improved understanding; it is therefore one great branch of the art of invention, to take account of these relations as they come into view, and dispose of them in such manner, that they may always lie open to the inspection of the mind, when disposed to turn its attention that way.

By carrying our attention successively from one part to another, we can upon occasion take in the whole; and knowing also the order and disposition of the parts, may have recourse to any of them at pleasure, when its aid becomes necessary in the course of our enquiries.

First, an *orderly combination* of things, and *classing* them together with art and address, brings great and otherwise unmanageable objects, upon a level with the powers of the mind.

It is of principal consideration in the business of *invention*, to have our thoughts so much under command, that in comparing things together, in order to discover the result of their mutual connections and dependence, all the several lights that tend to the clearing the subject we are upon, may lie distinctly open to the understanding, so as nothing material shall escape its view: because an oversight of this kind in summing up the account, must not only greatly retard its advances, but in many cases check its progress altogether.

Secondly, another advantage arising from this orderly disposition is, that hereby we free the mind from all unnecessary fatigue, and leave it to fix its attention upon any part separately, without perplexing itself with the consideration of the whole.

The mind, proceeding gradually thro' the several relations of its ideas, and marking the results of them at every step, can always proportion its enquiries to its strength; and confining itself to such a number of objects, as it can take in and manage at ease, sees more distinctly all the consequences that arise from comparing them one with another. When therefore, it comes afterwards to take a review of these its several advances, as by this mean the amount of every step of the investigation is fairly laid open to its inspection, by adjusting and putting these together in due order and method, it is enabled at last to discern the result of the whole.

There are two great branches of the *mathematicks*, peculiarly fitted to furnish us with models in this way: *arithmetick* I mean, and *algebra*. *Algebra* is universally known to be the very art and principle of *invention*; and in *arithmetick* too, we are frequently put upon the finding out of unknown numbers, by means of their relations and connections with others that are known.

The present method of notation is so contrived, as exactly to fall in with the form of numbering. For, as in the names of numbers, we rise from *units* to *tens*, from *tens* to *hundreds*, from *hundreds* to *thousands*, &c. so likewise in their notation, the same figures, in different places, signify these several combinations. Thus 2 in the first place on the right hand denotes two *units*, in the second place it expresses so many *tens*, in the third *hundreds*, in the fourth *thousands*. By this means it happens, that when a number is written down in figures, as every figure in it expresses some distinct combination, and all these combinations together make up the total sum; so may the several figures be considered as the constituent parts of the number. Thus the number 2436 is evidently by the very notation distinguished into four parts, mark'd by the four figures that serve to express it. For the first denotes *two thousand*, the second *four hundred*, the third *thirty* or *three tens*, and the fourth *six*. These several parts, tho' they here appear in a conjoined form, may yet be also expressed separately thus, 2000, 400, 30 and 6, and the amount is exactly the same.

This being the case, if it is required to find a number, equal to the sum of two others given; our business is, to examine separately these given numbers. Let it be proposed, to find a number, equal to the sum of these two: 2436 and 4352. As the finding of this by a single effort of thought, would be too violent an exercise for the mind; I consider the figures representing these numbers, as the parts of which they consist, and therefore set myself to discover their sums one after another. Thus 2 the first figure on the right hand of the one, added to 6 the first figure on the right hand of the other, makes 8, which is therefore the sum of these two parts. Again, the sum of 5 and 3, the two figures or parts in the second place, is likewise 8. But now as figures in the second place, denote not simple *units*, but *tens*; hence it is plain, that 5 and 3 here, signify five *tens* and three *tens*, or 50 and 30, whose sum therefore must be eight *tens*, or 80. And here again I call to mind, that having already obtained one figure of the sum, if I place that now found immediately after it, it will thereby stand also in the second place, and so really express, as it ought to do eight *tens* or 80. And thus it is happily contrived, that tho' in the addition of *tens*, I consider the figures composing them as denoting only ſimple *units*, which makes the operation eaſier and leſs perplexed; yet by the place their ſum obtains in the number found, it expreſſes the real amount of the parts added, taken in their full and compleat values. The ſame thing happens in ſumming the *hundreds* and *thouſands*; that is, tho' the figures expreſſing theſe combinations, are added together as ſimple *units*; yet their ſums ſtanding in the third and fourth places of the number found, thereby really denote *hundreds* and *thouſands*, and ſo repreſent the true value of the parts added.

If now we turn our thoughts from *arithmetick* to *algebra*, here alſo we ſhall find, that the great art of invention lies, in ſo regulating and diſpoſing our notices of things, that we may be enabled to proceed gradually in the ſearch of truth. For it is the principal aim of this ſcience, by exhibiting the ſeveral relations of things in a kind of ſymbolical language, ſo to repreſent them, to the imagination, as that we may carry our attention from one to another, in any order we pleaſe. Hence, however, numerous thoſe relations are, yet by taking only ſuch a number of them into conſideration at once, as is ſuited to the reach and capacity of the underſtanding, we avoid perplexity and confuſion in our reſearches, and never put our faculties too much upon the ſtretch, ſo as to loſe ourſelves amidſt the multiplicity of our own thoughts. As therefore in *arithmetic*, we riſe to a juſt conception of the greateſt numbers, by conſidering them as made up of various progreſſive combinations; ſo likewiſe in *algebra*, thoſe manifold relations that often intervene, between known and unknown quantities, are clearly repreſented to the mind, by throwing them into a ſeries of diſtinct equations. And as the moſt difficult queſtions relating to numbers are managed with eaſe, becauſe we can take the parts or figures ſeparately, and proceed with them one after another; ſo alſo the moſt intricate problems of *algebra* are in like manner readily unfolded, by examining the ſeveral equations apart, and unravelling them according to certain eſtabliſh'd rules of operation.

Hence it appears, that the buſineſs of invention as practiſed in algebra, depends entirely upon the art of abridging our thoughts, reducing the number of particulars taken under conſideration at once to the feweſt poſſible, and eſtabliſhing that progreſſive method of inveſtigation; great advantages may redound to ſcience, by a happy notation or expreſſion of our thoughts. For, by this means we are enabled to repreſent the relations of things in the form of equations, and by variouſly proceeding with theſe equations, to trace out ſtep by ſtep, the ſeveral particulars we are in queſt of. As the amount of every ſtep of the inveſtigation lies fairly before us, by comparing them variouſly among themſelves, and adjuſting them one to another, we come at length to diſcern the reſult of the whole, and are enabled to form our ſeveral diſcoveries into an uniform and well-connected ſyſtem of truths, which is the great end and aim of all our enquiries.

Of the method of ſcience. There are three ſeveral ways of coming at the knowledge of truth. *Firſt*, by contemplating the ideas in our own minds. When we ſet ourſelves to conſider the ideas in our own minds, we variouſly compare them together, in order to judge of their agreement or diſagreement. Now as all the truths deduced in this way flow from certain connections and relations, diſcerned between the ideas themſelves; and as when the ſame ideas are brought into compariſon, the ſame relations muſt ever, and invariably ſubſiſt between them; hence it is plain, that the knowledge acquired by the contemplation of our ideas, is of a neceſſary and unchangeable nature. But farther, as theſe relations between our ideas, are not only ſuppoſed to be real in themſelves, but alſo to be ſeen and diſcerned by the mind; and as when we clearly perceive a connection or repugnance between any two ideas, we cannot avoid judging them to agree or diſagree accordingly; it evidently follows, that our knowledge of this kind is attended with abſolute certainty and conviction, inſomuch that as it is impoſſible for us to withhold our aſſent, or entertain any doubt as to the reality of truths ſo offered to the underſtanding. The relation of equality between the whole and all its parts, is apparent to every one, who has formed to himſelf a diſtinct notion of what the words *whole* and *part* ſtand for.

The ſecond way of coming at knowledge is by means of the ſenſes. From them we receive information of the exiſtence of objects without us, of the union and conjunction of different qualities in the ſame ſubject, and of the operations of bodies one upon another. Thus our eyes tell us, that there is in the univerſe ſuch a body as we call the ſun; our ſight and touch, that light and heat, or at leaſt the power of exciting thoſe perceptions in us, co-exiſt in that body; and laſtly, by the ſame ſight we alſo learn, that fire has the power of diſſolving metals, or of reducing wood to charcoal and aſhes. Whence note, the teſtimony of the ſenſes, tho' ſufficient to convince ſober and reaſonable men, yet does not ſo unavoidably extort our aſſent, as to leave no room for ſuſpicion or diſtruſt.

The third and laſt way of coming at truth is, by by the *report* and *testimony* of others. This regards chiefly past facts and transactions, which having no longer any existence, cannot be brought within the present sphere of our observation, altho' this in many cases is a sufficient ground of assent, so as to produce a ready belief in the mind, yet it is liable to objections. Our senses, on some occasions deceive us, and therefore they may possibly on others. But this bare possibility creates little or no distrust; because there are fixed rules of judging, when they operate according to nature, and when they are perverted or given up to caprice. It is otherwise in matters of mere human testimony. For there, besides the supposition that the persons themselves may have been deceived, there is a farther possibility, that they may have conspired to impose upon others by a false relation. It would nevertheless be the height of folly, to reject all human testimony without distinction, because of this bare possibility. Hence the facts of history, when well attested, are readily embraced by the mind; and tho' the evidence attending them be not such, as produes a necessary and infallible assurance, it is yet abundantly sufficient to justify our belief, and leave those without excuse, who upon the bare ground of possibility, are for rejecting entirely the conveyance of testimony.

Upon the whole then it appears, that *absolute certainty*, such as is attended with *unavoidable assent*, and excludes all possibility of being deceived, is to be found only in the contemplation of our own ideas. It is absolutely impossible for a man to persuade himself that that is not, which he plainly and necessarily perceives to be. And it is to knowledge attended with this last kind of evidence alone, that in strictness and propriety of speech, we attribute the name of *science*. *Science* implies perception and discernment, what we ourselves see and cannot avoid seeing, and therefore has place only in matters of absolute certainty, where the truths advanced are either intuitive propositions, or deduced from them in a way of strict demonstration.

But here I expect it will be asked, what kind of knowledge is it that we have relating to bodies, their powers, properties, and operations one upon another? To this I answer, that we have already distinguished it by the name of *natural* or *experimental*. But that we may see more distinctly wherein the difference between *scientifical* and *natural* knowledge lies, it may not be improper to add the following observations. When we cast our eyes towards the sun, we immediately conclude, that there exists an object without us, corresponding to the idea in our minds.

Again, when a piece of gold is dissolved in *aqua regia*, we see indeed and own the effect produced, but cannot be said in strictness and propriety of speech, to have any perception or discernment of it. The reason is, because being unacquainted with the intimate nature both of *aqua regia* and gold, we cannot from the ideas of them in our minds deduce, why the one must operate upon the other in that particular manner. Hence it is, that our knowledge of the facts and operations of nature, extends not with certainty beyond the present instance, or what falls under our immediate notice; so that in all our researches relating to them, we must ever proceed in the way of trial and experiment, there being here no general or universal truths, whereon to found *scientifical* deductions.

Experience is here the true and proper foundation of our judgments, nor can we by any other means arrive at a discovery, of the several powers and properties of bodies. How long might a man contemplate the nature of hemlock, examine the structure of its parts in a microscope, and torture and analyse it by all the processes of chymestry, before he could pronounce with certainty the effect it will have upon the human body? One single experiment lays that open in an instant, which all the wit and invention of men would never of themselves have been able to trace. The same holds in all the other parts of natural philosophy. Our discoveries relating to electricity, the powers and properties of the load-stone, the force of gun-powder, &c. were not gained by reasoning, or the consideration of our abstract ideas, but by means of experiments made with the bodies themselves. Hence it happened, that while the philosophy of *Aristotle* prevailed in the schools, which dealt much in metaphysical notions, occult qualities, sympathies, antipathies, and such like words without meaning; the knowledge of nature was at a stand, because men pretended to argue abstractly about things, of which they had no perfect and adequate idea, whereon to ground such a method of reasoning. But now in the present age, that we have returned to the way of trial and experiment, which is indeed the only true foundation of natural philosophy, great advances have already been made, and the prospect of still greater lies before us.

Thus we may sufficiently understand, wherein the proper difference lies, between *scientifical* and *natural* knowledge. In matters of *science* we argue from the ideas in our own minds, and the connections and relations they have one to another. It is otherwise in the case of *natural* knowledge. Intuition and inward perception have here no place. We discern the powers and properties of those ob-

jects

jects that ſurrround us, merely by experience, and the impreſſions they make on the ſenſes.

It will naturally be aſked here, how come we by this aſſurance? I anſwer, not *ſcientifically*, and in the way of ſtrict *demonſtration*, but by *analogy*, and an *induction* of *experiments*. We diſtinguiſh fire, for inſtance, by ſuch of its qualities, as lie more immediately open to the notice of the ſenſes; among which light and heat are the moſt conſiderable. Examining ſtill farther into its nature, we find it likewiſe poſſeſſed of the power of diſſolving metals. But this new property, not having any neceſſary connection that we can trace, with thoſe other qualities by which fire is diſtinguiſhed, we cannot therefore argue with certainty, that whereever light and heat, *&c.* are, the power of diſſolving metals co-exiſts with them. 'Tis not till after we have tried the thing in a variety of experiments, and found it always to hold, that we begin to preſume there may be really ſome ſuch connection, tho' our views are too ſhort and imperfect to diſcover it. Hence we are led to frame a general concluſion, arguing from what has already happened, to what will happen again in the like caſes; inſomuch that where we meet with all the other properties of fire, in any body, we have not the leaſt doubt, but that upon trial, the power above mentioned will be found to belong to it alſo. This is called reaſoning by *analogy*; and it is, as we ſee, founded entirely upon induction, and experiments made with particular objects.

Having aſcertained the general properties of things by *analogy*, if we proceed next to eſtabliſh theſe as *poſtulata* in philoſophy, we can upon this foundation build ſtrict and *mathematical* demonſtrations, and thereby introduce *ſcientifical* reaſoning into *natural* knowledge, In this manner Sir *Iſaac Newton*, having determined the laws of gravity by a variety of experiments, and laying it down as a principle that it operates according to thoſe laws thro' the whole ſyſtem of nature; has hence in a way of ſtrict demonſtration, deduced the whole theory in the heavenly motions. For granting once this *poſtulatum*, that gravity belongs univerſally to all bodies, and that it acts according to that ſolid content, decreaſing with the diſtance in a given ratio; what Sir *Iſaac* has determined in regard to the planetary motions, follows from the bare conſideration of our own ideas; that is, neceſſarily and *ſcientifically*. Thus likewiſe in *opticks*, if we lay it down as a principle, that light is propagated on all ſides in right lines, and that the rays of it are reflected and refracted, according to certain fixed invariable laws, all which is known to be true by experience; we can, upon this foundation, eſtabliſh mathematically the theory of viſion. The ſame happens in *mechanicks*, *hydroſtaticks*, *pneumaticks*, &c. where from *poſtulata* aſcertained by experience, the whole theory relating to theſe branches of knowledge, follows in a way of ſtrict demonſtration.

If abſolute and infallible certainty is not to be obtained in *natural* knowledge, much leſs can we expect it in *hiſtorical*. For here teſtimony is the only ground of aſſent, and therefore the poſſibility of our being deceived, is ſtill greater than in the caſe of experience. There is however a way of reaſoning even here, that begets an entire acquieſcence, and leads us to embrace without wavering, the facts and reports of hiſtory. If for inſtance it appears, that the hiſtorian was a man of veracity; if he was a competent judge of what he relates; if he had ſufficient opportunities of being informed; if the book that bears his name was really writ by him; if it has been handed down to us uncorrupted; in fine, if what he relates is probable in itſelf, falls in naturally with the other events of that age, and is atteſted by contemporary writers. By theſe and ſuch like arguments, founded partly on criticiſm, partly on probable conjecture, we judge of paſt tranſactions; and though they are not capable of *ſcientifical* proof, yet in many caſes we arrive at an undoubted aſſurance of them. For as it is abſurd to demand mathematical demonſtration in matters of fact, becauſe they admit not of that kind of evidence; it is no leſs ſo to doubt of their reality, when they are proved by the beſt arguments their nature and quality will bear.

But here perhaps it will be aſked: Where is the advantage of barely contemplating our ideas, and tracing their ſeveral habitudes and relations, when it is in truth the reality of things that we are chiefly concerned to know, and thoſe reſpects they bear to us and one another? To this I anſwer: that if indeed our ideas no way regarded things themſelves, the knowledge acquired by their means would be of very little conſequence to human life. But ſince, as we have already obſerved, whatever is true in idea, is unavoidably ſo alſo in the reality of things, where things exiſt anſwerable to theſe ideas; it is apparent, that by copying our ideas with care from the real objects of nature, and framing them in a conformity to thoſe conjunctures and circumſtances in which we are moſt likely to be concerned, a way is laid open to diſcoveries of the greateſt importance to mankind. For in this caſe, our ſeveral reaſonings and concluſions, holding no leſs of the objects themſelves, than of the ideas by which they are repreſented, may be therefore applied with certainty to theſe objects, as often as they fall under our notice. It is not therefore enough that we ſet about the conſideration of any ideas at random; we muſt farther take care that thoſe ideas truly regard things themſelves.

It now remains that we lay down the rules of method peculiar to this branch of knowledge, and give ſome account of the manner, in which that certainty and conviction which are inſeparable from it, may be moſt naturally and effectually produced. *Science*, as we have ſaid, regards wholly the abſtract ideas of the mind, and the relations they have one to another. The great ſecret therefore of attaining it lies, in ſo managing and conducting our thoughts, as that theſe ſeveral relations may be laid open to the view of the underſtanding, and become the neceſſary and unavoidable objects of our perception. In order to this we muſt make it our firſt care, diſtinctly to frame and ſettle the ideas, about which our enquiries are to be employed. For though the multitude of parts, in many caſes, be great, I may ſay beyond belief; yet as they have been all previouſly formed into ſeparate claſſes, and the claſſes themſelves diſtinctly ſettled in the underſtanding; we find it eaſy by ſuch a ſeries of ſteps, to riſe to any idea how complex ſoever, and with a ſingle glance of thought embrace it in its full extent.

But it is not enough that we barely form ideas in our own minds: we muſt alſo contrive a way to render them ſtable and permanent, that when they diſappear upon calling off our attention, we may know how to retrieve them again with certainty. This is beſt done by words and deſcriptions, which ſerve not only to ſubject them to our own review, but alſo to lay them open to the perception of others.

Thus we ſee, that the *method of ſcience* begins with unfolding our ideas, and communicating them by means of definitions. And here it is of great importance to obſerve, that there muſt be in all languages, certain original and elementary names, whence our deſcriptions take their firſt riſe, and beyond which we cannot trace the meaning and ſignification of ſounds.

When, therefore, in the *method of ſcience*, we have finiſhed the buſineſs of *definitions*; it muſt be our next care, diſtinctly to unfold in *propoſitions*, thoſe immediate and intuitive *relations*, which are neceſſarily ſeen and owned by the mind, upon the very firſt comparing of our ideas one with another. Theſe propoſitions have obtained the name of *firſt principles*, becauſe occuring *firſt* in the order of knowledge, and being manifeſt of themſelves, they ſuppoſe not any *prior* truths in the mind, whence they may be evidenced and explained. The nature of theſe propoſitions is explained in the ſecond part, the notion of ſelf-evidence is unfolded, and the manner of diſtinguiſhing between the truths of this claſs, and thoſe that are demonſtrable is there taught alſo. Thus we are gradually led from ſimple ideas, through all the windings and labyrinths of truth, until we at length reach the higheſt and moſt exalted diſcoveries of human reaſon.

M A G I C K.

MAGIC, taken in its antient ſenſe, is the ſcience or diſcipline and doctrine of the *magi*, or wiſe-men of *Perſia*. — And taken in a more modern ſenſe, is a ſcience, which teaches to perform wonderful and ſurprizing effects.

Agrippa divides *magic* into three kinds, *natural*, *celeſtial*, and *ceremonial* or *ſuperſtitious*.

Natural magick is no more than the application of natural active cauſes to paſſive cauſes, or ſubjects, by means whereof many ſurprizing, but yet natural effects are produced; as producing roſes, figs, *&c.* in *March*, cauſing thunder, lightning, rains, winds, *&c.*

Baptiſta Porta has a treatiſe of *natural magic*, or of ſecrets for performing very extraordinary things by natural cauſes.

The *natural magick* of the *Chaldeans* was nothing but the knowledge of the powers of ſimples and minerals. The *magick*, which they called *theurgia*, conſiſted wholly in the knowledge of the ceremonies, to be obſerved in the worſhip of the gods, in order to be acceptable. By virtue of thoſe ceremonies they believed they could converſe with ſpiritual beings, and cure diſeaſes.

Celeſtial magick borders nearly on judiciary aſtrology; it attributes to ſpirits a kind of rule or dominion over the planets, and to the planets a dominion over men; and on thoſe principles build a ridiculous kind of ſyſtem.

Superſtitious or *goetick magick* conſiſts in the invocation of the devil; its effects are uſually evil and wicked, though very ſtrange, and ſeemingly ſurpaſſing the power of nature, ſuppoſed to be produced by virtue of ſome compact, either tacit or expreſs, with evil ſpirits: but the truth is, theſe have not all the power that is uſually imagined, nor do they produce half thoſe effects ordinarily aſcribed to them. *Paracelſus* tells us, that pronouncing the words *oſy oſya*, will make ſerpent stop their motion, and lie still as if they were dead.

Naude published an apology for all the great men suspected of *magick*. — *Agrippa* says, that the words used by those in compact with the devil, to invoke him, and to succeed in what they undertake, are *dies*, *mies*, *jesquet*, *benedafet*, *docevima*, *enitemaus*. There are an hundred other formulas of words, composed at pleasure, or gathered from different languages, or patched in imitation of it.

The origin of *magick*, according to our first definition, is ascribed to *Zoroaster*: *Salmasius* derives the very name from *Zoroaster*, who, he says, was surnamed *Mag*, whence *Magus*. — Others, make him only the restorer and improver of the *Persian* philosophy; alledging that many of the *Persian* rites, in use among the *Magi*, were borrowed from the *Jabii* among the *Chaldeans*, who agreed in many things with the *Magi* of the *Persians*; whence some make the name *magus* common both among the *Chaldeans* and *Persians*. Thus *Plutarch* mentions, that *Zoroaster* instituted *magi* among the *Chaldeans*, in imitation whereof the *Persians* had theirs too.

The philosophy principally cultivated among them was theology and politicks; they being always esteemed as the interpreters of all laws both divine and human, on which account they were wonderfully revered by the people. Hence *Cicero* observes, that none were admitted to the crown of *Persia*, but such as were well instructed in the discipline of the *Magi*, who taught τα βασιλικα and shewed princes how to govern.

Plato, *Apuleius*, *Laertius*, and others agree, that the philosophy of the *Magi* related principally to the worship of the Gods: they were the persons, who were to offer prayers, supplications, and sacrifices, as if the Gods would be heard by them alone.

According to *Lucian*, *Suidas*, &c. the theology, or worship of the Gods, about which the *Magi* were employed, was little more than the diabolical art of divination. So that μαγεια strictly taken, signifies divination.

Philo-Judæus describes the *Magi* to be diligent enquirers into nature, out of the love they bear to truth; and who setting themselves a-part for those things, contemplate the divine virtues the more clearly, and initiate others in the same mysteries.

Their descendants, the modern *Magi*, or fire-worshippers, are divided into three classes; whereof the first and most learned, neither eat nor kill animals, but adhere to the old institution of abstaining from living creatures. —The *Magi* of the second class, refrain only from tame animals; nor do the last kill all indifferently; it being the firm and distinguishing dogma of them all, that *there is a transmigration of soul*. To imitate the similitude between animals and men, they call the latter by the name of the former; thus their fellow-priests they called lions; the priestesses, lionesses; the servants, crows, *&c.*

Magic, according to our other definition, is only used to signify an unlawful and diabolical kind of science, particularly the *superstitious* and *goetic magick* depending on the assistance of the devil and departed souls.

Under this we include *oracles*. Oracle, was an answer usually couched in very dark and ambiguous terms, supposed to be given by Dæmons, either by the mouths of their idols, or by those of their priests to the people, who consulted them on things to come.

M. *Bayle* says positively, they were meer human artifices, which the devil had no hand in. He is strongly backed by *Van Dale* and M. *Fontenelle*, who have wrote expresly on the subject.

F. *Balthus*, a learned Jesuit, labours to prove that there were real *oracles*, and such as can never be attributed to any artifices of the priests or priestesses; several of these became silent in the first ages of the church, either by the coming of *Jesus Christ*, or by the prayers of the saints.

It was *Eusebius*, who first endeavour'd to persuade the Christians, that the coming of *Jesus Christ* had struck the oracles dumb; though it appears from the laws of *Theodosius*, *Gratian*, and *Valentinian*, that the *oracles* were still consulted as low as the year 385. *Cicero* says, the *oracles* became dumb in proportion as people growing less credulous, began to suspect them for cheats.

Most of the fathers of the church took it to be the devil that gave *oracles*; and looked on it as a pleasure he took to give dubious and equivocal answers; in order to have a handle to laugh at them. *Vossius* allows, that it was the devil who spoke in *oracles*, but thinks that the obscurity of his answer was owing to his ignorance, as to the precise circumstances of the events. That artful and studied obscurity, wherein the answers were couched, shewed the embarrass the devil was under; as those double meanings they usually bore provided for their accomplishment.

For my part I am of M. *Fontenelle*'s opinion, that the *oracles* were nothing but meer cheats, frauds, and impostures of the *Pagan* clergy, to impose on the too great credulity of mankind, gain a certain respect and veneration from them, pick their pockets, and render themselves absolutely necessary. For, to believe that it was the devil, who used to speak in the idols, is to arraign the veracity of the true God, who says positively, that *he wills*

that

that all men should be saved. If it be objected to this, that God suffered only the devil to speak in the idols, and that he is not obliged to undeceive us, if we will deceive ourselves; I'll answer, that the devil speaking in the idols, and giving *oracles*, could not be a single tolerance; since the devil being a pure spiritual intelligence, the nature thereof is only to form ideas, without being capable to invest them with words, since they have no organs to articulate them; God must have operated a miracle every time an oracle was pronounced, and therefore positively contributed towards deceiving mankind, and thereby rendered their reprobation of an absolute, or indispensible necessity, which none can suppose without impiety.

Oracle, is also used for the Dæmon who gave the answer, and the place where it was given.

The principal *oracles* of antiquity, were that of *Abæ*, mentioned by *Herodotus*; of *Amphiareus*; of the *Branchidæ* at *Didimus*; of the *Camps* at *Lacedæmon*; of *Dodona*; of *Jupiter Ammon*; of *Nabarca*, in the country of *Andriaca*, near the *Caspian Sea*; of *Trophonius*, mentioned by *Herodotus*; of *Chrysopolis*; of *Claros* in *Ionia*; of *Mallos*; of *Patarea*; of *Pela* in *Macedonia*; of *Phaselides* in *Cilicia*; of *Sinope* in *Paphlagonia*; of *Orpheus's Head*, mentioned by *Philostratus* in his life of *Apollonius*, &c.

But of all others, the *oracle* of *Apollo Pythius* at *Delphos*, was the most celebrated, this was consulted in the *dernier resort*, by most of the princes of those ages.

The *Pythia*, which was to be a pure virgin, was always in a rage when she gave *oracles*; at first she gave them in verse, and fell at length to prose, upon the people's beginning to laugh at the poorness of her versification.

MATHEMATICKS.

MATHEMATICKS (from μαθησις, which signifies *discipline* or *science*) is the science of quantity, or a science that considers magnitudes, either as computable or measurable.

Mathematicks are divided with regard to their end, into *speculative* and *practical*.

Speculative mathematicks are those, which rest in the bare contemplation of the properties of things.

Practical mathematicks are those, which apply the knowledge of those properties to some uses in life.

With regard to their object, *mathematicks* are divided into *pure* or *abstract*, and *mix'd*.

Pure mathematicks consider quantities abstractedly; without any relation to matter or bodies.

Mix'd mathematicks consider quantity as subsisting in material beings, *e. gr.* length in a road, breadth in a river, height in a star, *&c.*

Pure mathematicks again, either consider quantity as discrete, and so computable, as *arithmetick*; or as concrete, or continued, and so measurable, as *geometry*, and *trigonometry*.

Mix'd mathematicks are very extensive, and are distinguished by various names, as the subjects they consider, and the views, wherein they take them, vary; it being sufficient to determine an art to be a branch of *mix'd mathematicks*, that *pure mathematicks* are applicable thereto, *i. e.* that it may be explained and demonstrated from the principles of arithmetick and geometry. Such are

Mechanicks, which consider motion, or the law of moving bodies.—*Hydrostaticks*, which consider the laws of fluids, or of bodies gravitating in fluids.—*Pneumaticks*, the air, with regard to the laws of mensuration thereof.—*Hydraulicks*, the motion of fluids.—*Opticks* direct light or vision.—*Catoptricks*, reflected vision.—*Dioptricks*, refracted vision.—*Perspective*, the images of objects, in order to delineate or represent them.—*Astronomy*, the universe and the phænomena of the heavens.—*Geography*, the earth, both as in itself, and in its affections.—*Hydography*, the sea, principally as navigable.—*Chronology*, time, with regard to the measuring and distinguishing thereof.—*Gnomonicks*, or *Dialling*, shadows, in order for determining the hour of the day.—*Pyrotechny*, artificial fires, with regard both to diversion, and to the uses of war.—*Military Architecture*, the strength of places, with regard to their defence against an enemy.—*Civil Architecture* (now become a branch of *Mathematicks*) buildings.—*Musick*, sounds, and their effects on the ear. All which are treated of under their particular heads.

For the origin of the *Mathematicks*, *Josephus* dates it before the flood, and makes the sons of *Seth* observers of the course and order of the heavenly bodies.

The first who cultivated *mathematicks* after the flood, were the *Assyrians* and *Chaldeans*; from whom the same *Josephus* adds, they were carried by *Abraham* to the *Egyptians*; who proved such notable proficients, that *Aristotle* makes no scruple to fix the first rise of *mathematicks* among them. From *Egypt*, 584 years before Christ, they passed into

into *Greece* through the hands of *Thales*, who having learnt Geometry of the *Egyptian* priefts, taught it in his own country. After *Thales* comes *Pythagoras*, who among other mathematical arts, paid a peculiar regard to Arithmetick, fetching the greateft part of his philofophy from numbers: he was the firft, as *Laertius* tells us, who abftracted geometry from matter, and to him we owe the doctrine of incommenfurable magnitude, and the five regular bodies, befides the firft principles of mufick and aftronomy. *Pythagoras* was fucceeded by *Anaxagoras*, *Ænopides*, *Brifo*, *Antipho*, and *Hippocrates* of *Scio*; who all applied themfelves particularly to the quadrature of the circle, the duplicature of the cube, &c. but the laft with moft fuccefs: this laft is alfo mentioned by *Proclus*, as the firft who compiled elements of *mathematicks*.

Democritus excelled in *mathematicks* as well as phyficks, though none of his works in either kind are extant. The next in order is *Plato*, who not only improved *geometry*, but introduced it into *phyficks*, and fo laid the foundation of a folid philofophy. Out of his fchool proceeded a crowd of *mathematiciaus*; *Proclus* mentions thirteen of note; among whom was *Leodamus*, who improved the analyfis firft invented by *Plato*; *Theætetus*, who wrote elements; and *Archytas*, who has the credit of being the firft who applied *mathematicks* to ufe in life. Thefe were fucceeded by *Neocles* and *Theon*, the laft of whom contributed to the elements. *Eudoxus* excelled in Arithmetick and Geometry, and was the firft founder of a fyftem of Aftronomy. *Menechmus* invented the conick fections; and *Theudrus* and *Hermitomus* improved the elements.

As for *Ariftotle*, his works are fo ftored with *mathematicks*, that *Blancanus* compiled a whole book of them: out of his fchool came *Eudemus* and *Theophraftus*; the firft of whom wrote of numbers, geometry, and invifible lines; the latter a mathematical hiftory. To *Ariftcus*, *Ifidorus*, and *Hypficles*, we owe the books of folids, which, with the other books of elements, were improved, collected, and methodized by *Euclid*, who died 284 years before Chrift.

An hundred years after *Euclid*, came *Eratofthenes* and *Archimedes*. Contemporary with the latter was *Conon*, a geometrician and aftronomer. Soon after came *Apollonius Pergæus*; whofe conicks are ftill extant. To him are likewife afcribed the fourteenth and fifteenth books of *Euclid*, which are faid to have been contracted by *Hypficles*. *Hipparchus* and *Menelaus*, wrote on the fubtences in a circle; the latter alfo on fpherical triangles: *Theodofius*'s three books of fphericks are ftill extant; and all thefe, *Menelaus* excepted, lived before Chrift.

In the year 70, of Chrift, *Ptolemy* of *Alexandria* was born, the prince of aftronomers, and no mean geometrician; he was fucceeded by the philofopher *Plutarch*, of whom we have ftill extant fome mathematical problems. After him came *Eutocius*, who commented on *Archimedes*; and occafionally mentions the inventions of *Philo*, *Diocles*, *Nicomedes*, *Sporus*, and *Heron*, on the duplicature of the cube. To *Ctefebes* of *Alexandria* we owe our pumps; and *Geminus*, who came foon after, is preferred by *Proclus* to *Euclid* himfelf.

Diophantus of *Alexandria* was a great mafter of numbers, and the firft inventor of *Algebra*; among others of the antients, *Nichomacus* is celebrated for his arithmetical, geometrical, and mufical works; *Serenus* for his book on the fection of the cylinder; *Proclus* for his comments on *Euclid*; and *Theon* has the credit among fome of being author of the books of elements afcribed to *Euclid*. The laft to be named among the antients, is *Pappus* of *Alexandria*, who flourifhed in the year of Chrift 400, and is celebrated for his books of mathematical collections ftill extant.

MECHANICKS.

MECHANICKS are confidered under the mixed *mathematical fcience*, which confiders motion or moving powers, their nature and laws, with the effects thereof, in machines, &c.

That part of *mechanicks*, which confiders the motion of bodies arifing from gravity, is by fome called *ftaticks*; in diftinction from that part, which confiders the mechanical powers, and the application properly called *mechanicks*. So that on this footing *ftaticks* fhould be the doctrine or theory of motion; and *mechanicks* the application thereof. But as the whole doctrine of *mechanifm* depends entirely on a fole point, which is to find the *center of gravity* of bodies: I'll begin this treatife by examining what is gravity, with refpect to *mechanicks*; how gravity is divided; the center of gravity, &c.

DEFI-

DEFINITIONS.

Gravity, in *mechanicks*, denotes the tendency of bodies towards the center of the earth: and it is diſtinguiſhed into *abſolute* and *relative*.

Abſolute gravity is that, whereby a body deſcends freely through an unreſiſting medium; as a ſtone in the air, which in its deſcent only touches the ætherial particles.

Relative gravity is that, wherewith a body deſcends, after it has ſpent part of its weight in overcoming ſome reſiſtance. Such is that, wherewith a body deſcends along an inclined plane, where ſome part is employed in overcoming the reſiſtance or friction of the plane.

The *center of magnitude* of a body is a point as equally diſtant, as poſſible, from the two extreams.

The *center of motion* of a body is the fixed point, round which one or more heavy bodies, that have one common center of gravity, revolve.

The *center of gravity* is a point within a body, through which, if a plane, paſs the ſegments on each ſide will be equal and equiponderate, *i. e.* neither of them can move the other.

Whatever moves, or ſuſpends a body, is called a *moving power* or *faculty*.

The quantity of power is determined from the quantity of gravity of the power ſuſpended or moved, *v. g.* if the body A be carried downward, according to the line B C, *Fig.* 1. by a power of 10 pounds weight, the power, which ſtops its deſcent, whether it only ſuſpends it, or forces or draws it from C towards B, will be called a power of 10 pounds.

Whatever can accelerate, or ſtop the motion of a body, is called *machine*.

There are two ſorts of *machines*, ſome *ſimple* and others *compound*.

Simple machines are thoſe otherwiſe called *mechanical powers*.

There are ſix *ſimple machines*, to which all others may be reduced, *viz.* the *ballance*, *lever*, *wheel*, *pully*, *wedge*, and *ſcrew*; to which may be added the *inclin'd plane*, ſince it is certain that the moſt heavy bodies are lifted up by its means, which otherwiſe could not be moved.

Compound machine is that which is compoſed of ſeveral ſimple ones combined together.

The *application of the weight* or *power* to the lever, is the angle of the line of direction of that power or weight with the lever.

The *diſtance of power* or *weight* is the ſpace from the point of the machine, to which the power or weight is applied, to the center of the motion.

The *ballance* or *balance*, is uſed principally for determining the quality or difference of weights in heavy bodies, and conſequently their maſſes or quantities of matter.

The *ballance* is of two kinds,

1. The *antient* or *Roman*, called alſo *ſtatera Romana*, conſiſts of a lever, *a*, *Fig.* 2. or a beam, moveable on a center *b*, and ſuſpended near one of its extremes *c*; on one ſide the center *d*, are applied the bodies to be weighed, and their weight is meaſured by the diviſion marked on the beam; on the other ſide is the place where a weight moveable *e*, along it keeps the *ballance* in equilibrium.

2. The *modern ballance*, *Fig.* 3. now ordinarily in uſe, conſiſts of a lever or beam *a*, ſuſpended exactly by the middle *b*, to the extreams whereof are hung ſcales or baſons, *c c*.

In each caſe the beam is called the *jugum*, and the two moieties thereof on each ſide the axis, the *arms*: and the handle whereby it is held *trutina*. The line on which the beam turns, or which divides its *arms* is called the axis *d*, and when conſidered to the length of the *arms*, is eſteemed but a point, and called the *center of the ballance*; and the places where the weights are applied, the *points of ſuſpenſion* or *application*. That ſlender part perpendicular to the *jugum*, whereby either the equilibrium, or preponderancy of bodies is indicated, is called the *tongue of the ballance*, *e*.

In the *Roman ballance*, therefore, the weight uſed for a counter-ballance is the ſame, but the points of application various. In the common *ballance*, the counterpoiſe is various, and the point of application the ſame.

The principle on which each is founded is the ſame, and may be conceived from what follows.

The beam, *a a*, *Fig.* 3. which is the principal part of the *ballance*, is a lever of the firſt kind, which (inſtead of reſting on a *fulcrum* at *d*, its center of motion) is ſuſpended by ſomewhat faſten'd to *d*, its center of motion.

Hence as the known weight is to the unknown, ſo is the diſtance of the unknown weight from the center of motion, to the diſtance of the known weight, where the two weights will counter-poiſe to each other; conſequently the known weight ſhews the quality of the unknown.

To the *juſtneſs of a ballance* it is required, that the points of ſuſpenſion be exactly in the ſame line as the center of the *ballance*; that they be preciſely equidiſtant from that point on either ſide; that the *brachia* or *arms* be as long as conveniently they may, that there be as little friction as poſſible in the motion of the beam and ſcales, and laſtly, that the center of gravity of the beam be placed a little below the center of the motion.

A Lever is an inflexible right line, supported in a single point, on a fulcrum or prop, and used for the raising of weights; being either void of weight itself, or at least having such a weight as may be commodiously counter-balanced.

In a *lever* there are three things considered; the *weight* to be *raised* or *sustained*, the *power*, by which it is *raised* or *sustained*, and the *fulcrum* or *prop*, whereon the *lever* is sustained, or rather on which it moves round, the fulcrum remaining fix'd.

Levers are of three kinds; sometimes the *fulcrum* *b* is placed between the weight *a* and the power *c*, *Fig.* 5. this we call a *lever of the first kind.* Sometimes the weight *c* is between the *fulcrum b*, and the power *a*; which is called a *lever of the second kind*, as in *Fig.* 6. And sometimes the power acts between the weight and the fulcrum *b*, *Fig.* 7. which is the *lever of the third kind.*

In the first kind of levers, *Fig.* 5. so much as the distance *a b* surpasses the distance *c b*, as much the power *a* surpasses the weight *c*. Therefore if the space *a b*, which is between the power *a*, and the point fix'd *b* is ten times longer than the space *c b*, which is between the fulcrum *b* and the weight *c*, and that weight *c* be considered as a hundred pounds weight, provided the power *a* be equivalent to ten pounds and a little more, it will surpass the weight *c* and raise it, provided that when the power *a* shall descend by ten ounces or inches, and a little more, the point *c* be risen of an ounce or an inch breadth only, because whatever increase the power acquires, proceeds either from the greater space or velocity, or from the length of time.

The same must be said of the second kind of *lever*, because as the more the distance *a b*, *Fig.* 6. surpasses the distance *c b*, the more efficaciously and easily the power *a* surpasses the weight *c*.

The third kind of *levers* do not render the power *a*, *Fig.* 7. more efficacious; but rather increase the weight *c*, and adds strength to it, because the distance of the power *a* from the point fix'd *b*, is lesser than the distance of the weight *c*, from the same point fix'd *b*; but in that case the power must run through less space than the weight.

It appears by the sole inspection that the *Roman statera* is a *lever* of the first kind; for in the *forceps*, *a b c d*, *Fig.* 3. there are two *levers* of the first kind, which have but one hypomachlion, *viz.* in the point *a*, round which each arm of the *forceps* is turned; and the lesser is the distance *a d*, than either *a b* or *a c*, the better the power applied in *b* and *c*, counter-balance the body placed in *d*.

A knife placed by one of its sides in the point *a*, *Fig.* 6. so that it may incline towards that point, shews the second kind of *lever*; in which, if the power be applied in *c*, and a piece of bread, or some other thing like it, be placed in *b*, the more the power will be distant from the point fixt *a*, the stronger the power will act.

Thus when we use a *lever* of the first kind, the power can be greater or lesser than the weight, according as the distance of the weight is greater or lesser than that of the power.

When we use a *lever* of the second kind, the distance of the weight is necessarily lesser than the distance of the power, as the power is necessarily lesser than the weight.

On the contrary, when we make use of a *lever* of the third kind, the distance of the weight is necessarily greater than the distance of the powers, as the power is necessarily greater than the weight.

Axis in peritochio, is a machine or *mechanical* instrument proper, in which the cylinder *b i*, Fig. 9. called the *axis*, is sustained at both ends by the fulcrums *k l*, with the circle in *c*, called the *peritochium*, in the circumference whereof are made holes, to which are fitted the spokes, or *radii*, *a m c*, *b m d*, to which the force being applied, it winds up a rope round the axis, whereby the weight, &c. is to be raised.

The *axis in peritochio*, takes place in the motion of every machine, where a circle may be conceived described about a fixed *axis*, concentrick to the plane of a cylinder, about which it is placed, as in crane-wheels, mill-wheels, capstons, &c.

Nothing more easy than to shew that the *axis in peritochio*, as we represent it here, is to be referred to the *lever* of the first kind. For the point fixt is in the middle of the circle and axis, *viz.* in the point *a f*. For when the cylinder is turned round, innumerable fixt points can be conceived in it from the extreme *b* to *i*, or rather in lieu of points fixt, is to be conceived a middle fixt and immoveable line from *b* into *i*, round which the cylinder is turned. The power is in *a* or in *b*, &c. and recedes from the point fixt, or the middle immobile line, not only the whole semi-diameter of the axis and the circle, but besides of the whole length of the spoke *a m* or *b m*, &c. the weight placed in the point of the superficy, *e*, and is removed of the sole semi-diameter *e f*, from the point fix'd *f*. Whence the more the distance *a m* surpasses the distance *e f*, the easier the power applied in *a* surpasses the weight, which is understood to be placed in *e*; and the greater the radius, the more increase will the power acquire.

But if a periphery be put round the extremes *a b c* to make an entire wheel, which several men could turn round, it would be nothing more but continued. The same must be said of those large wheels, which men, shut up in them, turn round with their feet, to draw up by means of a cable, immense

immenſe weights, *viz.* either ſtones from quarries, or beams at the top of houſes, &c.

The *pulley*, *Fig.* 10. is a machine conſiſting of a little wheel or rundle, having a channel round it, and turning on an axis, ſerving by means of a rope which ſlides in its channel, for the raiſing of weights.

If the *pulley* be ſimple, *i. e.* if it has but one wheel or rundle (for ſome of them have ſeveral rundles) which rundle turns round an immobile axis, ſuch a pulley does not increaſe the power; for the motion of the weight *e* is equal to that of the power *a*, and the aſcent of *e* equal to the deſcent of *a*. Whence all the advantage ariſing from ſuch a machine, conſiſts only in that the rope does not wear off, and that it turns eaſier round the orb *b d*.

Hence a ſingle *pulley*, if the lines of direction of the power and the weight be tangents to the periphery neither aſſiſts nor impedes the power, but only changes its direction.

The uſe of the *pulley* therefore is, when the vertical direction of a power is to be changed into an horizontal one, or an aſcending direction into a deſcending one, and on the contrary.

But the great uſe of the *pulley* is, where ſeveral of them are combined; thus forming what *Vitruvius* and others after him called *Polyſpaſta*; the advantages whereof are, that the machine takes up but little room, is eaſily removed, and raiſes a very great weight.

As in my 10th figure, where there are two rundles, whoſe axis is immobile, *viz. a*, and the other whoſe axis is mobile, *viz. b*, of which a weight, *v. gr.* of a hundred pounds, depends; therefore if the rope be tied at one end to the nail *c*, and the other end be pulled by the power, I ſay, that the force of fifty pounds in the power *f*, is equivalent to the weight *d* of a hundred pounds: or the force of the hand *f* is double that it ſhould have without the aſſiſtance of the mobile rundle; for when the ratio of the velocity or ſpace, and of the weight or bulk is reciprocal between the power and the weight, they are in æquilibrio. For if the weight be of a hundred pounds, and the power *f* of fifty only, *i. e.* if the weight be double the power, the power will move with double the celerity of the weight, becauſe while the weight *d* is lifted up through that interval which is between *b* and *a*, the power *f* will bring up two ſegments of the rope, *viz. h g* and *i l*, which together are equal to double the ſpace *b a*; and therefore will be moved twice faſter: therefore its force will be double, and if it be heavier than fifty pounds, it will lift up the rundle *b* with the weight *d*.

If there be two mobile rundles, *c* and *d*, *Fig.* 11. a rope be tied to the immobile axis of the rundle *b*, which may be carried round as well by the two mobile rundles *c* and *d*, as by the immobile *a* and *b*, and drawn by the power *o e*; I ſay, that the force of the power *o* is quadruplicate. For to raiſe up the weight *e* from the point *c* to the point *b*, the power *o* muſt pull four ſegments of the rope, viz. *f g*, *h i*, *k l*, and *m n*, equal to the altitude *c b*; therefore the power muſt move four times faſter than the weight.

But we muſt obſerve, that the immobile rundles neither increaſe nor diminiſh the force of the power, but all increaſe of that kind proceeds from the moveable rundles, in the combined *pulleys*; and that force increaſes in proportion as the velocity of the power exceeds the velocity of the weight.

The Wheel, is a ſimple machine conſiſting of a round piece of wood, metal or other matter, which revolves on an axis.

The *wheel* is one of the principal powers of *mechanicks*. It has places in moſt engines; in effect, it is of an aſſemblage of *wheels*, moſt of our chief engines are compoſed; as clocks, mills, &c.

Its form is various according to the motion it is to have, and the uſe it is to anſwer. By this it is diſtinguiſhed into *ſimple* and *dented*.

Simple wheels are thoſe, whoſe circumference and axis is uniform, and which are uſed ſingly, and not combined. Such are the *wheels* of carriages, which are to have a double motion; the one circular about their axis, the other rectilinear; by which they advance along the road, &c. which two motions they appear to have, though in effect they have but one, it being impoſſible the ſame thing ſhould move, or be agitated two different ways at the ſame time.

This one is a ſpiral motion, as is eaſily ſeen by fixing a piece of chalk on the face of the *wheel*, ſo that it may draw a line on a wall, as the *wheel* moves. The line it here traces is a juſt ſpiral, and ſtill the more curve as the chalk is fixed nearer the axis. A very nice phænomenon of the motion of this *wheel* is ſeen in *Rota Ariſtotelica*, which is the name of a celebrated problem in *mechanicks*: thus called, becauſe firſt, that we know of, taken notice by *Ariſtotle*.

The ſolution is to this effect. The *wheel* of a coach is only acted on, or drawn in a right line, inaſmuch as it defeats that direction; of conſequence the cauſes of the two motions, the one right, the other circular, are equal, and therefore their effects, *i. e.* the motions are equal. And hence, the *wheel* deſcribes a right line on the ground equal to its circumference.

For

For the nave of the *wheel*, the caſe is otherwiſe. It is drawn in a right line by the ſame force as the *wheel*, but it only turns round, becauſe the *wheel* turns, and can only turn with it, and at the ſame time therewith. Hence it follows, that its circular velocity is leſs than its rectilinear one.

Since then it neceſſarily deſcribes a right line equal to that of the *wheel*, it can only do it by ſliding, or what they call the motion of the *raſion*. That is, a part of the circular nave cannot be applied to a part of a right line greater than itſelf, but by ſliding along that part; and that more or leſs, as the part of the nave is leſs than that of the circle.

We ſhall add, that in *ſimple wheels* the height ſhould always be proportioned to the ſtature of the animal that draws or moves them. The rule is, that the load, and the axis of the *wheel* be of the ſame height with the power that moves them; otherwiſe the axis being higher than the leaſt, part of the load will lie on him, or if it be lower he pulls to diſadvantage, and muſt exert a greater force.

The power of theſe *wheels* reſults from the difference of the radii or ſpokes of the axis and circumference. The canon is this: as the radius of the axis is to that of the circumference, ſo is any power to the weight it can ſuſtain hereby.

This is alſo the rule in the axis in the peritochio, and in effect, the *wheel* and the axis in peritochio are the ſame thing; only in theory, it is uſually called by the latter name, and in practice by the former.

Dented wheels, are thoſe either whoſe circumference or axis is cut into teeth, by which they are capable of moving and acting on one another, and of being combined together. The uſe of theſe is very conſpicuous in clocks, jacks, &c.

The power of the *dented wheel* depends on the ſame principle as that of the ſimple one. It is only that to the ſimple axis in peritochio, what a combined lever is to a ſimple lever.

Its doctrine is comprized in the following canon, *viz.* The ratio of the power to the weight, in order for that to be equivalent to this, muſt be compounded of the ratio of the diameter of the axis of the laſt *wheel* to the diameter of the firſt; and of the ratio of the number of revolutions of the laſt *wheel*, to thoſe of the firſt in the ſame time. But this doctrine will deſerve a more particular explication.

Suppoſe the weight *a*, *Fig.* 12. which by its force can raiſe one pound, and is underſtood to move the *wheel b*, and the little *wheel c* joined to its axis; if we ſuppoſe that there are only ten teeth in the little wheel *c*, and an hundred in the wheel *b*, very well adapted to the former and joined to them; it will happen hence, that while the ſmall *wheel c* turns ten times round, the great wheel *d* will turn but once. Likewiſe if the ſame ratio be put between the ſmall *wheel c*, joined to the *wheel d*, and between the *wheel f* implicated to it, then while the ſmall *wheel e*, together with the *wheel d* turn ten times round, the *wheel f* will be conceived to turn only once round: therefore the firſt *wheel b* will turn round ten times ſwifter than *d*, and the *wheel d* ten times ſwifter than *f*; or which is the ſame, the *wheel b* will turn round a hundred times ſwifter than *f*.

If a power moves a weight by means of divers *wheels*, the ſpace paſſed over by the weight is to the ſpace of the power as the power to the weight. Hence the greater the power, the faſter is the weight moved, and *vice verſâ*.

INCLINED PLANE (which I place here, becauſe it has a near relation to the other three powers already explained) is a *plane* which makes an oblique angle with an horizontal *plane:* which *inclined plane* is to be ſeen in our plate of *Hydraulicks*.

We make uſe of an *inclined plane* to raiſe up, or let fall heavy bodies with a greater facility, whereby part of their weight is taken away; as workmen find by experience and without being taught. For when a great weight is to be carried to a high place, they put it on an *inclined plane*, which plane is ſometimes ſupported with boards or cylinders, for the conveniency of tranſporting it from one place to another.

The *laws of deſcent of bodies* or *inclined planes* are,

1. If a body be placed on an *inclined plane*, its relative gravity will be to its abſolute gravity, as the length of the plane to its height. Hence, 1. Since a ball gravitates on the *inclined plane* with its relative gravity; the weight applied in a direction parallel to the length of the plane, will retain or ſuſpend it, provided the weight be to that of the ball, as the altitude of the plane is to its length.

2. The abſolute gravity of the body is to its retractive gravity applied on the *inclined plane*, as the whole ſine to the ſine of the angle of inclination.

3. Hence the reſpective gravities of the ſame body on different *inclined planes*, are to each other as the ſines of the angle of inclination.

4. The greater therefore the reſpective gravity is, the greater is the angle of inclination.

5. As therefore in a vertical *plane*, where the inclination is greateſt, *viz.* perpendicular, the reſpective gravity degenerates into abſolute; ſo in an horizontal *plane*, where there is no inclination, the reſpective gravity vaniſhes.

To find the ſine of the angle of inclination of a *plane*, on which a given power will be able to ſuſtain

tain a given weight. Say, as the given weight is to the given power, so is the whole sine to the sine of the angle of inclination of the *plane*. Thus, suppose a weight of 1000 be to be sustained by the power of 50, the angle of inclination will be found 2052.

If the weight descends according to the perpendicular direction, and raises up the weight in a direction parallel to the *inclined plane*; the height of the assent will be to that of the descent, as the sine of the angle of inclination to the whole sine.

The powers that raise weights through altitudes reciprocally proportional to them, are equal. This *Des Cartes* assumes as a principle whereby to demonstrate the powers of machines; hence we see why a loaden waggon is drawn with more difficulty on an inclined than an horizontal plane; as being pressed with a part of the weight, which is to the whole weight in a ratio of the altitude of the plane to its length.

A heavy body descends on an *inclined plane*, with a motion uniformly accelerated.

Hence, 1. The spaces of descent are in a duplicate ratio of the times, and likewise of the velocities; and therefore in equal times increase according to the unequal numbers, 1, 3, 5, 7, 9, &c.

2. The space passed over by a heavy body descending on an *inclined plane*, is subduple of that which it would pass over in the same time, with the velocity it has acquired at the end of its fall.

3. Heavy bodies therefore descend by the same laws on *inclined planes*, as in perpendicular planes. Hence it was that *Galileo*, to find the laws of perpendicular descents, made his experiments on *inclined planes*, in regard to the motions being slower in the latter than the former, as in the following theorem.

The velocity of a heavy body, bending on an *inclined plane*, at the end of any given time, is to the velocity which it would acquire in falling perpendicularly, in the same time, as the height of the *inclined plane* is to its length.

The WEDGE, *Fig.* 16. is a triangular prism, whose bases are equilateral acute-angled triangles.

Its doctrine is contained in this proposition: If the power directly applied to the head of the *wedge*, be to the resistance to be overcome by the *wedge*, as the thickness of the *wedge* is to its height, then the power will be equivalent to its resistance; and if increased, will overcome it.

For the firmness whereby the parts of the obstacles, suppose wood, adhere to one another, is the resistance to be overcome by the *wedge*.

Hence, if the thickness of the *wedge* (that is, the way of the impediment, and consequently its velocity) be to the height of the *wedge* (that is the way, and consequently the velocity of the power) as the power of the impediment, or resistance; then the momentum of the power, and the impediment, will be equal the one to the other; and consequently the power, being increased, will overcome the resistance.

Hence, 1. The power equivalent to half the resistance, is to it as the whole sine to the co-tangent of half the angle of the *wedge*.—And, 2. As the tangent of a less angle is less than that of a greater, the power must have a greater proportion to half the resistance, if the angle be greater than if less. Consequently the acuter the *wedge* is, the more does it increase the power.

To the *wedge* may be referred all edge-tools, and instruments which have a sharp point, in order to cut, cleave, slit, chop, pierce, bore, or the like; as knives, hatchets, swords, bodkins, &c.

The SCREW, is a right cylinder, furrowed spiral-wise, chiefly used in pressing or squeezing bodies close, though sometimes also in raising weights.

If the furrowed surface be convex, the *screw* is said to be *male*; if concave it is *female*.

The *doctrine of the screw* is,—1. As the compass described by the power in one turn of the *screw*, is to the interval or distance between any two immediate threads or spiral winding, so is the weight or resistance to the power; then the power and the resistance will be equivalent one to the other; and consequently, the power being a little increased will overcome the resistance.

2. As the distance between two threads is less, the power required to overcome the said resistance is less; therefore the finer the thread the easier the motion.

3. If the male *screw* be turned in the female at rest, a less power will be required to overcome the resistance.

4. The distance of the power from the center of the *screw*, the distance of two threads, and the power to be applied being given, to determine the resistance it will overcome; or the resistance being given, to find the power necessary to overcome it.

Find the periphery of a circle described by a radius, then the distance between the two threads, the periphery just found, and the given power; or to the periphery found, the distance of the two threads, and the given resistance, find a fourth proportional. This in the former case will be the resistance that will be overcome by the given power; and in the latter the power necessary to overcome the given resistance.

E. gr. Suppose the resistance between the two threads 3, the distance of the power from the center of the *screw* 25, and the power 30 pounds, the periphery

periphery of the circle to be described by the power, will be found 157: Therefore, as 3, 157 : 30, 1570, the weight to which the resistance is equal.

5. The resistance to be overcome by a given power being given; to determine the diameter of the *screw* the distance of two threads, and the length of the scytala or handle: the distance of the threads, and the diameter of the *screw* may be assumed at pleasure, if the male be to be turned in the female by a handle: then as the given power is to the resistance it is to overcome, so is the distance of the threads to a fourth number, which will be the periphery to be described by the handle, in a turn of the *screw*. The semi-diameter of this periphery therefore being sought, we have the length of the handle; but if the female *screw* be to be turned about the male without any handle, then the periphery and semi-diameter found, will be very nearly those of the *screw* required.

E. gr. Suppose the weight 6000, the power 100, and the distance of the threads 2 lines; for the periphery to be passed over by the power, say, as 100, 6000: 2, 120; the semi-diameter of which periphery being $\frac{1}{3}$ of 120=40 lines will be the length of the handle, if any be used; otherwise the side of the female *screw* must be 40 lines.

There are, besides the above-mentioned *screws*, the *endless screw*, and *Archimedes*'s *screw*.

The *endless* SCREW, is a *screw* fitted to turn a dented wheel, called *endless*, or *perpetual*, in regard it may be turned for ever, without coming at an end. From the scheme it is evident enough, that while the *screw* turns once round, the wheel only advances the distance of a tooth.

The *doctrine of the endless* SCREW, is:—If the power applied to the lever, or handle of an *endless screw*, be to the weight, in a ratio compounded of the periphery of the axis of the wheel, to the periphery described by the power, in turning the handle, and of the revolutions of the wheel, to the revolutions of the *screw*, the power will be equivalent to the weight.

Hence, 1. As the motion of the wheel is exceedingly slow, a small power may raise a vast weight, by means of an *endless screw*: for this reason, the great use of the *endless screw*, is either where a great weight is to be raised through a little space; or where a very slow, gentle motion is required: on which account it is very useful in clocks and watches.

2. The number of teeth, the distance of the power from the center of the *screw*, the radius of the axis, and the power being given, to find the weight it will raise.

Multiply the distance of the power from the centre of the *screw* into the number of teeth: the product is the space of the power passed through, in the time the weight passes through a space equal to the periphery of the axis. Find a fourth proportional to the radius of the axis, the space of the power now found and the power; this will be the weight the power is able to sustain.

Archimedes's SCREW, or the *spiral pump*, is a machine for the raising of water, invented by *Archimedes*. Its structure is as follows:

A leaden tube is wound round a cylinder, after the same manner as the spiral thread is drawn in the common *screw* above described. This cylinder is inclined to the horizon in an angle of about 15 degrees, and the orifice of the tube immerged under water. If then the *screw* be turned about by the handle, against the water; the water will raise up the spiral and be discharged at the other orifice of the cylinder.

This machine (whose figure is the second in the plate of *Hydraulicks*) with a very little strength, is able to rase a great quantity of water: whence it is found of good use in emptying of lakes, *&c.*

If the water be to be raised to any considerable height, one *screw* will not suffice; but the water drawn up by one, is to be taken by another, and so successively.

As the *mechanicks* are founded on *motion*, attempts have been made, from time to time, to find out a *perpetual motion*, i. e. a motion whieh is supplied and renewed from itself, without the intervention of any external cause; or in an uninterrupted communication of the same degree of motion from one part of matter to another, in a circle (or other curve returning it into itself) so as the same momentum still returns undiminished upon the first mover.

To find a *perpetual* MOTION, or construct an engine, *&c.* which shall have such a motion, is a famous problem that has employed the mathematicians for 2000 years.

Infinite are the schemes, designs, plans, engines, wheels, *&c.* to which this longed for *perpetual motion* has given birth; but there seems but little in nature to countenance all this assiduity and expectation: among all the laws of matter and motion, we know of none yet, which seems to lay any principle or foundation for such an effect.

The whole business of finding a *perpetual motion*, comes to this, *viz.* to make a weight heavier than itself, or an elastick force greater than itself; or, there must be some method of gaining a force equivalent to what is lost, by the artful disposition, and combination of *mechanick powers*: to which last point, then, all endeavours are directed: but how, or by what means such force should be gained, is still a mystery!

As *motion* is the foundation of *mechanics*, it will proper to add somewhat concerning the affecti-[illegible] causes, &c. of *local motion*.

[illegible]sophers, both antient and modern, agree a[illegible]ng themselves, that the *local motion* is a certain state, or manner of the mobile body, whereby it corresponds successively to several different places: But whether *rest* be something real and positive, is what is much controverted. *Aristotle*, *lib.* 5. *physic. c.* 8. and all the *Peripatetians* believe, that *rest* is nothing but a privation of *motion*. And *Des Cartes* is of opinion, that *rest* is no less real and positive than *motion* itself. In which controversy I'll chuse the medium: for *rest*, as I take it, can be defined *the remaining of a body in the same place or space*: therefore it can be call'ed either a state, or manner, or relation; and not a sole privation of motion, as *Aristotle* imagined it; much less is it to be considered, as some positive or real faculty in a body, whereby it can act or resist, as *Des Cartes* will have it.

It may be objected against my sentiment, by the *Peripatetitians*, that rest consists in that, which once admitted, its nature is easily understood; as it happens by admitting only the privation of motion, as darkness is understood by admitting only the privation of light.

To which I answer, that neither rest is understood by the sole privation of *motion*, nor *motion* understood, by the sole privation of rest, but either state is positive, one whereby a body corresponds to the different parts of the place, and the other whereby it corresponds to the same parts of a place; one or the other of those manners being always in a body. For if it ceases from moving it rests, and if it ceases from resting it is moved: whence *motion* and *rest* alternately succeed each other in a body.

As *motion* is the translation of a body from one place to another, which wants time to be accomplished; we should, therefore, understand the nature of *time* and *place*.

TIME, is *the successive duration of a thing which has a beginning, and which can have an end.* It is called *a successive duration*, because *time* does not exist together. 2. *Which has a beginning, and can have an end*, because time belongs to created things, which God has formed of nothing, and can reduce to nothing.

The name of *place* is ambiguous; for sometimes it signifies the superficies of a body, wherein another body is contained, sometimes a space, which can be occupied by all sorts of bodies; the first is called an *internal place*, and the other *external*.

I consider the superficies of the ambient body in two manners, *viz. physically*, and *mathematically*.— It is considered *physically*, when considered in a physical body, endued with several sensible qualities, *viz.* fluidity, mobility, &c. and *mathematically*, when considered as in an extended substance, or in the sole extension, abstracted mutually, from sensible qualities: these presupposed,

I say, that the *external place*, or *place* properly called, *viz.* the concave superficies of an ambient body containing another body, is in fact, and *physically* mobile, because it is continently moved, as it appears either in the air we are environed with, and which is agitated around us; or in running water, which washes the piles of a bridge.

But the *external place* considered *mathematically*, can be conceived immobile, because in it the sole extension is considered, as abstracted from the rest of the physical qualities, *viz.* fluidity, mobility, &c.

COROLLARY. When *motion* is defined the translation of a body from a place into another, *place* is considered *mathematically*, not *physically*.

The principal affections of *motion* are its *quantity*, *determination*, *reflection*, and *refraction*.

The *quantity of* MOTION is the answer to the question, *how great is the motion*, or that whereby any *motion* compared with another, is said to be either greater or less than that it is compared with. And this is to be taken from two chiefs, *viz.* from the bulk or weight of a mobile body, and from the velocity of the motion.

Therefore if the two bodies A and B, *Fig.* 16. are equal in bulk, and are moved with an equal celerity, there will be as much *motion* in one as there is in the other; but if one of them, *viz.* A, is moved with twice the celerity of the other, it will have twice the quantity of motion B has. Likewise if both be carried with the same velocity, and one be twice, or thrice, or four times the other, it will have twice, thrice, four times, the quantity of motion.

For if same force is used to throw, *v. gr.* a body of a pound weight at fifty feet distance, within the time of the second of an hour, the same force must necessarily be double, to throw it within the same time, at a hundred feet distance; and then the quantity of motion in it will be double.

For the same reason, if a body of a pound weight be carried with a certain force, within a minute's time to two hundred paces, certainly a body of two pounds will be moved, and within the same time, to a hundred paces; notwithstanding which there will be the same quantity of motion in both, because the force of the lesser weight is followed with a greater velocity. Therefore the particles of the first element of *Des Cartes* must be moved with a far greater celerity with the same quantity of motion, than those of the second element,

element, becauſe the firſt element is much thinner than the ſecond.

The Determination *of motion*, is *the direction thereof towards one part, rather than towards another.* Whence *motion* is taken from the impulſive faculty, which is ſometimes greater and ſometimes leſſer; and the *determination* is to be deduced from the manner whereby the impulſion is made, *v. gr.* when a ball is thrown with the battler againſt a wall, the *motion* proceeds from the blow or percuſſion; but the *determination* depends on the manner of throwing it, *viz.* from the different ſituation of the battler, which ſituation cauſes that the fall deſcribes one line rather than another. For nothing hinders a motion which is not interrupted, from being preſerved in a mobile body, though the *determination* be changed; *v. g.* when a ball falls obliquely into a wall and returns back, the determination thereof is changed, though the ſame motion continues.

Hence, though *motion* with regard to itſelf is to be ſaid *ſimple*, and the mobile deſcribes one line only, either right or curve, when moved from one point into another, we notwithſtanding conceive ſometimes two or more *determinations* in it; and the *motion* is ſaid to be compoſed in ſome manner, of thoſe two or more *determinations*, viz. where two or more cauſes endeavour to move ſeparately one and the ſame mobile into different parts, *v. g.* if one would croſs a river from B to D, *Fig.* 18. and be carried by almoſt the ſame rapidity of the water into G, whereby he is carried into D; then he'll follow neither the right line A G, nor the right A D, but the line A K. For if he had arrived at firſt by his own ſtrength to the point B, he ſhould have arrived at the point E by the ſtrength of the river. Therefore to anſwer thoſe two motions, *i. e.* to arrive at the point D, through that interval, which is between A and B; and to the point G, through that interval, which is between A and E, it is certainly neceſſary, that he ſhould be at the firſt inſtant in the point H, at the ſecond inſtant in the point I, and at the third in K.

The Reflection *of motion* in a mobile body, is *the regreſs of the mobile body from another body it cannot penetrate.* As when a ball be thrown againſt a wall, as it cannot penetrate the wall, and is endued with an elaſtick faculty, immediately returns back.

But when a body is thrown againſt another, it falls againſt it, either perpendicularly and directly, or obliquely; if it falls perpendicularly, and is capable of reflection, it muſt meaſure quite the ſame line, ſince there is no reaſon why it ſhould incline to one part rather than another, *v. gr.* when a bladder blown is thrown againſt the pavement, it is obſerved to return back according to the ſame perpendicular line.

But if that body falls obliquely againſt another, *viz.* if a ball be thrown according to the line A B, *Fig.* 19. againſt the line C B, in ſuch a manner as to form with it the angle A B C, leſs than a right one, then it will reflect on the other part, and keep the ſame inclination towards the ſuperficies B E, or from another angle equal to the former: the former is an *angle of incidence*, and the latter an *angle of reflection*; and thoſe angles, if the contact be made on a ſmooth and poliſhed ſuperficies, and meet with no obſtruction, muſt be equal, as is ſhewn in the ſecond diſſertation of *Des Cartes*'s Dioptricks, in this manner.

Let it be the ball A, *Fig.* 20. which is carried through the line A B, into the point B; its motion is underſtood to be compoſed of two others, *viz.* of a perpendicular, whereby it arrives at the line C B E, and of a horizontal, whereby it arrives at the line G B H, or tends towards D E F: whence it may be imagined, that the ball is impelled by a double power at once, *viz.* by one power, according to the perpendicular line A C; and by another, according to the horizontal line A R D. If thoſe faculties or powers be ſuppoſed equal, the line A C will be equal to the line A R, or C B; becauſe the ball advances as much by an horizontal motion, as it is thrown by a perpendicular one; and therefore the line A B will be the diagonal of the perfect ſquare A C B R, but if the faculties be ſuppoſed unequal, or if the motion is ſaid to be made according to a more oblique line, another proportion will be obſerved between the faculties or powers, and thoſe lines perpendicular and horizontal, and ſuch as the power will be to the power, ſuch will be the line to the other line.

For when the ball will have touched the point B in the ſuperficies or line C B E, which oppoſes the perpendicular *motion*, not the horizontal, it will change its perpendicular motion, not the horizontal: but though the determination be changed, the motion does not immediately ceaſe, for the ball returns with almoſt the ſame force it was thrown with. Hence it follows, that when it advances forward horizontally according to the length E D equal to itſelf C B, it will advance forward by a perpendicular motion according to the length E D equal to A C; ſo as for the angle of reflection D B E, to be equal to the angle of *incidence* A B C.

The ſame happens if C B E, *Fig.* 21. be imagined to be a ſmall cord, extended from the point

L

L to the point M, against which is thrown the ball A, according to the line A B, for then the cord will be bowed according to the perpendicular line B *i* K, to the point *i*, or thereabouts, and not according to the oblique line B *n f* to the point *n*; because the motion or inflection is easier and shorter, according to the perpendicular line, than according to the obliqueous: therefore that cord by its elasticity will reflect the ball in G; but when otherwise, the ball with the same force tends by a horizontal motion towards the point E, it must come back through the diagonal line B D, which is the middle line between both; and thus will form an angle of reflection equal to the angle of incidence. *See* the doctrine of *projectiles* under the article *Gunnery*.

As to the REFRACTION *of motion* — As often as a mobile body passes from a liquid one, into another liquid of a different kind, which it penetrates and divides, it is not reflected by it, but it sometimes suffers another mutation, called *refraction*.

REFRACTION, is the *inflection of motion, whereby a mobile body, according to the greater or lesser resistance of the liquid, which it enters obliquely, declines from its right line.* Therefore a mobile body falling perpendicularly on a liquid of a different kind, suffers no *refraction*, *viz.* if the ball A, *Fig.* 22. falls perpendicularly from the air into water, and begins to penetrate it in the point E, it will descend, by a right way, into B; since no reason occurs why it should incline more on one part than on the other. But if a mobile body, *viz.* a ball, enters the water in an obliqueous manner, then it will recede from the right way; in which recess, gravity and levity can produce some variation.

But as the doctrine of *refraction* regards, particularly, light, which we'll prove afterwards to be placed in a small body pressed and moved, it seems more proper to explain it in the rays of the light, in which there is properly neither gravity nor levity.

Let therefore the ray of light be *a b*, *Fig.* 23. which passes obliquely from the air into water, as it must on its way tend towards *c*, it will be refracted in *b*, in approaching the perpendicular *e f*.

If it had come from *d*, and passed from the water into the air, as soon as it had arrived at *b*, it had not proceeded forwards to *g*, but receding from the perpendicular line *e f*, it had inclined towards the point *a*.

Which to understand, you must conceive the solid ray *k k i l*, which falls obliquely into the water, where its point *i* shall reach the superficies of the water, while the point *b* will be still in the air: and as the resistance of the water is greater than that of the air, while the point *i* shall run through the space *i m*, the point *l* shall run through the space *l n*, which is much greater than the space *i m*, as the resistance of the water is much greater than that of the air: the one and the other motion *l n* and *i m*, is understood to be made circular, and round the center *r*, in which the line *l i* and *a m* are formed.

But when the line *i l* will be arrived at *m n*, and the whole ray shall touch the water with its anterior parts, it will find the same resistance every where; and thus will advance towards the part *o d p*, by a right motion, and not a circular one.

On the contrary, if the radius *o p m n* was to come out of the water, its point *n* would reach the air sooner than the point *m*; therefore while the point *n*, by a circular motion were moved into *l*, the point *m* should likewise be moved into *i*; and then both by the force of the water, and a direct way should tend towards K L, in receding from the perpendicular.

From this I'll pass to the true and proper cause of *motion*.

We call, 1. In metaphysicks, the true and proper efficient cause of *motion*, that which truly and properly produces *motion* in bodies, or which imprints a motion in them, or in a word moves them. — 2. To move the bodies, is to carry them from one place into another, by a continual fluctuation.

COROLLARY. The *motion* of bodies does not properly proceed from themselves, since they can neither carry themselves nor other bodies from one place into another; the faculty of moving themselves, or communicating a *motion* to other bodies is not contained in their nature, and they are clearly and distinctly conceived without a faculty or active principle of motion.

The occasion of the motion of the large and sensible bodies draws its beginning from a subtile and fluid matter, which the author of nature keeps in a perpetual motion; which can be demonstrated by induction: for, *v. gr.* in a watch, the motion of the index, which shews the hours, proceeds from the wheels, and the wheels are put in motion by the spring inclosed in the barrel; which spring does not move itself, but receives its motion from the subtile matter; which matter receives its motion from the first mover of all things.

A body can be the occasional cause of another body; as when the subtile matter runs against the large bodies, or somebody pushes a ball against another ball: thus incursion, or impulsion, is the occasion of the author of nature transferring those bodies into another place, according to the law he has prescribed to himself.

The natural bodies can be very well called the second nature; and nearest causes of *motions*, or natural effects; because those causes are employed by the author of nature to produce those effects: *v. gr.* the sun to produce light and heat.

The first and second cause of a continued motion in a body, is the same with the cause of the first motion.

Corollary I. A *motion* once imprinted into a body, continues always in it. till it be stopt by an outward cause, *viz.* by the bodies it meets in its way; because it cannot be changed or destroyed by that body into which it is received; since all body be idle of itself. Whence if it was moved in the vacuum, or rather in a space in which there were no resistance, its motion would be perpetual.

Corollary II. There is no definite term, towards which the motion tends, unless what proceeds from the bodies it meet in its way; for without those bodies the motion would be perpetual, and never interrupted, as we have already observed, and is plainly seen in the planets, the revolution whereof is perpetual.

The next thing which falls under our consideration is, *the cause of the reflected motion*; wherein I'll treat of *the elasticity of the bodies.*

Elasticity, or the *elastick faculty of bodies*, is the power of restoring itself to its former state; as when the branch of a tree, which was bowed returns to its former state of extension. Therefore a body, to be called *elastick*, must be first pressed or bowed, retaining all the while the power to reassume its former state.

Corollary. An *elastick body* must have at least some rigidity or hardness in its parts, whereby to support as much as possible its form, otherwise it would never endeavour to recover its former state.

Which notwithstanding the sole rigidity of the parts ought not to be considered as the proper cause of *elasticity*, since rigidity is in some measure the same with the *elastick faculty*, or at least proceeds from the same principle: which, when we consider with a great deal of attention, the nature of bodies, it seems to be nothing else but a certain subtile matter, which runs through the meatus of the larger bodies; which sentiment, which is that of *Des Cartes*, can be confirmed by several examples.

For, 1. When an ivory ball falls on the pavement, the parts where the contact is made, are plained, and consequently the passages of the subtile matter, closed. But the subtile matter, to flow more freely, endeavours to dilate those passages or meatus, by penetrating them: which it is impossible it should accomplish, without either removing the pavement, or lifting up the ball. But it is more easy to lift up the ball, than to remove the pavement; therefore it lifts up the ball, and restores it to its former state. Let the ball be *a d b*, *Fig.* 25. in which the part *a* be compressed in such a manner, as for the motion of the subtile matter from the part *c* through the part *b* to *d* and *e* to be retarded: then certainly that matter by the continual impulsion whereby it endeavours to dilate the pores of the ball, will restore to the ball its former shape. But as the ball received by the battler, not only becomes more plain in those parts which touch the the battler, but even bends the net of the battler, by the *elasticity* thereof it is repercussed; likewise an ivory ball falling on a marble table, is reflected, as well by its own *elasticity*, as by that of the table.

Secondly, The same thing may be observed in the spring inclosed in the barrel of a watch; for if the spring be inflected, the pores in the convex superficies are dilated, and closed in the concave. Whence the coarser particles of the subtile matter, may enter the convex superficies, but cannot penetrate the concave: and therefore endeavour to restore by their penchant, and pression, the body to its former state. Here it happens, that the subtile matter which flows continually, lengthwise, from one extreme of the spring to the other, affects as much as possible a right line, and consequently endeavours to extend the spring.

Next follow reflections on the *cause of a translated motion, where I'll treat of the laws of motions, observed in the collision of bodies.*

As God is the author of all motions, he has, notwithstanding, established causes, which are the occasion of his creating various motions; which causes are commonly called *second* or *natural*, and by modern Philosophers, *occasional.* Whence tho' bodies considered in themselves, are only accounted passive, not active; if notwithstanding they be consider'd with respect to the bodies they touch or impel, they are said to act on them.

But with what proportion one body operates on another, and communicates to it its motion, and which are the laws established by the author of nature, in the collision of bodies, is what can be discover'd only by observing carefully their natural effects, and a long meditation.

Des Cartes, who first of all attempted that discovery, says, *first*, That all bodies remain in that state in which they were once placed, till that state be changed by the encounter of other bodies. Thus we see a matter, which is square, retaining always the same figure, till something happens from another

ther part, which makes it change that figure. For the ſame reaſon, when the matter is at reſt, it can be excited to motion by another cauſe, but not of itſelf: that when it is moved, it continues in motion as long as it meets with nothing to ſtop its motion.

Secondly, That every part of matter which is moved, affects always a right line, though by the encounter of other bodies, it often ſteps out of the right road, and acquires a circular motion; as it happens in a river, the water whereof running againſt the pile of a bridge, returns back, and acquires a circular motion, when it ſhould have followed the ſtrait way, if it had met with no obſtruction to change its determination.

Hence it is that the ſtone *a*, *Fig.* 26. turn'd round in a ſling, by letting ſlip one of the chords of the ſling, is thrown according to the right line *a g*, which right line is the *tangent* of the circle, delineated by the ſling, *i. e.* it touches it in the point *a*.

Likewiſe, if corn, or any other minute bodies, be put on a mill-ſtone, turning round, and are carried by the motion of the mill-ſtone, they'll come out of it according to the tangent-lines. Whence it may be inferr'd, that all that's moved, even of a circular motion, affects always a right line, and recedes as much as poſſible from the center of motion; which is of a great uſe in phyſick.

Thirdly, *Des Cartes* adds, that as often as a body, which is in motion, meets with another, if it has a leſſer force to go forward according to a right line, than the other has to hinder it; then it reflects on the oppoſite part; and retaining its motion, changes only the determination of motion.

And that if a body, in motion, falls on a weaker body, all the motion it communicates to it, it loſes it. So that if a hard body encounters againſt a ſoft body, it transfers all its motion to it, *v. gr.* if a ball be thrown into a heap of duſt, the whole impetuoſity of the ball paſſes into the heap of duſt, or into the ambient air, and is thereby entirely ſtopped. I do not ſee that this latter part contains any thing contrary to reaſon.

The percuſſion of two bodies can be made in two manners: for either both run mutually againſt one another from oppoſite parts; or one runs againſt another, which is at reſt: or both are carried towards the ſame part, ſo that the body which is laſt, is moved with a greater celerity, and overtakes that which is foremoſt.

If they run againſt one another from oppoſite parts: they are either equal in bulk and velocity, or are equal in velocity, and unequal in bulk or weight; or laſtly, are equal in weight, and unequal in velocity.

If one of them runs againſt another which is at reſt, or that which is leſs runs againſt a bigger, or a big one falls on a leſſer; or an equal runs againſt another equal. Theſe three rules are explain'd by the fourth, fifth, and ſixth rule of *Des Cartes*.

If both are moved towards the ſame part; or an equal body overtakes another equal body; or a leſſer body overtakes a bigger; or laſtly, a greater overtakes a leſs. Whence three rules can likewiſe be eſtabliſhed, relating to this third manner of percuſſion: but *Des Cartes* has eſtabliſhed but one rule for it, *viz.* the ſeventh. For he has propoſed ſeven rules of the communication of *motions*, in the ſecond part of the principles, *Num.* 46. and following.

The firſt is thus: *If two equal bodies, as* A *and* B, Fig. 27. *directed from oppoſite parts with an equal celerity, encounter one another, after the colliſion, they will reflect with an equal celerity towards the place whence they departed.* For there is no cauſe why the motion ſhould periſh, but the determinations muſt be changed.

The firſt rule is obſerved in elaſtick bodies; for in thoſe which have no elaſticity; whether they be inflexible, as imagined by *Des Cartes*, or ſoft, it has no place; becauſe the oppoſite determinations in bodies deſtitute of elaſticity, deſtroy mutually one another; and thoſe bodies are only ſtopped by one another, but do not reflect.

But to apply theſe, and the following rules to experiments; and to imprint a certain quantity of motion into a body, comparatively to another; we commonly take two points in a wall, perpendicularly erected, *viz.* *a* and *b*, *Fig.* 28. to which we affix two nails, from which hang two threads *a g* and *b h*, whereby are deſcribed the two arches of a circle *h l f* and *g i c*, equal between themſelves, and diſtributed into equal diviſions. For then if the two equal balls *g* and *h*, ſuſpended by thoſe two threads, be both thrown down from the ſame height, they will run from oppoſite parts againſt one another in the point *m*, with an equal velocity of motion.

Therefore if they be both elaſticks, *viz.* either marble, or ivory, &c. then after the colliſion, they'll reflect with the ſame celerity to almoſt the ſame height from whence they were thrown. For if an elaſtick ball hits another elaſtick ball with the ſame force it was hit with by that other elaſtick ball; and if there was not a little obſtacle as well from the gravity of the ball, as from the reſiſtance of the air, they would mutually repel one another to the ſame place from which they were thrown.

But if the balls be deſtitute of elaſticity, *viz.* if they be made of ſoft clay, both, after the colliſion, will remain immoveable in the point *m*. Though it muſt not be inferred hence, that their motion is entirely

entirely perished; for it is transferred either into the parts of the balls, which being soft, are compressed, or swell in the form of a belly, or into the incumbent air, and subtile matter.

The second rule.—*If the bodies be unequal, and pushed against one another with an equal velocity; the lesser body shall reflect with the same celerity, and both advance together towards the same part.* This rule seems to me contrary to experience, even in bodies destitute of elasticity, from which *Des Cartes* has established it. For if the two bodies, *g* and *h*, be soft, so that *g* be twice as big as *h*, and both thrown from the same height (*viz.* from *i* and *h*, *Fig.* 28) the body *h* will fly back, but not with the same celerity it came down, for the motion of the lesser body will take from the motion of the bigger one a part equal to itself, and both move towards the part *f*, with that quantity of motion whereby the body *h* was surpassed by the body *g*, before their encounter.

But if those bodies destitute of elasticity, whether they be inflexible or soft, are supposed to have velocities reciprocal with the bulk; so that *v. gr.* the body *g* be twice the body *h*, but, *vicissim*, and moved twice slower, *viz.* if the body *g* be thrown from the point *i*, and the body *h* from the point *f*, which is twice farther, both after the collision, will remain immoveable, as is plainly seen in two soft balls, *viz.* made of clay. But however, as the quantity of motion is deduced both from the bulk and velocity, a body twice lesser than the other, but moved twice swifter, has the same motion as the other: hence it happens, that both rest in the point *m*, as if they were equal, and fallen with an equal velocity.

The third rule.—*If bodies be equal in bulk, but are moved with an unequal velocity, that only which is moved slower, will return back after the encounter, and both will be moved with an equal celerity towards the same part*, v. gr. If the body *g* approaches with six degrees of celerity; and the body *h* with four only, *Fig.* 29. the sole body *h* will return back after the collision, and the body *g*, besides, will communicate to it one of its degrees of velocity, that both afterwards may separately, with each five degrees of celerity, tend towards the same part.

But this rule is false, in that it can be adapted only to bodies destitute of elasticity; and because a lesser quantity of motion remains in them after the collision, than it establishes; for if the two soft bodies *g* and *h*, be supposed equal in bulk; and the body *g* runs with six degrees of velocity against the body *h* at rest, it will communicate to it three degreee of its velocity, that both may be carried with the same velocity towards the same part. But if *h* runs against *g* with four degrees of velocity, as supposed in *Des Cartes*'s hypothesis; then it will borrow four degrees of velocity from *g*, and both after the collision, be moved towards the same part; so that the two degrees of velocity remaining in the body *g*, will be equally distributed in them.

But if those equal bodies are said to be elastick, and the body *g* be thrown from the height *c*; and *h* from the height *l* only, so as the velocity will be greater in the body *g* than in the body *h*, both after the percussion will permute their velocities, and the body *g* reflect only into the point *i*, and the body *h* into the point *f*. The reason whereof is, that the body *g* which is moved with more celerity, strikes stronger the body *h* in the collision, than is stricken by it; hence they must change their velocities between them.

The fourth rule.—*If a body be less than another which is at rest, with whatever celerity it may be pushed against it, it will never communicate a motion to it, but will be reflected by it, into a contrary part*, v. gr. the body C C at rest, never can be moved either by the body A or the body B, *Fig.* 30. because a body at rest resists more to a greater celerity, than to a lesser, and the greater the celerity is in a lesser body, the more the resistance increases in a greater.

But that rule, which establishes rest in a body, as something real and positive, to resist the motion of another body; can be demonstrated contrary, both to reason and to experience.

And first it is contrary to experience: for if some softer body, *v. gr.* if the body *h* runs with three degrees of velocity against the body *g*, twice bigger and at rest; it will communicate to it two degrees of its velocity, and both united, will run with one degree of celerity against a body three times bigger than the body *h*.

If those bodies be elastick, and the lesser body *h* moved, is said to run against the greater *g* and at rest, the lesser body *h* will not (according to *Des Cartes*) return with all its motion, but will communicate something of it to the greater body *g*, having regard to the motion of both, and to the elastick faculty.

This rule of *Des Cartes* is also contrary to reason; for that a lesser body may be capable to give motion to a greater, it suffices that the rest of the greater be not infinite, and the motion of the lesser can be increased *in infinitum*: for hence it will happen at last, that the rest of the greater will be conquered by the motion of the lesser: but the rest of the greater body is not infinite, since it is only attributed to the bulk, which is finite; but the motion of the lesser body can be increased *in infinitum*, since it takes its quantity, not from the sole bulk, which

which is finite; but likewise from velocity, which can be increased *in infinitum*.

Therefore a less body can give motion to a greater, and the fourth rule of *Des Cartes* is not only contrary to experience, but likewise to reason.

The fifth rule.—*If the bigger body C C hits the lesser body A or B which is at rest*, Fig. 31. *it transfers to it as much of its motion as is sufficient to have them both moved with an equal velocity.* Let it be, for example, the body C C, which being double the body A, and having three degrees of velocity, will give one of them to it: for the body A will be equally moved with one degree, as the body C C with two.

This rule is agreeable to experience, since those bodies, after collision, are united into one; but is not observed in elastick bodies: for when a greater body is pushed against another body lesser, and at rest, though the greater begins to move towards the same part, it notwithstanding communicates a greater celerity than that it has, though it does not give it a greater quantity of motion.

The sixth rule.—*If the bodies A and B be equal, and the body B be at rest, the body A hitting with four degrees of celerity against the body B, will communicate to it one of its degrees of celerity, and with the three degrees of celerity remaining, will reflect into a contrary part.*

This rule, even according to *Des Cartes*'s doctrine, is entirely false: for the body A must give half its motion to the body B equal to it and at rest, that together they may advance towards the same parts, provided they be soft, and destitute of elasticity; because then they make but one body.

But if they be elasticks the body A will stop, and transfer its whole motion to the body B which was at rest before. For as the body A has two contrary determinations, one whereby it is carried into the body B, the other whereby it is repelled by its elasticity, those two determinations will mutually destroy one another, and consequently the body A be necessarily stopped: but as the body B has only one determination, which it receives from the body A, it therefore will be moved with that quantity of motion which was in the body A.

Therefore if the body A be pushed against the several bodies C D E F, for example, if a crown be thrown upon other crowns equal to it, all those bodies will stop except the last; for if the body A, in the collision has two contrary determinations, the body B will have two likewise as well as D and E; so that the body *f* which is repelled by none, must be moved.

For the same reason, if two bodies be thrown against several others, they will all stop except the two last. If three were thrown, only the three last would be moved.

The seventh and last rule is a little longer and more intricate, and not true: the sense of it is very near as follows.—*If B and C C*, Fig. 32. *be moved towards the same part, and C C which is double the other, goes foremost, but slower than B, so as to be at last overtaken by it, it can happen that B either will transfer part of its velocity to C C, or fly back with all its motion.*

For if the excess of celerity whereby B surpasses C C, be greater than the excess of magnitude, whereby C C surpasses B; then B will communicate to CC some of its motion; that both may be moved with an equal celerity towards the same part: but if the excess of celerity whereby B surpasses C C be less than the excess of magnitude whereby C C surpasses B, nothing of the motion of the body B will be transferred to CC; but the body B will fly back with all its motion.

This rule can be defended neither by experience, nor by reason: whence we must philosophise in another manner, of the reason of that percussion, and distinguish three cases.

For if the bodies in which the experiment is made be destitute of elasticity, *viz.* *g* and *h*, *Fig.* 33. and are moved towards the same part slowly at first, and afterwards with great celerity: either both are equal, or that which precedes, *viz.* *h* is greater, or lastly, that which follows, *viz.* *g* is greater.

If they be equal, and the body *g* is thrown down from the point *e*, and the body *h* from the point *i*; so that there be four degrees of velocity in the body *g*, and only two in the body *h*: after *g* shall have overtaken *h*, it will communicate to it one of the degrees of its celerity, that both together should proceed forward with three degrees of velocity; which celerity is half the celerity of both bodies taken together: for 4 and 2 degrees is six, and half that sum is 3.

Whence it may be inferred, that if the body *g* be greater than *h*, all other things supposed as before, *g* is not to communicate a whole degree of its celerity to *h*; but if it be lesser, *g* must communicate to it more than one degree of its celerity, because it is distributed according to the bulk. Therefore if when the bodies are equal, and the common velocity after the encounter be half the same composed of the former velocities; certainly when the body which is foremost will be lesser than the other, the common velocity will be greater than half the sum; and when that body will be greater, the common celerity is to be lesser than half the sum.

But if the bodies *g* and *h* be elastick and equal, after *g* will have overtook *h*, they'll interchange their velocities: for if the body *g* was to run, with four degrees of velocity against the body *h* at rest, it would hit it with all those four degrees, and be repulsed by so many degrees afterwards by the elasticity; and thus stop, having transferred its whole motion to the body *h*. Therefore if the body *h* flies with two degrees when hit by the body *g*, the percussion then will be of two degrees only: whence two degrees will be added to the body *h*, and two taken from the body *g*; and thus they will interchange their velocities.

At present I must say something of the *acceleration of the heavy bodies in the descent*. For the intelligence of those things, which have been happily discovered by our modern mathematicians, and have been published almost in our times, as well for the publick utility, as for the increase of learning: I say that,

Heavy bodies accelerate their motion in descending: and that acceleration very near follows the progress of the uneven numbers, 1, 3, 5, 7, since they are continually spurred on by the incumbent subtile matter; for as that subtile matter is always carried upwards, there is no reason or cause why its faculty or efficacy to force the heavy bodies downwards, should be diminish'd or destroyed

That that acceleration follows very near the progress of the uneven numbers, 1, 3, 5, 7, appears not only by the experiments of *Galileo*, but likewise of other famous Mathematicians, who by those they have made, particularly at the Observatory, have found, that a body falling, runs within the second of an hour, or the pulsation of an artery, one six feet; in the second instant, three; in the third, five; or rather, if within a second, it was fallen from the height of twelve feet; it fell within two seconds the height of forty-eight feet; and therefore, had run the second time, thirty-six feet, *i. e.* three times the space it had run the first time.

They have observed this in pendulums. For the ball being suspended at a rod three feet, eight lines and a half long, it performs a single vibration within the time of a second. But if the rod be four times longer, *viz.* twelve feet, two inches, and ten lines, it will perform a single vibration in twice the time, *viz.* in two seconds. So that to the first second are allowed three feet, with eight lines and a half; and to the last, three times three feet, or nine feet, twenty-five lines and a half. If the pendulum be nine times longer, *viz.* twenty-seven feet, six inches, and four lines and a half, it describes its arch within three seconds. For those sums, *viz.* three feet, with eight lines and a half; nine feet, with two inches, and one line and a half; fifteen feet, with three inches, and six lines and a half, make up the sum of twenty-seven feet, six inches, and four lines and a half.

Therefore heavy bodies follow very near, in their descent, especially in the lesser distances, the progress of the uneven numbers, 1, 3, 5, 7, &c.

There is no other cause of acceleration of the the motion of heavy bodies in the descent, than *that*, which first pushes it downwards, *viz.* the liquid matter whereby it is continually depressed.

2. The spaces run through by a heavy body in falling, are, in *Galileo*'s hypothesis, between them, as *quarters of times*. For if a heavy body in the first time, or pulsation of an artery, runs six feet, in the second, nine, in the third, fifteen, &c. it will follow hence, that at the end of the second time, it will have run twenty-four feet, *viz.* six within the first pulsation of an artery, and nine within the second. And if those twenty-four feet, are joined with twenty-eight, which it will run in the third time, they will make up fifty-two feet. And thus, at the end of the third time, it will be found to have run nine hexapedes; and four and nine are quadrate numbers.

This is commonly expressed, *Fig.* 30. in which the triangle, A 11, represents the space run through at the first time; the three triangles comprised within 11 and 22, the space run through at the second time, &c. For 2 and 2 are 4, which is a quadrate number, produced from a binary number, carried into itself. The ratio of all other angles is the same. Therefore the spaces run through by a heavy body in the hypothesis of *Galileo*, which as the lesser distances approaches nearer the truth, are between them as quarters of time.

The same is seen in pendulums; for a pendulum of three feet, eight lines and a half, accomplishes its simple vibration within the space of a second; as we have already observed; a pendulum of twelve feet, two inches and ten lines, within two seconds; and a pendulum of twenty-seven feet, six inches and four lines and a half, within three seconds.

For 3, 12, and 27, are between them as 1, 4, and 9; for every where the first number is contained four times in the second, and nine times in the third; 4 and 9 besides are quarters of times, *viz.* of two and three seconds. Therefore the spaces run through by a heavy body, according to *Galileo*'s hypothesis, are between them as quarters of times.

3. A heavy body, pushed by a horizontal motion *v. gr.* a leaden bullet exploded from a cannon, is carried by one motion only, and describes but one line: but it is moved by two motrice faculties or powers. *viz.* by a *horizontal motion*, from

from the lighted gun powder, and by a *perpendicular one*, from its innate gravity, or rather the pression of the subtile substance. Therefore of that double motion, *viz.* horizontal and perpendicular, is formed a certain composite motion, whereby is described a curve line: which line, such as it is, is made up in this manner.

The horizontal motion, the resistance of the air excluded, follows the natural series of the numbers, 1, 2, 3, 4; and the perpendicular motion advances forwards, according to the uneven numbers, 1, 3, 5, 7, as we have already observed. Therefore the line described by that double motion, the resistance of the air excluded, is a *parabola*.

For, a PARABOLA, *is a line in which the quarters of the ordinates, are between them, as parts of a diameter intercepted by those ordinates.* But a line described by a heavy body, thrown by a horizontal motion, is such a line. For in *Fig.* 31. if the horizontal lines 1 *g*, 3 *h*, 5 *i*, 7 *k*. called ordinate, are between them as the numbers, 1, 2, 3, 4; and the parts 6 1, 1 3, 3 5, 5 7, follow the progression of the uneven numbers, hence it can be understood that a quarter of the line 3 *h*, which is, *v. gr.* of two inches, is to a quarter of that line 5 *i*, which is of three inches, as *a b* 6 3 is to 6 5. For the quarter of the line 3 *h* of two inches is 4, and the quarter of the line 5 *i*, which is of three inches is 9: likewise 6 3, or 6, 1, 3, is 4; for it contains 1 + 3. Likewise 6 5, or 6, 1, 3, 5, is 9: For it contains 1 + 3 + 5. and thus the line *b g h i k*, which describes the water flowing from the fountain *a* through the pipe *b*, is parabolick.

All projected bodies, provided they be not thrown upwards by a perpendicular motion (for then they re-measure the same line) describe in their ascent and descent, an entire parabola.

Let it be, *v. gr.* a bullet exploded from the cannon *p*. *Fig.* 32. and sent according to the line *p m*, as it should be carried into the point *m*, it will be carried by its own weight into the point *a*, then into *g i l o*; and that line *p a g i l o* is parabolick. For as the bullet by its horizontal motion, the resistance of the air supposed, follows the series of the natural numbers, 1, 2, 3, 4, the lines *f g*, *h i*, *k l*, *n o*, will be as 1, 2, 3, 4; but as it follows in the descent the progress of the uneven numbers 1, 3, 5, 7, the parts of the diameter *a f*, *g h*, *h k*, *k n*, will be as the same numbers 1, 3, 5, 7: therefore, as we have observed already, the quarters of the ordinates will be between themselves, as the parts of the diameter intercepted by those ordinates; and consequently the bullet will very near describe a parabola. For heavy bodies do not fall perhaps, exactly according to the progress of the uneven numbers; and the air besides opposing the horizontal motion, hinders those heavy bodies from following the natural series of the numbers, by that horizontal motion; but the difference is not sensible in smaller distances. It does not seem foreign to our purpose to observe here, that bodies thrown to an angle of 55 degree, describe a very great parabola.

For if a bullet be thrown upwards, and according to a perpendicular line, so as to form with the horizontal line a right angle, or of 90 degrees, it will fall through the same line.

But if it follows a line nearer to the horizontal, and form with it a less acute angle, it will fall sooner by its weight.

Therefore to send it very far, and that it may describe a very great parabola, a middle line must be chosen between the horizontal and perpendicular, *viz.* which should form with the horizontal, a semi-right angle, or of 45 degrees.

For that reason, the more or less the line, according to which the projection is made, will be inclined to the horizon, one will be capable to judge into what place the bullets exploded will fall. For if above and beyond the forty-fifth degree of elevation, be taken equi-distant arches, *viz.* 40 and 50, the bullet will always fall in the same place of the horizon. But the parabola described by a bullet exploded according to 50 degrees of elevation, will be higher; and that according to 40 degrees of elevation, lower: though both will have the same amplitude, *i. e.* the bullet will arrive at the same point of the horizon.

If I be asked, which is the cause of the progress of the motion of heavy bodies, by uneven numbers? I answer, that as that progress is not observed with much accuracy, it is very difficult to assign the cause thereof. Though that assigned by *Galileo*, and his disciples, shew a great strength of imagination. Let's suppose, say they, that a heavy body descends so as to accomplish the first time, or within a second, an hexaped; if when it began to be moved, it had had that velocity it acquired after the first time, it had run double the space, *viz.* two hexapedes. Therefore in the second time, by the force of that impetus it has acquired, and which it retains, it will run two hexapedes, and another, besides, by its own gravity; so that it will run three hexapedes. Likewise the third time it will run, by the force it has acquired, not two hexapedes only, but four; to which if one be added, which it acquires by its own gravity, you'll have five hexapedes, which it will have to run in that time. There is the same ratio of increase in all the subsequent times; whereby they pretend that the motion of heavy bodies is to be accelerated

accelerated according to the progreſs of uneven numbers.

Theſe they commonly demonſtrate, *Fig.* 33. in which the line A B is ſaid to repreſent the times, *viz.* A 1, 12, 23, 3 B: and the lines 11, 22, 33, B C repreſent the velocities acquired to each time. And the ſpace over-run in the ſecond time, which is exhibited by the three triangles contained between 11 and 22, is triple that which is run the firſt time, and which is repreſented by the ſingle triangle A 11. Likewiſe the ſpace run through in the third time, and expreſſed by the triangles contained with 22 and 33, is the quintuple of the ſame firſt A 11, *&c.* if the heavy body at the beginning of its motion had had that velocity, which it acquired at the end, it ſhould have run double the ſpace: which is expreſſed by the triangle A B C D, whereof the triangle A B C is but one half. But all theſe things are only ſhadowed with figures, but not demonſtrated.

MEDICINE.

MEDICINE is the art, which treats of the means of *preſerving health*, when preſent; and of *reſtoring* it, when loſt.

If we look back to the *origin* of the art of *medicine*, we ſhall find its firſt foundations to be owing to mere chance, unforeſeen events, and natural inſtinct: in the early ages, the ſick were placed in croſs-ways, and other public places, to receive the advice of thoſe paſſengers, who knew an efficacious remedy ſuitable to their diſorder. And the better to preſerve the memory of a remarkable cure, both the diſeaſe and the remedy were engraved on pillars, or written on the walls of temples, that patients in the like caſes might have recourſe to them for inſtruction and relief. Thus what mere accident had diſcovered, was regiſtered in theſe *chronicles of health*.

This art aroſe from repeated trials and long experience, which gave an inſight into the virtues of herbs and plants, metals and minerals.

As to the part, which reaſon has acted in the improvement of *medicine*, it ſeems to have conſiſted in obſerving, 1. That diſeaſes attended with particular circumſtances, called *ſymptoms*, were ſometimes cured without the aſſiſtance of art, by ſpontaneous evacuations, as *hæmorrhages*, *diarrhœas*, *vomitings*, or *ſweats*: whence bleeding, purges, and vomits took their riſe. 2. That the patients were often relieved, by the *breaking out* of various tumours; whence aroſe the application of *topical* remedies. And, indeed, it is the beſt method of improving *phyſic*, to obſerve carefully what means nature, unaſſiſted by art, employs to free the conſtitution from diſtempers; ſince many important hints may be thence taken, for the relief of other patients under the like circumſtances.

Let us now ſay ſomething of the regular method of ſtudying this art. And firſt, with *Boerhaave*, let us imagine the young ſtudent laying the foundation of his art in the contemplation of *geometrical* figures, bodies, weights, meaſures, velocity, the fabric of, and the power of acting upon other bodies thence ariſing. While he employs his thoughts about theſe matters, he is likewiſe taught a juſt method of reaſoning; after which he may proceed to inform himſelf of the properties of fluidity, elaſticity, tenuity, weight, and tenacity of liquids, from *hydroſtatics*.

His reaſon being by this time much improved, he next applies to ſtudy the forces of fluids upon machines, and of theſe upon fluids; and to demonſtrate them by *mathematics*, confirm them by *hydroſtatics*, and illuſtrate them by chemical experiments; at the ſame time entertaining himſelf with ſpeculations on the nature of fire, water, air, ſalts, and other homogenous bodies.

Having laid this foundation, his next buſineſs is to apply himſelf to the ſtudy of *Anatomy*, in order to obtain a clear idea of the human fabric. To this he joins the knowledge of the vital fluids, and examines them with the aſſiſtance of *anatomy*, *chemiſtry*, *hydroſtatics*, and even of the microſcope; and ſo now you ſee him qualified for writing a theory of health, and inveſtigating the cauſes of diſeaſes. Now behold him buſied in furniſhing himſelf with medicinal obſervations, from all quarters, ſometimes he diſſects the dead bodies of perſons, whoſe diſeaſes he had obſerved; at other times, he marks the ſymptoms of ſickneſs procured by art in brutes; and at length collecting together all the effects of diſeaſes, with their remedies, whether learned from his own experience, or found in the beſt authors, he digeſts, conſiders, and compares them with thoſe which are demonſtrated by theory.

This, he tells us, is the method which he took himſelf, and which he recommended to his pupils, in order to gain a thorough knowledge of *medicine*.

If, then, he would advance the healing art, he ought to collect a ſelect treaſure of *practical* obſervations, reſt ſatisfied with a few but well choſen medicines;

medicines; be thoroughly acquainted with their virtues and efficacy in different constitutions and diseases; despise the cumbersome load of recipes with which practical writers of an inferior rank abound, reject the so much extolled medicines of the *chemists*, and attempt the relief of patients by a proper diet and exercise, and such medicines, as observation and sound philosophy recommend: for to the improvement of *anatomy* and *natural philosophy* is much of the success of *physic* to be attributed.

The knowledge of *medicines*, or suitable remedies are also highly necessary to physicians; who, in order to moderate the *impetus* in acute disorders, make evacuations, blunt acrimony, dilute too thick fluids, condense those that are too thin, brace up too lax parts, and relax such as are too much constricted; they also drive the humours to parts where they will be least prejudicial, upon occasion mitigate pain, and in langours, use stimulating medicines. Wine, vinegar, barley, nitre, honey, rhubarb, opium, and other simples, are found both safe and powerful medicines. *Sydenham* tells us, that all manner of diseases may be cured by bleeding, purging, with a subsequent opiate, and proper regimen. In chronical cases, mineral waters, salts, diaphoretics, soap, mercury, steel, with a few vegetables, and proper exercise, will generally effect the cure.

As to the *drugs* recommended by the *antients*, adds *Boerhaave*, we are, and always shall be, ignorant of them, unless perhaps a few; since they contented themselves with giving the virtues; omitting the description of plants, as things well known. The *moderns*, on the other hand, have been accurate in the descriptive part, but have given us very little concerning the virtues of plants, except what they transcribed from the antients, and this upon an uncertain supposition of the plants being the same. To conclude, what is there in the most elaborate preparation, that is worth half the pains taken about it? *mercury*, *opium*, the *peruvian* bark, and other simples, with fire and water, are acknowledged as the surest remedies by the ablest masters of the art; and these are found to be more efficacious in that crude state, in which bountiful nature has imparted them to us, than after the most operose and artificial preparations. We can despair of nothing, while we follow simplicity; but the event of intricate labour is fallacious.

Physick or *medicine* is divided into *five principal* branches; the *first* considers the human body as curable, and is called *physiology*; the object of this part are called *res naturales*. The *second* considers the diseases, their differences, causes, and effects: as it considers the causes in general, it is called *pathology*, *ætiology* when it penetrates into their causes; *nosology* when it examines their differences: and *symptomatology*, when it explains their effects. The objects of this part, are called *res præternaturales*, or beyond nature.

The *third* branch considers the signs or symptoms, and how to form a just prognostick, or judgment from them; with regard either to the administration of proper remedies, or to pronounce in the affirmative, on the recovery, or the dangerous state the patient is in: this is called *semeiotica*; and its objects are natural, non-natural, and preter-natural.

The *fourth* branch considers the remedies, and their use, whereby life may be preserved, whence it is called *hygieine*. Its objects are what we strictly call non-natural.

Lastly, the *fifth* furnishes the *materia medica*, its preparation and manner of exhibition, so as to restore health, and remove diseases, and is called *theraupeutica*, containing the *diætetica*, *pharmaceutica*, *chirurgica*, and *jatrica*.

I'll begin by an accurate explication of the first branch of *medicine*, viz. *physiology*; since no body can pretend to be a good physician, without as perfect a knowledge as possible can be acquired of the œconomy of the human body, called *animal œconomy*; which œconomy consists chiefly in explaining the parts thereof, their structure and use; but as I have already given that explication at large in my treatise of *Anatomy*, under the latter *A*; I'll content myself with examining carefully in this place, the humours of the human body, since they are the seat of all our diseases: and in proportion as they are predominant over one another, are the occasion of the difference of temperaments or constitutions.

HUMOUR is applied in medicine to any juice, or fluid part of the body, as the *chyle*, *blood*, *fat*, *serum*, *lymph*, *spirits*, *bile*, *seed*, *salival*, and *pancreatick juices*, &c.

The four humours so much talked of by the *antient* physicians, are four liquid substances, which they suppose to moisten the whole body of all animals, and to be the cause of the divers temperaments thereof. Those are the *blood*, *phlegm*, *bile*, and *melancholy*, or *atra bilis*.

The *modern* physicians chuse rather to distinguish them into *nutritions*, called also *elementary*; as *chyle* and *blood*; those *separated* from the blood, as *bile*, *saliva*, *urine*, &c. and those *return'd* into blood.

Humours again are distinguished into natural, or salutary, or morbid and corrupted. To the former belong all the juices ordinarily secreted for the uses of the body.

To the latter belong those compound humours, which thickning and growing putrid, cause tumors, abscesses, obstructions, and most diseases. Of the former *humours* I have spoken at large, under *Anatomy*; and of the latter I'll speak in this place, distinguishing them by various names, viz. *malignant*, *adust*, *acrimonious*, *corrosive*, *crude*, *peccant*, &c. *humours*; as more proper for my present subject.

A *malignant humour* is that, which in a disease renders it more than ordinarily dangerous and difficult of cure, as in epidemical and infectious fevers, attended with spots and eruptions of various kinds.

Adust humour is that, which by long heat becomes of a hot and fiery nature; such is choler supposed to be. Melancholy is usually considered as black and adust bile. Blood is said to be adust when by reason of some extraordinary heat, its more subtile parts are most evaporated, leaving the grosser with all the impurities therein, half torrified, as it were.

Acrimonious humour is that, which dissolves other humours in the body.

Acid humour is that, which coagulates the animal fluids, and produces obstructions with all their train of consequences.

Corrosive humour is that, which carries devastation wherever it passes, even breaking and lacerating the texture of the fibres, &c.

Crude humours are those, which want that preparation and elaboration, which they ordinarily receive from a thorough digestion.

Peccant humours, are those which offend either in quantity or qualities, *i. e.* when they are either morbid or in too great abundance, which humours are the cause of most diseases.

This brings us to the second branch of medicine, called *pathology*, and which considers *diseases* in general.

Disease, in *Medicine*, is that state of a living body, wherein the principal functions thereof, are either obstructed, impaired, or some of them entirely suspended.

An ingenious author holds the essence of a disease to consist in a want of that equilibrium between the solid and fluid parts, which is necessary to the maintenance of health: others add, that all diseases arise either from too lax or too strict a tension of the fibres.

Some diseases only impair the use of the part, as the *opthalmia*, *gout*, &c. others destroy it entirely, as the *gutta serena*, *palsy*, &c. some affect the whole body, as the *fever*, *apoplexy*, *epilepsy*, &c. others only impair a part, as the *Asthma*, *colick*, *dropsy*, &c. some only affect the body, as the *gout*; others disturb the mind, as *melancholy*, *delirium*, *vertigoes*, &c. others affect both the body and mind, as the *mania*, *phrenzy*, &c.

As the actions or conditions of the body, so also the diseases or effects thereof may be reduced to three general heads, *viz.* 1. Diseases of the *solid parts*.—2. Those of the *fluid parts*.—And 3. Diseases compounded of both.

A popular syllabus of diseases may be given, as follows:—the *solid parts*, i. e. the bones and flesh, may be disordered five ways, *viz.* rendered turgid by tumors, cut with wounds, corroded by ulcers or caries's; removed out of their places, as in hernia's, prolapsus's, and dislocations; or discontinued by fractures or contusions.

Diseases of the *fluids*, are either in the mass of the blood or the spirits:—those of the blood are reducible to two kinds, *viz.* those that thicken or inspissate, or, which amounts to the same, retard its motions; and those which attenuate and dissolve, and consequently accelerate it.

To this latter kind belong *fevers*, and feverish affections alone: all other diseases of the blood belong to the former.

In too thick a state of the blood, its principles are too crass, and its molecules too big, whence a lentor, lazy motion, and even stoppage, particularly in the sinuous passages of the glands: hence *obstructions*, *inflammations*, *scirrhus's*, *sarcoma's*, *veruca*, *pustules*, *œdematæ*, *impetigines*, and other *tumors* and *congestions*, both in the viscera, and habit of the body: and hence again, *drowsiness*, *melancholy*, *hypochondriacal affections*, &c. if this thick blood be too much replete with sharp acrid salts, it will destroy the texture of the parts and break out in ulcers, as in *phthisical*, *scrophulous*, *scorbutick*, and *venereal diseases*, *gangrenes*, *carbo's*, *cancers*, and other *erosive tumors*, according to the quality and degree of saltness and acrimony; and from the same source arises *cephalalgia's*, *cardialgia's*, *colicks*, *gout*, *rheumatism*, *pleurisies*, &c. which by abraiding the solid substance frequently emaciate the body.

The diseases of the *animal spirits* arise either, 1. From an intermission or retardation of their motion; or a diminution of their quantity; or,—2. From a disorder in their quality.

To the first class are reduced the *catalepsis*, *apoplexy*, *comacarus*, *palsy*, *stupor*, *tremor*, &c. To *the second*, belong the *mania*, *phrenzy*, *delirium*, *foolishness*, *melancholy*, *vertigo*, *spasms*, *epilepsy*, *hysterick affections*, *horror*, &c. Add, that as all diseases of the blood arise from external causes, *viz.* some one or more of the non-naturals, as food, air, evacuation,

evacuation, &c. so those of the spirits generally proceed from disorders of the blood.

Lastly, the diseases of the *fluids*, whether those in the blood or spirits, are seldom confined long thereto; but presently come to disturb and impede some of the functions of the solid parts, and at last corrupt the substance of the solids themselves. Hence compound or complicated diseases, which are infinitely various.

Boerhaave divides diseases into those of the *solids* and *fluids*.

Diseases of the *solids* he considers either of the *simple* and *similar* parts, or of the *organical*.

Similar diseases are, 1. Those of the least and smallest *fibres*, which are reducible to too great tension and laxness, too great strength or weakness, and a solution of their continuity.

2. Those of the *membranes*, which being only assemblages of the fibres mentioned, are subject to the same disorders.

3. Those of the last and smallest *canals*, which are formed of such *membranes*.

4. Of the *membranes* composed of such canals.

5. Of *canals* composed of such membranes, which are all the greater vessels of the body.

6. Of the *solid parts*, which are composed of canals compressed, and grown together so as to be void of humour to distend them; or canals growing into a consistent part, the humour hardening together with the vessel that contain it.

Lastly, supposing these parts all sound, diseases may befal them with respect to their structure, from a vice, or vicious application of the matter of nutrition.

Organical diseases.—An organical part consisting of the several simple parts above mentioned, and fitted to perform any office by means of some humour contained in it; may be considered, either in itself, as a solid part, or with respect to the humour it contains: in the first view, *organical diseases* are reducible to four classes.

1. Disorders in the figure and circumstances thereof; as *roughness*, *solidity*, *cavity*, &c.—To this belongs *anastomosis*, when one vessel opens into another; the *diapedesis*, when a rupture is made; *diaresis*, when a breach is occasioned by corrosion; the *emphrasis*, which is the total obstruction of the cavity, by a vicious grumous matter; the Στενοχωρια, or narrowness of the passage; the Θλιψις, or compression of the sides of the cavity; Συμφυσις, when the sides are quite closed up; and Συνιζησις, when the vessel is so emptied that the sides falling together, the cavity is lost.

2. In the number, where it is either deficient or redundant: but the parts seldom err in this respect, so as to occasion a *disease*.

3. In the magnitude; to which belong nodes, exostoses, and callus's.

4. In the situation and connexion; as when the ligaments are too long, or too short, when broke or depraved; also *distortions*, *luxations*, *subluxations*, *herniæ*, or *ruptures* in the groin, scrotum, bladder; *procidentiæ*, of the womb, bladder, and rectum; disorders of the tendons and muscles, particularly their flying out of their places; the relaxation or rupture of the membranous ligament that should retain them.

Lastly, there is a *disease*, common both to *similar* and *organical* parts, called *solution of continuity*; wherein their natural cohesion is separated: as by a wound or other cause.

If this happens to a simple similar part of the body, it is called simply *solutio continui*.—If to a compound or organical part, it acquires a particular denomination, from the nature of the part, the difference of the cause, or the manner of application; as a *wound*, *rupture*, *fracture*, *puncture*, *fissure*, *contusion*, *ulcer*, *corrosion*, *dilaceration*, *exfoliation*, *caries*, &c. all which are explained in the treatise of *Chirurgery*.

Diseases of fluids, considering those fluids simply, and in themselves, may be reduced to disorders in respect of quantity or quality; but considering them as contained in solids, they may err to in place and proportion.

As to the *first*, such an abundance of the humours, as disturb the animal functions, is called a *plethora*.

Plethora is chiefly understood of the blood, tho' sometimes of the other humours.

The *plethora* is the consequence of a good chylification, sanguification, &c. attended with a too sparing discharge by perspiration.

The *plethora* is chiefly produced in a body, whose organs of digestion are strong, blood-vessels lax, diet full of good juice, temperament sanguine, mind at ease and indolent, of a middle age, and in a moist air.—It renders heat and motion intolerable; stretches the great vessels, and compresses the smaller: and hence stiffness and heaviness, and on the least occasion ruptures in the vessels, suffocation, &c. *Diseases* from the defect of humours, we scarce know of any.

As to the *second*, such quality of the humours as disturb the animal functions is called *cacochimia*. Now this is either in the fluids considered in themselves, their own parts, and composition: or considered as they concur towards constituting som part of the body.

Gorœus gives the name *cacochimia*, to the abundance, or excess of any ill humour; whether it be

bile,

bile, pituita, *&c.* provided there be only one that thus offends in quantity.

If the morbid quality be conſidered in the particles of the humour, it muſt either conſiſt in an augmentation of bulk, whence the *emphraxis*, *atrophy*, *ſymphyſis*, and *ſynereſis*; or in the diminution thereof, as in the *diapnoe* and *ceneangeia*; or in an increaſe of ſolidity, whence too great an attenuation; or a decay thereof; whence a *lentor*, *ſtagnation*, and *coheſion*; or in the figure, as when of ſpherical it become angular, and conſequently, with reſpect to the part it is applied to, ſharp; whence *acrimonies*, both acid, alkaline, muriatick, ammoniack, ſaponaceous, vitriolick, *&c.* and oleoſities; or in rigidity and flexibility; or in elaſticity; or in coheſion, and diviſibility.

Again, all the juices being conſidered together, the principal diſorders they are ſubject to, are too great fluidity or tenacity; too much velocity in their veſſels, or too little.

Laſtly, conſidering the fluids are contained in the ſolids, there ariſes divers *diſeaſes*, merely from their changing of place; which may be reduced to two claſſes, *viz.*—The groſſer humours intruding themſelves into the finer canals; and the humours extravaſating, or getting out among the ſolid parts; whence *inflammations aneuriſma's*, *varices*, *echymoſes*, *œdema's*, *puſtules*, *dropſy*, *ſpongeous membranes* of the head, breaſt, abdomen, and uterus; and *emphyſema's*; all mentioned at large in the treatiſe of *Chirurgery*.

Add, that the humours collected and ſtagnating among the parts, grow putrid, purulent, ichorous, eroſive, and ſharp; and thus deſtroy the tender ſtamina of ſolids; whence *ſinus's*, *fiſtula's*, *ulcers*, *gangrenes*, *ſphacelus's*, *cancers*.

Thoſe are the prime differences of the diſeaſes of the body, and from theſe ariſe moſt of the reſt: ſo that they may be regarded, not only as diſeaſes, but as the cauſes of diſeaſes.

There is another diviſion of *diſeaſes* in uſe among Phyſicians, taken from certain external accidents, and are diſtinguiſhed,—1. With reſpect to their cauſe, into *idiopathy*, *ſympathy*, *protopathy*, *deutropathy*, *hereditary*, *connate*, and *acquired*.

IDIOPATHY is a diſeaſe, or indiſpoſition, peculiar to ſome member, or part of the body; not cauſed by any other *diſeaſe*, or preceding affection; nor having any dependance on the reſt of the body. Thus a cataract in the eye in an *idiopathy*; and epilepſy is either *idiopathick* or *ſymphatick*; *idiopathick*, when it happens purely thro' ſome fault in the brain; *ſympathick*, when it is preceded by ſome other diſorder.

SYMPATHY is an indiſpoſition befalling one part of the body, through the defect or diſorder of another; whether it be from the affluence of ſome humour, or vapour ſent from elſewhere; or from the want of the influence of ſome matter neceſſary to its action.

HEREDITARY are *diſeaſes* capable of being tranſmitted, by blood, from father to ſon. The *gout*, *king's evil*, *madneſs*. &c. are *hereditary diſeaſes*, i. e. are tranſmitted from the parents in the ſtamen, or firſt rudiments of the fœtus; and ſuch, probably, is the origin of numerous other chronick *diſeaſes*.

2. With reſpect to their ſubject, into diſeaſes of old age, children, adults, men, women, maids, pregnant, parturient; endemical, epidemical, *&c.*

Endemical diſeaſe is that which affects many people together, in the ſame country; as proceeding from ſome cauſe peculiar to the country where it reigns:—Such are the *ſcurvy* in the northern climates; *intermitting fevers* and *colicks*, in marſhy places, *&c.*

Epidemical diſeaſe is a general or ſpreading diſorder, as the plague, ariſing from ſome corruption, or malignity of the air, which ſeizes a great number of people in a little time.

3. With reſpect to duration, into *moſt acute*, which terminate in four days; *acute*, in twenty; and *chronical*, which are all thoſe of longer continuance.

4. With reſpect to ſeaſons, into *vernal*, *autumnal*, *continual* and *intermitting*.

5. With reſpect to their effects, into *benign*, *malignant*, *curable*, *incurable*, *mortal*, and *contagious*.

And, 6. With reſpect to their ſtate, into *beginning*, *progreſs*, *ſtate*, *declenſion*, and *end*.

The entering into a particular examen of the cauſe of a particular diſeaſe, is called *æthiology*. To examine their differences, *noſology*; and to explain their effects, *ſymptomatology*; all which I'll treat of in the examen of the different maladies of the human body: and this leads me into the third branch of my diviſion of *Medicine*.

The third branch of *Phyſick* or *Medicine*, called *ſemeiotice* or *ſemeiotica*, is that part which conſiders the ſigns or indications of health and diſeaſes.

INDICATIONS, in *Phyſick*, ſignnifies the pointing out, or diſcovering what is fit to be done, and what means applied in any caſe from the knowledge of the nature of the diſeaſe, and the virtues of medicines.

There are four kinds of *indications*, viz. *preſervative*, *curative*, *palliative*, and *vital*.

A *preſervative indication* is that, which directs how to cut off the cauſe of an approaching diſeaſe.

A *curative indication* is that, which ſhews how to remove a diſeaſe actually formed.

A *palliative indication* directs how to leſſen the effects of a diſeaſe, or take off ſome of its ſymptoms, before it can be wholly removed.

And *vital indication* relates to the ſtrength of the body, which muſt be narrowly inquired into, before any remedy, particularly a violent one, can be adminiſter'd with ſafety; a phyſician ſhould make it his whole ſtudy to examine carefully all the *indications* mentioned.

1. The *preſervative indication*, by preſcribing in time to his patient, remedies which he thinks the moſt ſpecifick to prevent a malady, which he ſees him threaten'd with: and not ſuffer a ſlight indiſpoſition to degenerate perhaps into a dangerous malady.

2. If the diſeaſe be actually formed, then the *curative indication* is to be minded, by preſcribing thoſe remedies, which he knows to be the moſt ſpecifick, for the ſpeedy cure of ſuch a malady, without loading the ſtomach with poiſonous medicines.

3. The *palliative indication* is of very great conſequence, ſince there are ſometimes ſymptoms much more dangerous than the malady itſelf, and which neglected, even for ſo ſhort a time, put the patient in very great danger; and others, which, if not taken off, will render the diſeaſe rebellious to all remedies; therefore this axiom is not true, in all circumſtances, *ſublata cauſa tollitur effectus.*

4. As to *vital indications*, though the remedy is well appropriated to the malady, and produces the effect expected from it; if it operates with too much violence, it may weaken the patient to ſuch a degree, as to reduce him into a worſe condition, than he was while afflicted with the diſeaſe he has been cured of,

The *counter indications* contribute alſo very much towards avoiding thoſe dangerous inconveniencies. For a *counter* or *contra indication*, is an *indication* which forbids that to be done which the main ſcope of a diſeaſe points out. Suppoſe, *e. gr.* in the cure of a diſeaſe, a vomit were judged proper, if the patient be ſubject to a vomiting of blood, or has an extremely weak ſtomach, it is a ſufficient *contra-indication*, as to its exhibition: for if he be ſubject to a vomiting of blood, the efforts made in vomiting may cauſe a violent hæmorrhage; and if his ſtomach be very weak, vomiting may occaſion a ſyncope, or other dangerous accidents. The ſame is to be ſaid of thoſe who are ſuſpected to have abſceſſes in the capacity of the breaſt, who are not to take vomits, for fear they ſhould be ſuffocated, during the efforts, by the abſceſs breaking at that time.

Next to *indications*, and *contra-indications*, are *ſigns*, which in medicine denote ſome appearance in the body, diſtinguiſhable by the ſenſes; whence, by juſt reaſoning, is inferred the preſence, nature, ſtate, of health, a diſeaſe, or death.

Thoſe *ſigns* which denote the preſent condition of a body, whether ſick or well, dying or the like, are called *diagnoſtick ſigns.* Thoſe which foretel the future ſtate thereof are called *prognoſtick ſigns.*

As all *ſigns* are effects produced by the cauſe of the diſeaſe, the diſeaſe itſelf, and the ſymptoms; they uſually note the preſent condition of the matter which firſt produced the diſeaſe, and even of that produced by the diſeaſe: on which footing *ſigns* are all reducible to theſe three claſes, *viz.*—*Signs.* 1. Of crudity and coction of the diſeaſe. 2. Of its event, whether in health, ſickneſs, or death. 3. And of its ſecretion and excretion; which laſt ſigns are called *critical* ones.

Crudity, ſometimes denotes that ſtate of a diſeaſe, wherein the morbifick matter is of ſuch bulk, figure, coheſion, mobility, or inactivity, as creates or increaſes the diſeaſe.

The *crudity* is diſcovered,—1. From the diſeaſe continuing its degree of ſtrength, or increaſing.—2. From a continual increaſe of ſymptoms.—3. From a diſorderly exerciſe of the functions.—4. But chiefly from a fault in the quantity or quality of the humours; both thoſe ſtill circulating, and thoſe ſecreted; as of *ſweat*, *tears*, *mucus* of the noſe, *ſaliva*, *ſputum*, the *bile*, *urine*, *ichor*, *pus*, *blood*, *menſes*, *lochia*, *milk*, *aphthæ*, &c.

The ſtate of the diſeaſe wherein the crude matter is changed, and rendered leſs peccant and laudable, is called *digeſtion*, *concoction*, or *maturation.*

Digestion is that ſtate of a diſeaſe wherein the morbifick matter is ſo changed in bulk, figure, coheſion, mobility, *&c.* by the uſe of proper medicine, or even by the force of nature, as to be leſs noxious, and hurtful, and conſequently to abate the violence of the diſtemper. The matter of the diſeaſe ſo far *digeſted*, as to become next a kin to ſalubrious or healthy matter, is ſaid to be reſolved; which is done either by the natural ſtrength of the patient, or of its own accord, or by the application of remedies; whereby its bulk, figure, coheſion, *&c.* are ſo far changed, as that is ceaſes to be morbid, and becomes laudable.

This, *Boerhaave* obſerves, is of all others the moſt perfect cure, where it is effected without any evacuation; as ſuppoſing the matter favourable, the conſtitution excellent, and the medicines good.

Critical figns are certain figns ufually arifing in the courfe of acute difeafes, as fevers, fmall-pox, *&c.* which indicate the patient's ftate, and determine him either to recover or grow worfe

The *crifes* have been frequently obferved to happen on the feventh, fourteenth, or twentieth day.

As to the *theory of critical days*, it may be obferved, that the connection of any morbifick matter and the humour to be fecerned, is nothing elfe but a change thereof into fuch a due magnitude or fmallnefs, as it may be carried by the circulating blood along the canals, and excerned by veffels deftined for that purpofe. But if the morbifick matter cannot be reduced to fuch a magnitude or fmallnefs as may correfpond to the orifices of the fecretary veffels; then either an abfcefs or hæmorrhage will follow, if a *crifis* be begun; for which reafon abfceffes, *&c.* are accounted lefs *perfect crifis*. But that the morbifick matter may be reduced to a due magnitude or fmallnefs, and its wifh'd-for difcharge take place, there is required a confiderable time, if the quantity of matter be large; that is, if the diftemper be great and fevere: and fince there are a great many caufes, and thofe very conftant, which may occafion the blood and offending humours therein, to be of a different fluidity in the inhabitants of different climates; it is impoffible but that different fpaces of time fhould be required for the finifhing concoction: which make it impoffible to determine the *critical days* in one climate, from what they are found to be in another.

Among all other figns, a judicious phyfician muft mind, in a particular manner, the *critical* and *prognoftical* ones. The *critical*, becaufe though a difeafe declares itfelf favourably, by fome figns of a good crifis; if thofe figns be not minded, the *crifis* may be either neglected, and thereby fruftrated of the good effects it would otherwife have produced; if, *e. gr.* by a fweat, in fuffering the patient to cool himfelf, either outwardly, by thrufting his arms out of his bed, *&c.* or inwardly, by taking fome cooling draughts, *&c.*—Or prevented, by the adminiftring of fome remedy, to procure the evacuation of the morbifick matter, otherwife than nature had determined itfelf to do it; whereby being difturbed in its falutary operations, the patient is expofed to the imminent danger of lofing his life. The *prognoftick figns* are very near of the fome confequence; fince it is on them that the Phyfician muft found his judgment of the recovery or death of his patient; in which he muft not fhew too much precipitation, inclining rather to uncertainty, while he fees fome probable figns of a recovery, let them be ever fo fmall or glimmering, than pronounce affirmatively on the death.

Symptom is ordinarily confounded with *fign*, and defined an appearance, or affemblage of appearances, in a difeafe, which fhew its nature and quality; and from which one may judge of the event thereof.

In which fenfe a *delirium* is held a fymptom of a *fever*.—*Pain*, *wakening*, *drowfinefs*, *convulfions*, *fuppreffion of urine*, *difficulty of breathing* and *fwallowing*; *coughs*, *diftaftes*, *naufea's*, *thirft*, *fwoonings*, *faintings*, *loofenefs*, *coftivenefs*, *drynefs*, and *blacknefs of tongue*, are the principal fymptoms of difeafes.

Boerhaave gives another notion of fymptoms: every preternatural thing arifing from a difeafe, has its caufe, in fuch manner, however, as that it may be diftinguifhed from the difeafe itfelf, and from its next caufe, is properly a *fymptom* of the difeafe.

If it arife, after the fame manner, from the caufe of the difeafe, it is called a *fymptom* of the caufe.

If it arife from fome former *fymptom*, as its caufe, it is properly called a *fymptom* of a *fymptom*.

Whatever happens to a difeafe from any other caufes than thofe mentioned, is properly called an *epigennema*.

Hence it appears, that the *fymptoms* above recited, are really difeafes themfelves. They are various as to number, effect, *&c.* though, after the antients, they may be conveniently enough reduced to faults in the functions, excretions, and retentions.

Under the firft come all diminutions, abolitions, increafes, and depravations of animal actions, particularly with regard to hunger and thirft, fleeping and waking.

Under the fecond come *naufea's*, *vomitings*, *lienteries*, *cœliac affections*, *diarrhœa's*, *dyfenteries*, *illiack paffions*, &c.

Under the third come the *jaundice*, *ftone*, *dropfy*, *fever*, *ifchuria*, *ftrangury*, *afthma*, *catarrhea*, &c.

Let us now confider the fourth branch of my divifion of *Medicine*, called *Hygieine*.

Hygieine may be divided into three parts, *viz.* *Prophylactice*, which forces and prevents difeafes.—*Synteritice*, employed in preferving health.—And *Analeptice*, whofe office is to cure difeafes.

But before I proceed further on this divifion, I muft give the reader a notion of *remedies* or *medicines* in general.

Medicines, or *remedies*, or *medicaments*, denote any natural fubftances applied to a human body, in order to anfwer fome intention of cure.

Medicines are diftinguifhed, with regard to the manner of application, into *internal* and *external*.

Internal medicines are thofe taken in at the mouth.

External

External or *topical medicines* are those applied outwardly to any particular part.

With regard to their different manner of operation, *medicines* are distinguished into *agglutinants, alterants, anastomachics, astringents, evacuents, incarnatives, specificks,* &c.

A general idea of the manner wherein *medicines* operate on a human body, as explained by the sect of mechanical physicians, may be conceived from what follows.

A few different sorts of particles, variously combined, will produce great variety of fluids; some may have one sort, some two, some three or more. If we suppose only five different sorts of particles in the blood, and call them *a, b, c, d, e*; their several combinations, without varying the proportions in which they are mix'd, will be these following; but whether more or less need not be determined.

a b : *a c* : *a d* : *a e* :
b c : *b d* : *b e* : *c d* :
c e : *d e* : *a b c* : *a d c* :
a b d : *a b c* : *a c e* : *a d e* :
b d c : *b d e* : *b e c* : *d e c* :
a b c d : *a b c e* : *a c d e* : *a b d e* : *b c d e* : *a b c d e.*

I must confess that this system of combinations, adapted to the different manner of the operating of remedies, is a pretty diverting thing, especially for those which have some notion of Algebra: but I must confess also, that in my sentiment, it has no other merit; and does not at all explain in an intelligible manner, that of operating of medicines; and there is scarce any appearance of truth in it, the whole system or hypothesis being founded in part on the false supposition, that purgatives penetrate as far as the substance of the blood, to separate the humours which superabound in it, in order for their secretion, which is false; for if *purgatives* were to enter the substance of the blood, they would prove more prejudicial than beneficial to it, for by the excessive fermentation they might excite in it, they would so disunite the particles the whole mass is composed of, as to occasion diseases much more dangerous than those whereof the cure is attempted by their means; therefore *purgatives* operate no where else but in the primæ viæ; where by irritating the glands they meet with on their passage, they force them to contract themselves with such violence, as to secrete through their spongeous substance the humour they contain; and as there is no intermission in the circulation of the blood, and in that circulation it is always unloading itself of the superfluous humours, more or less, according to its faculty of secretion, which is increased or diminished, in proportion to its greater or lesser velocity, the glands are no sooner empty but they are filled again; and as they are some time before they can recover their former state and contract their pores, extremely dilated by the irritation, the secretion continues, more or less, according as the purgatives are more or less violent, and consequently have made a greater or lesser impression on the membranes of the glands; and if the irritation has been excessive, the pores of the glands being excessively dilated every where, as well towards receiving the secretion of the blood, as towards secreting that secretion; the evacuation of the humours will consequently be more copious, and continue longer, whereby one may very well account for the copiousness of a salivation; for as the pores of the glands are extremely dilated by the continual rotation of the mercurial particles thro' them; when a too great quantity of those particles is introduced into them, by means of a too copious friction, or inward administration of mercurial preparations, that rotation being more violent by a too great number of the mercurial particles crowding through the pores, they are so much dilated, that their contractive faculty is thereby almost entirely imbecillitated; so that the humours finding a more free passage that way than any where else, flow all thither in abundance, and with great impetuosity.

As to *sudorificks*, they certainly penetrate as far as into the substance of the blood; for as they are composed of more subtile particles than the purgatives, and those particles less embarassed with viscous and ramous ones, they are therefore easier volatilized in the stomach, and rendered capable thereby to penetrate the most exiguous pores of the substance of the chyle, which ushers them along with it into the mass of blood; and the greater is the number of those particles it is loaded with, the more copious is the secretion of the humours, for if they be but in small quantity, they only produce an insensible perspiration, if otherwise they provoke sweat. Their manner of operating in the blood is by rarefaction; but as though humours cannot be all equally well attenuated, some of them, especially the phlegm, being of a too viscous texture to be entirely rarefied, the coarser particles thereof being too heavy to be ushered through the pores, along with the volatile ones of the remedies, which the native heat keeps in a continual motion, they follow their own propensity downwards, and are evacuated through the primæ viæ along with the urine; those who have took a sudorifick evacuating much more of that excrement immediately after the remedy has done operating, or even while it operates than they did before.

The *diuretick*s being compoſed of hooked, ſharp, and inciſive particles, faſten or entangle themſelves in the ramous texture of the phlegm, which they ſhake and lacerate, more or leſs, according as their motion is more or leſs accelerated by the native warmth, which laceration producing a more than ordinary heap of watery humour, that humour forces with impetuoſity through its natural paſſage, meeting with oppoſition from all other parts, whence enſues a greater evacuation of urine.

Now for the diviſion of *hygiene* into *prophylactice*, *ſynteritice*, and *analeptice*.

Prophylactice is that part of *Medicine*, which directs the preventing or preſerving from diſeaſes; which conſiſts, according to ſome, in taking remedies by way of precaution.

The principal preſervations, according to *Boerhaave*, are abſtinence, quiet, drinking of warm water; and after this a gentle and continued motion till the firſt appearance of ſweat; then a profuſe ſleeping, the body well covered.

By ſuch means, ſays he, groſs humours are dilated, the veſſels relaxed, and noxious matter excreted.—He adds, that the beſt defence againſt the force of external cold, is to leſſen the winter's cloathing late in the ſpring, and to encreaſe the ſummer's cloathing ſoon in autumn.

Dr. *Wenceſlaus Dobr. Zenſky de Nigro Ponte* gives us an univerſal *preſervative* againſt infection in all diſeaſes. Whoever, ſays he, in converſing with patients of any kind, would preſerve himſelf from infection, muſt, while he is within the ſphere of their effluvia, never ſwallow his ſpittle, but ſpit it out: for he conceives it to be the ſpittle that firſt imbibes the infection.

Syteritice relates to what is uſed to preſerve health; therefore there is no difference between it and *prophylactice*; for the ſame means which are uſed to prevent diſeaſes, are uſed to preſerve health.

Analeptice relates to remedies proper to reſtore the body, when waſted or emaciated, either by the continuance of a diſeaſe, or the want of food; which remedies are called *reſtoratives*.

The *medicines* that come under this denomination, are of an emollient ſoftening nature, but nutritive withal, and are rather adminiſtered to repair the waſtes of the conſtitution, than to alter and rectify its diſorders.

Such are ſuppoſed to be the leaves of *white and black maiden-hair*, *black hellebore*, *rocket*, *eruca*, *ſcabious*, *colts-feet*, [illegible], *chick peas*, *hops*, *chocolate*, *piſtachio nuts*, *balſam of Tolu*, *bdellium*, *benzoin*, *ſtorax*, *eryngo*, *iris*, *ſatyrion*, generous wines, mutton-juice, and a juice extracted from beef, and the trunks of vipers, in balneo mariæ, to take two or three ſpoonfuls of it twice or thrice a day.

To reduce all this theory into practice, I'll divide the human body into three parts, *viz.* the *head*, *breaſt*, and *abdomen*; and treat of all the different diſeaſes each part is ſubject to; of their cauſes, ſymptoms, prognoſticks, and the manner of curing them. Beginning by the diſeaſes of the head.

Diseases *of the* Head. The Head, is ſubject to ſeveral very dangerous diſeaſes, *viz.* to the *apoplexy*, *carus*, *coma*, *epilepſy*, *lethargy*, *mania*, *madneſs*, *palſy*, *phrenzy*, *ſyncope*, &c.

The Apoplexy, is a ſudden privation of all the ſenſes, and all the ſenſible motions of the body, except thoſe of the heart and lungs, attended with a great depravation or ſuſpenſion of the principal faculties of the ſoul.

Hippocrates diſtinguiſhes two kinds of *apoplexies*, the one *ſtrong*, the other *weak*; only differing in the greater or leſs difficulty of reſpiration and pulſation. In the *former* the pulſe and breath ſeem entirely ſtopped. In the *latter* there are conſiderable remains of them.

The more modern authors diſtinguiſh *apoplexies* from their cauſe, into *ſanguineous* and *pituitous*; to which may be added *lymphatick*, *polypous*, *ſerous*, *atrabilary*, &c.

Cauſes of Apoplexy. — *Apoplexy* is occaſioned by a ſudden and violent obſtruction of the circulation of the animal ſpirits, through the organs of ſenſe, and a ſuſpenſion of their generation in the ventricles of the brain, proceeding either from an interruption of the paſſage of the blood into the brain, whereby it is deprived of the vital ſpirits neceſſary for the formation of the animal ones; or from an abundance of phlegm, or viſcid pituita, wherewith the brain is oppreſſed, as is obſervable in winter *apoplexies*, or in thoſe of old people; or from a melancholick acid humour that coagulates the blood, or too groſs a lympha which ſtop up the nerves, or a plethora which oppreſſes them; or from excreſcences withinſide the cranium preſſing the veſſels; or from a polypus blocking up the carotydes, *&c.*

Signs of an Apoplexy. — The fit of an *apoplexy* is uſually preceded by a violent pain of the head, dimneſs, and loſs of ſight or memory. — Sometimes by an univerſal indolence; and ſometimes by a flux of pituitous matter by the noſe and mouth.

Symptoms of Apoplexy. — *Apoplexy* is attended with a ſnoring and difficulty of breathing; ſometimes with a fever, rarely with a foaming at the mouth, frequently with a ſweat, hæmorrhoids, or diarrhæa, and ſo goes off.

Prognoſtick

Prognostick of Apoplexy. — *Apoplexy*, in general, is always very dangerous; but much more so when it proceeds from a groſs lympha, which obſtructs the paſſage of the animal ſpirits through the nerves; or a coagulated blood; for as that malady cannot be cured but by large evacuations; the groſs lympha cannot be evacuated, till it be rarefied, which rarefaction cannot be done always ſo ſoon, as it would be neceſſary to ſave the life of the patient: neither can the blood be eaſily diſſolved; therefore the patient moſt commonly dies of an *apoplexy* proceeding from thoſe two cauſes; and always of that proceeding from a polypus. — The leſs dangerous is that cauſed by a pituita, or an atrabilis, which can be eaſily rarefied by remedies adminiſtred in time; and theſe are the kinds of *apoplexy* which have theſe intervals, the laſt whereof is almoſt always mortal.

Cure of the apoplexy. — To prevent an *apoplexy*, wine and hard labour are to be avoided; no eating to exceſs; nor no ſleeping after dinner; exerciſe to be kept up; and care and chagrin to be kept under. — To *cure* an *apoplexy*, medicines muſt be uſed that occaſion large evacuations; and nothing of opiate or aſtringents to be meddled withal. During the fit, copious bleeding in the jugulars to be uſed, and the patient laid on his back, applying ſtrong volatiles to the noſe; blowing up ſtrong ſternutatories, and rubbing the temples with cephalick mixtures. A hot iron may alſo be applied near the vertex or occiput; and epiſpaſticks to the neck: to which are added powerful purgatives, clyſters, &c. — Cupping, and ſcarifications on the head, are commended by ſome in lieu of venæſection.

Boerhaave preſcribes for the *Apoplexy*, the following *gargariſm*, *maſticatory*, *vomitive*, *purgative*, *fumigation*, and *clyſter*.

Gargariſm — Take the roots of imperatory, pyrheter, and ſmall galanga, of each an ounce; the leaves of rue, origan, and thyme, of each a handful; flowers of lavender, and matricary, of each an ounce; the bark of winter, ſix drachms: mix all the ingredients to boil in three pints of water, in a veſſel well cover'd, to the diminution of a fourth part; ſtrain the decoction, and to the colature, when cold, add three drachms of ſpirit of ſal armoniack, for a gargariſm, which muſt be uſed cold.

Maſticatory, which excites a ſalivation. — Take maſtick, white wax, ginger, of each an ounce, to make paſtiles, &c.

Vomitive. — Take an ounce and half of emetick wine, and an ounce of oxymel of ſquills mixed together for a doſe. — Or take ſix grains of *emetick tartar*. — Or take an ounce of the juice of wild radiſh, extracted by expreſſion; two ounces of oxymel of ſquills mixed together for a doſe. — Or take two grains of powder of algaroth.

Purgative. — Take ten grains of diacrydium, ten grains of reſin of jalap, two drachms of rectified ſpirit of wine, mix well all the ingredients together in a mortar, and add to the mixture ſix drachms of laxative ſyrup of roſes compoſed with ſenna, for a doſe.

Fumigation, which irritates the noſtrils. — Take the diſtilled oils of roſemary, of tanſy, of lavender, rue, wormwood, of each four drops, a drachm of the infuſion of caſtoreum, an ounce of the unguent for the nerves, and a drachm of the oleoſum volatile ſalt, mixed together into a balſam, for a fumigation under the noſe of the patient, and to rub the temples withal.

An *acrimonious clyſter.* — Take half a drachm of the pulp of coloquintida, a drachm and half of leaves of tobacco. boil them in ten ounces of water, ſtrain the decoction, and to the colature add two drachms of ſal gemma, for a clyſter.

This remedy is alſo very good for the apoplexy, to help towards the rarefaction of the humours, after the evacuations required have been made. Take twenty drops of volatile ſpirit of ſal ammoniack, fifteen drops of tincture of karabe, and an ounce of water or carduus benedictus, mixed together for a doſe. — This remedy being uſed every month, after the firſt fit, may prevent a ſecond, provided the patient be well purged at leaſt twice a year, with half a drachm of gilla vitrioli, or ſeven grains of emetick tartar.

Carus is a ſpecies of *lethargick diſeaſe*, conſiſting in a profound ſleep, with a ſudden deprivation of ſenſation and motion, and an acute fever.

Cauſes of the *Carus.* — The *cauſes* of the *carus* are almoſt the ſame with thoſe of the *apoplexy*; the general one being alſo an interruption of the animal ſpirits through the organs of ſenſe, but not ſo abſolute a one as in the *apoplexy*, ſince it proceeds only from an atrabilis, which does not obſtruct entirely the paſſage, and can be eaſily rarefied by the violent agitation, aſſiſted therein by ſome remedies appropriated to the malady.

Symptoms. — The moſt conſiderable ſymptoms of the *carus* is a violent fever, attended with an exceſſive heat, which manifeſts itſelf in a particular manner on the face; and an almoſt entire privation of the ſenſitive faculty.

Cure. — The ſame remedies uſed in the *apoplexy*, are alſo uſed in the *carus*; but not in ſo large a doſe: and I have even ſeen patients afflicted with that malady, recover their ſenſes by means of the ſmoak of paper burnt under their noſe: or by rubbing their temples with hungary-water; but the ſureſt remedy is cupping or bleeding.

The Coma is a ſort of *ſleepy diſeaſe*, otherwiſe called *cataphora*; conſiſting in a violent propenſity to ſleep, whether ſleep enſues or not.

Cauſes of the Coma. — The cauſe may be any thing that prevents the courſe of ſpirits; as the cold, humid temperature of the brain: hot putrid vapours aſcending into the head, and ſtopping the canals of the animal ſpirits, narcotick vapours, *&c.* or it may ariſe from the conflict or jarring mixture of bile and pituita.

Cure. — The remedies for a *coma*, are thoſe, which occaſion great evacuations; as violent clyſters, or vomitives; medicines that purge and dry the brain; and thoſe which occaſion revulſions of humours; as veſicatories, cauteries, *&c.* to which may be added volatile ſpirits, ſalts, and moſt cephalicks.

The Epilepsy is a convulſion, either of the whole body, or ſome of its parts, attended with a deprivation of the ſenſes and underſtanding, and returning from time to time in fits or paroxiſms.

This is called the *falling ſickneſs*.

Cauſe of the Epilepſy. — *Boerhaave* attributes the cauſe of this diſeaſe to too much action of the brain on the motory nerves, and none on the ſenſative ones. Some account for it from the abundance of ſharp humours mixing with the animal ſpirits, and giving them extraordinary and irregular motions and directions; whence ariſes its diſtinction from a ſyncope and apoplexy, which take away all motion as well as ſenſe.

The *Epilepſy* is either *idiopathick*, or *ſympathetick*. It is *idiopathick* when it ariſes merely from a diſorder of the brain or ſpirits: and *ſympathetick* when it is preceded by ſome other diſeaſe.

Symptoms. — The patient ſeized herewith falls inſtantly, and ſuddenly down, or rather throws and precipitates himſelf violently to the ground: when down he grinds his teeth, foams at the mouth, and frequently ſhakes his head; his arms, legs, neck, back, *&c.* either becoming rigid, or variouſly diſtorted. And as all the parts are in a violent contraction, there is frequently an involuntary flux of urine, ſeed, and fæcal matter. After ſome time he returns to himſelf, only retaining a head-ach, heavineſs, wearineſs of the limbs, *&c.*

Cure. — The cure is very difficult; the principal anti epilepticks are, the roots of piony, leaves of lillies of the valley, ſeeds of rue, miſletoe of the oak, or hazel, box-wood, ſpirit of black-cherries, ſpirit of human blood, human ſecundines, human cranium, tooth of ſea-horſe, caſtoreum, peacocks dung, camphire, ſalt, and oil of amber.

To recover a perſon in a fit, tobacco ſmoak, or that of burnt feathers, is recommended. *Barbette*, above all things, directs the flowers and ſpirit of ſal armoniack againſt this diſeaſe. *Crato*, native cinnabar. Sir *John Colbatch* has an expreſs treatiſe on the miſletoe of the oak, to ſhew it is a ſpecifick in this diſeaſe. Elks claws have long had the reputation of the ſame.

Mania, in *Medicine*, *madneſs*, is a vehement kind of delirium, without a fever.

My ſentiment on the cauſes of this melancholick diſeaſe, is, that it proceeds either from an evil temperature of the brain, or from a bad conformation thereof, and ſometimes from both. That a violent madneſs, attended with rage, fury, *&c.* proceeds from a too great ſiccity of the brain; which thereby being render'd uncapable of moderating the too great impetuoſity of the vital ſpirits uſher'd into it along with the blood, leave thoſe ſpirits to eſcape in the ſame confuſion they are brought in, to the place of their deſtination, the ventricles, where they crowd in too great abundance, and loaded with the impurities they have contracted in the maſs of the blood, and which ſhould have been ſeparated from them by the refrigerating quality of the brain, in their paſſage through it, before their admiſſion into the ventricles; hence enſues a conflict between them and the few animal ſpirits they meet with there, appointed for their further elaboration into animal ſpirits, and directions, but which meeting with ſuch inſuperable obſtacles, are not only fruſtrated in their deſign, but overpower'd by ſo great a quantity of heterogeneous bodies, are themſelves diverted from their natural courſe, and forced to follow the irregular impetuoſity of the prevailing imperfect ſpirits. A *melancholick mania* proceeds from a too great viſcidity of the brain, which obſtruct the paſſage of the vital ſpirits to the ventricles, for the formation of a quantity of animal ſpirits, ſufficient to diſcharge the functions of the ſeveral faculties of the ſoul. And an *alternative mania* proceeds from ſome diſorders in the organs of thoſe faculties, whereby the animal ſpirits are often diverted from their natural determination.

Cure. — The *outrageous mania* is eaſier palliated than any of the two others, becauſe, as it proceeds in part from the too great abundance, and too violent impetuoſity of the ſpirits; that impetuoſity may be moderated by copious evacuations, eſpecially of the blood; and by aliments of little ſubſtance, adminiſter'd with a parſimonious hand.

Palsy, *Paralyſis*, is a diſeaſe wherein the body, or ſome of its parts loſe their motion, and ſometimes their ſenſation or feeling.

Cauſes.

Causes.— The causes of the *palsy*, are an impeded influx of the nervous spirits into the villi of the muscles; or of the arterious blood into their vessels; which may happen from some fault, either in the brain, the nerves, muscles, or their vessels.

Division of the Palsy.— The *palsy* is said to be *perfect* or compleat, when there is a privation of motion, and sensation, at the same time. *Imperfect*, when one of the two is destroyed, the other remaining.

The *palsy* again is either *universal*, *lateral*, or *partial*.

Universal Palsy, called also *paraphlegia*, or *paraphlexia*, is a general immobility of all the muscles that receive nerves from the cerebrum, or cerebellum, except those of the head. Its *cause* is usually supposed to reside in the ventricles of the brain, or in the root of the spinal marrow.

The *Paraphlegia* is seldom a primary disease, usually a secondary one, attending, or following an apoplexy, scorbutus, carus or arthritis.

Lateral Palsy, called also *hemiphlegia*, is the same disease with the *paraphlegia*, only that it affects but one side of the body. Its cause is the same, only restrained to one side of the brain, or spinal marrow.

Partial Palsy, is where some particular part or member alone is affected, *e. gr.* where the motion of the arm or leg is destroyed.

The *cause* of the *palsy*, whether universal or partial, is an obstruction of the passage of the animal spirits through the nerves; either entire when the part is deprived both of motion and sensation; or in part, when it is deprived but of one of those two faculties.

Prognostick.— Palsy, whether universal or partial, is always incurable in old people; for as the source whence the animal spirits flow is much exhausted in them, and consequently the channels through which they flow to all the parts of the body, much contracted, through the scarcity of those spirits, which flow then but in a very small quantity through them; those passages once obstructed, those spirits flowing neither in a quantity, nor with an impetuosity capable to conquer them, take another course; whereby those passages are soon entirely contracted, and consequently rendered useless.— In young persons, who abound yet with animal spirits, those spirits, assisted with medicines, can force their passage through the nerves, let the obstruction be ever so great provided the remedies be well appropriated to the malady.

Cure.— The cure of the *palsy*, according to *Waldschmit*, does not differ much from that of the venereal disease. Internally mercurial, sudorificks, and decoctions of the woods are good: externally unctions, particularly of spirituous and penetrating things; and bathing. The *mare*, as they call it in *France*, or the grounds of the grape after the wine has been extracted from it, is also an excellent remedy, by putting the patient to sweat in it.

Here follow the medicines of Dr. *Boerhaave*, for this disease.— Take mastich, olibanum, succin, of each half an ounce; mix them together for a powder; which you'll burn on lighted coals, and receive the vapour thereof in a piece of thick flannel, very dry, to rub hard the parts with it. Take three ounces of spirit of lavender, two drachms of sal armoniack, four drachms of tincture of castoreum, and six ounces of distilled water of lavender, which must be mixed together to rub the parts therewith. Take plaister of cumin, of melilot, galbanum, of each an ounce, and half an ounce of the oil of castoreum, for a plaister, which must be spread on leather, and applied on the afflicted part after it has been well rubbed.

Take the infused oils of wormwood, anet, camomile, rue, castoreum, saffron, iris, earth-worms, nardus, of each a drachm; unguent of *Agrippa*, of athanita martiotum, for the nerves, of each six drachms; mixed together for a liniment. He prescribes likewise the acrimonious plaisters of *cuminum*, *galbanum* and *melilot*.

PHRENZY, *phrenitis*, *phrenesis*, is a constant and vehement delirium, or distraction, accompanied with an acute fever.

It differs from the *mania*, and *melancholy*, in that those are without fevers.

Causes.—Physicians generally make the *phrenzy* to consist in an inflammation of the meninges of the brain; and distinguish it from the *paraphrenitis*, which is supposed to be an inflammation of the diaphragm.

Willis will have them the same disease, and both to consist in an inflammation of the animal spirits. He only distinguishes them as the inflammation arises from the cerebrum alone, or from the cerebrum and cerebellum together; and concludes that they both arise after a fever, from the boiling blood throwing its adust excrements into the brain.

Boerhaave makes the *phrenitis* either true, wherein the cerebrum or meninges, or both are inflamed; or symptomatick, where the matter of a fever is translated into the cerebrum.

Prognostick.— The true *phrenzy* either kills on the third, fourth, fifth, or seventh day; or changes into a mania, lethargy, comus, &c.—Tremors, gnashing

gnaſhing of the teeth, grumous blood diſtilling from the noſe, are prognoſticks of death.

Cure.—If the *phrenzy* ariſes from a ſuppreſſion of the natural evacuations; thoſe evacuations muſt be firſt rectified: but if from any other cauſe, the too violent motion of the ſpirits muſt be appeaſed firſt.

Spasm, *ſpaſma*, or *ſpaſmus*, is a great term of equal importance with the Latin *convulſio*, and the Engliſh *convulſion*.

Cardan diſtinguiſhes two kinds of *ſpaſms*; the firſt conſiſting in a conſtant contraction of the muſcles, which renders the members rigid and inflexible. The ſecond, in ſudden unnatural motions and palpitations, frequently intermitting and beginning again.

Cauſes. — *Spaſms*, in whatever part of the body they be, ariſe from the animal ſpirits meeting with obſtructions in their paſſage through the nerves, which divert them from the natural direction they had received in the cerebrum; whence,

Symptoms. — Proceed the unnatural motions of the parts of the body, a *ſpaſm* is attended with, which are greater or leſs, more or leſs frequent, according as the obſtructions are greater, and more difficult to conquer.

There are *accidental ſpaſms*, which are of a ſhort continuance, as thoſe ariſing from flatulencies, or from bites of venomous beaſts, or from the puncture of a nerve, from the acrimony of the humours vellicating the ſtomach, exceſſive cold, hyſterick vapours, &c.

There are ſpaſms peculiar to certain members, and diſtinguiſhed by particular names: that of the mouth is called *ſpaſmus cynicus*; that of the penis *ſatyriazis*.

The *cynick ſpaſm* is a ſort of convulſion, whereby the patient is brought to imitate the geſtures, ſnarlings, howling, &c. of a dog.

Dr. *Friend* in the *Philoſophical Tranſactions*, gives us an account of a very extraordinary *ſpaſmus* of this kind, wherewith two families at *Blackthorn* in *Oxfordſhire* were ſeized.

This diſeaſe the doctor takes to be natural, and to ariſe from the common cauſe of all convulſions, *viz.* from the animal ſpirits growing unruly in the nerves, and driving the muſcles into various contractions, according to the circumſtances of the indiſpoſitions.

The Nuns of *Loudun* in *France*, ſo well known throughout the whole world, by the nick-name of *Devils* of *Loudun* (becauſe ſuppoſed poſſeſſed by the devil) were certainly afflicted with nothing elſe but a *ſpaſmus* of this kind, though poor *Grandier*, their father director, was unjuſtly burnt, under the falſe pretence that he had contributed to their ſuppoſed poſſeſſion; and I really believe that moſt of the poſſeſſions mentioned in Church Hiſtories (thoſe mentioned in the ſcripture excepted) were nothing elſe but *ſpaſms* or *epilepſies*.

Prognoſtick. — A *ſpaſmus* happening after the taking of *Hellebore*, or any other violent purgative, is mortal: *ſpaſms* attended with violent and continual fevers are alſo very dangerous.

Cure. — The celebrated Dr. *Charleton* preſcribes for convulſions the powder of an old raven: all the remedies proper to reſtore the natural motion of the animal ſpirits, are good for the convulſions and ſpaſms, as ſudorificks, diaphoreticks, &c.

Syncope is a deep and ſudden ſwooning, wherein the patient continues without any ſenſible heat, motion, ſenſe, or reſpiration; is ſeized with a cold ſweat over the whole body, and all the parts turn pale and cold, as if dead.

Cauſes. — There are ſeveral cauſes of *ſyncope*; 1. Too great an exhauſtion of ſpirits, as after long diets, exceſſive unctions, violent exerciſes, long bathing, &c. — 2. The irregular motion of the ſpirits, preventing their due influx into the parts, as ſometimes happens in fear, wrath, and other violent paſſions. — 3. In moderate hemorrhages. — 4. An ill conſtitution of blood, as in cacochymias, or in perſons who have taken ſomething that either diſſolves or coagulates the blood. — 5. Secret diſeaſes, as abſceſſes, or polypus's of the heart, worms, &c.

Prognoſtick.—The *ſyncopes* are very dangerous which ariſe from hæmorrhages, or from a too great exhauſtion of ſpirits; and thoſe proceeding from abſceſſes, or polypus's of the heart, are almoſt always mortal.

Cure. —The volatile ſpirits and aromaticks, are preſcribed for *ſyncopes*. *Heurnius* recommends treacle water and cinnamon water. And *Etmuller* the volatile ſalt of vipers, ſpirit of ſal ammoniack, oil of amber, and ſometimes bleeding.

Vertigo, is an indiſpoſition of the brain, wherein the patient ſees the objects about him as if they turned round, and fancies he turns round himſelf, though all the while at reſt.

Phyſicians diſtinguiſh two kinds, or rather two degrees of *vertigoes*. — The firſt, called a *ſimple vertigo*, is when the body and external objects appear to turn round, without any great dimneſs of ſight.

The other called *ſcotania*, or *vertigo tenebroſa*, is when the eyes are alſo darkened, and as it were covered with a miſt.

Some make a third ſtage, *viz. vertigo caduca*, wherein the patient actually falls down. But this ſeems ſcarce to differ from an epilepſy.

Sometimes

Sometimes the *vertigo* is seated in the fore part of the head, and sometimes in the hind part; the latter is much more dangerous.

Causes of the vertigo.—*Bellini* accounts for the *vertigo* very well, from a preternatural motion in the retina.

The *external causes of vertigoes* are a continued turning round of the body, drunkenness, too long fasting, immoderate exercise, surprize, voracity, much use of pulse, onions, leeks, radishes, cabbage, mustard, &c. and in general whatever may press, distend, or contract the arteries.

Cure of the vertigoes.—The first step in the cure is bleeding in the jugular or cupping; then they proceed to an emetick; then a vesiccatory on the neck, or a perpetual blister, or issues; with sternutatories and other medicines, that obtained in the apoplexy.

Diseases of the THROAT. The QUINSEY, called also *angina*, is an inflammation of the throat, and particularly of the muscles of the larynx or pharynx, which exactly closing the chinks thereof, prevent the air from passing in and out of the trachea, and the food from being swallowed and conveyed into the stomach.

Causes of the quinsey.—The *quinsey* is caused by a defluxion of blood, either pure or bilious, from the branches of the carotide arteries; and there causing a phlegmon, either a simple or an erysipelatous one.

Symptoms of the quinsey.—The general symptoms of the *quinsey* are, that it is always attended with a difficulty of respiration, and of deglution. The *true quinsey* is always attended with a fever. And the *spurious* is free from it.

Prognostick of the quinsey.—That *quinsey* is of all others the most dangerous when the tumour is neither perceivable on the inside nor the outside. That appearing on the outside is the most curable.

Cure of the quinsey. In the *external quinsey*, before any suppuration appears, recourse is had to repeated venesection in the jugulars.—Vesicatories and cupping are also used with emollient gargles, &c.

The following is an excellent gargle for the *quinsey.*—Take two ounces of the best honey; the buds of black-berry bushes, and dried red roses, of each a handful; put them to boil together in three pints of river-water, for the space of half a quarter of an hour, skimming well the decoction, and straining it afterwards with expression; the colature is the gargle, wherewith the patient must gargle his throat as often as possible.

In *violent quinseys* recourse should be had to laryngotomy, or bronchotomy, which though rarely practised, may yet be used with safety.

Diseases of the THORAX *or* BREAST. The principal maladies of the *breast* are the *empyema*, *asthma*, *phthisick*, *peripneumony*, *pleurisy*, &c.

The EPYEMA 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.

Signs of the empyema.—The *empyema* is distinguished by a difficulty of breathing, a dry cough, a heaviness about the diaphragm, a noise, and fluctuating of the matter upon moving; slow fever, ruddy cheeks, hollow eyes, the tips of the fingers hot, and a swelling of the abdomen.

Cure of the empyema.—The difficulty of the cure of this disease proceeds from the difficulty of absorbing, or evacuating such extravasated matter: if nature shews any endeavour to throw it off by vomiting or urine, or the like, she must be seconded, and assisted therein. Thus, if the urine be purulent, administer dieureticks. If the stools, laxatives. If the spitting, expectorants or even emeticks; though I would not advise to attempt this last remedy, but with the utmost caution, lest the patient should be suffocated in the operation.

There is also a kind of *spurious* or *bastard empyema*, proceeding from a pituitous or serous humour, brought by some duct or passage into the thorax; where corrupting, it degenerates into a matter like pus. An *empyema*, in course of time, breeds a *phthisis*.

The *Asthma* is a difficulty of breathing, arising from a disorder of the lungs; and usually attended with violent motions of the diaphragm, abdominal, and intercostal muscles, to the very scapula, and the pinnæ of the nostrils; as also a rattling in the throat.

If respiration be only thick and quick, without the other symptoms, it is called a *Dypsnæa*. If it be so intense as to occasion a violent motion of the muscles of the thorax, so that the patient cannot be tolerably easy, except in an erect posture, it is called *orthopnæa*.

The *asthma* is usually divided into *moist* and *dry*, or *manifest* and *occult*, or *pneumonick* and *convulsive*. The first attended with an expectoration of purulent matter: the latter without.

Causes of the true, or pneumonick asthma.—The *true* or *pneumonick asthma*, is occasioned by an abundance of seriosities, or of gross, viscous or purulent humours, collected in the cavity of the lungs, which stop up, or streighten the passages of the air, and compress the bronchia. It may also be owing

owing to empyema's, phthifis's, polypus's, crudities in the ftomach, cachexies, *&c.*

Caufes of the convulfive Afthma.—The *convulfive afthma* is fuppofed to be occafioned by an irregular motion of the animal fpirits; and happens when the fpirits do not flow faft enough, or in fufficient quantity into the mufcles of the breaft, either by the reafon of an obftruction, or fome other obftacle: the neceffary confequence whereof is a violent and painful refpiration. The *afthma* again is either continual or periodical, and intermitting; which laft returns where a fober regimen is not obferv'd.

Symptoms of the afthma.—The greateft fymptoms of the *afthma*, are an extreme difficulty of refpiration, efpecially when the patient is in bed, and in a prone pofture; the contents of the lower belly in that cafe, bearing againft the diaphragm, fo as to leffen the capacity of the breaft, and to leave the lungs lefs room to move.——It is alfo always attended with a violent dry cough.

Cure of the true, or *pneumonick afthma.*—What I call cure, in this place, are only the means ufed to eafe the patient in the moft violent paroxifms of the difeafe, and render them lefs frequent, which is done by bleeding; after which emeticks may be ufed; and if the paroxifm returns, epifpafticks, with clyfters inftead of purges. Infufions of *fim. equin.* or the juice thereof, being deterfive and attenuating, are reputed excellent. Linctus's alfo give fome relief; millepedes, fpirit of gum ammoniack, with fal ammoniack, coffee, tincture of fulphur, *&c.* are commended in *afthmatick* cafes.

The *cure of the convulfive kind*, is attempted by anti-epilepticks, anti-hyftericks, anti-fpafmodicks, opiates, *&c.*

Phthifick in its general fenfe, denotes any kind of confumption of the body, in what part foever it be feated, or from what caufe foever it arife. Thus we have a nervous *phthifis*, and renal *phthifis*, dorfal *phthifis*, pulmonary *phthifis*, &c.

But *phthifis*, in its proper fenfe, is reftrained to a pulmonary confumption, or a confumption arifing from an ulcer, or other diforder of the lungs, accompanied with a flow hectick fever, which waftes, extenuates, and confumes the mufcular flefh.

Caufes of the phthifick—*Sydenham* obferves, that the *hectical phthifis* has its origin in the winter's cold; from a fharp humour trickling down upon the lungs, where like a catarrhea, it irritates them fo as to raife a cough. Among the caufes of this difeafe may be reckoned intemperance, as it brings on a plethora or cacochymia, peripneumonies, afthma's, pleurifies, *&c*—*Morton* adds that the *phthifis* frequently arifes from an ill conformation of the breaft; which is either natural, as when the breaft is too narrow, the neck too long, *&c.* or accidental, where there happens a curvity or diftortion of the breaft.

Symptoms of a hectical phthifis.—This difeafe is attended with a fpitting, firft of a vifcid pituita, then a heavy fetid pus, then of pure blood, and fometimes of the very fubftance of the lungs rotted by ulceration; with night-fweats, falling of the hair, and colliquative flux, which is foon follow'd by death. *Sydenham* fays, that the *phthifis* kills two thirds of thofe who die of chronick difeafes. Among the fymptoms *Morton* reckons a naufea, or reaching, with a heat in the palms of the hands, and rednefs in the cheeks, all after eating.

In the laft ftage of the *phthifis*, the nofe appears fharp, the eyes, hollow, the temples fallen, the ears cold and contracted, the fkin about the forehead hard and dry, and the complexion greenifh, or livid, *&c.* which is called *facies hypccratica.*

Prognoftick.—A confirmed *hectical phthifis*, is almoft always incurable, and confequently mortal, becaufe then almoft the whole fubftance of the lungs is fuppofed ulcerated, the which it is impoffible to reftore to its former laudable confiftence.

Cure of an hectical phthifis.—Though the cure of this difeafe be extremely difficult, *Sydenham* advifes, the defluxion on the lungs, in the firft ftage to be abated by blood letting, *&c.* and pectoral to be ufed, accommodated to the various ftates of the difeafe, *viz.* incraffants, attenuants, to affwage the hectick, *&c.* with emulfions, affes-milk, *&c.* and balfamicks to cure the ulcer.

But he is of opinion, that the chief affiftance in this is from riding on horfeback, where the patient need not confine himfelf to any laws of diet, *&c.* this alone, he adds, is almoft as fure a cure for a *phthifis*, as the cortex for an intermitting fever.

Dr. *Baynard* recommends butter-milk, as an admirable fuccedaneum to affes-milk. *Sylvius* fays he knows of no medicine, either internal or external, fo good againft frefh ulcers of the lungs, as balfam of fulphur, efpecially when prepared with oil of annifeed.

Etmuller obferves, that vomitories are good in a beginning *phthifis*, purgations by all means to be avoided; and commends the ufe of medicines made of tobacco.

Bonetus holds the *phthifis* to be contagious; and that there are frequent inftances of it being communicated by cloaths, linnen, beds, *&c.* I would not affirm, that it can be communicated by thefe things, but I have feen it communicated by laying in the fame bed with a *phthifical* perfon. I would not even advife any body to eat or drink after a perfon affected with a confummate *phthifis*.

Pitcairn

Pitcairn recommends *mercurius dulcis*, in the beginning of a *phthisis*; and *Barbette* and *Colbatch* assert, that contrary to the opinion of most authors, they have frequently used acids with success in the *phthisis*.

Boerhaave prescribes the following remedies for an *hectick phthisis*.

A *conditum*.—Take three ounces of conserve of red roses; two drachms of bol armoniack reduced into an impalpable powder; and as much syrup of myrtle, as is necessary to make a conditum; of which the patient shall take half a drachm every two hours.

A *conserve*.—Take three ounces of the leaves of plaintain, while yet very tender, an ounce and a half of flowers of wild poppies; and an ounce of the seed of plaintain, newly gather'd; mix all these ingredients with a sufficient quantity of sugar, to make a conserve, of which the patient shall take half a drachm every two hours.

A *decoction*.—Boil two handfuls of sorrel in a pint of whey, strain the decoction, and give every hour a glass thereof to the patient.

To promote a cure of this disease abstain from all sorts of ragouts, fricassees, and all kinds of dishes, where too much salt or spices are introduced; of all sorts of pulses, or other windy aliments; of all spirituous liquors, unless it be those, which are truly cordial, as the ratafia, ros-solis, *&c.* and even those must be used with a great deal of moderation; abstaining above all things from beer, or any other such liquor; and from any meat which is not of a light digestion, or that can promote a looseness; preferring roasted to boiled meat, drinking always the oldest wine, and the most cordial; eating sweetmeats often, and other dry aliments.

For common drink a ptizan, made of jujubes, and dates, of each four ounces; a handful of the smallest maiden-hair; two ounces of liquorice scraped and stringed; and two golden pippins, cut in quarters; all these ingredients to be boiled together, in three quarts of river-water, to the consumption of a sixth part; the jujubes and dates having been open'd before they are put to boil. Of this ptizan the patient may drink as much as he pleases.

PLEURISY is a violent pain in the side, attended with an acute fever, a cough, and a difficulty of breathing.

Causes of the pleurisy.—The *pleurisy* arises from an inflammation of some part of the pleura, to which is frequently joined that of the exterior and superficial part of the lungs. It usually arises upon cooling too hastily, after violent heat; as by drinking cold water, laying open to the air, *&c.*

This inflammation seizes any part of the teguments of the thorax, *viz.* either the pleura or mediastinum; and therefore the pricking pain may be felt in any part of the thorax: but the place it most ordinarily insists is the side; sometimes the left, sometimes the right, sometimes higher, sometimes lower.

This makes what we call the *true* or *internal pleurisy*; in opposition to the *spurious* or *external pleurisy*, which is a pain in the side without any fever, and frequently without any cough; and is supposed to arise from a sharp serosity, lodged in the pleura, or higher among the internal muscles.

Symptoms of a pleurisy.—The *symptoms* of a *true* pleurisy, is a sharp and fixed pain commonly in the left side, attended with a violent fever, and a great difficulty of breathing; and also with a short dry cough. A *false* pleurisy is only attended, as already observed, with the same pain, difficulty of breathing, and cough, but without fever.

Prognostick.—Both *pleurisies*, either *true* or *spurious*, are very dangerous, and require a speedy relief; and when after the necessary remedies have been administered, the symptoms increase instead of diminishing, or even remain the same, the disease is mortal.

Cure.—The great remedy in the true pleurisy is copious and repeating bleeding. In adults, *Sydenham* observes, is seldom cured with less than the loss of forty ounces of blood.

Boerhaave prescribes the following remedies to be applied inwardly for the *pleurisy*.

Fomentation.—Take mallows, marsh-mallows, and parietary, of each two handfuls; red poppies and henbane, of each a handful; flowers of elder, of camomile, and of melilot, of each three ounces; boil all these ingredients in new milk, for a fomentation.

Liniment to anoint the sides.—Take four drachms of sugar of saturn; six drachms of vinegar; and an ounce of oil of roses extracted by infusion; mixed together for a liniment to anoint the sides.

Internal remedies.—A *decoction*.—Take leaves of tussilage, and of marsh-mallows, of each two handfuls; flowers of red poppies, and of althæa, of each a handful and an half; parsley roots, sarsaparilla, of each three ounces; four drachms of linseed bruised; of lettuce, and of carduus dominæ, of each an ounce: boil all the ingredients together in a sufficient quantity of water, that there may be three pints left, whereof the patient shall drink two ounces every hour.

An *emulsion*.—Take the four great cold seeds, and the four small ones, of each three drachms; two ounces of seed of white poppies; mix them all together with barley-water, for an emulsion, with

 fourteen

fourteen ounces thereof shall be mixed a drachm and half of pure nitre; and an ounce of syrup of maiden hair: of which emulsion the patient may drink a glass every quarter of an hour.

PERIPNEUMONY is an inflammation of some part of the thorax, properly of the lungs, attended with an acute fever, and a difficulty of breathing.

The *peripneumony* is distinguished into *true*, and *spurious*.

The *true peripneumony* is a real inflammation of the substance of the lungs, attended with a symptomatical fever and a cough: by the former of which it is distinguished from an asthma, and by the latter from a pleurisy.

Causes of the true peripneumony.—Its usual causes are want of exercise, hard study, suppression of natural evacuation, or moist air, and the like.

Symptoms.—When the *peripneumony* arises from a phlegmon, the patient spits pure blood; when it is erysipelatous, the sputum is yellow, and not much tinged with red. In this last the breast is not so much contracted, but the fever more violent.

Prognostick.—The *peripneumony* is more dangerous, though less painful than a pleurisy, particularly in young people which are soon carried off: its usual way of going off is by expectoration of well concocted, reddish, yellow, or white matter. The flowing of the menses, or any hæmorrhage, a diarrhæa, abscesses about the ears or other parts, are also good prognosticks.

Cure.—The medicines prescribed for the cure of the *peripneumony*, are mostly the same that obtain in asthmatick and pleuritick cases.

Dr. *Boerhaave* prescribes the following remedies.

Decoctions.—Take forty ounces of a decoction of barley, two drachms of nitre, and four ounces of oximel; mix them together, of which the patient shall drink two ounces, warm, every quarter of an hour. Or take the leaves of parietary, agrimony, dendelion, of each a handful; the seeds bruised of white poppies, and of fennel, of each an ounce; liquorice, an ounce and a half; to make fifty ounces of decoction; which must be drank in the same manner as that above prescribed.

Aliments.—Pulses, farinous matters, pease, and summer fruits, ripe.

Spurious, or *bastard* PERIPNEUMONY is a disease of the lungs, arising from a heavy pituitous matter generated throughout the whole mass of the blood, and discharged upon the lungs.

Signs.—The *spurious peripneumony* is known by the viscidity, paleness, and slowness of the blood, ropiness of the saliva, paleness, and want of scent of the urine, swellings and obstructions in the minuter vessels, short breath, oppression in the throrax, &c.—Worn out, phlegmatick, cold, phthisical, catarrhous constitutions, are most liable to it.

Symptoms.—It begins with a feebleness, indolence, weariness, difficulty of breathing, oppression of the breast, feverishness; and goes on, without any great appearance of danger, to death itself; without any prognostick thereof in the urine, pulse, &c.

Cure.—This disease is cured by blood-letting, clysters, thin diet, diluters, astergents, and aperients.

Dr. *Boerhaave* prescribes the following remedies, for the *spurious peripneumony*.

Clyster.—Take three ounces of honey; a drachm of nitre; a yolk of an egg, and eight ounces of a decoction of barley for a *clyster*.

A *decoction.*—Take two ounces of the roots of fennel, four ounces of gramen; of leaves of parietary, and of agrimony, of each a handful and an half; an ounce of the seeds of white poppies, bruised; and an ounce and a half of liquorice: boil all these ingredients together, in such a quantity of water, as there may be two pints of the decoction left; two ounces hereof the patient must drink every two hours.

CONSUMPTION is a disease arising from a defect of nourishment; or a preternatural decay of the body, by a gradual waste of muscular flesh,

A *consumption* may be either *accidental*, *natural*, or *hereditary*.

Causes of an *accidental consumption.*—*Accidental consumptions* may arise, 1. From ulcers, chalky stones, or polypus's in the lungs, caused by something that obstructs the circulation in the pulmonary vessels, or renders the blood viscid, as a suppression of any natural evacuation.—2. From intemperance, occasioning either a cacochymia, or plethora.—3. From peripneumonies, pleurisies, asthma's, coughs, catarrhs, diarrhæa's, venereal disorders, and excess of venery.—4. From grief, hard study, &c.

Causes of natural consumptions.—Natural consumptions may arise from the thorax, or an evil conformation of the parts.

Causes of an *hereditary consumption.*—An hereditary consumption may be communicated from the parents without any other visible cause.

Symptoms.—A *consumption* usually begins with flying pains and stitches; pain at the pit of the stomach, or in the diaphragm; frequent spitting, loss of appetite, a quick pulse, a sweetness or saltness in the saliva, heats and flushings in the face and palms of the hands after meals, and hectick fever towards the evening, heaviness, faintness, night-sweats; and where the lungs are first disordered,

ordered, a cough, catarrh, or asthma usually precede it.

When these symptoms are violent it is confirmed; and then comes on an expectoration of purulent or bloody matter, and the vomica pulmonum; at length the feet swell, the expectoration stops: a diarrhæa comes on; then the facies hippocratica, and death.

Cure of an *universal*, or *mascular consumption*.—The cure of this dangerous disease depends principally upon removal into a proper air; also upon a regular nourishing diet: and the appetite is to be excited by proper bitters, and other stomachicks.

In a *pulmonary consumption*, or *phthisis*, balsamick medicines, and vulnerary medicines, a great quantity of oleaginous medicines is used in these cases, but I am of Mr. *Wainwright*'s opinion, that the particles of oily medicines are too gross and viscid to enter the small orifices of the lacteals; and think that their operation or effect being confined to the first passages, they are not only of no service in the cure, but are apt to pall the appetite, occasion obstructions in the mouth of the lacteals, and diarrhæas.

A COUGH is a disease affecting the lungs, occasioned by a sharp serous humour, vellicating the fibrous coat thereof, and urging it to a discharge by spitting, &c.

When the humour is so subtile that the lungs cannot lay hold of it to throw it off, or when the humour is so thick that it will not give way, it is said to be a *dry cough*.

Prognostick.—*Dry coughs* are the most dangerous.—*Hippocrates* says, that *cough* ceases if the testicles swell.

Cure.—A pectoral syrup, and decoctions, are medicines for a cough of any kind whatever; and a few drops of laudanum may be administered with safety, to appease the violence of the paroxisms, and prevent some dangerous consequences it may be attended with; as the breaking of some blood-vessels, and the bursting of abscesses, if there were any in the capacity of the thorax.

The HICKUP is a convulsive motion of the diaphragm, whereby that muscle retiring impetuously downwards, impels the parts beneath it.

Causes of the hickup.—The *hickup* is occasioned by sharp humours, a too great plenitude of the stomach, a bit of any thing stopped at its upper orifice; or, in general, by any thing capable of irritating the nerves of the diaphragm.

Note, That the *hickup* is a very dangerous symptom, in a chronical disease.

Cure of the *hickup*.—The remedy for the *hickup*, according to *Hippocrates*, is to fetch the breath very long; or even to stop the breath for some time. A sneezing happening upon a *hickup* generally cures it; the diaphragm shook by the violent expiration, being apt to throw off what before irritated it.

As the chief seat of the blood is in the *thorax*, where it receives its last degree of perfection in the ventricles of the heart, and the blood is, as it were, the focus of several very dangerous maladies, the human body is afflicted with; or, to speak more properly and clearly, as from the disorders, intemperies, or corruption of the mass of blood, arise the greatest part of the maladies we are subject to, I'll treat in this place of those different maladies, beginning by *fevers* of all kinds.

A FEVER, *febris*, is a disease or rather class of diseases, proceeding from an excessive effervescency of the blood, occasioned by its being obstructed in its circulation.

The truth whereof appears from the different *periodical* changes, or *paroxisms*, a *fever* is attended with.

1. The first indication we have of a fever is from the pulse being quicker than usual; which quickness does not proceed, as some imagine, from the blood being then accelerated, but rather from its being obstructed in its circulation; which obstruction hindering the usual quantity of blood from falling into the ventricles of the heart, and consequently their dilating themselves to their natural extent to receive it, and contracting themselves as usual to expel it; render that dilatation and contraction more frequent, and therefore the pulsation of the arteries quicker.

The next thing sensible in a fever is a certain chilness, because as the natural heat is communicated to the extremities of the body, by means of the circulation, that circulation once obstructed, that heat diminishes every where, as being then deprived of the supplies it received continually from its natural source. Till the vital spirits crowding to that part where the obstruction happens, there ensues a conflict between them and the morbifick matter, whence an excessive effervescency, in the mass of the blood, which causes that violent heat, which succeeds to the chilness, and which lasts, till the blood has conquer'd the obstacle, forced its way thro', and re-assum'd its former course; then the paroxism diminishes.

Causes of fevers.—The causes of fevers are innumerable; and the disease even often arises in the soundest bodies, where there was no previous morbifick apparatus; as cacochymia [illegible] but merely from [illegible] change of air, food, [illegible] ration in the non-naturals. A fever, [illegible] obferves, is an infeparable companion of an inflammation.

Symptoms of fevers.—The fymptoms are many; every fever arifing from any internal caufe, is attended with a quick pulfe, and unufual heat, at different times, and in different degrees. Where thefe are intenfe, the fever is acute; where remifs, flow.

The difeafe begins almoft always with a fenfe of chilnefs; and in its progrefs is chiefly diftinguifhed by the velocity of the pulfe: fo that a too quick contraction of the heart, as already obferved, furnifhes the proper idea of a fever, and the health of the patient is the fcope nature chiefly aims at in the difeafe. Other attendant fymptoms are ufually a laborious and difturbed refpiration, an uniform, high-colour'd urine; a parchednefs and drynefs of the tongue, mouth, *&c.* a clamminefs of the faliva; thirft; wakefulnefs, and naufea againft every thing but thin diluting liquors.

Cure of the fevers.—The general indication in the cure of fevers is to raife the obftructions, which hinder the eafy circulation of the blood, by evacuating the morbifick matter which caufes thofe obftructions; or at leaft fixing it in fuch a manner, that circulating no longer with the blood, it may be eafier evacuated.

The cure of fevers, *Boerhaave* fummarily comprehends in correcting the fharp, irritating ferbile matter, diffolving the lentor, and mitigating the fymptoms. If nature feems to carry the fever too high, it muft be moderated by abftinence, thin diet, drinking of water, bleeding, and cooling clyfters. If fhe brings it on too flowly, it muft be excited by cardiacks, aromaticks, volatiles, *&c.*—The caufe removed, the fymptoms ceafe of courfe; and if they can be bore without much danger of life, it were beft not to enter into any particular care thereof: if they be unfeafonable, or too fevere, they are each to be abated with the proper reamedies.

Sydenham recommends an emetick in the beginning of a fever; or if it have been then omitted in any other ftage thereof; efpecially where there is a propenfity to vomiting: for want of this, a diarrhæa frequently fucceeds, which is exceedingly dangerous. After this he ufes a paregorick; and the following days, if there be no indication to repeat the venæfection, nor any diarrhæa, he prefcribes, every other day an enema, till the twelfth day, when matters coming to a crifis, he has recourfe to hotter medicines, in order to promote and accelerate it. He adds, that if the difeafe proceed well, and the fermentation be laudable, there is no occafion for any phyfick at all. About the fifteenth day, if the urine be found to feparate, and give a fediment, and the fymptoms be abated, a cathartick is ufually ordered, left the fediment returning into the blood again, occafion a relapfe.—Nothing cools the patient, and abates the fever, fo much as a cathartick after venæfection.

The more acute the fever, the thinner, according to *Etmuller*, muft be the diet. It is no matter if the patient fhould faft for feveral days running; for never did feverifh perfons die of hunger: eating always exafperates the difeafe. Vomitories, he allows the principal place in the cure of all fevers; but as a patron of the hot regimen, affigns fudorificks the fecond. Spirit of fal ammoniack, or its fal volatile, he obferves, is an univerfal febrifuge, and rarely fails. All fugar things are hurtful.

Prognoftick—So long as the urine remains crude, that it does not give a fediment, the patient's cafe is dubious: but when once the coction commences, and the urine feparates, the great danger is over. Among the figns of death, fome authors are of opinion, that there is none more certain than a frequent blowing of the nofe without any difcharge of matter. A ftrong, equal pulfe, with deliria, tremors, twitches of the tendons, and other fymptoms, fatal in the difeafes of the nervous kind, always prefage well in fevers. On the contrary, a quick, weak, faltering pulfe, however favourable the other fymptoms may feem, infallibly proclaim death at the door, fays Dr. *Morton*.

Note, That it appears by obfervation, that a frequent letting of blood, renders perfons more inclinable to fevers.

The moft general, and genuine divifion of fevers, is into *effential* and *fymptomatick*.

Effential fever is that, whofe primary caufe is in the blood itfelf; and which does not arife, as an effect, or fymptom, from any other difeafe in the folids, or other parts. This is what we abfolutely and properly call a *fever*.

Symptomatick fever is that, which arifes, as an accident or fymptom of fome other antecedent diforder, as an inflammation, phlegmon, eryfipela's, impofthume, fmall-pox, pleurify, *&c.* Whence it is particularly denominated *inflammatory*, *eryfipelatous*, *purulent*, *variolous* or *pleuritick fever*.

Effential fevers are generally diftinguifhed into *continued* and *intermitting*:——Others chufe to divide them into *diary*, *intermitting*, *continent*, and *continued*.

Continual fever is that, which gives the patient no refpite or intermiffion. This is fub-divided into *putrid* and *not putrid*.

Continual fever not putrid, is that, wherein the parts of the blood are not fo diffolved and broke, as as to give occafion for the principal parts thereof to be fecreted, or that wherein there is not any difcharge of putrid, purulent matter into the blood. Of this there are two kinds, the *diary* and *ſynochus*; to which ſome add the *hectick*.

Diary fever is that, which does not ordinarily hold beyond twenty four hours. It is frequently got by too much exerciſe, or other external accidents; and cured by reſt alone, and keeping a-bed:—If it remains for ſeveral days, it is either called a continual *ephemera*, or a ſimple *ſynochus*.

Hectick fever is a ſlow durable *fever*, which extenuates and emaciates the body by inſenſible degrees.

It has three ſtages:—the firſt, while it conſumes the juices of the body:—the ſecond, when it exhauſts the fleſhy ſubſtance of its humidity: and the third, when it lays hold of, and deſtroys the ſolids themſelves; in which laſt ſtage it is reputed incurable.

Continual putrid fever is that, wherein the texture of the blood is rendered ſo lax, or even diſſolved, that its parts or principles ſeparating, ſome of the principal are ſecreted, and loſt.

Putrid fevers are frequently conſidered as *ſecundary* ones, ariſing from the diſcharge of putrid, purulent matter from ſome morbid part; as an ulcer in the lungs, &c. They are divided into *ſimple* and *compound*, or *remitting*.

Simple continual putrid fever, or a *continent fever*, properly ſo called, by the *Greeks* Συνοχος, is that which continues uniformly from firſt to laſt, without any fits, or periods of exaſperation and remiſſion of heat, and the other ſymptoms.

Willis divides the *putrid fever* into four ſtadia or ſtages. The beginning, which is attended with a chilneſs, ſhivering, wearineſs, thirſt, wakefulneſs, pain in the head and loins, nauſea and vomiting. The increaſe, wherein the former ſymptoms are heightened, with the addition of deliria, convulſive motions, foulneſs of the mouth, high turbid urine without any laudable ſediment or hypoſtaſis. The ſtate, which contains the criſis, which in this diſeaſe is much what the paroxiſm is in *intermittents*: for, as that returns at certain hours, ſo do the critical motions in continued fevers happen on the fourth, fifth, ſixth, and ſeventh day. The laſt ſtage is the declenſion, which ends either in recovery or death.

Theſe *fevers* are ſubdivided into *burning* and *ſlow*.

Ardent, or *burning fever*, is a very acute *fever*, attended with a vehement heat, intolerable thirſt, a dry cough, delirium, and other violent ſymptoms.

Prognoſtick. It frequently kills on the third or fourth day, rarely exceeds the ſeventh. It often goes off in an hæmorrhage, on the third or fourth day; which, if it proves too ſparing, is mortal. Sometimes it goes off by ſtools, vomiting, &c. and ſometimes ends in a peripneumony.

To the claſs of *burning fevers* are reducible, the *liperia*, *aſſodes*, *belodes*, &c.

The *liperia* is a burning fever, wherein the heat is very intenſe within ſide, and at the ſame time the external parts are cold.

The *aſſodes* is a burning fever, attended with great inquietudes, nauſea, vomiting, &c.

The *belodes* is a fever, wherein the patient ſweats continually.

The *ſyncopal fever* is that attended with frequent ſwoonings.

The *epials* is that, wherein both heat and cold are felt in the ſame part at the ſame time.

Slow fevers are gentle, but durable ones, which conſume the patient by degrees. They uſually ariſe from diſorders in the lympha or pituita; whence *Sylvius* calls them *lymphatick fevers*.

The principal of theſe are the catarrhal, attended with a catarrh, cough, hoarſeneſs, &c. And the *ſcorbutick fevers*, into which acute fevers, and ſometimes *intermittents* degenerate. To this claſs are alſo reducible,

Colliquative fevers, wherein the whole body is conſumed and emaciated in no long time; the ſolid parts, with the fat, &c, melted down, and carried by a diarrhæa, ſweat, urine, &c.

Remitting fever, called alſo a *continual fever*, and a *compound continual fever*, is that which continues ſome time without any gradual increaſe of heat; yet is liable to alternate fits of remiſſion and aggravation; either ſtated and periodical, or irregular.

Of this there are divers kinds, denominated from the periods of returning; as the *remitting*, *continual quotidian*, *continual tertian*, *continual quartan*, &c. which are only a continued *fever*, whoſe acceſſes or ſeverer fits return every day, or every other day, or every third day, or every fourth day.

Some enumerate divers other more complicated continual *fevers*, as the *double* or *triple quotidian*, which has two or three paroxiſms every day: *double* or *triple tertian*, or *quartan*, which has two or three every third or fourth day: the *ſemi-tertian*, which conſiſts of a continual and two intermitting *fevers* of different kinds, *viz.* a *quotidian* and *tertian*. The patient, beſides a continual fever, having an extraordinary fit every day, and every other day two.

Others divide the *remitting*, or *compound continual fever*, into *ſimple* and *ſpurious*.

The *ſimple remittent* returns regularly, and is only diſtinguiſhed from an *intermittent*, in that the feveriſh heat in the intervals of this latter is never quite extinguiſhed; and that the paroxiſms do not begin

with

with so much chilness and horror, and goes off in profuse sweats.

The *spurious remittent* is attended with grievous symptoms in the nervous kind, resembling those of the rheumatism, cholick, pleurisy, and other inflammatory and spasmodick diseases; besides immoderate excretions, vomitings, diarrhæa's, &c. whence its returns are uncertain and variable.

The *simple* rarely, if ever, kills: the *spurious* frequently. Sometimes it degenerates into a malignant Συνοχος.

Cure of these fevers. The first is cured with the *quinquina*, or Jesuits bark, almost as infallibly, as an intermittent; the febrile ferment being much the same in both; and the same remedy is found almost a sure, though not so speedy a remedy of the spurious, if properly applied.

Intermitting fever is that, which ceases and returns again alternately, at stated periods, called also an *ague*.

In this kind, cold and heat, shivering and sweat, succeed each other.

Symptoms of an intermitting fever. The paroxisms are attended with sicknefs, nausea's, vomitings, head-ach, pain in the back and loins, &c. The paroxisms are acute, but the disease usually more or less chronical.

Prognostick. No body was ever killed of an intermitting fever, except in the first stage of the paroxism, during the shivering, caused by the oppression of the spirits. When the disease becomes of a very old standing, it sometimes degenerates into other fatal ones.

Cure of the intermitting fever. As to the cure, it is found by abundant observations, that neither bleeding nor emeticks, nor catharticks, nor any other remedy administered during the fit, avail any thing. A just dose of vinum benedictum, three hours before the paroxism, *Morton* assures us, has often cured it: antimonium diaphoreticum, a little before the paroxism, has the like effect: and salt of wormwood is commended on the same occasion. *Dolæus* mentions lapis lazuli, taken in spirit of wine before the fit, as admirable.

And several bitters, as cardus benedictus, gentian root, camomile flowers, pulvis febrifugus, &c. were much valued before the invention of the *bark*; which, by the general consent of physicians, is allowed a specifick for intermitting fevers, in all seasons, ages, and constitutions.

Intermitting fever are of divers kinds, as the

Quotidian fever, where the paroxism returns every day. *Double quotidian*, which returns twice in twenty-four hours.

Tertian fever, which only returns every other day; which again is either *legitimate* or *spurious*. The *legitimate tertian* only holds twelve hours, and is followed by an absolute intermission. The *spurious tertian* exceeds twelve hours, and sometimes holds eighteen or twenty.

Double tertian is that which returns twice every other day. The name *double tertian* is also used where the fever returns every day, like a quotidian, only at different times of the day; the third fit answering to the time of the first, the fourth to that of the second, &c.

Quartan fever is that which only returns every third day, leaving two days intermission between every two fits.

Double quartan is that which has two fits every fourth day. The same is also given to the fever which returns every two days successively, only leaving one day's intermission.

Triple quartan fever is that which has three fits every fourth day; or that which returns every day like a quotidian, only at different seasons of the day; the fourth fit answering to the time of the first, the fifth to the second, &c.

Causes of intermission. All these various kinds of intermissions, proceed from the greater or lesser number of obstructions the blood meets with in its course; and the more or less time it takes in conquering them.

Lastly, there are some extraordinary species of fevers, not reducible to any of the forementioned classes, as *malignant*, *eruptive*, and *pestilential* fevers.

Malignant fevers are those, wherein the usual, regular symptoms do not appear, (nature being oppressed with the malignity of the febrile matter) but other foreign symptoms arise, as a pain about the stomach and præcordia; a livid complexion, with the face much disfigured, &c. sometimes efflorescences on the skin, &c.

Some authors, from microscopical observations affirm, that in all malignant fevers the blood is so corrupted, that swarms of little worms are generated therein, which occasion most of the symptoms.

Cure of malignant fevers.——In all malignant fevers the blood is too fluid. Blood-letting has here no place vomitories do well at first, afterwards sudorificks, and alexipharmicks. Blisters are commended in the process of the disease.

Eruptive fevers are those, which, beside the symptoms common to other fevers, have their crisis attended with cutaneous eruptions. Such are those of the small pox, meazles, the petechial, the purple or scarlet fever, and the miliary fever.

Symptoms.——The other symptoms are a grievous oppression of the breast, laborious short breath, obstinate waking, spasms, sore throat, cough, &c.

Prog-

Prognostick.——All these kinds of fevers are very dangerous; and are always cured by antidotes and sudorificks.

Pestilential fevers are acute, contagious, and mortal diseases ——Some will have the fever to be the disease, or plague itself; others only account it a symptom of the plague.

Petechial fever is a malignant fever, wherein, beside the other symptoms on the fourth, or more frequently the seventh day, *petechiæ*, or *red-spots*, like flea-bites, appear chiefly on the breast, shoulder, and abdomen. The spots, afterwards, turn paler, then yellow, and so disappear. When they grow livid, or black, they usually prove fatal. The petechial fever is also called *febris lenticularis*, and *pulicaris*.

The Plague, or *pestilence*, is a very acute, malignant, and contagious disease; usually proving mortal.

The *plague* is commonly defined by a *malignant fever*; but *Diemerbroeck* thinks the two ought to be distinguished; the fever not being the essence, but only a symptom or effect of the plague.

Causes of the plague.—The origin and cause of the plague has been a celebrated subject of controversy among physicians. The disorder is generally supposed to be communicated by the air; but how, and in what manner the air becomes thus deadly, is the question.—Some will have insects the cause of plagues, as of blights; which being brought in swarms from other parts, by the winds are taken into the lungs by respiration, mixed with the blood and juices, and attack and corrode the viscera.

Mr. *Boyle* attributes plagues principally to the effluvia, or exhalations breathed into the atmosphere from noxious minerals.

Symptoms of the Plague.—The plague according to *Sydenham*, usually begins with a chilness and shivering, like the access of an intermitting fever, then comes on a nausea, with vehement vomitings, an intense pain about the region of the heart, as if pinched in a press; and a burning fever, which continually preys on the patient, till either death, or the eruption of some bubo, parotis, or other tumour, in the inguina or axillæ, or behind the ears relieve him, and discharge the matter of the disease. Sometimes, indeed, it attacks without any fever; purple spots appearing all at once, the certain signs of present death: but this rarely happens, except at the beginning of some terrible plague. It has also been known to make its first appearance in tumours, without any fever, or other violent symptom.

Heaviness, pain in the stomach, head and back, cardialgy, broken sleep, anxiety, alteration in the look, difficulty of breathing, hiccough, syncope, delirium, convulsive twitchings, diarrhœa, eyes sunk or inflamed, tongue black and dry, vehement drought, fœtid breath, carbuncles, livid spots, purple, green, &c. are also symptoms usually attending this disease.

Prognosticks of the Plague.—A great deal of the prognostick depends on the circumstances of the tumours, or plague-sores: as they appear, and increase, the fever abates; and as they sink, or diminish, renews again. When they happen about the time of the crisis, and suppurate kindly, they are good prognosticks of a happy recovery.

In the terrible plague at *Nimeguen*, *Diemerbroeck*, who attended the sick thro' the whole progress thereof, relates, that those taken ill about new and full moon, rarely escaped; that faintings, swoonings, and palpitations of the heart, were usually deadly signs; an intermitting pulse always mortal; drowsiness, sneezings, tremulous motions, doating, sore throat, &c were ill omens: pleurisies, always mortal; costiveness a good sign; a diarrhœa almost constantly fatal; bloody stools, or urines, always presaged ill.

Cure of the Plague.—As to the cure, physicians are much divided. It is generally attempted by alexipharmicks and cardiacks, with the assistance either of sudorificks, or phlebotomy, or both. Many eminent physicians, both antient and modern, highly commend blood-letting; *Sydenham* particularly says, that if used copiously, and in time, it never yet did harm, but that sudorificks often prove pernicious: *Diemerbroeck*, on the contrary, with other very experienced writers, protests against phlebotomy, as very dangerous, and often deadly: their chief hope they built on diaphoreticks and sudorificks, as the only means to evacuate the morbifick matter. Emeticks and purgatives are expresly forbid: and yet Dr. *Sayer* used the former with good success in the beginning of the disease in the plague at *London*, *Anno* 1640.

The juice of lemons is commended, as of singular efficacy in the plague, and pestilential fevers. *Piso* relates that it is the principal remedy of the *Indians*, and protests he never knew any thing come up to it. Dr. *Harris* observes, that the same is what the *Turks* have principally recourse to. Camphire is also much extolled; this, *Etmuller*, assures us, was the basis of *Heinsius*'s antipestilential oil, who had a statue erected to him when dead, in the city of *Verona*, for the service he had done hereby. It was prepared of equal quantity of camphire, citron bark, and amber. Viperine salt, and rob of elder-berries, are also commended.

For preservatives against the plague, they are usually summed up in that popular distich.

Hæc

Hæc tria labificam tollunt adverbia pestem,
Mox longe, tarde, cede, recede, redi.

Cauteries, and especially issues, and setons in the inguina, are found of great service in preserving from infection. A piece of myrrh, held in the mouth in contagious places, is also commended. But *Diemerbroeck* assures, that there is nothing better in this intention than smoaking tobacco; but he adds, that it was only so to such as had not made the practice familiar to them. The other preservatives used by that author, were the *rad. heleni*, cardamoms, white wine vinegar, and chearfulness; and when he found his spirits low, as if the diseases were taking possession, a cup of generous wine, sometimes even to a degree of ebriety.

The Scurvy is a disease very frequent in the northern countries; particularly in fenny, wet, humid places, exposed to the north, &c.

Causes of the Scurvy. — *Charleton* observes, that it arises chiefly from sharp, saline particles, taken in by inspiration, from salt and corrupted meats eaten, from bad waters drank, from nastiness, deep chagrins, &c.

Symptoms of the Scurvy. — The most usual symptoms are bleeding, coughing, vomitting, difficulty of breathing, loosenes, a relaxation of the parts, sweating, a fœtid smell of the gums, a falling of the teeth, stinking breath, reddish or yellow livid spots, pains of the arms and legs, weariness, faintings, laziness, head-ach, &c.

Prognostick of the Scurvy. — A confirmed scurvy is always very dangerous; especially when the person afflicted therewith, indulges that inaction, or indolency inseparable from it, and neglects keeping himself very clean.

Cure of the Scurvy.—The cure is very difficult; and when the disease is rooted next to impossible. It sometimes goes off in a flux by stool, sometimes by the hæmorrhoides, and sometimes by urine; but more often degenerates into a dropsy, atrophy, apoplexy, epilepsy, or convulsions.

A very exact diet is held of more effect than the best medicines; without this it becomes incurable. Bleeding does not avail; strong purgatives are hurtful: so is sugar and all sugar'd things. *Mercurius Dulcis* used internally, so as not to salivate, but only raise a sweating, is found excellent. *Dolæus* undertakes to cure any *scorbutus* in twelve days time, by the use of this alone; only the patient to drink nothing at all times but a proper decoction, and to abstain from acids and hog's flesh. *Charleton* recommends a continued use of milk, particularly milk emulsions of sweet almonds, decoctions of china, broths, and other anti-acids and analepticks. — *Etmuller* makes the basis of the cure of the *scorbutus*, and hypochondriacal disease, the same, *viz.* copious vomiting; strong cathartricks, he observes, are prejudicial; but gentle ones good; for the body is to be still kept open. He adds, that vinegar is hurtful, and yet the acid juices of fruits and vegetables wholesome. Accordingly the use of lemon-juice is much recommended by *Lister*. Milk, and all milky things, while the stomach is yet able to digest, are excellent; so are mercurials.—*Etmuller*, instead of mercurials, recommends antimonials.

Thus much in general. — For the particular symptoms, particular medicines adapted thereto are to be used, only mixing antiscorbuticks with them all.

The chief simple antiscorbuticks are, horse-raddish, sorrel, butter-bur, scorzonera, sow-thistle, zedoary, polypody, elecampane, guaiacum, sassafras, mustard-seed, (which is the best of all) nasturtium aquaticum, trifolium paludosum, oranges, lemons. juniper-berries, cream of tartar, tartarum vitriolatum, &c.

Boerhaave prescribes the following remedies for the scurvy,

Vomitives. — Take tartarum vitriolatum, cream of tartar, and sal polychreste, of each half a drachm; mix them together for a powder, which shall be taken in a pint of whey, in the morning; the patient drinking afterwards twelve ounces of whey.

Attenuant and *digestive remedies.* — A drachm of the tincture of salt of tartar of *Van Helmont*, made with two ounces of wine.

A drachm of the tincture of mars of *Ludovicus*, with an ounce of wine.

The salts of the vegetables of *Tachenius*, with three ounces of wine.

Two drachms of elixir proprietatis with vinegar, &c.

The Evil, or *king's-evil*, is a disease called in medicine, *strumæ* and *scrophulæ*, consisting in scirrhous tumours, arising most commonly about the neck, but some also on the other glandulous parts, as the breast, arm-pits, groin, &c.

Causes of the king's-Evil. — The cause of the king's-evil is a thick and viscous limpha, extravasated in the substance of the glands, and renders them imbecil towards the secretion of the serum.

The king's evil is a contagious malady, and is propagated from father to son, and from generation to generation; therefore it is considered in *France* as an impediment to matrimony; so that a marriage contracted, where either of the contracting parties is attainted with that distemper, is declared null by the laws of that realm.

The *king's evil* is a disease very rebellious to all sorts of remedies, especially when rooted in, and it is but very ſeldom that patients are thoroughly cured.

Diseases *of the* Abdomen. The *hypochondriack* is a very comprehenſive diſeaſe.

When conceived, as is ſituate in the hypochondriack regions, or ariſing from ſome diſorder of the parts contained therein, *viz.* the ſpleen, liver, *&c.* it is properly called the *hypochondriacal diſeaſe*, *ſpleen*, &c.

When conceived as owing to ſome diſorder of the womb, it is called *hyſterick affection.*

And laſtly, when the flatulent rumblings in the inteſtines, belchings, *&c.* are conſidered, it is called the *vapours.*

Cauſes of the Hypochrondriack — The ſeat of this diſeaſe is commonly ſuppoſed to be in the animal ſpirits, and the nervous ſyſtem. Its cauſe is referred to an acid ſalt abounding in the maſs of blood; to which the ill diſpoſition of the ſtomach, and the other parts contained in the epigaſtrium, may greatly contribute. *Purcel* aſſigns crudities and indigeſtions as the prime cauſe, and in that he is not at all miſtaken. According to *Sydenham*, vehement motions of the body, or more uſually violent perturbations of the mind, as grief, anger, fear, *&c.* are its procatarctick cauſes.

Symptoms of the Hypochondriack. — Its ſymptoms are very numerous; the moſt uſual are a pain in the ſtomach, windineſs, vomitings, a ſwelling or diſtention of the *hypochrondriums*, or upper part of the belly, noiſe and rumblings in the lower venter, wandering pains, a conſtriction of the breaſt, difficulty of breathing, palpitation of the heart, faintings, watchings, inquietudes, ſwimming of the head, fear, ſuſpicions, melancholy, deliriums, *&c.* Not that all theſe accidents befall always every perſon afflict d with this diſeaſe; but ſometimes ſome of them, and others at other times, according to the conſtitution, *&c* of the patient.

In effect, the hypochondriacal is a very vague indeterminate ſort of diſorder. Dr. *Sydenham* obſerves, that its ſymptoms ape or emulate thoſe of moſt other diſeaſes; and that whatever part it is in, it produces ſomewhat like the common diſeaſe of that part. Thus in the head it produces a ſort of apoplexy, fits like to epilepſy, called hyſterick fits, intolerable head ach, *&c.* In perſons affected with the *cholorosis*, it produces a palpitation of the heart; ſometimes, though rarely, it ſeizes the lungs, and cauſes a continual dry cough: it alſo imitates the cholick and iliack paſſion and ſometimes the ſtone, jaundice, *&c.* In the inteſtines it produces a diarrhæa; in the ſtomach nauſea's. Sometimes it ſeizes the external parts, and particularly the back, which it renders chilly and painful; and the legs and thighs, which it ſwells ſo as to reſemble the dropſy: ſeizing the teeth it reſembles the ſcurvy, (indeed *Etmuller* makes the ſcurvy itſelf to be a great degree of this diſeaſe.) Laſtly, which is the moſt unhappy circumſtance of all, the patient is more affected in mind than in body.

Prognoſtick. — The hypochondriack is a very common and obſtinate diſeaſe; and as it proves rebellious to almoſt all ſorts of remedie, it teazes both the patient afflicted therewith, and the phyſician who undertakes the cure thereof; and though it proves very ſeldom mortal, it notwithſtanding moſt commonly accompanies the patient to the grave.

Cure of the Hypochondriack. — Adviſing the patient to be chearful, and to avoid all that can cauſe him the leaſt uneaſineſs, as chagrin or melancholy; order the uſe of the half-bath, to repair the tone of the ſtomach, and to procure a good digeſtion of the aliments; then try firſt, by gentle purgatives, to evacuate the morbifick matter both by ſtool and urine; and forbid the uſe of all ſorts of aliments, which are not of a very eaſy digeſtion: next preſcribe ſtomachicks, reſtoratives, and cephalicks; and conclude by remedies to purify the maſs of blood; preſcribing beſides a moderate exerciſe.

The *hyſterick* is, as already obſerved, a ſpecies of the *hypochondriack*, peculiar to women, and ſuppoſed to ariſe from ſome diſorder of the womb.

Cauſes of the Hyſterick.—The ordinary cauſes of this diſorder are violent paſſions, rage, love, grief, bad news, ſweet ſmell. The real cauſe being in the animal ſpirits, and the nervous ſyſtem.

The more common ſymptoms or accidents of this diſeaſe, are a ſwimming of the head, dazling of the eyes, inquietudes, pains of the abdomen, belches, nauſeas, vomitings, deliriums, convulſions. It is not always attended with all theſe ſymptoms, but ſometimes with more, and ſometimes with leſs, and thoſe more or leſs violent.

Baglivi adds, that hyſterick women feel a ſenſe of cold in the crown of the head; and this he takes to be the chief diagnoſtick of the diſeaſe.

Prognoſtick. — This malady proves very ſeldom mortal, but it is a very obſtinate one, and rebellious to almoſt all ſorts of remedies, eſpecially as to a perfect cure thereof.

Cure of the Hyſterick. — During the paroxiſm fetid things, whether internally or externally applied, are of advantage, particularly *caſtoreum*, the ſmoak of burnt horn, or burnt feathers held to the noſe. Volatile ſpirits alſo help to awake the patient out of the paroxiſm; as alſo tickling in the ſoles of the feet. Where it is ſeverer than ordinary,

ordinary, recourse must be had to puncture, scarification, vesicatories, causticks, *&c.*

The Clorosis (which signifies *greenness, verdure,* from the *Greek* χλον, *grass*) is a feminine disease, vulgarly called the *green-sickness,* &c.

Its usual subjects are girls, maids, and widows; and even wives, whose husbands are deficient, *&c.*

Causes of the Clorosis. — This disease comes on commonly antecedent to, or about the time of the eruption of the menses. Though the stoppage of the menses is not always the cause of this distemper; for they sometimes flow regularly, though but seldom, in the progress thereof. — According to *Etmuller*, the suppression of the menses are rather the effect than the cause. I rather attribute the cause of this disease to an effrenate desire of the act of venery, which generate a plenitude in the spermatick vessels, which for want of evacuation, acquire a preternatural quality, which sends putrid vapours into the mass of the blood, which infects it, and renders it very slow in its circulation.

Symptoms. — This disease gives a pale, yellow, or greenish tincture to the complexion, with a circle of violet under the eyes. — The patient is melancholy, and uneasy; has frequently a low wandering fever, with an unequal pulse, vomiting, heaviness, listlesness, drowsiness, difficulty of breathing, longing for absurd foods, *&c.*

Prognostick. — This malady is much more troublesome than dangerous.

Cure of the Chlorosis. — The most specifick remedy for this disease is the human coition; tho' it is chiefly attempted by bleeding in the foot, chalybeates, and bitters. In the colder constitutions, decoctions of guaiacum are found of use.

The Jaundice (from the *French jaunisse*, yellowness, or *jaune*, yellow) is a disease consisting in a suffusion of the bile, and rejection thereof to the surface of the body, whereby the whole exterior habit is discolour'd.

Causes of the Jaundice. — There are three kinds of *jaundice.* The first, properly called the *jaundice,* or *yellow jaundice,* is owing to the yellow bile, which, in this case is too exalted, or too abundant in the mass of the blood; or perhaps to an obstruction of the glands of the liver, which prevents the gall being duly separated from the blood; or to a stoppage of the porus bilarius, or the like means, whereby the mixture of that fluid with the aliment in the intestines is prevented.

The second, called the *black jaundice*, is owing to the same bile being mingled with acids.

The third, bordering on green, takes its rise also from a mixture of bile with an acid.

Diagnostick.—In the *yellow jaundice*, the *albuginea*, or white of the eye, and the skin, are chiefly yellow; and besides troubled with an itching. In the *black jaundice*, the natural colour is lost, by reason of an atrabiliary humour, spread underneath the skin: it first appears brownish, and afterwards of a lead-colour.

Prognostick.—The jaundice often proves a forerunner of the dropsy.—The *black jaundice* is incurable, especially in men advanced in years; who when afflicted with it, must prepare for the other world.

Cure —The acid spirit of sal ammoniack, is said to be an excellent remedy against the jaundice.

The Dropsy is a preternatural collection of *serum*, or water, in some part of the body; or a too great proportion thereof in the blood.

The *dropsy* acquires different names from the different parts it afflicts, or the different parts the waters are collected in.

That of the abdomen, or lower belly, called simply and absolutely *dropsy*, is particularly denominated *ascites.* — That of the whole habit of the body, *anasarca*, or *leucophlegmatica.* — That of the head, *hydrocephalus.* —That of the scrotum, *hydrocele.*

There is also a species of this disease supposed to be caused, instead of water, by a collection of wind, called *tympanites*; and by *Hippocrates, dry dropsy.*—We also meet with dropsies of the breast, pericardium, uterus, ovaries, *&c.*

Causes of Dropsy. — The causes of dropsy in general, are whatever may obstruct the serous part of the blood, so as to make it stagnate in the vessels; or burst the vessels themselves, so as to let the blood out among the membranes; or weaken and relax the tone of the vessels; or thin the blood, and make it watery, or lessen perspiration.

These causes are various, *viz.* sometimes acute diseases, scirrhous tumours of any of the more noble viscera, excessive evacuations, particularly hæmorrhages, hard drinking, *&c.*

Symptoms of the Dropsy. — The *ascites* or water-dropsy of the abdomen, is the most usual case, and what we particularly call the dropsy. Its symptoms are tumours, first of the feet and legs, and afterwards of the abdomen, which keeps continually growing; and if the belly be struck or shook, there is heard a quashing of water. Add to this three other attendants, *viz.* a dypsnæa, intense thirst, and sparing urine; with which may be number'd heaviness, listlesness, costiveness, a light fever, and an emaciation of the body. — *Baglivi* notes, that in a dropsy arising from a morbid liver, there is always a vehement dry cough, which is never observed in the other cases.

Prognostick.

Prognoſtick.—The dropſy is always a dangerous diſeaſe, and though cured in appearance, for ſome time, returns again, and kills the patient at laſt. *Tycho Brahe* notes, that hydropick perſons uſually die about full-moon.

Cure of the Dropſy.— The curative indications are two, *viz.* the evacuation of the water, and the ſtrengthening of the blood and viſcera. The firſt is effected by ſtrong purgatives, particularly elaterium, and the infuſion of crocus metallorum, though this laſt works upwards more than downwards. For ſuch as are too weak to bear purgatives, Dr. *Sydenham* recommends diureticks, whereof the beſt are thoſe made of lixivial ſalts.

For the ſecond intention, exerciſe and change of air, wine, and other generous liquors, alſo ſtomachicks, chalybeates, and other corroborating medicines are preſcribed.

Where other means fail for evacuating the water, recourſe is had to the paracenteſis, or operation of tapping, deſcribed in the Treatiſe of *Chirurgery.*

Mayern recommends *mercurius dulcis*, and nitre, and ants eggs, for the promoting of urine, and draining the tumour. Exerciſe, and change of air, wine, and other generous liquors cautiouſly taken, have alſo their uſe. *Wainwright* extols an infuſion of green tea in rheniſh wine; as alſo briony juice, as excellent in this diſeaſe; ſome commend garlick. The millepedes are alſo an excellent remedy.

Boerhaave preſcribes the following remedies: take the root of imperatory, *ariſtolochiæ longæ, & rotundæ*, zedoariæ, ſileri montanæ, of each an ounce: ſix drachms of ginger; two ounces of the ſummits of little centaury; an ounce of roſmarin; bays and juniper berries, of each an ounce and a half; thyme and ſerperlium, of each an ounce; the ſeeds of wormwood, and of tanzy, of each an ounce; pounded together to make a ſubtile powder; then take ſix ounces of that powder, and four pints of the beſt *French* wine; to make of them a medicinal wine; of which the patient ſhall drink two ounces four times a day, with the precaution of having his ſtomach empty before he takes it.

The Anasarca is a ſort of univerſal dropſy, wherein the whole ſubſtance of the body is ſtuffed or bloated with pituitous humours.

The *anaſarca* is the ſame, with what is otherwiſe called *leucophlegmatica.*

Cauſes of the Anaſarca—It may be either owing to ſome diſorder of the blood, which in this diſeaſe is of a pale colour, viſcid and cold, or to an aqueous humour extravaſated, and gather'd together in the muſcles and the pores of the ſkin.

Symptoms.—In an *anaſarca* the legs ſwell at the beginning, eſpecially towards night, and then pit remarkably: the urine is pale, the appetite decays; at length the ſwelling riſes higher, and appears in the thighs, belly, breaſt, and arms. The face becomes pale and cadaverous; the fleſh ſoft and lax; a difficulty of reſpiration comes on, attended with a ſlow fever.

Prognoſtick.—This diſeaſe is extremely dangerous, and always mortal in perſons advanced in years.

Cure.—The remedies uſed in the *aſcites* or water-dropſy, are uſed in this; but ſeldom with any ſucceſs.

The Tympany is a flatulent tumour, or ſwelling of the abdomen or belly, very hard, equable, and permanent; whereby the ſkin is ſtretched ſo tight, it gives a ſound like that of a drum.

Cauſes of the tympanites.—Some are of opinion that wind certainly makes a principal part of the morbid matter; but this is ſcarce ever found without water, excepting at the beginning; ſo that ſome will not allow of any difference between the *tympany* and the *aſcites.*

Some ſuppoſe it to ariſe from a watery humour extravaſated and rarefied into vapour; and by a property common to it with common air, corrupting the parts. But this *Boerhaave* makes a particular kind of tympanites, or windy dropſy; and adds, that it is cured like the *aſcites*, or watery dropſy, by tapping, &c.

Others will have the *tympanites* to ariſe from the air inſinuating itſelf through perforations in the putrified inteſtines. A tympanite from this cauſe, *Boerhaave*, who makes it a peculiar claſs, obſerves, is almoſt always incurable.

Symptoms.—The ſymptoms of the *tympanites* are an exceſſive tenſion of the abdomen, an irregular and hard pulſe, frequent head-ach, &c.

Prognoſtick.——The tympanites rarely kills of itſelf; but it almoſt always accompanies the patient to the grave, or degenerates into an *aſcites.*

Cure—Cathartick rather aggravate than alleviate this diſeaſe: antihyſtericks, antiſcorbuticks, chalybeates, and ſtrengthners are of uſe, before it be commenced an aſcites. Equal quantities of leek and elder leaves mixed analytically, is a famed empirical medicine, which has often proved effectual, when every thing elſe had failed.

It is uſual to apply carminatives to the belly, as the emplaiſter of cummin-ſeeds, &c. and alſo to uſe carminatives mixed with cathartick, diureticks, &c. internally.

Colera morbus is a ſudden overflowing or eruption of the bile, or bilious matters, both upwards and down-

downwards. It has its name either from the great quantity of choler it evacuates, or becauſe the matter is inceſſantly expelled at the inteſtines, which they antiently called *cholades*.

Cauſes.—It is ſuppoſed to have its riſe from the great abundance of bilious humours; which being very acrimonious, vellicate the membranes of the ſtomach and inteſtines; and by that means occaſion unuſual and violent contractions. Dr. *Sydenham* obſerves, it generally attacks about the latter end of ſummer, and proceeds not unfrequently from ſurfeits.

Prognoſtick.—The *cholera morbus* is very dangerous; it carries off the patient in a very ſhort time.

Cure—Dr. *Sydenham* ſays, that the cure depends upon large quantities of chicken-broth, drank ſo as to excite vomiting plentifully; and that the broth is alſo to be injected clyſter-wiſe. He adds, that the cure is to be compleated by laudanum given at proper intervals, and in proper doſes.

The remedy in the *Indies* for the *cholera morbus*, or *mandechin*, is to keep the patient from drinking, and to burn the ſoals of his feet.

Another method in the cure of the *cholera morbus* is to begin by preſcribing a doſe of ipecacuanha; and when that remedy has done operating, to order ſome ſpoonfuls of mutton-juice, in balneo mariæ, and adminiſtered to the patient by intervals; and at night a few drops of laudanum. Preſcribe likewiſe clyſters made of a ſheep's head, wool and all; to which add a few drops of laudanum.

Dysentery is a bloody *diarrhœa*, or a flux of blood by ſtool, attended with pain and griping.

The word *dyſentery* is formed from the *Greek* δυς, *difficulty*, and ἐντερον, *inteſtine*; and properly ſignifies that kind of flux of the belly, characteriſed by the frequency of ſtools, or dejections, mixed with blood, and accompanied with gripes: the fever, ulcer, &c. which attend it, are not eſſential to the diſeaſe; though many, both of the antient and modern, think the ulcer is.

Cauſes of the dyſentery.—Phyſicians aſſign ſeveral cauſes of the *dyſentery*, *viz.* the next, ſecond, mediate, and remote cauſes.

The next cauſe of the dyſentery is a ſerous, or other morbid humour, mixed with the maſs of blood; the conſequence of which is a too great fermentation in the blood, and a diſſolution of its parts, which are thus render'd too liquid.

The ſecond caſe is a vellication, and irritation of the nervous fibres of the inteſtines, occaſioned by ſharp, acid humours, ſeparated from the blood; which occaſion the ſpiral fibres that produce the periſtaltick motion of the guts to move too faſt, and thus to expel the matters too haſtily out of the inteſtines.

The mediate cauſe is ſome foreign body adhering ſtrongly to the inteſtines, and by its ſharp points, vellicating their nervous fibres, and at length ulcerating them.

The remote cauſes are any thing that corrupt the maſs of the blood, as viſcid, and crude, ſharp juices; ill foods; autumnal fruits; grapes; new wine drunk in exceſs; poiſons; violent medicines; waters conveyed through leaden pipes; rainy weather in the ſpring, with a dry winter, and a hot ſummer.

Symptoms.—The ſeat of the diſeaſe is in the inteſtines, either the big, or ſmall, or both. When the diſeaſe is in the ſmall ones, the gripes begin long before the ſtools, and are felt about the navel; and the blood and excrements are more blended, as being longer together. When the larger inteſtines are ſeized, the pain is leſs vehement, and is felt lower, &c.

The *dyſentery*, *Sydenham* obſerves, begins with a chilneſs and ſhivering; which is followed by a a heat; then gripings of the belly enſue, with mucous or ſanious ſtools, which, in proceſs of time, are found interſperſed with ſtreaks of blood, with vehement pain.

The ſtools are ſometimes void of blood, and yet if they be frequent and attended with gripes, and a mucous colluvies, the ſame author ſays it is a proper dyſentery. Along with the excrements, beſides a whitiſh mucoſity, frequently comes ſcrapings of the guts, in form of little ſkins.

Prognoſtick.—The *dyſentery* is always a very dangerous diſeaſe; but much more ſo, if pure blood be evacuated, for then the patient's life is in great danger; and likewiſe when the dejections, or ſtools, have a cadaverous ſmell.

Cure.—The ipecacuanha is excellent on this occaſion: not ſo much as a vomitary, Dr. *Freind* obſerves, as a ſudorifick; having this faculty, beyond all other emeticks, that it corrects the dyſenterick ferment, in proportion as it evacuates it. In the *Philoſophical Tranſactions* we have an expreſs diſcourſe on the ſubject; where it is aſſerted to be infallible in all dyſenteries and looſeneſſes, how dangerous and inveterate ſoever; except in pulmonick and hydropick patients, whoſe fluxes are indications of approaching death.

Sydenham orders phlebotomy; but *Willis* ſays, no evacuation is good; and preſcribes hot cardiacks; as ſpirit of wine a little burnt, &c. Balſamick and ſtyptick medicines are alſo to be uſed, according to the divers cauſes and ſymptoms of the diſeaſe.

Borri, in a letter to *Bartholine*, affirms, there is

no

no better medicaments in a dyſentery than roſe-water, wherein gold has been extinguiſhed.

Dolæus relates, that he cured above a hundred perſons with oil of ſweet almonds, mixed with orange juice.

Purgatives have rarely any good effect in dyſenteries, as increaſing the fermentation of the blood, and irritating the fibres of the inteſtines more and more. Nor are emeticks much better; as tending to draw the peccant humours into the ſtomach, or at leaſt into the higher inteſtines, and cauſe more frequent ſtools.

DIARRHOEA is a looſeneſs, or flux in the belly; or a profuſe evacuation of liquid excrements by ſtool.

The word, in the general, is uſed for any kind of flux of the belly; but properly for that wherein the humour or excrement flows out either pure, or mixed with, or without pain, in a fluid ſtate.

Diarrhœa's are of divers kinds, according to the diverſity of the excrements: ſome being bilious; ſome pituitous, and ſome purulent.

Cauſes.—The *purulent diarrhœa* always ariſe from ſome abſceſs open'd in the body; the reſt, either from morbid humours, irritating the inteſtines, and expreſſing the juices out of the adjacent parts; or from a laxneſs of the inteſtinal fibres; or an extraordinary fermentation in the blood, whereby it diſcharges its excrements into the inteſtines.

Prognoſticks.—Diarrhœa's, where the ſtools are very frequent, and of an inſupportable cadaverous ſmell, are always dangerous.

Cure.—In the cure of diarrhœa's, from whatever cauſe they ariſe, the ſtomach muſt be corroborated, and ſudorificks to be mixed with abſorbents. The patient to drink ſparingly. Quince and wine burnt with aromaticks is good. *Wainwright* obſerves, that a flannel ſhirt contributes much to the cure of an habitual diarrhœa.

LIENTERY is a kind of looſeneſs, wherein the food paſſes ſo ſuddenly through the ſtomach and guts, as to be thrown out by ſtool, with little or no alteration.

Cauſes.—The *lientery* is generally owing to a defect in the ferment of the ſtomach, or to a relaxation of the pylorus, attended with ſo briſk an irritation of the fibres of the ſtomach, that inſtead of retaining the aliment it lets it paſs. Exceſs of drinking ſometimes occaſions this diſeaſe by relaxing the ſtomach, and eſpecially the pylorus, too immoderately.

Symptoms.—Thoſe afflicted with this diſeaſe, have always a little fever, with a ſudden chilneſs ſeizing them all over ſeveral times in a day. The motion to go to ſtool is ſo quick and ſo violent, that they cannot ſtop it for any ſpace of time.

Prognoſtick.—This malady is more troubleſome than dangerous; though it moſt commonly accompanies the patient to the grave, for it is not only almoſt incurable, but it is even often very dangerous to cure it.

COLICK is a ſevere gnawing pain, felt in the lower venter, ſo called becauſe the ordinary ſeat of the diſorder was antiently ſuppoſed to be in the inteſtine colon.

We uſually diſtinguiſh three kinds of *colick*, the *bilious*, *windy*, and *nephritick*.

Cauſe of the bilious colick.—The *bilious colick* has its riſe from certain ſharp, bilious, ſtimulating humours, which being diffuſed through the inteſtines, vellicate their fibres, and occaſion a ſenſation of pain.

Symptoms.—Dr. *Sydenham* obſerves, that the bilious colick uſually attacks about the beginning of ſummer; that it is generally attended with a vomiting of bilious green liquor; that the patient complains of exceſſive heat, great gripings, faintneſs, *&c.*

Prognoſtick.——*Sydenham* is of opinion, that if the bilious colick be not ſoon remedied it is apt to turn into the *iliack paſſion*. And *Baglivi* notes, that if the patient ſweats much, and be much enfeebled, the diſeaſe is apt to degenerate into a palſy.

Cure.——The cure, *Baglivi* ſays, depends on bleeding, gentle catharticks, and clyſters: and if it ariſe from a crapula, an emetick is to precede; after which the cure is to be compleated by proper anodynes.

Wind-colick is vagabond, never ſtaying in any fixed place, being produced by windy vapours, which ſwell and diſtend the inteſtines they are incloſed in.

The *nephritick colick* is that, felt uſually in the reins whence it has its name.

Cauſe of the nephritick.——It has uſually its riſe from ſome ſtone or gravel detached from the kidneys, and fallen into the pelvis.

Symptoms.——The *nephritick* is always attended with violent reachings and vomitings, and an exceſſive heat, in the region of the loins.

Prognoſtick.——The nephritick is a very painful diſeaſe, and is alſo very dangerous.

Cure for all ſorts of colicks.——In colicks ariſing from flatulencies, carminative waters, oils, aromaticks, *&c.* are always to be added to the compoſitions: —— and in nephritick colicks, beſides emollient clyſters, ſolutions of manna, cremor tartari, *&c.* in whey, *&c.* and proper oleaginous mixtures are to be exhibited to relax the fibres; after which proper anodynes take place. In a fit of the nephritick, the firſt remedy I preſcribe to eaſe the patient is, oil of ſweet almonds, ſyrup of marſh mallows and lemons, of each half an ounce;

and an ounce of water of parietary, mixed together for a doſe.

Baglivi recommends camomile as an antidote againſt the colick, from what cauſe ſoever it ariſe. Where the diſeaſe is obſtinate, much riding has been found of eſpecial ſervice.

The ILIACK PASSION is a violent kind of colick; called alſo *volvulus*, *miſerere*, and *cardapſus*.

Cauſes of the iliack paſſion.——The immediate cauſe of the *iliack paſſion* is owing to an irregularity or inverſion of the *periſtaltick* motion of the guts, *viz.* when it begins with the lower, and is continued upwards; which irregular motion is called *antiperiſtaltick*; and is occaſioned by the hardneſs of the excrements, which obſtructs the paſſage through inflammation of the inteſtines, and their engagement in the *anus* or *ſcrotum*, as ſometimes happens in *hernias*.

Symptoms.——Perſons afflicted with this diſeaſe expel the feculent matter by the mouth, which expulſion is accompanied with a ſwelling and tenſion of the abdomen, an intenſe pain, and a total conſtipation.

Prognoſtick.——The *iliack paſſion* is a very dangerous malady; which requires immediate relief; otherwiſe it carries off the patient in a very ſhort time.

Cure.—Some have been cured of this diſeaſe, by ſwallowing a great quantity of quickſilver, or a muſket ball, or a ball of regulus of antimony. The following pills are a good remedy for the iliack paſſion: Take eight grains of troches of alhandel, three grains of diacyrdium, and eight grains of ſagapenum; mixed together in the juice of leeks, for a doſe of pills; which may be repeated if the diſeaſe continues.

The STONE is a diſeaſe, called alſo *calculus*, and *lithiaſis*, and occaſionally the *gravel*. It conſiſts of a ſtony concretion, formed either in the bladder or kidneys; which prevents the diſcharge of urine, and occaſions violent pains.

I attribute the generation of the ſtone to a viſcid or ſlimy matter, ſeparated from the urine in the pelvis; and which being too thick to be uſhered through the ureters along with the urine, adheres to the pelvis, where it is condenſed by the exceſſive heat of the kidneys, increaſed by the efforts it makes to unload itſelf of that foreign body; and where it grows in bulk by the new acceſſion of the like ſlimy matter, the quantity thereof augments in proportion, as the pelvis grows more weak in its natural functions.

The ſtone in the bladder is firſt formed in the pelvis of the kidneys; whence falling into the bladder it becomes augmented by new *lamellæ*, or coats.

Symptoms of the ſtone in the kidneys.—The ſymptoms of the ſtone in the kidneys, are, 1. A fixed obtuſe pain in the region of the loins, appearing like a weight loading the reins. As the ſtone falls out of the *pelvis* into the ureter, the pain is exceedingly acute and racking, which holds till either the ſtone be got into the bladder, or returned again into the pelvis.——2. An inflexibility of the *ſpina dorſi*, from the extenſion and compreſſion of the nerves.——3. A ſtupor of the thigh and leg of that ſide, from the conſent of parts.——4. A retraction of the teſticle.——5. A very ſmall quantity of urine, either thin and limpid, or bloody. But as ſoon as the ſtone is got into the bladder, the urine becomes thick, turbid, blackiſh, and in great quantity.

Symptoms of the ſtone in the bladder.——The ſymptoms of the ſtone in the bladder, are a ſenſe of heavineſs in the *perinæum*, and *inguinal* region, a perpetual and troubleſome deſire of making water, which is followed with a ſharp pain, particularly in the *glands* of the *penis*, whence a *prolapſus* of the *anus*. But the ſureſt way of finding it is by the touch, *viz.* by thruſting the finger or a *catheter* up the *anus*.

Prognoſtick.—The ſtone, both in the kidneys and bladder, but more particularly in the kidneys, is a very cruel malady; which, though it does not kill always the patient, but keeps him languiſhing for ſeveral years in the moſt excruciating tortures, makes him notwthſtanding wiſh often for death, to finiſh his miſeries.

Cure of the ſtone.—The cure of the ſtone is either by ſome medicines, which will diſſolve or break the concrete ſtone; ſo that it may be evacuated by piece-meal, which is called a *lithonthriptick*, or by enlarging the capacity of the veſſels; or by the operation of cutting, called *lithotomy*; which operation is deſcribed at large in the treatiſe of *Chirurgery*.

Deckers recommends calcined egg-ſhells, as excellent in all ſuppreſſions of urine; *Hamilton*, linſeed oil; and Mr. *Boyle*, the herb arſemart.

From the maladies of the abdomen or lower venter, I'll paſs to thoſe which affect the extremities of the body.

DISEASES of the EXTREMITIES.

The GOUT is a painful diſeaſe, occaſioned by a flux of ſharp humours, upon the joints of the body.

Some phyſicians define the *gout*, an inflammation, ſwelling, and painfulneſs of the joints.

Cauſes

Cauſes of the gout.——The gout is ſuppoſed to ariſe from a redundancy of humours, and a weakneſs of the joints. Its proper ſeat is in the limbs, not in the trunk of the body: in the latter caſe it frequently proves mortal, not in the former.

According as different parts are affected by this diſtemper, it goes by different names. When it ſeizes the feet, it is called *podagra*. When the knees, *gonagra*. When the hands, *chiragra*. And when the hip-joint, *ſciatica*, &c. Sometimes it attacks the whole body at the ſame time, and then it is called the *general* and *univerſal gout*.

The gout may be hereditary or natural to the conſtitution, proceeding from a too great conſtriction of the capillary veſſels, whence the gouty humour is more eaſily lodged, and detained in them. It may alſo proceed from high living, crapula's, and eating ſuch things as are hard of digeſtion; a ſedentary life; drinking too freely of tartarous wines; irregular living; exceſs in venery; an obſtructed perſpiration.

Some are of opinion, that the immediate cauſe of the gout, appears to be an alkaline or acrimonious matter in the blood; which being ſeparated from it, at particular times, falls upon the joints, but moſt frequently upon the feet and hands; which if it be repelled, or if the blood be overcharged therewith, ſo that a criſis cannot be procured in the extremities (as generally happens in old age) it falls upon the nobler parts.

My ſentiment is, that the immediate cauſe of the gout is a kind of vitriolick ſalt, uſhered into the maſs of the blood, by a bad coction of the aliments; but which at firſt is in ſo ſmall a quantity in the whole maſs, that it produces none of thoſe bad effects, which could be expected from it, as a coagulum, &c. its being continually volatilized by the native heat, and kept in a continual motion by the rapidity of the circulation, till that native heat being much abated, and the circulation becoming much ſlower towards the extremities; that ſalt loſing thereby its motion, falls by its own weight on thoſe parts, and corrode the tendereſt thereof, ſuch as the articulations; whence enſues, that excruciating pain felt in the paroxyſm, and which continues, till nature, in the convulſions excited thereby, calls the animal ſpirits to the ſuccour of the afflicted part, which following the natural impulſe, crowd thither; and by the exceſſive heat, they cauſe in the part, by their continual rotation, exalt once more thoſe ſaline particles, and expel the greateſt part thereof by perſpiration; but as thoſe cannot force their way through the fleſh, without cauſing ſome diſorders in the mechaniſm of the fibres, by their acuteneſs and ſharpneſs, hence enſues the ſwelling of the part.

The gout is either regular or irregular.—Regular, when it appears to be ſeated in the extremities of the body, returns at fixed periods, and with a gradual increaſe, and decline of the ſymptoms. Irregular, when the paroxyſms are frequent and uncertain; when the ſymptoms vary, and happen promiſcuouſly, and the diſeaſe appears to be ſeated in the internal parts of the body; as the ſtomach, brain, &c. leaving the extreme parts, as the hands, feet, &c. free from pain.

Symptoms of the regular gout.—The regular gout, chiefly and immediately affects the tendons, nerves, membranes, and ligaments of the body about the joints. Sometimes a cold ſhivering fit precedes, and generally a fever accompanies its firſt appearance, which ſoon goes off, and returns by intervals. A ſlight pain is felt in the joints, where the criſis is performed, which increaſes gradually; and in the *podagra*, generally fixes firſt on the great toe; then proceeding to the *tarſus* and *metatarſus*; ſometimes, eſpecially in old age, it attacks the knees and hands; and wherever it is, by wounding and corroding the part, cauſes a violent pain, not unlike that of a diſlocated bone. When the pain is at its ſtate, *i. e.* while the native heat is working to exalt and expel the ſaline particles, which cauſe it, there appears an inflammation and ſwelling; both which increaſe, as the pain decreaſes; and upon their remiſſion, the paroxyſm is ended; tho' the tenderneſs and ſwelling, in ſevere fits, will ſometimes remain a longer time, and cauſe an uneaſineſs upon motion.

The pain increaſes towards night, and decreaſes towards the morning; the longer the intervals between the paroxyſms, the more ſevere they prove, and the longer they generally continue; becauſe there is then a greater quantity of the morbifick matter gather'd in the neighbourhood of the part; which is much more difficult, and takes much more time to be expelled.

The diſeaſe uſually returns twice a year, *viz.* in the ſpring and autumn; and in the latter paroxyſm, is, ſometimes, two or three months before it comes to a period: though its duration is ſometimes not above three or four weeks.

Theſe are called cardinal paroxyſms, to diſtinguiſh them from others of leſs duration, which happen between the ſpring and autumn. The more high-colour'd the urine, and the leſs ſediment it depoſits, the further is the diſeaſe from the ſtate of concoction, as it is term'd. According to the violence and continuance of the fever, the paroxyſm proves more or leſs ſevere.

In conſtitutions much broke or ſhatter'd with the gout, there are uſually ſtony or chalky concretions formed in the joints of the fingers or toes, and thence tranflated to the vifcera; which cafe is often attended with irregular, frequent, and fhort paroxyfms in the extremities. In the decline of life, when the ufual fits do not happen; if the gouty matter be fuddenly repelled from the extremities (to ufe the improper common ftile) by an improper regimen or medicines, it ufually feizes the internal parts, and frequently the ftomach, head, inteftines, *&c.* caufing want of appetite, reaching to vomit, indigeftion or cachexia, the jaundice, afthma, diarrhœa; and at laft fo obftruct the fine capillary, nervous tubes (efpecially thofe of the ftomach and brain) as poffibly to hinder the flux of the animal fpirits: upon which death fuddenly enfues.

Sydenham gives us the hiftory of a regular fit of the gout in the feet. It begins towards the clofe of *January*, or beginning of *February*, without the leaft previous notice; except, perhaps, a crudity or apfy for fome weeks before-hand; with a fort of intumefcence, and a heavinefs of the body, which continually increafes, till at laft a paroxyfm breaks out; being preceded, fome days, with a fort of torpor, and a fenfible defcent of the flatulencies through the flefh of the thighs, with fome fpafmodick fymptoms. The day before the paroxyfm, the patient's appetite is very greedy; an hour or two after midnight he is waked by a pain, commonly in his great toe, fometimes in the heel, ancle, or the calf of the leg, not unlike the pain felt upon the diflocation of the faid bones; with a fenfe as if water was fprinkled on the part affected. This is fucceeded by a chilnefs, and fome approach to a fever: the pain, in the mean time, which at firft was more remifs, gradually increafes; in proportion to which the chilnefs abates. By night it is arrived at its height, and fettled about the ligaments of the bones of the tarfus and metatarfus; where it fometimes refembles a violent tenfion; and fometimes a laceration of thefe ligaments; fometimes the biting or gnawing of a dog, or a fqueezing or coarctation. Thus far the part affected has fuch an exquifite fenfe, that it cannot bear the weight of the linen, nor even the fhaking of the room, occafioned by a perfon's ftepping. Hence a thoufand vain endeavours to get eafe, by changing the pofture of the body, the pofition of the foot, *&c.* till about two or three o'clock in the morning (the fpace of a nychthemeron from its accefs) when a remiffion is firft perceived; the morbid matter being by this time tolerably digefted, or even diffipated: the patient thereupon drops afleep, and at his waking finds his pain much abated, but the part newly fwelled. A few days hence the other foot undergoes the fame fate: fometimes both are attacked from the firft. From the time it has feized on both legs, the fymptoms become more irregular and precarious, both as to the time of invafion, and the duration thereof. But thus ftill holds, that the pain recruits in the night, and remits again in the morning. A feries of thefe little, alternate acceffes, *&c.* conftitute a fit, or paroxyfm of the gout, which holds longer or lefs, according to the age, *&c.* of the patient. In ftrong people, and thofe who have had it often, fourteen days is a moderate paroxyfm. In old people, and thofe long ufed to it, it will hold two months.

For the firft fourteen days, the patient is ufually coftive; a lofs of appetite, chilnefs towards evening, and a heavinefs and uneafinefs of the parts not affected, attend the whole paroxyfm. As it goes off, he is feized with an intolerable itching, efpecially between the fingers; the furfur falls, and his toes fcale, as if he had drank poifon.

Such is the courfe of a regular gout; but when thro' improper treatment, it is difturbed or prolonged, it feizes the hands, wrifts, elbows, knees, and other parts: fometimes diftorting the fingers, and taking away their ufe; fometimes generating tophaceous concretions, or knots about the ligaments of the joints, refembling chalk, or crab's eyes; fometimes rifing a whitifh inflammable tumour, almoft as big as an egg about the elbows.

It may be added, that where a perfon has laboured under the gout for many years; the pain is fenfibly leffen'd each paroxyfm, till at length it becomes rather an uneafinefs than a pain: hence that reflection of *Sydenham*, *dolor in hoc morbo amariffimum eft naturæ pharmacum.*

Prognoftick of the gout.—The gout is ranked among the number of incurable difeafes: in effect, we have no true and affured remedy yet difcovered for it; thofe that now obtain are little more than palliatives, they tend to affuage the pain, to diminifh it for a time, but not to extirpate it.

Cure of the gout.—Bleeding and purging are found abfolutely prejudicial: emeticks, according to *Pitcairn* and *Etmuller*, may do good in the beginning of the difeafe. But upon the whole, nothing in *Sydenham*'s opinion, proves of more fervice than digeftives or medicines which ftrengthen the ftomach, and promote digeftion: as angelica-root, enul. campan. the theriac. andromach. the jefuit's bark, and antifcorbuticks: thefe chiefly to be adminiftered in the intervals between the paroxifms. *Mufgrave* however recommends internally repellent, and principally cardiacks, externally emplaifters gum. carm. or oxycroc. or cephalic, with burgundy pitch; or green fear-cloth, commonly called *bat-cafe*, &c. Yet *Doleus* affirms, that repellents do more harm than good; and

and gives us the following *recipe*, as more than equal to all others. ℞ *Confect. hamech* ℥j. *pulv. jalap* ℥*ſs. extract. trifol. febrin.* ʒij. *litharg. aur.* ℥vj. *ſapæ antim.* ʒ*ſs. ſacchar. Canth.* ℥vj. *ol. olicar, q. ſ. ceræ & picis parum f. ſ. a.* An emplaiſter to be laid on the joint affected, till the pain and the morbid matter be driven away.

The RHEUMATISM (which bears a great reſemblance of the *gout*, whence ſome call it *univerſal gout)* is a painful diſorder felt in various external parts of the body, accompanied with heavineſs, difficulty of motion, and frequently a wandering fever, ſometimes fixed in the muſcular and membranous parts of the body, happening chiefly in autumn, and its proper ſeat is ſuppoſed to be in the *membrana communis* of the muſcles; which it renders rigid and unfit for motion, without great pain.

The *rheumatiſm* is either *univerſal* or *particular.*

Univerſal rheumatiſm is that, which attacks all the parts of the body, even the internal ones.

Particular rheumatiſm is that, which is confined to particular parts. In which caſe the pains are uſually erratick, paſſing from one ſide to another; but ſometimes fixed. This is alſo called a *windy* or *ſcorbutick* rheumatiſm.

The difference between the rheumatiſm and the gout conſiſts chiefly in this, that the rheumatiſm attacks not only the joints, as the gout does, but alſo the muſcles and membranes between the joints.

Cauſe of the rheumatiſm.—The rheumatiſm is ſuppoſed to ariſe from a ſharp ſerous humour thrown on the ſenſible parts, and occaſioning a pain by its vellication.

The expoſing the body too ſuddenly to the cold air, after having heated it to a great degree, is the moſt uſual remote cauſe.

Symptoms.—A fit of the rheumatiſm is frequently preceded by a fever of two or three days, and ſometimes by a ſhivering. The attack happens in various parts of the body, as the hands, arms, thighs, legs, feet, *&c.* a redneſs, ſwelling, and lameneſs often ſucceeding. The pain ſometimes fixing in the loins, and reaching as far as the os ſacrum; this diſorder is called *lumbago*, and bears a near reſemblance to the nephritis; being only diſtinguiſhable therefrom by this, that the latter is attended with a vomiting, which the former is not.

Prognoſtick.—The rheumatiſm uſually proves a tedious laſting diſeaſe, holding for ſeveral months, ſometimes years; not continually, but by paroxiſms, in aged perſons, and thoſe of weak conſtitutions and decayed viſcera; it ſometimes ſeizes the head.

Cure.—The cure is by evacuation, chiefly, according to *Sydenham*, by repeated phlebotomy, with a plentiful uſe of volatiles and diluters. *Schmitzius* recommends ſudorificks; and *Muſgrave* cathartick and emeticks; and I recommend the hot half-bath with diaphoreticks and diureticks.

RICKETS is a diſorder affecting the bones of children, and cauſing a conſiderable protuberance, incurvation or diſtortion thereof.

Cauſes.—This diſeaſe ſometimes ariſes from a fault in ſwathing the child, rolling him too tight in ſome places, and too looſe in others; placing him in an inconvenient, or too often in the ſame poſture, or ſuffering him to be long wet. It is likewiſe attributed to the want of proper motion, and the uſing of the child to be borne in one arm only; whence the legs and knees remain too long in the ſame incurvated ſituation. 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.

Prognoſtick.—The rickets uſually appear between the firſt eight months, and the ſixth year of the child's age: the part it affects grows lax, flaccid, and weak; and if it be the legs, they become unable to ſupport the body. All the parts ſubſervient to voluntary motion are likewiſe debilitated and enfeebled; and the child grows pale, ſickly, ſlothful, and cannot ſit erect.

His head generally becomes too large for the trunk, and cannot be ſupported or managed by the muſcles of the neck, which gradually wear away. Swelling and knotty excreſcencies appear in the wriſts, ancles, and tops of the ribs; and the bones of the legs and thighs grow bowed and crooked. The like diſorder ſometimes alſo ſeizes the bones of the arms.

Prognoſtick.—If the ſymptoms continue long, the thorax becomes ſtrait, a difficulty of reſpiration enſues, as alſo a cough, and a hectick fever; the abdomen ſwells, the pulſe grows weak and languid, and the ſymptoms increaſing at length prove mortal.

Cure.—When the diſorder is taken early, it may be remedied by proper bolſters and bandages, ſuited to the parts affected: not otherwiſe.

Others chuſe a liniment of rum and palm oil; and others a plaiſter de minio and oxycroceum, applied along the back to cover the whole ſpine. Dry frictions over the whole body, with a warm linnen cloth before the fire, eſpecially on the parts affected, are of great ſervice. The oil of ſnails is very famous for the ſame intention, being what drops from them, after bruiſing and ſuſpending them in a flannel bag. With this the limbs and ſpinal bone are anointed.

Some want much cold bathing, before the diſtemper comes to be confirmed, during *May* and *June*, continuing the child in the water two or three ſeconds at each plunge; but I do not at all approve of this remedy, for of ſeveral children that have been thus plunged, to my certain knowledge, none have been cured, and ſome have died.

Cutaneous Diseases. The leprosy, is a foul cutaneous diſeaſe, appearing in dry, white, thin, ſcurfy ſcabs, either over the whole body, or only ſome part of it; and uſually attended with a vehement itching, and other pains.

Cauſes.—The *leproſy* ſeems to ariſe from a great obſtruction of perſpiration; whereby the thin ſaline humours are thrown off from the blood, and arreſted by the denſity and cloſeneſs of the cuticula.

Symptoms.—The ſymptoms of the antient *lepra*, as laid down by *Galen*, and others, are as follows:—The patient's voice is hoarſe, and comes rather through the noſe than the mouth; the blood full of little white ſhining bodies, like grains of millet, which upon filtration ſeparate themſelves from it; the ſerum is ſcabious, and deſtitute of its natural humidity, inſomuch that ſalt applied to it does not diſſolve; it is ſo dry, that vinegar poured on it boils; and is ſo ſtrongly bound together by little imperceptible threads, that calcined lead thrown into it ſwims. The face reſembles a coal half extinct, unctuous, ſhining, and bloated, with frequent hard knots, green at bottom, and white at top. The hair is ſhort, ſtiff, and brinded, and not to be torn off without bringing away ſome of the rotten fleſh to which it adheres; if it grows again, either on the head or chin, it is always white. Athwart the forehead run large wrinkles or furrows, from one temple to the other; the eyes red and inflamed, and ſhine like thoſe of a cat; the ears ſwell'd and red, eaten with ulcers towards the bottom, and encompaſſed with little glands; the noſe ſunk, becauſe of the rotting of the cartilage; the tongue dry and black, ſwell'd, ulcerated, divided with furrows, and ſpotted with grains of white; the ſkin covered with ulcers, that die and revive on each other, or with white ſpots or ſcales like a fiſh; it is rough and inſenſible, and when cut, inſtead of blood, yields a ſanious liquor. It arrives in time to ſuch a degree of inſenſibility, that the wriſt, feet, or even the large tendon, may be pierced with a needle, without the patient's feeling any pain. At laſt the noſe, fingers, toes, and even privy members fall off entire, and by a death peculiar to each of them, anticipate that of the patient. It is added, that the body is ſo hot, that a freſh apple held in the hand above an hour, will be dried and wrinkled, as if expoſed to the ſun for a week.

Cure.—As to the cure, that which proved effectual in ſouthern countries fails among us, where the ſtrongeſt medicament, and the moſt powerful mercurials are neceſſary. Bathing is judged to be of good uſe in the lepra.

The Itch is a diſeaſe of the ſkin, wherein it is corrupted by the oozing out of certain ſharp ſaline humours, which gather into puſtules, and occaſion a pruritus or itching.

There are two kinds of *itch*, a *humid*, and a *dry* kind. The latter has been uſually ſuppoſed to be owing to an atrabilary humour; and the former to a ſaline pituita.—They are both contagious.

Cauſes.—Dr. *Bononio* has given a much more rational account of the cauſe of this diſtemper, than any author before him: he examined ſeveral globules of the matter picked out of the puſtules of itchy perſons with a microſcope, and found them to be minute living creatures, in ſhape reſembling a tortoiſe, of briſk motion, with ſix feet, a ſharp head, and two little horns at the end of the ſnout. Hence he makes no ſcruple to attribute this diſeaſe to the continual bitings of theſe animalcules in the ſkin; by means of which, ſome portion of the ſerum oozing out through the ſmall apertures of the cutis, little watery bladders are made, within which the inſects continuing to gnaw, the infected are forced to ſcratch, and by ſcratching increaſe the miſchief; breaking not only the little puſtules, but the ſkin too, and ſome little blood veſſels, and ſo make ſcabs, cruſty ſores, &c.

Hence we perceive how the itch comes to be catching; ſince theſe creatures, by ſimple contacts, eaſily paſs from one body to another; their motion being wonderfully ſwift, and they crawling on the ſurface of the body, as well as under the cuticula.

Cure.—The cure of the itch is attempted with lixivial waſhes, baths, and ointments made of ſalts, ſulphurs, mercury, &c. theſe being very powerful in killing the vermin lodged in the cavities of the ſkin, which ſcratching will never do, they being too minute to be caught under the nails. And if in practice it is found, that this diſeaſe, after it ſeemed to be cured by unction, frequently returns again, this is eaſily accounted for, ſince though the ointment may have killed all the living creatures, yet it may not poſſibly have deſtroy'd all their eggs, laid, as it were, in the neſts of the ſkin; from

from which they afterwards breed again, and renew the diftemper.

Herpes is a cutaneous heat or inflammation, attended with a roughnefs of the fkin, and the eruption of a number of little puftules fpreading every way.

There are divers kinds of this difeafe: as,

Miliary herpes, which is an affemblage of innumerable little puftules, under the cuticle, of the fize of millet feeds; popularly called the *fhingles*.

The *herpes miliaris*, according to *Wifeman*, approaches very nearly to the nature of the plora, and therefore to be cured with mercurial cathartics, &c.

Simple herpes, is a fingle puftule or two, rifing chiefly on the face, of a whitifh or yellowifh colour, pointed, and with an inflamed bafe.—Thefe dry away of their own accord, upon letting out the little drops of pus contained in them.

A third fpecies of herpes is what the *French* otherwife call *ferpigo*; and in *Englifh*, a *tetter*, or *ringworm*.

Herpes exudens is a more corrofive kind; the puftules are ruddy, and attended with an itching and ulcerate the parts they rife on.

Erysipelas is a difeafe of the fkin, called St. *Anthony's fire*, whofe feat is any part of the body, but principally the face.

Caufes of the eryfipelas.—Dr. *Quincy* accounts for the *eryfipelas* from a too fizy blood, which obftructing the capillaries, occafions inflammations: others from a too fharp and bilious blood, which, on account of its great fubtilty, occafions no fenfible tumour; but fpreads and diffufes itfelf all around. Its colour, though red, generally inclines towards a yellow, on account of the mixture of bile; and always the more of the bile, the more dangerous the difeafe.

There is another fpecies of *eryfipelas*, though lefs ufual than the former; moft commonly arifing from a too copious drinking of fpirituous liquors.

Symptoms. — The fymptoms of the firft kind of eryfipelas, are, that it fhews itfelf in a ruddy inflammation of the part, with a little fwelling of the fame; an intenfe pain, and a crowd of little puftules, which, as the inflammation increafes, grow into veficulæ. The difeafe fpreads itfelf apace; fhifting from one place to another, with a fever attending it. It attacks the patient all at once, and chiefly when out in the air; whence the country people call it blafting, *fideratio*. — The other fpecies of eryfipelas, begins with a fever, after which there is an univerfal eruption of puftules, almoft over the whole body, much like thofe after the ftinging of nettles, and fometimes rifing into veficulæ. At going off they leave an intolerable itching, and as often as fcratched, return again.

Etmuller gives it as the diftinguifhing character of an eryfipelas, that when preffed very lightly by the finger, there follows a white fpot, which prefently after becomes red again; which does not happen in an ordinary inflammation, unlefs when violently preffed. — Scorbutick people are moft fubject to this difeafe.

Cure. — It is difputed, whether purging be good in the eryfipelas? *Sydenham* recommends it the next day after bleeding. *Etmuller* cautions us againft them both, and recommends diaphoreticks. Dr. *Freind* obferves, that in the laft ftage of an eryfipela's of the head, attended with a coma, delirium, &c. unlefs carthartick will do good, the cafe is defperate. All unctuous aftringents, and cold applications, externally, are dangerous; and fometimes makes the eryfipelas degenerate into a gangrene.

Diseases *of the* Eyes. Ophthalmia is a difeafe of the eyes, properly, an inflammation of the *tunica adnata*, or *conjunctiva*, accompanied with a rednefs, heat, and pain.

The *ophthalmia* is either moift or dry: in the firft there is a fhedding of tears, in the fecond none at all.

Caufes of the Ophthalmia. — The immediate caufe of the *ophthalmia*, is the blood flowing in too great abundance in the little veffels of the *adnata*, fo as to ftagnate therein, and diftend them. The remote caufes are the fame with thofe of other inflammations. In fummer it is frequent to have *epidemick ophthalmia's*.

Symptoms. It fometimes happens in the *ophthalmia*, that the two eye-lids are fo diftorted, that the eye continues conftantly open, without being able to fhut; which is called χημωσις; fometimes the eyelids are fo faften'd together, that the eye cannot be open'd, which is called φιμωσις, *q. d.* clofure of things that fhould be open.

Cure. — Snow applied to the afflicted eye, is reputed a good remedy for the *ophthalmia*: the *Ephemerides* of the *Leopoldine* academy, mention an *ophthalmia* cured by applying cow's dung, while hot, between two linen cloths, to the eye. A fox's tongue, and the fat and gall of a viper, are empirical prefervatives againft the *ophthalmia*. — The cure of the *ophthalmia*'s, according to the modern practice, depends chiefly on the due repetition of purgatives. If thefe fail, recourfe is had to veficatories, iffues, fetons, &c. *Thomas Pitcairn* prefers bleeding; it being his obfervation, that no difeafe disease requires copious bleeding so much as the *ophthalmia*.

Pitcairn, and some others, distinguish an external and internal *ophthalmia*; the first in the *adnata*, which is that hitherto spoke of; the second in the *retina*. The symptoms or indications of the latter, are *muscæ volitantes*, dust seeming to fly in the air, &c. This when inveterate, degenerates into a *gutta serena*, or *amaurosis*.

Gutta Serena is a disease of the eyes, being an entire privation of sight, without any apparent fault or disorder of the part, excepting that the pupil looks somewhat larger, and blacker than before

Cause of the gutta serena.——Its cause is supposed to be a compression, or obstruction of the optick nerves, which prevents the due flux of the animal spirits into the *retina*.

Symptoms. — The *muscæ volitantes* are a pathognomonick sign of a growing *gutta serena*.

Prognostick. —The *gutta serena* is one of the most dangerous and untractable of all the diseases of the eyes.

Cure.—The cure of the *gutta serena*, according to *Pitcairn*, must be attempted with mercurials, and even salivation, and with decoctions of guaiacum.

Before we proceed to the last part of *medicine*, I shall insert a few remarks on the several sects which have arose in this science.

Empiricks. *Empiricks*, were such physicians of antiquity as formed themselves rules and methods, on their own practice and experience, and not on any knowledge of natural causes, or the study of good authors, and who prescribed without enquiring into the nature of the disease, or the properties and virtues of their medicines; depending wholly on the authority of some general experienced remedies.

Medicine was almost altogether in the hands of *Empiricks*, till the time of *Hippocrates*, who first introduced reason, and the use of theory therein; and hence arose a new sect called *Theoretici*.

The word *Empirick* is now confounded with that of *Charlatan*, or *Quack*, and applied to persons who practise physick at random, without a proper education, or understanding any thing of the principles of the art; retailing their poisonous *nostrums*, in some publick place, where, by their buffoneries, they assemble the ignorant rabble, on purpose to cozen them of their pence, and but too often of their health.

Dogmatists. The *Dogmatists*, were a sect of antient physicians called also *Logici*, Logicians, from their using the rules of logick and reason in subjects of their profession.

They laid down definitions and divisions, reducing diseases to certain genera, those genera to species, and furnishing remedies for them all; supposing principles, drawing consequences, and applying those principles and consequences to the particular diseases under consideration. In which sense the *Dogmatists* stand contradistinguished to *Empiricks* and *Methodists*.

The *Dogmatists* were those, who brought physick into a form and arrangement like those of other speculative sciences, defining, dividing, laying down the principles and drawing conclusions: and hence also the apellation of *Logici*, q. d. reasoners. They also applied themselves to seek the causes of diseases, the nature of remedies, &c.

Erasistratus, a famous *Dogmatist*, went so far, that not contented to dissect dogs, and other brute animals, he begged condemned criminals of the magistrates, opened them while alive, and searched in their entrails.

Methodists. The *Methodists* were a sect of antient physicians who reduced the whole healing art, to a few common principles, or appearances.

The *Methodists* were the followers of *Thessalus*, whence they were also called *Thessalici*. They were strenuously opposed by *Galen* in several of his writings; who scrupled not to assert, that the methodical heresy ruined every thing that was good in the art.

Quincy mistakenly uses *Methodists*, *Methodici*, for those physicians, who adhere to the doctrine of *Galen* and the schools; and who cure with bleeding, purges, &c. duly applied according to the symptoms, circumstances, &c. in opposition to Empiricks and Chymists, who use violent medicines and pretended secrets, or nostrums.

Galenists. The *Galenists*, are such physicians as practise, prescribe, or write on *galenical* principles, thus called because introduced by *Claudius Galen*, born at *Pergamus* in *Asia*, the son of *Nicon*, a famous architect, and pupil of *Satyron* and *Perops* two able physicians. He first distinguished himself at *Athens*, then at *Alexandria*, and lastly at *Rome*; where he wrote a great deal, and where he also died in the year of Christ 140.

He is said to have composed two hundred Treatises, whereof there are one hundred and seventy still extant.

This author digesting and collecting what the authors before him had done; and explaining every thing according to the ſtricteſt doctrines of the *Peripateticks*, ſet *phyſick* on a new footing, introduced the doctrine of the four elements; the cardinal qualities, and their degrees, and the four humours or temperaments.

Medicine was wholly *galenical*, till the times of *Paracelſus*. *Geber* indeed, and after him *Raymond Lully*, *Arnoldus de Villa Nova*, and *Baſil Valentine*, made ſome attempts to apply *chymiſtry* to *medicine*, eſpecially the laſt of them, but no great advance was made. *Paracelſus*, and after him *Van Helmont*, altered the whole body of *medicine*, exploded *galeniſm*, and the *peripatetick* doctrine, and rendered *medicine* wholly *chymical*

The late improvements in philoſophy, have reformed and retrieved the *galenical medicine*, which has now little of *Galen*'s in it. It is become all *mechanical* and *corpuſcular*: inſtead of qualities and degrees, every thing is now reduced to *mechanical* affections; to the figures, bulks, gravities, &c. of the component particles, and to the great principle of attraction.

The *Galeniſts* ſtand oppoſed to the *Chymiſts*: the *materia medica* of the firſt is chiefly of the vegetable kind; the virtues of which they procure by the more ſimple and eaſy means, and ſeldom go beyond decoction. The latter take in minerals, ſalts, ſtones, and even metals, and ſemi metals: theſe, they hold, afford more efficacious remedies, and their virtues, procured by long, artful, laboured proceſſes, with the help of fire, are had more pure, and in a leſſer compaſs.

At preſent the *Galeniſts* and *Chymiſts* are pretty well accommodated, and moſt phyſicians uſe the preparations and remedies of both, as appears in the following preſcriptions.

We are now arrived at the laſt branch in our diviſion of medicine, which furniſhes the *materia medica*, &c.

Here we are firſt to conſider the buſineſs of an Apothecary.

APOTHECARY, from Αποθηκη, *ſhop*, is a perſon whoſe profeſſion is to execute the phyſician's preſcriptions, in the preparation and compoſition of medicines or remedies, which are to be adminiſtred to the patient.

His knowledge muſt be particularly improved in *pharmacy*. i. e. *remedy*, which is an art or ſcience which teaches how to chuſe, prepare and mix remedies.

Pharmacy is divided into *galenical* and *chymical*.

Galenical PHARMACY conſiſts in the knowledge and management of the ſeveral parts of the *materia medica*, now in the hands of the Apothecaries.

Chymical PHARMACY, called alſo *ſpagyrical* and *hermetical*, is that introduced by *Paracelſus*, who calls it *ars diſtillatoria*, conſiſting in the reſolving of mixt bodies, in order to ſeparate from them the uſeleſs ſubſtances, and make of them more exalted and eſſential remedies.

Pharmacy has for its object all the natural bodies, called mixts; which are divided into three claſſes, *viz. animals*, *minerals*, and *vegetables*.

Under *animals* is included not only their fleſh, but likewiſe their bones, nails, milk, blood, hairs, and excrements.

Under *minerals*, the ſeven metals, mineral matters, ſtones, and earths.

And under *vegetables*, the plants, ſaps, gums, reſines, fruits, excreſcences, ſeeds, flowers, moſſes, rinds, roots, juices, tartars, fæculæ, and all other things which proceed from them.

Of all thoſe things here recapitulated, *pharmacy* has found the ſecret to prepare remedies for the cure of the different maladies, the human body is afflicted with. But what can be meant by that term *remedy*?

A REMEDY is all that being applied outwardly, or given inwardly, excites ſome alteration in our humours, and cauſes in them a ſalutary change-ment.

Remedies are divided into *ſimple* and *compound*.

Simple remedies are thoſe employ'd as they grow naturally; ſuch are all thoſe which *Botany* ſupplies us with.

Compound remedies are a mixture of ſeveral ingredients.

Remedies are moſt commonly divided, on account of their virtues, into *alterative*, *purgative*, and *ſtrengthening*.

Alterative remedies are thoſe, which being applied outwardly or given inwardly, procure ſome change in our body, either by heating or cooling, humecting or drying, ſoftening or condenſing, rarifying or ſoporiferous, binding or opening, digeſting or reſolving, corroding or inſpiſſating, deterging or ſtopping.

Purgative remedies are thoſe, which by a certain fermentation and irritation they excite in the body, looſen the ſuperfluous humours, liquify them, and put them in a condition of being evacuated. Which remedies I divide into *cathartick* or *purgative*, *emetick* or *vomitive*, *diaphoretick* or *ſudorifick*, *diuretick* or *aperitive*.

The *carthartick* or *purgatives*, are ſubdivided into *phlegmagogues*, *cholagogues*, *melanagogues*, *hydragogues*, and *panchymagogues*.

The *phlegmagogues* are thoſe, which being compoſed of volatile and penetrating parts, are more

more diſpoſed than others to be uſhered to th brain where they rarefy and diſſolve the *pituita*, whence they are ſaid to purge particularly the brain; ſuch are the *agarick*, *coloquintida*, the ſeed of cardamum and the flowers of peach trees.

The *cholagogues* are thoſe, which having not ſo much action as the others, are only capable to ſtir the humours which are ſoon looſen'd, whence they purge the bile ſooner than any other humour; ſuch are the *caſſia*, *rhubarb*, *manna*, and *honey*.

The *melanagogues* are thoſe, which being compoſed of fix'd and extremely purgative parts, diſſolve the tartarous and melancholick humour, which is the moſt difficult to unlooſen: ſuch are the *ſcammony*, *turbith*, *ſenna*, *hellebore*.

The *hydragogues* are thoſe, which being compoſed of reſinous and ſaline parts, open the lymphatick veſſels, and make the ſeroſity to flow: ſuch are the *jalap*, *mechoacham*, *iris*, &c.

The *panchymagogues* are mixtures of all kinds of purgatives; and are ſaid to purge all humours: ſuch are the *catholicon*, the *confection hamech*, the *extract panchymagogues*, &c.

Emeticks or *vomitives* are purgatives full of ſaline ſulphurs, ſo much diſpoſed to motion, that they act a ſoon as they are in the ſtomach: ſuch are the *liver of antimony*, *emetick tartar*, *vitriol*, *azarum*, *verdigreaſe*, *tincture of tobacco*, *the juice of wormwood*, and of *carduus benedictus*, the *white* and *black hellebore*, &c.

Diaphoretick or *ſudorifick remedies* are thoſe, which being compoſed of volatile parts, open the pores of the body, and expel the humours by perſpiration: ſuch are the *volatile ſalts*, the *china-root*, *ſarſaparilla*, *gayac*, &c.

The *diuretick* or *aperitive remedies* are thoſe, which being compoſed of ſaline and penetrating parts, rarefy the blood, and make the ſeroſity thereof to precipitate with more rapidiy than before: ſuch are the *ſalprunella*, the *ſpirit of ſalt*, *white wine*, *parſley*, *bruſcus*, *aſparagus*, *parietary* &c.

Strengthening remedies are thoſe, which by the conformity of their parts, with the ſpirits of our body, rectify the alterations, which had happen'd in the humours, or the ſpirits themſelves, by exciting in them the motion, which had been interrupted, either by moderating that which is too violent, or by expelling the impurities.

Remedies heat or cool, either by themſelves or by accident. They *heat* of themſelves when being compoſed of ſaline and ſulphurous parts, they increaſe the agitation of the humours in the body of thoſe who uſe them: ſuch are *wormwood*, *ginger*, *cinnamon*, *pepper*, *cloves*, *nutmeg*, &c. They heat by accident, when in cauſing obſtructions in ſome veſſels, the humours which were to run through are ſtopped and ferment in them, whence reſults a heat in the whole body: ſuch are the *narcoticks*, *acids*, and ſeveral raw fruits.

They *cool* of themſelves, when being compoſed of aqueous and glutinous parts, they temperate the acrimony of the humours, and moderate the rapidity of their courſe: ſuch are *lettuces*, *porcelain*, *bugloſs*, the *gums tragacanth* and *arabic*, &c. They cool by accident, when being hot and acrimonious, but in a ſmall quantity in a great deal of aqueous liquor, they ſerve as a vehicle to it, to make it penetrate: ſuch are *brandy*, *ſpirit of vitriol*, *ſpirit of ſulphur*, &c. Theſe acid ſpirits cool, likewiſe, in fixing and precipitating the volatile ſalts and ſulphurs of the body, which by their too great agitation cauſed the heat: they cool, beſides, in puſhing by urine, becauſe they carry off, and expel the humours, which by their ſojourning, produce in the veſſels a foreign heat.

Remedies are humecting, when being aqueous or phlegmatick they increaſe the aqueous part of the humours: ſuch as *mallows*, *porcelain*, *lettuce*, and *cucumbers*.

Remedies dry in four different manners. 1. When by the tenuity of their parts, or their ſulphurous ſalts, they uſher out thro' the pores the ſuperfluous humidities: ſuch are the *ſarſaparilla*, the *china-root*, *ſaſſafras*, *gayac*, &c. 2. When by their terreſtrial and porous parts, they abſorb and blunt the acrimonious humours: ſuch are the *litharge*, *terra ſigillata*, *lapis calaminaris*, *crabs-eye*, *coral*, and other alkaline matters. 3. When being cauſtick, they burn the extremities of the ſmall veſſels, which ſupply the part with humour, and form there a trombus, which hinders the wound from being drenched with that humour as it was before: ſuch are the *vitriol*, *burnt allum*, *lapis infernalis*, *red precipitate*, and the *corroſive acid ſpirits*. 4. When, being deterſives, they cleanſe the wounds of their *ſania*; for there being then no more matter to excite a fermentation, the fleſh grows, and the cicatrice is formed: ſuch are the *phagedenic water*, *water of arquebuſade*, the *tincture of aloes*, and of *myrrh*, the *ariſtoloches*, and other *vulneraries*.

Remedies mollify or ſoften, when they are compoſed of mucilaginous or ſlimy parts, and of ſome ſalt, which ſerve for a vehicle to make them penetrate: ſuch are *mallows*, *violets*, *line-ſeeds*, and *fenugreec-ſeeds*.

Remedies condenſe in two manners. 1. In drying the ſuperfluous humours: ſuch are the *ſudorificks*. 2. In congealing the humour by the cold they communicate to the part, when they are applied upon it: ſuch are *lead*, the *ſperm of frogs*, the

the *white of eggs*, *cold water*, &c. or in congealing the humour by means of the acid they contain: ſuch are *ſorrel*, *barberries*, *gooſeberries*, *ſtrawberries*, *oxicrat*, and the *acid ſpirits* taken inwardly.

Remedies rareſy or attenuate, when being compoſed of ſubtile and penetrating parts, they divide the humours and render them more fluid: ſuch are the *ſpirit of wine*, and the *volatile ſalts*.

Remedies are ſoporous in two manners. 1. By cooling the blood a little, and moderating its too great rapidity: ſuch are the *emulſions*, *lohochs*, and *fomentations*. 2. In carrying a narcotick or thickening vapour to the brain, which moderate the motion of the ſpirits, and hinders them from circulating with ſo much impetuoſity as they did before: ſuch are *poppies* and *opium*.

Remedies are aſtringent, (1.) By their ſtypticity; becauſe being impregnated with a terreſtrial and crude acid, they coagulate eaſily the humours, by the approximation of the fibres of the *viſcera*: ſuch are the *ſumach*, *quinces*. *medlars*, &c. eſpecially before they are ripe. (2.) By their terreſtrial and alkaline parts, becauſe they abſorb the acrimonious humour, which cauſed the looſeneſs and vomiting: ſuch are *terra ſigillata*, *bol*, *chalk*, &c. (3.) In exciting ſweat, becauſe they uſher out through the pores the cauſe of the malady: ſuch are the *china-root*, *ſarſaparilla*, *diaphoretick antimony*, &c. (4.) In purging, which they do firſt, when thoſe remedies, beſides their purgative quality, contain terrene or ſtyptick parts, which, after the evacuation, remain and produce their effect: ſuch are the *ipecacuanha*, *rhubarb*, *myrabolans*, *tamarines*, &c. And by accident, when after the evacuation, the purgative has excited, one is hard bound for ſeveral days afterwards, that effect proceeding from the remedy having evacuated a great deal of humidities, there is not enough left in the inteſtines to humect the matters. (5.) They are aſtringent, when being aperitive, they divert the ſeroſities, which flow into the inteſtines: ſuch are the roots of *gramen*, &c.

Remedies looſen the abdomen or belly, either by exciting in the body ſome ſlight purgative fermentation: ſuch are the *violets*, *prunes*, *apples*, *cherries*; or by ſoftening and liquifying the matters: ſuch are *milk*, *veal-broth*, the decoctions of *borage* and *bugloſs*; and the *fomentations* and *baths*.

Remedies are digeſtive, or excite ſuppuration, by their ſaline and penetrating parts, which rareſying the humours ſtopped, give them motion and fermentation enough to break the ſkin; and force its way through: ſuch are *onions*, *gums*, *levana*, &c.

Remedies are reſolutive. 1. When being full of volatile and penetrating parts, they open the pores and give an iſſue to the humour which cauſed the malady: ſuch are the *volatile ſpirits*, and *mercury*. 2. When being compoſed of mucilaginous and mollifying parts, they mollify the humour which had too much conſiſtence, and diſpoſe it to be uſhered out by the circulation of the blood, and of the other humours: ſuch are *poultices*, and the *plaiſters of mellilot*, and of *mucilage*. 3. When being compoſed of cold and condenſing ſubſtances, they appeaſe the too great motion of the ſpirits, which cauſed the malady; and hinder them from returning in ſo great a quantity: ſuch are *lead*, *marcaſſites*, the *ſolanum*, the *henbane*, the *mendragora*, &c.

Remedies are corroſive when they are impregnated with very acrimonious, pricking, and burning ſalts: ſuch are *lapis infernalis*, *cauſtick ſtones*, *red precipitate*, *corroſive ſublimate*, and *butter of antimony*.

Remedies are inſpiſſating, when being compoſed of glutinous parts, they thicken the humours: ſuch are the roots of *ſymphitum*, of *althæa*, *pearl-barley*, the *gums tragacanth* and *arabick*, and the *ſarcocolla*.

Remedies are deterſive, when being compoſed of ſaline or rareſying parts, they diſpoſe the humour towards looſening itſelf: ſuch are the *aloes*, *myrrh*, *phagedenick-water*, *allum*.

Remedies ſtop or hinder the humours from flowing any more on a part already afflicted, as on a wound: ſuch are the common *oxycrat*, the *oxycrat of ſaturn*, and the *chalybeate-wine*.

Cordial or *cardiack remedies* are thoſe, which ſtrengthen the heart, in repairing the exhauſted ſpirits, and giving the body more vigour than it had before.

There are two ſorts of thoſe *remedies*, viz. rareſying, and fixing.

The fixing by the tenuity of their ſubſtance, and their volatility, increaſe the motion and circulation of the humours: ſuch are the *powder of viper*, the *confection of alkermes*, *muſk*, *ambergreaſe*, *cinnamon*, &c.

The fixing by their acidity, or narcotick quality, moderates or ſuſpends the too impetuous motion of the ſpirits: ſuch are the *ſpirit of vitriol*, the *acid juices of lemons*, *oranges*, *gooſeberries*, *barberries*, and the *narcoticks*.

Cephalick remedies are thoſe, which being compoſed of ſulphurous and ſaline volatile parts, give an agreeable vapour to the brain, which, after it has attenuated and diſſipated in part the coarſer *pituita*, revive the animal ſpirits, and excite the circulations

circulations of the humours: such are *tobacco*, *betony*, *stæchas*, *sage*, *marjoram*, *cloves*, *thyme*, *rosemary*, *lavender*.

Ophthalmick remedies are those, which strengthen and cure the maladies of the eyes, whereof there are several sorts. — Some of them strengthen in heating, when the sight has been debilitated by want of spirits, or by a fluxion of some pituitous or phlegmatick humour: such are *brandy*, *fennel-water*, *hungary-water*, &c. The others strengthen the eyes in cooling them, when they are red and inflamed: such are *nurse's milk*, *plantain-water*, the *white of eggs*, &c. The others cure the eyes in deterging and drying the little ulcers formed in them: such are the *colyrium of Lanfranc*, *prepared tutty*, *salt of saturn*, *sugar-candy*, *iris of Florence*, *vitriol*, and the *troches of rhasis*.

Dentrifick remedies are those, which being detersive, and astringent, are proper to cleanse the teeth, fasten them, and strengthen their ligaments; such are the *chalybeate wine*, the *wood of lentisk*, *red roses*, *coral*, *pumice-stone*, *burnt bread*, *cream of tartar*: some rank among those remedies, the *spirits of vitriol*, and of *salt*, which cleanse and whiten the teeth in a very short time; but corrode and spoil them.

Pectoral remedies are those, which being composed of oily, soft, and temperate substances, soften the acrimonious humours which could fall into the breast, and loosen the phlegm adhering to it: such are *milk*, *honey*, the *tussilago*, the *capillaries*, the *pulmonary*, the *red poppies*, the *borage*, the *bugloss*, the *liquorice*, the *root of althæa*, *raisins*, *almonds*, *figs*, *dates*, *pistachoe-nuts*, and *jujubes*. We use, likewise, detersive and rarefying *remedies* in the maladies of the belly, where there is obstruction; as in the asthma, such are the roots of *enula campana*, of *iris*; the preparations of *sulphur*, and of the *flowers of benjcin*.

Stomachick remedies are those, which being composed of saline, acrimonious, and attenuating parts, excite heat, and fermentation enough in the stomach, to dissolve a viscous and phlegmatick matter, which embarrasses its fibres, obstructs the motion of the spirits, and hinders the digestion: such are *cinnamon*, *nutmeg*, *coriander seed*, *anniseed*, *fennel*, *wormwood*, *mint*, *lemon*, and *orange-peels*. Sometimes also, those fibres of the stomach being only relaxed, there want but astringent remedies to strengthen them: as *conserve of roses*, *confection of alkermes*, &c.

Hepatick remedies thus called because they were supposed to strengthen the liver, are proper to correct the vices of the blood: such are the *chicory*, *lettuces*, *hops*, *agrimony*, *polipody*, *fumitary*, *rhubarb*, *aloes*.

Splenick remedies, thus called because useful in the maladies of the spleen, abound with aperitive salts, which purge by urine, and carry off the obstructions of the spleen, and of the other viscera: such are the *ceterach*, the *tamaris*, the *caper-tree*, the *chervil*, the *great centaury*, and the *mars*.

Hysterick remedies are those, which are employ'd for the maladies of the womb, or *matrice*, whereof there are several sorts. Some of them being composed of subtile or spirituous saline parts, help that part towards the expulsion of what is hurtful to it: such are the *troches of myrrh*, the *oil of succin*, *cinnamon-water*, *castoreum*, *aristoloche*, *artemisia*, *matricaria*, *melissa*, *rue*, *savern*, *white marrubium*, *saffron*, *acorns*, *gum-ammoniac*, *galbanum*, *assafœtida*, *sagapenum*, *opoponax*, *camphire*. The others being composed of fixed or condensing parts, appease and abate the vapours which arise from the matrice: such are *common water*, *spirit of vitriol*, *spirit of nitre* dulcified, and the *laudanum*.

Carminative remedies are those, which being composed of spirituous and saline parts, rarefy and dissolve the coarse matter which retained the winds in the body, and procure their expulsion, such are *anniseeds*, *fennel-seeds*, *camomile*, *melilot*, *cinnamon*, *zedoary*, *coriander-seeds*.

There are *herbs*, *roots*, *flowers*, *seeds*, *farinæ*, *waters*, *oils*, *unguentums*, &c. to which are attributed the qualities and virtues above-mentioned in a particular manner, *viz.*

The *vulnerary* Herbs are the *agrimony*, *bugle*, *sanicle*, *alchymilla*, *perwinkle*, *pulmonary*, *veronica*, *brunella*, the *capillaries*, and several others.

The *five aperitive* Roots are those of *bruscus*, *asparagus*, *fennel*, *parsley*, and *smallage*.—Several other roots are also *aperitive*, and as much in use as those, *viz.* those of *gramen*, of *eringium*, of *marsh-mallows*, &c. but it pleased the antients to find thus the number of *five aperitive roots*.

The *five* Capillaries are the *common* or *black adiantum*, the *white adiantum*, called *capillary of Montpelier*, the *polytric*, the *ceterach* or *scolopander*, and the *salvia vitæ*, or *ruta muraria*.

The three *cordial* Flowers are those of *bugloss*, of *borage* and of *violet*. Several other flowers could be as justly called *cordial*, as those of *gelly-flowers*, or *ros solis*, and of *roses*.

The *four carminative* Flowers are those of *camomile*, of *melilot*, of *matricaria*, and of *anthum*.

The common *emollient* Herbs are the *mallow*, *marsh-mallow*, *branc-ursina*, *wall flowers*, *mercurialis*, *parietary*, *beath*, *atriplex*, the *roots of white lilies*, &c.

The *four large* Cold Seeds are those of *gourd*, *water-melon*, *melon*, and *cucumber*.

The

The *four small* Cold Seeds are those of *lettuce*, *purslain*, *endive*, and *succory*.

The *four great* Hot Seeds are those of *anniseed*, *fennel*, *cumin*, and *caraway*.

The *four small* Hot Seeds are those of *smallage*, of *stone-parsley*, *bishop's-weed*, and *wild-carrot*.

The *four cordial* Waters are those of *endive*, of *succory*, of *bugloss*, and of *scabious*; to which might be added several other waters of equal virtue, as those of *carduus benedictus*, of *ulmaria*, of *scorzonera*, of *oxytriphyllum*, of *sorrel*, of *melissa*, of *black cherries*, and of *borage*.

The *four antipleuritick* Waters are those of *scabious*, of *carduus benedictus*, of *taraxacon*, and of *red poppies*.

The *three stomachic* Oils are those of *wormwood*, of *coinces* and of *mastich*. There are others, which have still more virtue, as those of *nutmeg*, of *mace*, of *cloves*, and of *bays*.

The *three hot* Unguents are the *unguent of Agrippa*, the *unguent of althæa*, and the *unguent nerval*.

The *four cold* Unguents are the *album rhasis*, the *populeum*, the *cerat of Galen*, and the *unguent of roses*.

The *four* Farinæ, or *flours*, are those of *barley*, of *beans*, of *broom-rape*, and of *lupines*: to which are often added those of *wheat*, of *lentils*, of *line* and *fenugreek-seeds*.

Having thus given a general idea of the qualities and virtues of the different remedies, and of their different manner of operating, I'll proceed to the preparation of those remedies, according to the rules prescribed by the *Galenical pharmacy*.

The *Galenical* Pharmacy is reduced to three general operations, which are the *election*, *preparation*, and *mixture of the remedies*.

The Election consists in the choice of the simple drugs, the remedies are composed of. To proceed with exactness in that choice, several circumstances are to be observed, *viz.* the *places* where those drugs grow, the *climate*, the *neighbourhood*, the *time*, the *substance*, *smell*, *taste*, *colour*, *bigness*.

1. As to the *places*; some drugs require the air of the woods, or fields; others the culture of gardens; some aquatick or marshy, others dry and parched up places; some mountains and hills, and others vallies; some walls and rocks, others the sides of roads, ditches or vineyards; some fat, and others sandy earths.

2. As to the *climate*; some excel in hot, and others in cold countries; thus the *senna* of the *Levant* is much more purgative than that, which grows in other countries: the *iris* and *fennel* of *Florence* is much better than those of *England* and *France*. The *cochlearia* is more abundant, and has more virtue in *England* and *Holland* than in *France*.

3. As to the *neighbourhood*; some acquire more virtue from the neighbouring plants, as the *epithym* from the *thyme*, the *cassuta* from the *line*, the *polypodium* and *misseltoe* from the oak. Others have more strength when they are at a distance from one another, as the *coloquintida*.

4. As to the *time*; some are in their greatest vigour in the spring, others in the summer, and others in autumn; though no very precise time can be fixed in that occasion; for according to the difference of the climates, the mixt grow slower or quicker. The general rule is, that plants are to be gathered, if possible, in fair weather, before they shoot forth their seeds:—The *fruits*, *seeds*, *fungus*, must be gathered when they are at their full growth. The animals must be killed young, vigorous, and before they have copulated with the female. And the *minerals* must be dug out of the mines when they have the bigness, solidity, weight and colour required.

5. As to the *substance*; the one must be compact, as the *opium*; the other friable, as *scammony*; the others heavy, as *cassia ligma*; others light, as *agarick*. Some liquids as common *terebinthine*; others hard and dry, as *aloes*; others soft as the *tamarinds*, and others hard, as the *myrabolans*.

6. As to the *smell*; several remedies are much better, as they are more odorant, as the *sanders*, *sassafras*, and *cinnamon*.

7. As to the *taste*; some are sweet, as the *liquorice*; bitter, as the *aloes*; sour, as the *tamarinds*; hot, as the *ginger*; styptick, as the *acacia*.

8. As to the *colour*; some must be white, as the *agarick*; black, as the *tamarinds*; red, as *sanguis draconis*; green, as the *verdet*; blue, as the *curcuma*; grey, as the *jalap*.

9. As to the *length* and *bigness*; some must be long, and moderately big, as, the *cassia*, the *viper*, &c. others must be small, as *bartshorns*, which must be taken while young, and puppies.

The Preparation of *remedies*, consist in *washing*, *picking*, *drying*, *humecting*, *infusing*, *macerating*, or *boiling* them.

1. They must be washed either to cleanse them of the dirt, as it is done to roots as soon as they are taken out of the ground, or to purify them of some acrimonious part they contain; thus the *litharge* and *tutia* are washed in water; or to increase their virtue, as when *pomatum* is washed in odorous water.

2. They must be picked of their coarse and useless parts, as *senna* is picked of its sticks and dead leaves; a sort of string is picked off certain roots; the stones are picked out of dried rasins, those stones being hard and astringent.

3. They must be dried, as the vegetables and animals which are exposed to the sun, or dried from it, that the humidity thereof being dissipated, they may be kept without corruption. But as the flowers in drying often lose their colour and smell, some of them must be wrapped up in grey paper, in small bundles, as those of *St. John's-wort*, and of *little centaury*. For *red roses* they must be dried quickly in the sun, for if they were dried slowly they would lose their colour; the large roots can scarcely be dried without the inside rotting, and we often see large pieces of rhubarb spoiled in the heart, therefore they must be chosen of a moderate bigness. The roots of *jalap*, of *mechoacam*, and of *briony* are cut in slices, that they may be easier dried. The *fruits* which abound in superfluous humidity, must be dried in an oven, otherwise they rot: *vipers* must be fastened to a string and dried from the sun.

Those drugs should not be dried too long, lest they should lose the best of their substance. When dried they must be kept in boxes.

4. They must be humected; thus *steel filings* and *iron-rust* must be humected with dew or rain-water, to open them and increase their virtue.

5. They are infused in liquors, either to dissolve them, as *cerus* in vinegar, or to communicate their virtue to the liquor, as when *rhubarb*, *senna*, or *red roses*, are steeped in water; or to correct the too great strength of their action, as when the root of *esula* is steeped in vinegar before it is used; or to open them and increase their virtue, as when *dates* are steeped in white wine, or hydromel, and when antimony is steeped in an acid liquor to render it emetick; or to preserve them as when fruits, roots, or animals are preserved in brandy or vinegar, or to render them britly, so that they may be easily pulverized, as when red-hot crystal and flints are extinguished in water.

6. They are *macerated* or *put in digestion*, as when after red roses have been pounded, they are put in a pot, covered with salt, and left thus for several months, that the salt and oil being exalted by fermentation, a greater abundance of spirits may be extracted from them when they are distilled. Honey is made to scum in water, then is put in a warm place for several months, that by digestion and fermentation it may grow vinous.

7. They are boiled either to soften them, as when the roots of *enula* and *althæa* are boiled to extract a pulp from them, or that they may communicate their quality to the decoction, as when *ptisans* are made; or to render them thick, as when the *juice of quinces* is boiled in *sapa*; or to preserve them, or to correct them, as when the *cassia* is boiled to hinder it from exciting vapours; or to free them of their useless parts, as when the *litharge* and other preparations of lead are boiled with oil or grease; or to increase their strength, as when *rhubarb* is torrified to render it more astringent; the *alum* calcined to render it escarotic.

8. They are sawed or cut, as the *woods*; hatched, as the *herbs*; rasped, as *hart-horn*; filed, as *iron* and *steel*; broken or bruised, as *roots* and *dried fruits*.

9. They are reduced into powder, either in a mill, as the *farinæ*; or in a mortar, as the *senna*, *rhubarb*; or on a porphyry with a muller, as the *coral*, and *pearls*.

1. The *mixture of remedies* consists in mixing and uniting them together, in order to form compositions of them. For that *mixture* we must first distinguish the ingredients, which unite naturally together, from those, which cannot be united but by art: oil, for example, unites very well with fat substances, but it cannot mix but imperfectly with watery ones; therefore the mixture thereof must be made in a mortar, as in the preparation of the *unguentum nutritum*, or *butter of saturn*: spirit of salt seems to mix easily with the spirit of wine, which notwithstanding, the mixture is more intimate when they are made to circulate together in a circulatory vessel, as in the preparation of *spirit of salt dulcified*. Some *oil of cinnamon*, or other *essence*, is mixed with sugar-candy in powder to make the *oleum saccharum*, that the oil being thereby rarefied in the parts of the sugar, may be dissolved with it in watery liquors: *turpentine* is mixed with yolk of eggs to render it dissoluble in decoctions.

2. One must know the means to be used for the mixture of drugs; for it suffices sometimes to agitate them together in a mortar, as *powders*; and when *mercury* is to be extinguished in turpentine: sometimes they must be beaten a long time, as when *flowers* are mixed with sugar for *conserves*, when masses for pills, and troches are to be made; sometimes they must be dissolved in *aqua fortis*, as when some chymical preparations are made on metals: sometimes it is necessary to *boil them together*, as sugar and honey, with juices, decoctions, and infusions, to make *syrups*, and several other compositions: sometimes there must be a consumption of the humidity at a slow fire, after the mixture, as in the preparation of some electuaries. Sometimes they must be mixed together with the bistorter, as pulps and powders in sugar and honey: sometimes they must be liquified together, as wax, rosin, and pitch with oils: sometimes they must be melted by a violent fire, as metals, and several minerals, which are put in fusion together: sometimes they are amalgamated, as *mercury* with gold and silver.

3. An order must be observed in the mixture of the

the drugs; for fome muft be mixed before the others; for example, in the compofitions, the pulps muft be mixed before the powders, and the powders before the effences; odorous and volatile ingredients muft be commonly left for the end, left their virtue fhould be altered by heat and agitation; the fcammony, aloes, and other gums clotten in the electuaries, if they be mixed while the matter is yet too hot, therefore one muft wait till it be almoft cold: the wax and pitch are not to be mixed or melted in plaifters, till the litharge or minium, or cerufs, if it enters into them, be done.

When *tablettes* or *lozenges* are made, where no acid enters, the liquor muft be mixed at once with the fugar to make them boil together; but if it be wanted to prepare *acid lozenges*, as thofe of barberries, of lemon, of pomegranates, the juice ought not to be mixed but by degrees with the fugar over the fire, and dried in proportion; for if the juice that is to be employ'd in it was put all at once, one could not give the mixture by coction, confiftence enough to form lozenges of it; for when it is wanted to make the *fal-polychreft*, the fulphur is mixed with the faltpeter before the matter is thrown into the red-hot crucible, and in the preparation of fal prunellæ, the faltpetre is put into fufion, before the fulphur be mixed with it.

4. The compofition muft be of a good confiftence, kept in a dry place; and if it be liquid, as electuaries, muft be ftirred, from time to time, with a fpatula, to give room for the fermentation.

A Decoction, of the Latin *decoquere*, *to boil*, is made to diffolve the action and ufeful fubftances of a mixt into a proper liquor; or to foften thofe mixts, fo that a pulp may be extracted from them.

The *liquors* ufed for *decoctions*, are *water*, *wine*, *vinegar*, *milk* and *whey*.

The more hard and compact the drugs are, the more liquor is wanted to boil them. And a *decoction* muft be fometimes preceded by infufion, that the liquor may have time enough to extract the fubftance of the mixts; as in the decoction of the woods, viz. *farfaparilla*, *china*, *faffafras*, *guaiac*, and *box*.

One muft avoid, as much as poffible, boiling the aromaticks, becaufe their volatile principles, which are the moft effential, are diffipated in boiling: therefore it is beft to put them in a hot liquor to infufe, in a veffel well covered.

When we make a *decoction* of feveral ingredients, we muft begin, for example, by boiling the barley, the chips of hartfhorn and ivory, the roots of gramen, for half an hour at a moderate fire; putting afterwards the other roots newly gathered (well wafhed and picked of their hearts or ftrings, and cut in fmall pieces) to boil for a quarter of an hour; proceeding to the fruits after they have been pared and ftoned, and cut in pieces, if they be large; then the herbs chopped, and the feeds bruifed; concluding with the flowers and liquorice, which muft be boiled but very little: the whole is thrown afterwards into an earthen pan, or pewter bafon, over the cinnamon bruifed, the fanders, the faffafras rafped, and the other aromaticks; the veffel then is covered; and when the *decoction* is cool, it is ftrained, and afterwards left to fettle, that it may be decanted clear.

If animals, as craw-fifh, frogs, or vipers, are to be in the decoction, they muft be always put in at the beginning; but then the decoction is to be made over a flow fire, left there fhould be a too great diffipation of the effential and volatile falts.

Let our firft prefcription be for a *caphelick decoction*.

Cephalick decoction—Take miffeltoe and cloves, of each fix drachms; of juniper-berries three ounces; flowers of fage, of betony, of marjoram, of each a handful; and let them be boiled, according to the above directions, in three quarts of common water, *i. e.* river-water, which is always beft for all forts of decoctions.

The juniper-berries muft be bruifed, and when, together with the flowers, they have boiled two or three gallops, the decoction muft be thrown into an earthen pan, and well covered till it be cold.—It cannot be kept longer than two days in hot, and four in cold weather.

Virtues.—For the epilepfy, apoplexy, lethargy. *Dofes.*—From two ounces to fix.

A *pectoral decoction.*—Take two ounces of jar-raifins ftoned, fifteen dates, two ounces of jujubes, an ounce of pearl-barley; let the whole boil in three pints of common water to the confumption of a third part, and towards the end of the coction add half an ounce of liquorice bruifed, the leaves of maiden-hair, ground-ivy, and tuffilago, of each a handful; let the whole macerate together for the fpace of a quarter of an hour, and then ftrain the decoction.

The raifins and dates muft be ftoned, and the jujubes chofen very frefh; and in ftraining the decoction it muft be done with expreffion.

Virtues.—It is proper to excite expectoration, for an inveterate cough, and to loofen the tenacious matters, which obftructing the bronchia of the lungs ftops the refpiration. *Dofe.*——From two ounces to fix.

A *bitter decoction.*—Take the tops of little centaury, the leaves of agrimony, flowers of camomile, of each half a handful, two drachms of gentian-root, of feeds of carduus benedictus, and of lemon, of each a drachm and a half; white wine and fpring water, of each a pint and a half; let it boil till it be reduced to half.

The feeds muft be bruifed, the gentian-root cut in fmall pieces, and boiled together in the water. then the fummets, the leaves, flowers, and white-wine, fhall be added to it, and left to boil to the confumption of half the humidity; afterwards it fhall be ftrained by expreffion. If it be wanted to render that decoction purgative, fix drachms of fenna, one of rhubarb, and four fcruples of falt of little centaury, muft be put to infufe in it, warm for a whole day.

Virtues.—It is proper to expel intermittent fevers, to kill the worms and purify the blood. *Dofe.*—One glafs in the morning fafting, and another at night.

We often fee that the bitter remedies are febrifuge, becaufe the faline and fulphurous fubftance which compofe the bitter, is proper to rarefy and diffolve the matter, which forms the obftructions and caufes the fever.

INFUSION comes from the *Latin* word *infundere*, to fteep.

Drugs are *infufed*, either to foften them, as when dates are fteeped in hydromel; or to correct them, to temperate their acrimony, as when the root of *efula* is put to infufe in vinegar; or to extract their fubftance and virtue, as when fenna, rhubarb, myrabolans, or agarick, are put to infufe in common water, or in juices.

The liquors commonly employed for *infufions*, called in terms of chymiftry, *menftruum*, are common and diftilled waters, whey, juices of plants, rain-water, dew, wines, brandy, fpirit of wine, diftilled or not diftilled vinegar.

To make *infufions* with prudence and utility, one muft know the nature of the fubftance of the drugs, which are to be infufed, in order to give them a convenient diffolvent. All forts of liquor is not capable to extract the virtues of all forts of mixts. Water, for example, is fufficient to extract the fubftances of the fenna, rhubarb, tamarinds, *&c.* but it is not proper to receive thofe of the jalap, tar, turbith; there are wanted for thofe refinous mixts, fulphurous liquors, as brandy, fpirit of wine, or others, which fhould be of a nature to diffolve the rofines

The time to be employ'd in *infufions* is not limited; for, as the mixts are more or lefs hard; and their principles more or lefs difficult to be loofened; there is likewife more or lefs time required fo it.

The APOZEMS are ftrong decoctions of feveral forts of roots, herbs, fruits, feeds, and other parts of plants, appropriated in virtues to the maladies, for which they are given: thofe *apozems* can be render'd purgatives, by making to infufe in them purgative drugs.

For an *alterating* and *aperitive apozem.*—Take the roots of gramen, of parfley, of afparagus, and white tartar, of each half an ounce; wild cherries, *Kentifh* cherries, and dried *French* beans, of each three drachms; the leaves of fuccory, of parietary, of fellery, of chervil, of each a handful: let them boil together in three quarts of common water to the confumption of a third part; and ftrain it afterwards with expreffion.

Virtues.—It is proper to raife the obftructions of the liver, of the fpleen, of the mefentery, and of the matrice; and for the ftone and gravel.——The *Dofe* is a glafs full twice a day.

The tartar muft be coarfely pulverized, the roots well cleanfed, bruifed, and cut in fmall pieces, and put together to boil for about half an hour in the water; adding, afterwards, the fruits opened, and the *French* beans bruifed; and when the decoction fhall have boiled for a quarter of an hour longer, the herbs hatched muft be thrown into it; and then it fhall be left to boil to the confumption of a third part; and afterwards taken off the fire, and when half cold, ftrained through a cloth by expreffion. This is the *apozem.* One may make on this model, *pectoral apozems*, with pectoral drugs; *cephalick*, with cephalick drugs; and *hyfterick*, with hyfterick drugs.

JULEP, or JULEB, is a *Perfian* name, which fignifies fweet draughts; the *Greeks* call it ζουλαπιον, and the *Latins julepus*, and *julapium*, or *hydrofaccharum*. It is a mixture of fyrups, and diftilled waters, or light decoctions, the preparation whereof is commonly of an ounce of fyrup, on fix ounces of water or decoction.

Juleps are made of different fyrups, and of different liquors, according to the maladies for which they are adminiftered. They may be render'd four either with acid fpirits or juices; they are not prepared, but when they are wanted; becaufe they cannot be kept longer than two or three days in winter; and about twenty-four hours in fummer in a cool place: *juleps* are never mixed with purgatives.

For an *hyfterick julep.*—Take the diftilled waters of *meliffa*, and of mugwort, of each two ounces; one ounce of orange-flowers, two drachms of cinnamon; one ounce of mugwort; tincture of caftor, and oleous aromatick volatile falt, of each four drops: mix them well together for a *julep* of one dofe.

2 *Virtues.*

Virtues.—It diſſipates the vapours; fortifies, and provokes the menſes.

Emulsion came from the Latin *emulgere*, to milk; for in fact this remedy approaches very near the colour and conſiſtence of milk: it is extracted from almonds, cold ſeeds, or fruits diſſolved in diſtilled water, which are ſtrained hard, and edulcorated with ſugar or ſyrups.

For a *cooling* and *aperitive emulſion* —Take one ounce of the four cold ſeeds; the ſeeds of althæa and of white poppies, of each one drachm: let them be pounded in a marble mortar, pouring ſlowly over them a quart of decoction of the roots of althæa, and of parſley; ſtrain it by expreſſion: and to the colatura add four ounces of ſyrup of marſh-mallows.

Virtues.—It is proper to expel, gently, the ſand from the reins and bladder, to temperate and ſoften the acrimony of the urine, when it proceeds from a clap, or from another cauſe.

Potion comes from the *Latin potare*, to drink. This name can be given to all ſorts of draughts; but in medicine it is moſt commonly reſtrained to certain mixtures of ſeveral powders, confections, electuaries, ſyrups, elixirs, tinctures, eſſences, diſſolved in liquors. There may be prepared *potions* of all ſorts, for each malady in particular; for there are *anodyne*, *emetick*, *ſtomachick*, and ſeveral other potions.

A *cordial potion* is properly a julep, in which have been mixed ſimple, or compound drugs; and powders, and cordial confections.

A *cephalick potion* is a julep, in which have been mixed cephalick remedies.

A *purgative potion* is a purgative medicine, or apozem

For a *cordial potion.*—Take a drachm of confection alkermes, an ounce of ſyrup of lemons, water of bugloſs, and of carduus benedictus, of each one ounce and a half, mixed together for a potion.

Virtues.—This potion is proper to fortify the heart, and to reſiſt the malignity of the humours. It may be taken all at once, or at different times.

To this potion may be added *ſalt of viper*, diaphoretick antimony, volatile ſalts, and ſeveral other ſuch remedies, according to the intention of the phyſician.

For a *cephalick potion.*——Take one drachm of confection alkermes, a ſcruple of volatile ſalt of hartſhorn, an ounce of treacle water, the water of betony, and marjoram, of each an ounce and a half, mixed together for a potion, which is to be taken by ſpoonfuls.

Virtues.—This *potion* is proper to fortify the brain, for the epilepſy, apoplexy, lethargy, and palſy: the doſe is two or three ſpoonfuls at once.

Several other cephalick drugs may be added to this potion, as the tincture of caſtor, the diaſcordium, and the eſſence of cloves.

For a *potion for the cholick.*—Take one ounce of mint-water, half an ounce of cinnamon water, an ounce of ſyrup of diaſcordium, half the yolk of a new-laid egg, the oil of juniper-berries, the ſpirit of ſal ammoniac, and of lavender compoſed, of each ten drops, two grains of ſalt of wormwood, mixed together for a potion to be taken by ſpoonful.

Virtues.—This potion cures the windy cholick, and diſſipates winds generated in the ſtomach, for want of digeſtion.

For an *aſtringent potion, to ſtop the vomiting or ſpitting of blood.*—Take an ounce of ſyrup of myrtle, a dram of ſanguis draconis, the eyes of crawfiſh prepared, and ſix drachms of vinegar, mixed together for a potion to be taken by ſpoonfuls.

Virtues.—This potion is aſtringent, proper to ſtop the ſpitting and vomiting of blood, a looſeneſs, and the dyſenteria; for loſſes of blood, for the whites in women, and other immoderate evacuations of the matrice.——The *doſe* is a ſpoonful often repeated.

Mixture comes from the latin *miſcere*, which ſignifies *to mix*, though this name appears very general, and can be given to a vaſt number of different ſorts of *mixtures* made in *pharmacy*, it is notſtanding more properly adapted to certain *mixtures* of ſpirits, eſſences, elixirs, and diſtilled waters, which being adminiſtered in a ſmall doſe, produce notwithſtanding the ſame effect of remedies given in a greater volume, and operates ſooner.

For a *diuretick mixture.*—Take an ounce of ſpirit of turpentine; rectified ſalt, dulcified nitre, of each three drachms; ſuccin, and elixir proprietatis, of each two drachms; to be mixed together for a *mixture*.

Virtues.—It is proper for the ſtone, the gravel, the ſuppreſſion of urine, and the nephritick cholick—— The *doſe* is from four to fifteen drops in white wine, or a liquor appropriated to the diſtemper.

A Bolus is a ſort of remedy of the conſiſtence of paſte, which is moſt commonly a purgative, divided into ſeveral parts before it is taken.

The conſiſtence of the *bolus*'s is moſt commonly like that of the electuaries; and the matter thereof different, according to the different indications.

For a *cathartick*, and *aperitive bolus*, for a gonorrhœa. Take half an ounce of confection hamec, a drach of turpentine, half a drach of cream of of tartar, and fifteen grains of mercurius dulcis, mixed together for a *bolus*.

Virtues.—It purges both by stool, and by urine; and cleanses the urethra, and spermatick vessels, of the venereal virus.

The Gargarisms are liquid remedies proper for the maladies of the throat, which is washed therewith without swallowing them.

For a *gargarism to stop a salivation*, excited by the mercury.—Take a drachm of whole barley, plantain's flowers, nuts of cypress, pomegranate-peal, flowers of sumach, of each half an ounce, two drachms of barberries, boil them in common water and red wine, a pint of each, to the consumption of a third part; strain them, and in the colature, dissolve two drachms of extract of mars astringent, half a drachm of salt of saturn, and two ounces of honey of roses, for a *gargarism*.

The barley must boil first in the water, then the pomegranate-peal, the barberries, and the nuts of Cypress bruised are added to it, and afterwards the wine; and when the decoction has boiled still a little longer, the herbs and flowers are thrown into it, the coction continuing till the diminution of a third part; then it is strained by expression; and in a pound of the colature, the honey of roses, the extract of mars astringent, and the salt of saturn are dissolved.

Virtues.—This *gargarism* is very astringent, proper to dry the ulcers of the mouth, to fasten the gums, and to stop a salivation when the patient washes often his mouth with it.

The Errhina, in latin *nasalia*, are remedies introduced into the nose, to make one blow his nose or sneeze. They are made of various forms, sometimes in powder, sometimes liquid, sometimes like a sort of unguent, and sometimes in a solid mass, divided into small pyramidical sticks.

For a *sternutatory powder*.—Take white hellebore, tobacco, iris of Florence, each two drachms, flowers of lilies of the valley, of betony, of marjoram, and of sage, of each a drachm.

The drugs must be pounded together in a brass mortar, and afterwards passed through a common coarse sierce.

Virtues.—It is proper to excite sneezing and to purge the brain.

A scruple of euphorbium may be added to it, when used in the apoplexy or lethargy, but in all other occasions it is dangerous to introduce *euphorbium* into the nose, because of its violent effects.

Injection is a liquor introduced by means of a syringe, into several small cavities of the human body; as into the natural parts of both sexes, into wounds, and even into the intestines; for the clysters are a kind of *injections*: the matter of the *injections* are different, according to the different indications.

For *an injection to stop a gonorrhœa*—Take plaintain and rose-water, of each four ounces; an ounce of honey of roses; a drachm of vulnerary and styptick tincture, mixed together for an *injection*.

Virtues.—This injection is astringent, proper to strengthen the spermatick vessels, and stop the gonorrhœa.

Clyster, or *clysmus*, or *enema*, are *Greek* names, the two first signify washing, and the last *injection*.

For an *emollient and laxative clyster*.—Take two pints of the cooling and emollient decoction; an ounce of lenitive electuary; two ounces of honey of violets, mixed together for a *clyster*.

Virtues—It is proper for those who are hard-bound, to purge the lower abdomen of bilious and other humours, to temperate the heat of the entrails, and appease the fever.

Whey may be used instead of the decoction, to render the *clyster* still more cooling.

For a *detersive clyster*.—Take a pint of a detersive decoction half an ounce of double catholicon, two ounces of honey of roses, and the yolk of a new-laid egg, mixed altogether for a detersive clyster.

Virtues.—It is proper to purge in stopping a looseness, and instead of the double catholicon, we may prescribe oil of sweet almonds, or of white lilies, especially when the looseness is accompanied with slimy matters, which cause continual motions.

For a *clyster for the nephritick*.—Take the leaves of marsh-mallows, and parietary, of each a handful, flowers of St. John's-wort, and of the golden rod, of each as much as one can hold between three fingers, three drachms of juniper berries, and two drachms of linseed, boil them together in a quart of common water, to the consumption of half the humidity; strain them with expression, and in a pint of the colature, dissolve lenitive electuary, laxative bendict, of each half an ounce; two ounces of honey of violets; two drachms of turpentine of *Venice*; and six drachms of linseed oil. For a *clyster*.

Virtues.—It is proper to open the passages of the urine; and to cure the nephritick and windy cholick.

The decoction is sometimes made with white wine; and the *clysters* with oil or grease, purge less than those where there is none; because oily sub-

stances

ſtances blunt by their ramous parts the points of the purgatives.

SUPPOSITORIES are ſolid remedies, of a pyramidal figure, and of the thickneſs and length of the little finger. They have been invented to ſupply the want of *clyſters*. This remedy is proper to open a little the body; it is thruſt into the fundament, and kept there as long as poſſible, that it may have time to penetrate and ſoften a little the matters, and provoke the inteſtine *rectum*, by pricking it; but it is very far from having the ſame efficacy as a clyſter.

The common matter of *ſuppoſitory*, is common honey, boiled to a ſolid conſiſtence; it is ſharpen'd with a little ſalt. When the *ſuppoſitories* are to be ſtronger, there muſt be added either half an ounce of electuary of *hiera picra*, or two drachms of aloes.

The honey and ſalt muſt be put in an iron ladle, or in a little ſkillet, over a ſlow fire, where they muſt boil till the matter has acquired a ſolid conſiſtence, which will be known if a little bit thereof be put to cool; then it muſt be poured boiling hot on the bottom of a little mortar turn'd upſide down; and the *ſuppoſitories* formed on a marble, or board greaſed with oil.

PESSARIES are alſo ſolid remedies, very near of the bigneſs of a finger, and of a pyramidal figure; they are introduced into the matrice, after an end thereof has been faſtened to a ribband, that the *peſſary* may be taken out at pleaſure.

Peſſaries can be made of cork, or of a light wood, or with a root, or with a little ſheath made of a thin ſilk, and filled with powders incorporated with wax, oil and cotton, the whole preſſed very hard in the ſheath, that it may have ſolidity enough to be introduced into the matrice: one muſt take care, likewiſe, that the ſeam be very even, and well flatten'd, leſt it ſhould wound the matrice. That made of wood, or of cork, or of root, muſt be anointed with a linament compoſed of drugs appropriated to the intention of the phyſician; for example, if it be to provoke the *menſes*, the following liniment is very proper.

A *liniment* for *peſſaries*.—Take myrrh and aloes, of each a drachm; a ſcruple of ſaffron; eight grains of camphire; four grains of caſtoreum, pound them well together, and mix them in an ounce and a half of unguent of *althæa*, or marſh-mallows. Add to it two drachms of *ſperma ceti*; and ſix drops of oil of ſuccin; for a liniment.

If it be to ſtop a too great a flooding of the menſes, the following liniment is very good.

A *liniment for aſtringent peſſaries*.—Take prepared coral, and *terra ſigillata*, of each two drachms; ſix grains of ſolid *laudanum*, pounded, and mixed together in two ounces of white wax, and an ounce of oil of ſolanum, in which is dipped a ſufficient quantity of cotton for a hard mixture, proper to fill the little ſheaths of ſilk.

A FOMENTATION is moſt commonly made of decoctions of emolient and cooling herbs, to ſoften ſome hardneſſes formed in the lower abdomen, or of aſtringent liquors, to ſtrengthen and bend the fibres: pieces of cloth are dipped in thoſe *fomentations*, kept hot, and applied on the afflicted part; or the herbs are put in ſmall cloth-bags, and after they have been made to boil, are applied. There are alſo *dry fomentations*, made on ſeveral parts of the body; as fried bran or oats, which are applied hot, between two cloths, for rheumatical pains; vervein fried for the pain in the ſide, in the pleuriſy; parietary to be applied on the region of the urethra, in the nephritick cholick: a hog's bladder is filled with hot milk, and applied on the lower abdomen: ſalt and aſhes are calcined to be applied hot on the neck, to dry and diſſipate the catarrhea's. Laſtly, one may uſe almoſt as many ſorts of *fomentations*, as there are different ſorts of maladies, which afflict the human body.

For a *fomentation for diſlocations and contuſions*.—Take roſemary, ſage, marſh-mallows, hyſſop, and lavender, of each a handful; the rind of pomegranate, bays, and juniper-berries, of each an ounce; fill ſmall linen bags with thoſe herbs, &c. bruiſed and mixed together; and put them to boil in two quarts of lees of red wine over a ſlow fire, the veſſel cover'd, to the conſumption, of a third part; then apply the bags hot on the part.

Virtues.—This *fomentation* is proper to ſtrengthen and conſolidate diſlocated bones, the nerves and ligaments; to reſolve the tumours, which follow the contuſi ons; and to help the digeſtion, when applied on the ſtomach.

The decoction muſt be half cold before it is uſed, then one of the bags is taken out, ſqueezed a little between the hands, and applied on the part, where it is left about an hour; then is taken off, and the other put in its place; continuing to apply thus the bags, alternatively five or ſix times; leaving that, which is applied laſt, five or ſix hours on the part.

EMBROCATION is an aſperſion made of ſome liquor, by means of tow or ſpunges on ſeveral parts of the body, and particularly on the head, to open the pores, and to ſtrengthen.

An *embrocation* is properly a lotion, moſt commonly compoſed of decoctions, or ſpirit of wine,

or

or of oxyrhonodinus, prepared with oil and vinegar of roſes, on the ſhaved head of the patient, as well to prevent a delirium, as to cure it.

For an *embrocation for a lethargy*—Take the roots of Cypreſs, of iris of *Florence*, calamus aromaticus, of each half an ounce; of leaves of ſage, of roſemary, and of betony, bays-berries, and coriander and cumin-ſeeds, of each two drachms; boil them in three pints of common water to the conſumption of a third part, then ſtrain them by expreſſion, and to the colature add four drachms of brandy; for an *embrocation* for the head.

Lotion comes from the verb *lavare*, to waſh. I'll treat here only of the *lotions*, made to ſome parts of the body in particular, with medicinal liquors, to kill the vermine, &c.

For a *lotion to kill lice in the head.*—Take two ounces of ſtaphyſagria, an ounce of ſemen contra, the leaves of wormwood, of betony, and of little centaury, of each two handfuls: boil them in two pints of water, to the conſumption of a third part, ſtrain it, and waſh the head with it, warm. It kills the lice and crabs. This decoction can alſo be made in urine, adding to it an ounce and half of the roots of enula campana.

For a *lotion to render red hair black.*—Take half a pound of the peel of green walnuts, the bark of oak, galls, of each two ounces; the leaves of myrtle tree, of pomegranate-tree, of each a handful: boil them in three pints of water to the conſumption of a third part; ſtrain hard the decoction, and in the colature diſſolve roch-alum, and green vitriol, of each an ounce and a half for a *lotion.*

Though this lotion belongs more properly to dying than to medicine; it will, notwithſtanding, pleaſe thoſe who having red hair want to make them change colour; which may be done by waſhing them with this ink, and letting them dry before they are wiped.

A mucilage is ſometimes a ſlimy liquor, which ſpins when it is poured, and ſometimes a ſize. It is commonly made of roots of althæa, of ſymphitum, of the ſeeds of lin, of fenugreek, quinces, or pſyllium, the gums tragacanth, Arabick, or of plumb-tree, the glue of fiſh, the ſkin of a ram infuſed, or boiled in water. All *mucilages* are ſoftening.

For *a common emolient mucilage.*—Take four ounces of the roots of marſh-mallows; the ſeeds of lin and fenugreek, of each an ounce; let them infuſe for twelve hours in two quarts of warm water, then boil them over a ſlow fire, to the reduction of half the humidity, and ſtrain afterwards the mucilage with expreſſion.

Virtues.—This *mucilage* is proper to ſoften the hardneſs, to appeaſe the pains and to ſweeten.

Epithema is a *Greek* word, which ſignifies *fomentation*—There are two ſorts of *epithems*, one *liquid*, and the other *ſolid.*

The *liquid epithema* is a ſort of fomentation more ſpirituous than the others, which are uſed only for the regions of the heart and liver. Simple and compound diſtilled waters, light decoctions, vinegar, lemon-juice, are the common matters of the liquid *epithems.*

A *ſolid epithem* is a mixture of treacle, confections, mithridate, opiate of ſolomon, diaſcordium, conſerve of roſes, of gillyflowers, bugloſs, *&c* of the cordial powders, as the diamargaritum, diarrodon, diatriaſantali, and even the compoſed oil of ſcorpion of Mathiol, ſpread moſt commonly on a piece of ſcarlet cloth, or on leather, and applied about the region of the heart to ſtrengthen it.

For a *liquid cordial epithem.*—Take the waters of bugloſs, of ſcabious, of carduus benedictus, and of roſes, of each three ounces; treacle and confection alkermes, of each half an ounce; and two drachms of the powder diarrodon abbatis, mixed together for an *epithem.* One muſt have two pieces of ſcarlet or other cloth, large enough to cover the region of the heart or that of the liver; and having warmed the epithem in a diſh, the pieces of cloth muſt be ſoaked in it, and applied every quarter of an hour, one after another, as preſcribed in the fomentations, covering the *epithem* with ſome thick cloth, to entertain the heat as long as poſſible.

Virtues.—This *epithem* is proper to revive the heart, and ſtrengthen it, to awake the ſpirits, and reſiſt the malignity of the humours. To this *epithema* may be added ſuch cordials as are judged proper.

For a *ſolid epithema.*—Take an ounce of conſerve of roſes, confection alkermes, and treacle, of each two drachms; for a ſolid epithema, which muſt be ſpread on woollen cloth, and applied warm on the region of the heart.

Virtues.—This *epithema* is ſuppoſed to ſtrengthen the heart by rarefying the blood, and facilitating its circulation.

Perfumes in medicine, may be divided into *liquid* and *dry perfumes*:—*Liquid perfumes*, are all the fragrant waters and caſſoletes.—*Dry perfumes*, are paſtilles, juniper-berries, and the wood of juniper, *&c.* which are burnt in the chambers of patients, to correct the bad air.

A *powder for a corroborative perfume.*—Take three

three drachms of troches of nutmegs; *calamus aromaticus*, cinnamon, ſtorax, benzoin, of each a drachm and a half; mace, cloves, of each half a drachm; roſes, marjoram, of each two ſcruples, all coarſely pounded together for a *perfu e*, to be burnt on lighted coals, for the patient to take the vapour thereof.

Virtues.—It ſtrengthens the heart, and recreates the ſpirits.

A FRONTAL is a remedy applied on the forehead, to appeaſe a little the head-ach, and provoke ſleep. It is ſometimes compoſed of dried remedies, as roſes, ſanders, betony, marjoram, coriander-ſeed, elder-flowers, and of nenuphar; of lavender, kernels of peach-ſtones, or of apricocks bruiſed, when it is wanted to rarefy a coarſe pituita, and ſtrengthen the brain.—Sometimes with wet linen dipped in roſe-water, and vinegar of roſes, to ſtop the bleeding of the noſe; ſometimes with unguents, leaves of green plants, of gourd, lattuces, porcelain, vine; of green flowers pounded, of conſerves, of opium, to provoke ſleep, and moderate the head-ach, which accompany a violent fever.

A *liquid frontal*.—Take lattuces, conſerve of roſes, and nymphæ, of each half an ounce; three drachms of populeum; a drachm of ſea-ſalt, half a drachm of liquid laudanum; to be mixed for a *frontal*.

Virtues.—It is proper to appeaſe a violent head-ach and to provoke ſleep.

COLLYRES are remedies deſigned particularly for the maladies of the eyes.

Collyres are either *dry* or *liquid*.

Dry Collyres are the troches of *rhaſis*, prepared tutty, ſugar candy, iris, white vitriol in powder, which is blown thrown a ſmall pipe into the eye, to diſſipate the cataracts in their beginning.

Liquid collyres are compoſed of ophthalmick waters and powders, as prepared tutty, diſſolved in water of roſes, of plantain, fennel, and celandine, ophthalmick unguents, are alſo called *collyres*, as the unguent of tutty, and ſeveral others.

For a *cooling collyre*.—Take the waters of plantain, of roſes, and of fennel, of each two ounces; and half an ounce of whites of eggs, to be mixed together for a *collyre*.

Virtues.—It is proper for the inflammations and pains of the eyes, ſoftening and embaraſſing, by its glutinous parts, the acrimonious ſalts, which cauſe that diſorder. A fine piece of linen cloth, or a little bit of thin veal, is imbibed with that *collyre*, and applied on the afflicted eye.

A CATAPLASM is an outward remedy of the conſiſtence of a paſte, compoſed, moſt commonly, of flowers, pulps, oils, unguents, gums, and powders. It is applied on the parts of the human body, ſometimes to reſolve, ſometimes to appeaſe the pains, and ſometimes to raiſe the ſpirits.

For an *anodyne and reſolutive cataplaſm*.—Take four ounces of crumbs of bread, and a pint of new milk; boil them together to the conſiſtence of a *cataplaſm*; then add to it two yolks of eggs, an ounce of oil of roſes; and a drachm of ſaffron well pounded.

Virtues.—It is reſolutive, and proper to appeaſe the pains, and reſolve the tumours, being applied hot on the part: ſometimes a drachm of laudanum is added to this *cataplaſm*, to render it more anodyne.

The DENTRIFICKS, in Latin *dentrificia*, are remedies uſed to cleanſe the teeth, and preſerve them: ſuch are the *woods of lentiſk*, the *ſanders*, the *wood of roſes*, *prepar'd coral*, *burnt bread*, *pumice ſtone*, *cryſtal calcined*, *hart's horn*, *ivory*, and *egg-ſhells*, theſe alkalies mixed, or every one by itſelf, are very proper to cleanſe the teeth, and appeaſe the acrimony of the ſalts left in them after eating. The ſpirits of ſalt and of vitriol, whiten the teeth in a very ſhort time, but they corrode them.

Next comes the preparation of *coral*, *pearls*, *crab's eyes*, *ſpodium*, or *burnt ivory*, *precious ſtones*, *ſuccinum*, or *carabé*, *ſtone hematites*, *load-ſtone*, and ſeveral other ſuch matters.

To prepare well thoſe matters, the *coral*, for example, muſt be pounded firſt, as much as poſſible, in a braſs mortar, then the powder ſhall be thrown on a table of porphyry, to be ground, with a ſufficient quantity of roſe-water. to the conſiſtence of a paſte: that paſte muſt be ground with a muller, till it makes no more noiſe on the porphyry; and then it muſt be formed in little troches, which is the prepar'd coral; which grows paler in grinding, and aſſumes a fleſh-colour; the water mixed with it, ſerves only to grind it more exactly, and with greater facility.

Virtues.—*Prepared coral* is ſuppoſed good to ſtop a looſeneſs, the hæmorrhages and gonorrhœa's.—The *doſe* is from ſix grains to a ſcruple.

The *pearls*, *mother of pearls*, and other *ſhells*, are as hard as the coral, and are attended with the ſame difficulties; and take as much time in their preparation in the mortar, and on the porphyry; but *crab's eyes*, *burnt ivory*, and other ſuch calcined matters, do not require ſo much trituration.

The preparation of the *tutty*, and the *lapis calaminaris*, is different from that of the coral, *&c.*

no otherwise than they are calcined and washed before they are pulverized, to carry off their most saline and sulphurous parts.

Therefore one may take what quantity he pleases of those two drugs, of *tutty*, for example, and make it red-hot in a crucible placed between lighted coals; when red-hot, it must be thrown into a bason full of water, and left there for half an hour; which operation must be repeated twice more, changing the water every time: afterwards the *tutty* having been drained, must be ground on a porphyry with a muller, mixing with it as much plantain, or rose-water, as is necessary to reduce it to an impalpable powder; then it is formed into small troches.

Virtues.—The *tutty* is desiccative, and proper for the maladies of the eyes. It is the basis of the unguent pompholix; it is mixed in the collyres, and in fresh butter: it cleanses the sania of the eyes, in drying and fortifying the fibres.

Note, That several content themselves with washing the *tutty* without calcining it, which does not occasion a very considerable difference,

The *preparation of the bol*, *terra sigillata*, *chalk*, *litharge* and *ceruss*, consists in pulverizing the matters, and purifying them of some coarse and terrestrial parts they contain.

Therefore take what quantity you please of one of those drugs, for example, of *bol*, reduce it into a subtile powder in a brass mortar, and having put it in an earthen pan, pour water over it, stirring the matter, and decanting afterwards gently the water into a vessel, that the purest and most subtile of the powder may run out with the water: you'll continue to wash and agitate the matter, and to pour the liquor into another vessel, till nothing but sand or another coarse matter remains at the bottom, which must be thrown away; then all the lotions must be poured into a funnel garnished with grey paper, that the water may be separated from the matter; and then the *bol* remaing shall be formed into little troches, which must be dried in the sun.

Virtues.—The *bol* is astringent, and proper to stop a looseness, hæmorrhages, and gonorrhœa's.—The *dose* is from ten grains to a scruple.

This preparation is not of a great utility, for very little coarse matter is separated from the *fine bol*, and that impurity besides could not be capable to produce any bad effect in the body: as for the *coarse bol*, as it is only used outwardly, it is no otherwise prepared than, by reducing it into a powder, in a brass mortar.

The *litharge* requires no other preparation than that of the *coarse bol*, viz. to be put in a subtile powder in a brass mortar.

As for the *ceruss*, the lotion renders it whiter, and consequently more proper for the Cosmeticks, and for painting: but for Pharmacy it suffices to reduce it into a subtile powder.

The *preparation of the lapis lazuli*, for *ultramarine*, consists in separating from the *lapis* the blue, saline, and sulphurous part, from its metallick and terrestrial part.

Therefore take what quantity you please of the bluest *lapis* you can find, without any gold or other veins, pound it in a brass mortar, then grind it on the porphyry, with a small quantity of common water, till it makes no more noise under the muller; this done, mix it in a sort of paste made of pitch, wax, and linseed-oil: this mixture shall be washed, working it continually in the hands over a marble sloping, with water, which shall be poured over it by degrees, and the lotions received in a bason placed under the marble; the matter must be washed thus till it gives no more blue; but the lotions must be separated, for the first contain the finest *ultramarine*; after they have been left to settle, the water is decanted gently, and a fine blue powder is found precipitated at the bottom, which must be put to drain in a funnel garnished with grey paper, then dried; and this is the *ultramarine* used by painters: it is also used in medicine; but as the greasy paste it is wrapped in, would give some disagreeable impression to it, one should be contented with grinding it on the porphyry.

Virtues.—The *lapis lazuli* prepared. is esteemed a cordial, proper to resist venom, and to purify the blood; it enters into the confection alkermes.—The *dose* is from four to fifteen grains.

The *preparation of gum lacca*, consists in purifying it of its terrestrial parts, by imprinting in it a vulnerary and detersive quality.

Therefore a decoction must be made of two drachms of the roots of aristoloch, or *hart-wort*, in two pints of water to the diminution of a third; having strained the decoction, four drachms of gum-lacca bruised, but not in powder, must be put to boil slowly in it, till the purest part of the gum may be separated from the fæces, and swims a-top, then that pure part must be gathered and put to dry in the sun.

Virtues.—The *gum-lacca* thus prepared, is detersive, astringent, proper to strengthen the stomach and the gums: it serves also as a basis for sealing-wax.

The Scammony, which comes from *Aleppo* is esteemed the best; it must be chosen the purest, the most resinous and most friable that can be found, and must be reduced into a fine powder.

The

The most common method at present of preparing the *scammony*, is to reduce it into powder, and make it receive through a grey paper, for about a quarter of an hour, the vapour of the sulphur which is burnt under it, stirring it gently from time to time with a spatula. It is pretended that this sulphurous vapour rarefies the glutinous substance of the *scammony*, and hinders it from griping; it is called *diacridium sulphuratum*.

If the *scammony* wants a preparation there is no better than this: — steep for about two hours an ounce of liquorice well bruised, in eight or nine ounces of warm water; strain the infusion and mix in it four ounces of good *scammony*, in an earthen porringer, which must be placed on the sand, and the humidity made to evaporate at a slow fire till the *scammony* has reassumed its former solidity: it is called *diacridium glycyrizatum*, and is a very good purgative. It purges particularly the melancholick humour, and operates without griping.—The *dose* is from ten grains to a scruple The extract of liquorice mixed in this preparation of *scammony*, sweetens it much; therefore a greater quantity thereof is administered than that of the other *diacridiums*, even as far as twenty grains, which produce a very good effect.

The *glycirized diacridium* must be kept in a bottle well corked, otherwise it would grow damp, because of the extract of liquorice.

There is likewise a syrup made of sugar, brandy, and scammony, by setting the mixture on fire; and when the flame is extinguished the mixture is kept for use. It purges without griping; and the *dose* is from one spoonful to two.

The *preparation* of the *euphorbium* consists in purifying it and softening it.

Take what quantity you please of the best and purest *euphorbium*, reduce it into powder, and having put it in a matrass, pour over it depurated juice of lemon to the height of four fingers breadth; stop the matrass, and place it in digestion at a sand-heat, stirring it from time to time; and the gum being dissolved, the liquor must be strained through a linen cloth, into a glass or earthen vessel, which being placed at a sand-heat, the humidity is made to evaporate to the consistence of an extract. This is the *euphorbium* prepared, which must be kept in a pot.

The *euphorbium* must be humected with some lemon juice, while pounding, to avoid being incommoded by it; for the little quantity thereof which enters the nose or the eyes, causes in them an insupportable acrimony and heat.

I disapprove much the use of the *euphorbium* for the inside.

The *preparations* of the *onions of scylle*, consists, 1. In drying them, to deprive them of their hurtful and superfluous humidity: 2. In boiling them, to extract the pulp thereof.

For the first, you must take *onions of scylle*, of a moderate bigness, found and well fed, then you'll take off with a wooden knife the rind or first red and dry leaves, which are to be thrown away; taking afterwards the whitish laminæ and leaving the heart and roots as useless; which laminæ must be dried in the sun.

For the *second*, the *onions of scylle* must be wrapped in common paste, and put in the oven till they are grown soft, which is known by introducing a little picked stick into them; then the paste must be separated from them, and the pulp of the *scylle* taken out, to be made in troches of *scylle*.

Virtues.—The *scylle* enters several compositions, it rarefies and incites the pituita; it is used in the epilepsy, in the asthma, and to resist venom.

The *preparation* of the *millepedes*, and other such insects, consists in drying them in the sun, to preserve them, and reduce them into powder when they are wanted.

The *millepedes* are killed in white-wine, or in water sharpened with salt; then they are dried in the sun, to reduce them into powder.

Virtues.—The *millepedes* are aperitive, and proper to expel the gravel, the stone, for the nephritick, and the retention of urine.—The *dose* is from one scruple to one drachm.

If sixteen ounces of *millepedes* have been prepared according to the method here described they'll weigh after they are dried, but seven ounces and a half. The volatile salt of *millepedes* is thought to be good to ease the excruciating pains of the gout, those of the rheumatism, and other maladies which happen to the muscles and nerves.

The *preparation* of *vipers*, consists in drying them, that they may be easily kept.

You must chuse the biggest and most lively vipers, in the spring or autumn, cut their heads, skin them, take out their entrails, wash their trunks in water, and tie them to a packthread, that they may be hung to dry in a dry place, drying their hearts and livers in the same manner.

The fat must be separated from the intestines, and melted gently in a porringer over a little fire, then strained with expression through a fine linen cloth, to separate it from its membranes; and being cold, must be poured into a bottle to be kept for use. It is liquid like oil, because of the quantity of volatile salt it contains, which exceeds much that of the fat of other animals.

When the trunks, hearts, and livers of vipers are to be kept long whole, it is very proper to anoint

anoint them ſlightly with balſam of *Peru*, for it hinders the worms from getting into them.

The *powder of vipers* is made, ſometimes, in pulveriſing the trunks of the vipers alone; and ſometimes with the addition of the livers and hearts: that done, in this laſt manner is beſt; but it cannot be kept ſo long, as when made with the trunks alone, becauſe the livers and hearts being oily make it grow rank, and worms are generated in it.

Virtues.—It is pretended that the *powder of vipers* is proper to purify the blood, to expel the bad humours by perſpiration, to reſiſt venom, for intermittent and malignant fevers, the ſmall-pox, and the plague.—The *doſe* is from eight grains to two ſcruples.—The *liver* and *heart*, put together in powder, is what we call *mineral bezoard.*—The *doſe* is from ſix grains to a ſcruple.

The *fat of vipers*, is proper to rarefy the humours, and to excite perſpiration: it is preſcribed in malignant fevers, and in the ſmall-pox.—The *doſe* is from one drop to ſix.—It is alſo uſed outwardly to reſolve tumours.

Next comes the *preparation of hartſhorn*, *ivory*, *human cranium*, &c.

Thoſe parts of animals having no bad qualities, and their ſubſtance being of a nature to be eaſily diſſolved in the ſtomach, they want no other preparation than that of being raſped and pulverized; all others invented to refine on this, render, it is true, the parts of animals alkaline, and more aſtringent, but deſtroy at the ſame time what they have beſt; for the fire in the calcination diſſipate their volatile ſalt and oil, in which conſiſted their principal virtue.

From this I'll paſs to the *preparation*, or purification of ſeveral *gums*, which cannot be eaſily reduced into powder, as the *galbanum*, the *gum ammoniack*, *opoponax*, and *ſagapenum*.

You may take what quantity you pleaſe of one or ſeveral of theſe gums, break them in ſmall pieces, and put them to ſteep for ſome hours in vinegar, where they muſt be melted over a ſlow fire: the diſſolution muſt be ſtrained with a ſtrong expreſſion; and the grounds left put in new vinegar to perfect the diſſolution of the gum; this diſſolution muſt be ſtrained like the firſt, and mixed with it in an earthen pan, which muſt be placed over the fire, to make the humidity thereof to evaporate to the conſiſtence of plaiſter; and thus you'll have the gums purified.

Virtues.—They are proper to ſoften, to reſolve, to help ſuppuration, to abate the vapours, they are applied on the navel, and on tumours.

When thoſe gums are to be pulveriſed, one muſt chuſe the fineſt and cleareſt, and make them dry gently between two papers, in the ſun, or at the fire. They are eaſily reduced into powder, when mixed with other drugs.

Juices are liquors, which flow, ſometimes, ſpontaneouſly, or which are extracted from vegetables, either by inciſion, or expreſſion; ſome are alſo extracted from animals, but under other names.

Juices extracted by inciſion are purer and better than thoſe extracted by expreſſion; becauſe the expreſſion makes a great deal of terrene parts flow together with the liquor.

To extract a *juice* by inciſion, there are inciſions made in the plant, or in the root, and through thoſe apertures flows by degrees an humour, which is made to evaporate, either in the ſun, or at a ſlow fire: in that manner the aloes ſuccotrina, the ſcammony, and the ſanguis draconis are prepared.

Juices are *extracted by expreſſion*, by pounding a plant or ſome part thereof in a mortar, and ſqueezing it hard; for then a liquor comes out of it, which can be made to thicken, either in the ſun, or at the fire: in this manner are extracted the aloes cabalin, the meconium, which we callopium, the acacia, the hypociſtis, and the elaterium.

A greater quantity of juice is extracted from the plant, if before the expreſſion it be left ſome hours in digeſtion, than if it was put to the preſs ſo ſoon as it is pounded, becauſe in the digeſtion the juice is looſen'd, and becomes leſs viſcous.

There is more difficulty to extract the juice of viſcous plants, as of the borage, bugloſs, *&c.* than of others; and it is proper to warm them before they are put into the preſs.

When *juices* are to be kept in liquor, they muſt be depurated, either by boiling them a little, and ſtraining them; or leaving them expoſed one day or two to the ſun, and decanting them ſoftly afterwards, from their ſediment. Then bottles muſt be filled with it to the neck, putting ſome ſweet oil a-top, to the height of two fingers breadth. That oil hinders the external air from penetrating into it, and conſequently its being corrupted; it may be kept good by that means at leaſt a whole year.

For the *preparation of the black juice of liquorice*, commonly called *Spaniſh liquorice.* Take two pounds of extract of liquorice, half a pound of white ſugar; gums tragacanth and arabick, of each four ounces: mix the whole together for a maſs, to be formed into rotules.

To make the extract of *liquorice*, you muſt ſcrape and bruiſe a quantity of green or dry *liquorice*, and having ſtrung it, put it into a large earthen pan, pour hot water over it, and leave it in digeſtion

digestion over a slow fire, for seven or eight hours; then the infusion must be strained with expression, and the *liquorice* put again to steep in other hot water, which must be strained as before, and both colatures mixed together, and the humidity thereof made to evaporate over a slow fire to the consistence of extract. This is the best *extract of liquorice* that can be made, but it cannot be kept in form of rotules, because it grows damp easily, and has besides a disagreeable taste. Therefore to give it some form, and an agreeable taste, the sugar and gums mentioned in the description, must be mixed with it; which to do, one must bruise gums tragacanth, and arabick, of each four ounces, and put them to steep in about three pints of warm water, till they be dissolved into a mucilage; the whole must be strained through a proper sieve, and the colature having been mixed with the sugar and extract of *liquorice* in an earthen pan, the whole must be placed over a slow fire, to evaporate the humidity of the mixture, stirring it continually with a spatula, till it be reduced to the consistence of an extract or hard paste, of which will be form'd magrotules to be kept for use.

Virtues:—The *Spanish liquorice* thus prepared, is an excellent remedy for a cold, and to facilitate expectoration, and to soften the acrimony of the breast, by leaving a little bit of it to melt in the mouth.

Next comes the preparation of the *rhohob*, *sapa*, and *defrutum*.

RHOHOB or ROB, is an *Arabick* name, whereby is understood the juice of any fruit whatever, boiled to the consistence of honey.

The name of SAPA is only adapted to the juice of grapes boiled.

The DEFRUTUM is nothing else but the juice of raisins, evaporated to the diminution of a third part only.

For the *preparation of the rhohob of mulberries*, or *simple diaphcrum.* Take four pounds of the juice of *mulberries*, and two pounds of honey skimmed; boil them together to a just consistence.

You must take the *mulberries* before they are quite ripe; pound them in a marble mortar, and extract the juice thereof, which must be left to depurate a day or two in the sun; after which, having been strained, two parts thereof shall be mixed with one part of honey, in a glazed earthen dish; and put to evaporate at a slow fire, to the consistence of honey. This will be the *simple rhohob of mulberries*, which must be kept in a pot.

Virtues.—This *rhohob* is proper for the inflammation of the throat, for the aphthes or little ulcers, which come in the mouth of new-born children. It is also very proper to temperate the acrimony of the humours, to cleanse and consolidate. This remedy is sometimes taken alone by spoonfuls; but it is oftener mixed in cooling or detersive decoctions, or proper to the intentions of the physician.

A MEDICINAL WINE is a wine impregnated with the substances and qualities of one, or several kinds of medicinal drugs.

For the *preparation of the wine of wormwood.*—Take a bundle of the dried summits of wormwood in blossom, and three ounces of cinnamon bruised; put them into about fifty quarts of white wine, newly made, and place the vessel in the cave, the bung-hole open, and leave it there to ferment: the fermentation over, the vessel must be filled quite, and well stopped: then you'll have the *wine of wormwood.*

Virtues.—The *wine of wormwood* strengthens the stomach, provokes the appetite, kills the worms, cures the windy cholick, abates the vapours, provokes the menses, and is very proper for the greensickness.——The common *dose* is half, or even a full glass, for several days successively.

For the *preparation of a magistral purgative wine.*—Take six drachms of senna, cardamum, and seeds of violets, of each two drachms; troches of agarick, and the best rhubarb, of each a drachm and a half; a drachm of cinnamon, to be infused together for 24 hours in a quart of wine; then the colature must be preserved for use.

Virtues.—This remedy has a purgative property for pituitous and melancholick constitutions; for the palsy, apoplexy, quartan ague, and the scurvy. ——The *dose* is a glass-full in the morning fasting, which must be continued for several days successively.

Three ounces of syrup of apples composed, may be added to this infusion, to render it more purgative.

For the *preparation of a febrifuge wine.*—Take two ounces of quinquina or jesuit's bark, put them to infuse in a quart of strong white wine, in a matrass, large enough, that the third part thereof may remain empty; put the matrass well corked in a warm place, for the space of 24 hours, shaking it often during that time; then decant the liquor, leaving the grounds at the bottom.

Virtues.—This wine is an excellent febrifuge for intermitting fevers; by the patient taking half a glass of it every four hours, for fifteen days successively, in the hours of the intermission: but when the fever is stopped, he must be contented with one or two doses every day, to hinder the return of the access.

If this wine be taken a little muddy at first, *viz.*

it

if it be shaken before it is poured off the ground, it will stop the fever sooner.

A Medicinal Vinegar is a vinegar filled with the substances and virtues of one or several sorts of drugs, which serve in Medicine.

For the *preparation of vinegar of squills*.—Take two or three onions of *squills* well fed and very sound, pare the outward rind, which is half dried, separate the laminæ with a wooden or ivory knife, throwing away the heart as useless; cut the laminæ into pieces, put one pound thereof in a large glass bottle, and pour upon it four quarts of good white wine vinegar, cork the bottle, and place it in digestion at the sun, where it must be left forty days; then the infusion must be strained with expression, and kept in a bottle well corked.

Virtues.—This *vinegar* is esteemed proper for the epilepsy, to purify the blood, to resist venom, and to expel the wind.——The *dose* is from one ounce to three. It is used likewise in gargarisms for the squinancy.

Conserves differ from *condits* in their consistence; for they are prepared into a paste, whereas *condits* are either boiled whole, or in pieces in the sugar.

The name of *conserve* has been justly given them, since they are made with no other view than to preserve the parts of the vegetables in all their goodness; for the sugar mixed with them being a salt it stops the pores thereof, absorbs their too great humidity, and hinders the air from entring into it, to excite a fermentation, which we call corruption.

It is to be observed, notwithstanding, that liquid *conserves* ferment for some days after they have been made.

For a *soft conserve of roses*——Take the buds of roses before they are quite open, cut off with scissars the white part which is called nail; weigh a pound of those buds thus prepared, and make them boil two or three gallops in three pints of common water, strain the liquor with expression, and pound those roses thus softened in a marble mortar, till they be reduced to a pulp, and may melt entirely in the mouth; mean while two pounds of sugar must be put to boil in the decoction to the consistence of an electuary; and being then taken off the fire, the pounded roses must be exactly mixed in it, putting again the bason over a very slow fire, and stirring continually the *conserve*, making thereby the humidity to evaporate gently, till it has acquired a reasonable consistence; then the *conserve* is put in a pot to be kept.

Virtues.——This *conserve* is proper to appease a cough, to stop hæmorrhages, vomiting, and a looseness; to strengthen the heart and the stomach, and to help digestion.——The *dose* is from one drachm to three: it most commonly enters the solid of them.

The common method of preparing the conserve of roses, is to beat the buds of red roses cleansed, as above, with double their weight of sugar, till the mixture be in form of an electuary, then to put the *conserve* in an earthen pot, and expose it for some days to the sun, till a fermentation ensues, and a more exact union of the parts.

The *conserve* must be made so soon as the roses are cut, for if they be left exposed to the air they lose part of their beauty. The decoction carries off almost all the tincture; but it is no matter, since that decoction is used to boil the sugar; the tincture is not lost in boiling, for when the mixture is made, the conserve appears, as fine as can be. If some drops of spirit of vitriol or of sulphur be mixed in the *conserve* of roses, they will heighten its colour, and render it of a more agreeable taste, but it will turn pale as it grows old.

For the *preparation of a solid conserve of roses.*—Take an ounce of red roses separated from their whitish part, and in powder; mix it with a wooden spatula, with about a drachm of spirit of vitriol; boil a pound of superfine sugar in four ounces of rose-water to the consistence of tablettes; take the sugar off the fire, and incorporate with it, with the same wooden spatula, the powder of roses; when the matter will be almost cold, you must throw it by bits on a marble, or a paper anointed with oil, where it shall be left to harden, keeping it afterwards in a box.

Virtue.—The same virtues are attributed to this *conserve* as to the liquid, but it has not so much. The powder of vitriol the powder of roses is moistened with, renders the *conserve* more beautiful than it would be, because it extends and rarefies the parts, which give the colour to the roses.

For the *preparation of the conserve of juniper-berries.*—Take four pounds of juniper-berries newly gathered, bruise them, and put them to boil over a slow fire, in a sufficient quantity of water, and in an earthen pot covered, till they be soft; take them out of the decoction, and strain them through a sieve; boil in the decoction two pounds of white sugar, to the consistence of syrup, then mix with it the pulp of juniper-berries, six ounces of the best rhubarb in powder, half an ounce of nutmegs, an ounce and a half of the best cinnamon, six ounces of galanga; calamus aromaticus, ginger, and mace, of each four scruples, stirring them continually together with a wooden spatula, and over the fire, till the conserve be done; then it must be taken off the

the fire, and when cold, put into a pot to be kept.

Virtues.—This *conserve* is an excellent remedy to strengthen the stomach, provoke the urine, and keep the body open.

Preparations of HONEY.

Virtues.——*Honey* opens the body, and is good for the maladies of the breast and lungs; hydromels are made of it, which are powerful detersives; and it is employ'd in clysters.

For the *preparation of the oxymel of squills*, or *squills*. Mix in a glazed earthen dish, three parts of the best honey, with two of vinegar of squills; put it to boil over a slow fire, skimming it, to the consistence of syrup; it is the *oxymel of squills*.

Virtues.—This *oxymel* is proper to incite and attenuate the phlegm fastened to the lungs, breast, and other *viscera*; it is used for the squinancies, and for the epilepsy, mixed in lohochs and gargarisms; it is also taken in waters appropriated to the maladies, from one drachm to an ounce. It is stronger than the simple *oxymel* to loosen the phlegm.

For the *preparation of honey of roses.*—Pound in a marble mortar, red roses newly gather'd, to the consistence of paste; leave them in digestion for five or six hours in a cold place; then carry them to the press to extract the juice; weigh that juice, and mix it with the same quantity of good honey: clarify the mixture with the white of an egg; then having strained it warm through the flannel, put it to boil to the consistence of syrup; and it is fit to be kept for use.

Virtues.——It is detersive and astringent; and is employ'd in the gargarisms, for a sore mouth, and a sore throat; in astringent injections and clysters.

For the *preparation of the honey of mercurialis.* Mix together an equal quantity of the juice of mercurialis with common honey; boil them, and skimming them, to the consistence of syrup; strain it through a sieve turn'd upside down, and keep it in stone juggs.

Virtues.——This *honey* is more purgative than the preceding ones; and is employ'd in clysters for the windy cholick, and the hystericks.——The *dose* is from an ounce to three.

SYRUPS.

Syrups are properly liquid conserves of the purest substances of the mixts. They are commonly made with sugar, rather than with honey, and are clarified to give them a more agreeable taste and smell An apothecary must renew them pretty often, for in growing old, they lose much of their virtue: it is true, that there are several of them which cannot be made but once a year; but there are also several others which can be renewed several times in the year.

The *clarification of syrups* is done in the following manner: The white of an egg is put in a bason with three or four ounces of the liquor, which ought not to be hot, for then the white of the egg would curdle; they are beaten togeth r, for some time, with rods, and the whole turn d into a scum, then the sugar, and the rest of the liquor, are added to it; that mixture is put to boil two or three gallops over the fire, that the white of the egg, which is viscous, may load itself with the dirt which is in the *syrup*, and be separated tow rds the sides of the bason; when the *syrup* which boils in the middle appears very clear, it must be skimmed, and strained afterwards through a flannel; then the clarified *syrup* is made to boil to the consistence required, skimming it again from time to time if it wants it. When there are more than three pounds of sugar to be clarified, it requires more than one white of an egg.

The *consistence of a syrup* must be glutinous, and a little viscous, forming, when pour'd gently from a spoon, big drops when it is most out of the spoon, and a short string. But *syrups* do not all want the same coction. Acid *syrups*, as those of barberries, gooseberries, pomegranates, &c keep well enough, though they have received but a slight coction, because of their acid salt. As to *syrups* which have not that acidity, and are to be kept long, they want a stronger coction; taking care, notwithstanding, that they be not too much done, lest they should candy in cooling, which would oblige the Apothecary to melt them over again in balneo mariæ. The candy is a crystallization of the sugar.

Syrups, made with powder-sugar, are less subject to grow candy, than those prepared with loaf-sugar: because powder-sugar contains an unctuosity which hinders it from crystallizing so easily. But to hinder a *syrup* from growing candy, one has only but to mix, while it boils, half an ounce of the best honey, for each pound of sugar: it is also very proper to stir it a little with a spoon, while it cools, to hinder it from condensing at the bottom, and it must not be shut up in a vessel, if it is to be kept, before it is quite cold; for it may happen, that when it has been put a little warm in a pot, and cover'd, the humidity, which ascends in a vapour to the top of the pot, falls back on the *syrup*, and makes it grow musty a-top, and candy at the bottom.

For the *preparation of a simple syrup of maiden hair.*——Take six ounces of the best *maiden hair* you can find, and newly gather'd, cut it small, and put it to infuse in two quarts of warm water

ter for six or seven hours; boil afterwards the infusion to the diminution of a fourth of the humidity, strain it with expression and mix three pounds of sugar in the colature, clarifying the mixture according to the method heretofore prescribed, straining it through the flannel, and putting it to boil to the consistence of *syrup*.

Virtues.—This *syrup* is good for the cough, for the maladies of the breast, to soften the matrice after a delivery, and for the maladies of the spleen. A spoonful thereof is mixed in juleps, emulsions, and ptisans. It is given to new-born children, with oil of sweet almonds, and to women newly delivered.

For the *preparation of a solutive syrup of roses.*—Take pale roses gather'd in the morning, free them of their pecules and calices, pound them in a marble mortar, and having left them a few hours in digestion, strain them to extract the juice thereof, which must be left to depurate either in the sun or in some other warm place; then pour it by inclination, and having strained it through a flannel, mix with it an equal weight of sugar, and make the mixture boil at a slow fire, to the consistence of *syrup*.

Virtues.—This *syrup* purges gently the serosities, and other humours in strengthening the stomach. —The *dose* is from half an ounce to two ounces.

For the *preparation of a cathartick syrup of buckthorn.*——Take a good quantity of ripe berries of buckthorn; bruise them in a marble mortar, where they must be left some hours in digestion, then strained with expression; leaving the juice afterwards to depurate, by being put to settle, for ten or twelve hours, in a warm place; and after it has been separated from its fæces by inclination, take six pounds of that juice and mix it with four pounds of sugar, and half a pound of skimm'd honey, and put the mixture to boil over a slow fire, to the consistence of *syrup*; and towards the end of the operation add to it, tied in a piece of linen cloth, three drachms of cinnamon, and two drachms of mastick, which must be left ever after to steep in the syrup.

Virtues.—This syrup is a great purgative, and evacuates principally the serosities; it is prescribed for the gout, the hydropsy, and for obstructions. —The *dose* is from two drachms to an ounce and a half. The patient must eat as soon as he has taken it; for if he was to abstain from eating, as it is observed after the taking of other purgatives, this syrup would be griping; because the buckthorn contains an acid essential salt, which would prick the membranes of the stomach, and of the intestines; but the mucilaginous substance of the aliments softens that salt in embarrassing its points.

For the *preparation of the syrup of epithym*, or *doder.*——Take the *doder*, citrine mirabolans, tamarinds, of each two ounces and a half; agarick and salt of fumitory, of each six drachms: hatch the doder, bruise the mirabolans, and dissolve the tamarinds by degrees in some distilled water of buglose, boiling-hot; then put the whole to infuse for twenty-four hours in two quarts of the same distilled water of buglose, also hot, in a glazed earthen pot and covered: the next day strain the infusion by expression, and having left it to settle for a few hours, pour it by inclination, and mix with the colature two pounds of sugar, then put the mixture in an earthen dish, and boil it over a slow fire, to the consistence of syrup.

Virtues.—This syrup is prescribed to purge the black bile, and the hypochondriacal melancholy, for the leprosy, itch, venereal disease, epilepsy, cancers, and malignant ulcers.—The *dose* is from half an ounce to two ounces.

For the *preparation of a syrup of scammony.*——Take three drachms of the best scammony, reduced to a coarse powder; three drachms of liquorice well scraped and bruised, put them together in a matrass, and pour over them a pint and a half of the best brandy; stop the matrass, and put it in digestion in horse dung, or in another warm place, for three days, shaking it from time to time; afterwards the tincture must be filtered, and two pounds of white sugar having been added to it, the mixture must be boiled in an earthen dish, over a slow fire, to the consistence of syrup.

Virtues.——This syrup is proper to purge the hypochondriacal melancholy, for the lethargy, and apoplexy.——The *dose* is from two drachms to an ounce and a half. It is a vigorous purgative.

In *three drachms* of this syrup, there are *three grains of scammony.*—In *half an ounce*, six grains of scammony.—In *five drachms*, seven grains and a half of scammony.—In *six drachms*, nine grains of scammony.—In *seven drachms*, ten grains and a half of scammony.—In *an ounce*, half a scruple of scammony.—In *nine drachms*, thirteen grains and a half of scammony.—In *ten drachms*, fifteen grains of scammony.—In *eleven drachms*, sixteen grains and a half of scammony.—In *an ounce and a half*, eighteen grains of scammony.

For the *preparation of a solutive syrup of violets.* Take two pounds of flowers of violets, whole, and half a pound of seeds of violets bruised; put them to infuse for twelve hours in three quarts of boiling water; then boil slightly the infusion, strain it by expression; and in the colature put to infuse flowers and seeds of violets as before; in this second infusion strained shall be reiterated the infusions and colatures, till the liquor be entirely impregnated with the

the fubftance of the violets, which will be known at the violets coming out tinged with the liquor. In the laft infufion mix three pounds of white fugar, clarify the mixture, and boil it to the confiftence of fyrup.

Virtues.——This fyrup purges the bile and the ferofities.——The *dofe* is from half an ounce to two ounces.

For the *preparation of fyrup of rhubarb.*—Take half a pound of the beft rhubarb, and fix drachms of foluble tartar; cut the rhubarb in little pieces, and put it with the foluble tartar in a glazed earthen pot, pour over it three or four pints of boiling-hot water, cover the pot, and leave the matter in digeftion for ten or twelve hours, boiling it afterwards flightly, and ftraining it with expreffion; and the grounds are put back into the pot, and made to fteep in other boiling-hot water for five or fix hours; then, after it has been boiled flightly, and ftrained as before, the tinctures are mixed together and left to fettle; and after they have been filtrated and mixed with three pounds of white fugar, the whole mixture is put to boil over a flow fire to the confiftence of fyrup.

Virtues.—This fyrup purges the bile, is good for a loofenefs, and for the worms.—The *dofe* is from half an ounce to two ounces.

For the *preparation of fyrup of barberries.*——Take the juice of barberries, newly extracted and depurated, and white fugar, of each two pounds; boil them together over a flow fire to the confiftence of fyrup.

Virtues.—This fyrup is aftringent and cooling: it is ufed in juleps to ftop a loofenefs, to ftrengthen the heart, and refift the malignity of the humours. —The *dofe* is from half an ounce to an ounce and a half.

For the *preparation of the fyrup of pomegranates.* Take the juice of four pomegranates, newly extracted and depurated; and white fugar, of each two pounds, mix them together in an earthen difh; put the difh over a flow fire, and make the humidity of the mixture to evaporate to the confiftence of fyrup.

Virtues.—This fyrup rejoices the heart, ftops vomiting, the loofenefs, the hæmorrhages, and quenches thirft in cooling.——The *dofe* is from half an ounce to an ounce and a half.

It is not neceffary to boil the four fyrups as much as others, becaufe the effential acid they contain, preferve them, though they have not the ordinary confiftence.

For the *preparation of the fyrup of quinces.*——Mix in a glazed earthen difh, equal parts of the juice of quinces, depurated, (by expofing it two or three days to the fun, and filtrating it afterwards) and of white fugar, *v. gr.* two pounds of each; place the difh over a flow fire, and make the humidity to evaporate to the confiftence of fyrup.

Virtues.—The fyrup of quinces is aftringent; proper to ftrengthen the ftomach, and to ftop the loofenefs.——The *dofe* is from half an ounce to an ounce and a half.

If the juice of quinces was employ'd without being depurated, it would make a jelly of quinces inftead of fyrup.

For the *preparation of a fimple fyrup of poppies.*—Cut in fmall pieces two pounds of heads of white poppies, newly gather'd, in their maturity, and one pound of heads of black poppies; put them in a glazed earthen pot, and pour over them four quarts of boiling-hot water, cover the pot, and leave the matter in infufion for 24 hours; boil it afterwards gently to the diminution of half the humidity; ftrain the decoction with a ftrong expreffion, and with the colature mix three pounds of fugar; clarify the mixture and boil it to the confiftence of fyrup.

Virtues.—This fyrup is fomniferous, proper to foften the acrimony of the throat, and of the *trachæa*, to appeafe pains, to ftop fluxions, a cough, fpitting of blood, and the dyfentery; it is prefcribed in all the occafions where it is neceffary to ftop the too great motion of the humours.——The *dofe* is from half an ounce to ten drachms.

For the *preparation of the fyrup of ground-ivy.*—Let about nine or ten handfuls of ground-ivy, gather'd in its greateft vigour, be exactly pounded in a marble mortar; moiften the matter with eight or nine ounces of warm water; cover the mortar, and leave the matter in digeftion for ten or twelve hours; then ftrain it, and having flightly boiled the juice, ftrain it two or three times through a flannel: weigh that juice thus depurated, and having mixed with it an equal quantity of fugar, place the mixture over a flow fire, and let it boil to the confiftence of fyrup.

Virtues.—This *fyrup* is proper for the maladies of the lungs, and of the breaft, proceeding from a coarfe pituita, which falls upon them. It is good for the afthma, to raife the obftructions of the fpleen, of the liver, of the mefentery, and of the matrix, it provokes the menfes, and is alfo fudorifick.——The *dofe* is from half an ounce to two ounces.

Ground-ivy is commonly in its vigour in the month of *April* and *June*.

For the *preparation of the fyrup of hyffop.*—Put to boil in three quarts of water half an ounce of pearl-barley, hyffop, roots of fennel and liquorice, of each ten drachms; fix drachms of white adiantus; an ounce and a half of jar-raifins ftoned, jujubs and dates, of each thirty; ten figs; the ſeeds of mallows, quinces, and gum tragacanth, of each three drachms; boil them all together to the diminution of a third part of the humidity; clarify the decoction by ſettling; and having mixed with it two pounds of ſugar, let the mixture boil over a ſlow fire to the conſiſtence of ſyrup.

Virtues.—This ſyrup is proper for the maladies of the breaſt, when cauſed by phlegm and obſtructions; it is preſcribed for the aſthma, to provoke urine, and expel the ſand from the reins.——The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of a ſyrup of quinquina.*——Take half a pound of the beſt quinquina, coarſely pounded; put it in a glazed earthen pot, and pour over it two quarts of the beſt white wine; cover the pot and put it in digeſtion in balneo mariæ, or in another warm place, for three days, ſtirring the matter from time to time. Boil afterwards gently the infuſion in the ſame pot, to the diminution of a fourth of the humidity; ſtrain it with expreſſion, and to the colature add three pounds of white ſugar; clarify the mixture, and put it to boil over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is febrifuge; it ſtops all intermittent fevers.——The *doſe* is from half an ounce to two ounces, diſſolved in the water of little centaury.

It is more proper to make this ſyrup in an earthen veſſel, than in a copper baſon, to avoid the impreſſion which the ſyrup may take from the copper.

This ſyrup is not to be uſed till after the patient has been well purged, becauſe it fixes the humour. It muſt be given three or four times a day, and the uſe thereof continued for 15 days ſucceſſively at leaſt.

For the *preparation of ſyrup of camomile.*—Take one pound of camomile flowers, newly gathered, put one third of thoſe flowers to infuſe in two quarts of ſpring-water, boiling hot, for twelve hours: which expired, boil ſlightly the infuſion, ſtrain it by expreſſion, and in the colature put to infuſe the ſame quantity of new flowers, for the ſame ſpace of time as before, boiling, afterwards, and ſtraining the infuſion in the ſame manner; repeating the ſame proceſs a third time, with what is left of the pound of flowers; but in the laſt colature mix three pounds of the beſt ſugar, clarify the mixture, and put it afterwards to boil over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is excellent for the windy cholick, and to provoke the menſes.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſyrup of mint.*—Take the juices of quinces, and of pomegranate, of each two pounds, put to infuſe in them for twenty-four hours, eight ounces of mint pounded, and two ounces of red roſes; then put the infuſion to boil ſlightly, ſtrain it afterwards with expreſſion, and mix in it three pounds of white ſugar, and having clarified the mixture, put it to boil over a ſlow fire to the conſiſtence of ſyrup; which is to be aromatiſed with two drachms of the troches of *gall a moſchata*, tied in a piece of linen cloth, and twelve drops of oil of mint.

Virtues.—This ſyrup is proper to ſtrengthen the ſtomach in faſtening the fibres; to ſtop vomiting, nauſea's, hickups, and the lienteria.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſimple ſyrup of ſcordium.*—Take two pints and a half of the juice of ſcordium, two pounds of white ſugar, and ſix drachms of the ſalt of ſcordium; clarify the mixture, and boil it over a ſlow fire, to the conſiſtence of ſyrup.

Virtues.—This ſyrup is uſed againſt the plague, the malignant fevers, and the worms; it provokes perſpiration and the menſes.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the compoſed ſyrup of ſcordium.*—Take a quart of the ſimple ſyrup of ſcordium, mix in it half a drachm of the volatile oleous aromatick ſpirit, camphire diſſolved in two drachms of ſpirit of wine, and muſk, of each half a ſcruple, tied in a piece of linen cloth, for a ſyrup.

Virtues.—This ſyrup is uſed for malignant fevers, and other maladies proceeding from the corruption of the humours.—The *doſe* is from half an ounce to an ounce and a half.

For the *preparation of the ſyrup of kermes.*——Pound in a marble mortar the grains of kermes, when they are very ripe and very red; leave them in a cold digeſtion for ſeven or eight hours, to rarefy a little their viſcous ſubſtance; then put them in a ſtrong linen cloth, and carry them to the preſs, to extract the juice thereof, leave that juice to ſettle for a few hours, and ſeparate it afterwards from its coarſer fæces, by decanting it into another veſſel: weigh that juice, and having mixed with it an equal quantity of ſugar, place the mixture over a ſlow fire, to boil gently to the conſiſtence of ſyrup.

Virtues.—This ſyrup ſtrengthens the heart and the ſtomach, reſiſts the malignity of the humours, and hinders abortion.——The *doſe* is from half an ounce to an ounce.

Lohoch.

Lohoch, *eclegma* and *linctus*, are three words which ſignify the ſame thing, viz. *licking*, *ſucking*; the firſt is *Arabick*, the ſecond *Greek*, and the third *Latin:* they were given for names to pectoral compoſitions, which have a middle conſiſtence, between ſyrups and ſoft electuaries; the patients are made to ſuck them with a ſtick of liquorice, by dipping one end thereof in them, or with a ſpoon, that being taken by degrees they may remain longer in the paſſage, and humect better the breaſt; they

are

are commonly prepared when wanted, becauſe moſt of the remedies which enter their compoſition are ready at all times, and their mixture is not difficult.

For a *pectoral lohoch*. Pound together the roots of enula campana and liquorice, of each a drachm and a half: take ſugar-candy, and oxymel of ſquills, of each half an ounce, and three drachms of the powder diatragacanth; mix all the drugs together with a ſufficient quantity of ſyrup of red poppies, for a *lohoch*.

Virtues. This *lohoch* is uſed in the pleuriſy, aſthma, phthiſick, and other maladies of the breaſt and lungs; it incites and attenuates the phlegm, and excites expectoration.

A *lohoch to ſtop the ſpitting of blood*. Take three drachms of the powder diatragacanth, red roſes, crab's eyes prepared, and prepared coral, of each two drachms, a drachm and a half of conſolida major in powder, fifteen grains of ſalt of ſaturn, four grains of laudanum, the mucilages of the ſeeds of quinces and of pſyllium, of each half an ounce; mix the drugs together in a ſufficient quantity of ſyrup of St. John's-wort.

The roſes and the roots of conſolida major muſt be pounded together, and be mixed with the reſt of the powders: the laudanum muſt be diſſolved in a mortar with about half an ounce of the ſyrup; and then all the other drugs are added to it, to make a *lohoch*, with a ſufficient quantity of the ſame ſyrup.

Virtues. This *lohoch* is proper, not only to ſtop the ſpitting of blood, but likewiſe all other hæmorrhages. It is taken at the end of a ſtick of liquorice.

For a *ſimple lohoch of ſquill*. Take equal parts of the juice of ſquills, and of ſkimmed honey, and boil them together in a glazed earthen diſh, over a ſlow fire to a due conſiſtence.

Virtues. This *lohoch* is proper to rarefy or attenuate the phlegm, and excite expectoration; it helps reſpiration, and is uſed in the aſthma and peripneumony.

Powders.

It is neceſſary to reduce into *powder* the dry ingredients which enter the compoſitions of *Medicine*; not only that they may be eaſier and more exactly mixed in them, but that they may likewiſe communicate better their virtue when they are in the body.

Powders are uſually made in braſs mortars; but when they muſt be very fine, they are uſually ground on the porphyry, to render them impalpable: tho' this laſt preparation is ſeldom for any thing elſe but minerals, ſtones and earths.

When *gums* are to be reduced into *powder*, it is neceſſary to anoint the bottom of the mortar, and the end of the peſtle, with ſome drops of oil of ſweet almonds, or other oil, otherwiſe the gums would ſtick to the mortar, and would be pounded but with great difficulty, except notwithſtanding the following:—When the gums arabick and tragacanth are to be pounded, the mortar muſt be heated before with lighted coals, that the heat may diſſipate a ſuperfluous humidity which is in the gums, and would hinder the pulveriſation.——To pound the maſtich, the bottom of the mortar, and the end of the peſtle, muſt be moiſtened firſt with a little water, otherwiſe it would ſtick to the mortar.—When dry aromatick matters, as the cinnamon and ſanders, are to be reduced into powder, they muſt be moiſten'd with ſome water appropriated to their virtue, to hinder the diſſipation, which otherwiſe, would happen of their moſt ſubtile particles.—To pound the coloquintida, it muſt have been anointed before with oil of roſes, otherwiſe much of its particles would eſcape.—When the euphorbium, the cantharides, and the white hellebore are to be pounded, they muſt be humected with ſome drops of vinegar, or other appropriated liquor; for, without that precaution the artiſt would be much incommoded by the volatile particles of thoſe matters, which being agitated by the peſtle, fly and enter the noſe and the eyes, which excites a violent ſneezing and tears. When the ſaffron, roſes, and ſeveral other flowers which preſerve always ſome humidity, though they appear dry, are to be reduced into powder, they muſt be dried gently between two papers in the ſun, or before the fire, otherwiſe it would be very difficult to pound them. The opium, acacia, hypoſiſtis, liquorice juice, galbanum, opoponax, ſagapenum, and aſafœtida, when by themſelves, are not eaſily reduced into powder; but when mixed with dry ingredients of another nature, and in great quantity, they are eaſily conquered: the ſame may be ſaid of the almonds, cold ſeeds, ſmall nuts, &c. When flints and other ſuch hard ſtones are to be pounded, they muſt have been made red-hot ſeveral times before, and extinguiſhed in water to ſoften them, otherwiſe it would be very difficult to reduce them into powder. When the talc of *Venice* is to be pounded, it muſt be expoſed for about half a quarter of an hour to a great flaming fire, then pounded in an iron mortar almoſt made red-hot. To pound horns, agarick, and nux vomica, they muſt be raſped before, and afterwards pounded in a mortar of metal. To pound lead and tin, they muſt be put in fuſion in an earthen diſh, then by ſtirring them continually over the fire, for the ſpace of half an hour or an hour, they'll reduce themſelves into powder. Several of the matters to be reduced into powder are to be beaten hard, as wood, roots, leaves, ſeeds, fruits, horns, and bones; but ſeveral others are only to be bruiſed in the mortar, as the aloes, ſcammony, earths, and ſtarch. Salts, and other acrimonious and corroſive matters, are to be pounded in mortars of glaſs, marble, or of ſtone, to avoid the impreſſion they could receive from the metal.

For the *preparation of the worm-powder of the Phyſicians of the faculty of* Paris.—Take the ſeeds of common wormwood, of porcelain, and aloes, of each half an ounce; the beſt rhubarb, ſenna, coralline, dried ſummits of ſcordium, of each two drachms: the drugs being all pounded, ſhall be mixed together for a powder to be kept for uſe.

Virtues.——This powder kills and expels the worms, provokes the menſes, and reſiſts the malignity of the humours. The *doſe* is from half a ſcruple to a drachm.

The purgatives of this preparation, are the aloes, ſenna, and rhubarb.

The powders where the preparations of mercury enter, ought not to be taken without being formed into a bolus, leſt the mercury which is heavy, ſhould remain behind in the teeth and ſhake them.

For the *preparation of an excellent powder for the dyſenteria*.—Take two ounces of the root *ipecacuanha*; citrin mirabolans, and rhubarb, of each three drachms; and an ounce of ſeed of plantain: pound all thoſe drugs together in a braſs mortar, for a powder to be kept for uſe.

Virtues.—This powder excites vomiting without violence, it purges by ſtools, and ſtops the dyſenteria.——The *doſe* is from a ſcruple to four.

For a *preparation of a powder for the phthiſick.*—Take half an ounce of the ſeed of white poppies: gums arabick and tragacanth, the ſeeds of althæa, of cotton, of porcelain, the four great cold ſeeds, of each a drachm and a half; the aſhes of crawfiſh, and the lungs of a fox, prepared, of each four ſcruples: the gums arabick and tragacanth muſt be pounded together in a mortar heated; the crawfiſh muſt be burnt in a pot made red hot, till they be reduced to aſhes, the ſeeds muſt alſo be pounded a-part till they be reduced into a paſte; and all the drugs muſt afterwards be mixed together for a powder, to be kept for uſe.

Virtues.—This powder is not only good for the phthiſick, but for all the maladies of the breaſt; it abſorbs and ſoftens the acrimony of the ſeroſities which fall from the brain, thickens them, and helps expectoration.—The *doſe* is from a ſcruple to a drachm.

For the *preparation of the gaſcoyn powder*, otherwiſe called *the powder of the Counteſs of* Kent.——Take four ounces of the black ends of the claws of crabs; crab's eyes, oriental pearls, and red coral prepared, of each an ounce; white ſuccin, the root of contrayerva, and of viperina, of each ſix drachms: two drachms of the ſtone of oriental bezoard; four ſcruples of the bone of a ſtag's heart; and two ſcruples of ſaffron: take out the fleſh of the crab's claws; then bruiſe them with the crab's eyes, the bone of the ſtag's heart, and the bezoard in a mortar; grind them afterwards on the porphyry, till they be reduced into an impalpable powder; let the roots be likewiſe pounded together; and the ſaffron by itſelf, after it has been dried between two papers, at a ſlow heat: mix all thoſe powders together with the pearls and prepared coral, and moiſten them with an ounce and a half of ſpirit of honey; mixing them afterwards with a jelly of vipers, to be formed in troches, which muſt be dried from the ſun, and kept for uſe.

Virtues.—This powder is much eſteemed to reſiſt the malignity of humours, for the ſcurvy, the ſmall pox, and other epidemical maladies.—The *doſe* is from half a ſcruple, to half a drachm.

For the *preparation of a powder to facilitate or haſten a delivery*.—Take cinnamon, dictamnum of *Crete*, ſaffron, borax, troches of myrrh, of each a drachm; and half a drachm of ſavern: let the cinnamon, dictamnum, and ſavern, be pounded together; and the troches and borax together; then mix all the ingredients for a powder to be kept for uſe.

Virtues.—It is proper to haſten the delivery, when the woman is in labour; and to expel the after-birth.—The *doſe* is from a ſcruple to two: it is alſo uſed to provoke the menſes; diſſolved in white wine, or water of mugwort.

For the *preparation of a powder for the after-pains.*—Take the roots of conſolida major dried, acorn and ſuccir, of each a drachm and a half; dried orange-peel, mace, ſaffron coriander-ſeed, of each two ſcruples: let all the drugs be pounded together into a fine powder to be kept for uſe.

Virtues.—This powder is proper to appeaſe the after pains, and for the windy cholick.—The *doſe* is from a ſcruple to two.

For the *preparation of a powder for the piles*, or *hemorrhoides*.—Take an ounce of the beſt wheat-flour, half an ounce of crocus martis; oriental bole prepared, the root of verbaſcum, of each two drachms; white hermodacts infuſed for a whole night in ſpirit of wine, and dried again afterwards, dried flowers of red poppies, white ſugar-candy, ſanguis draconis, olibanum, of each a drachm and a half: let all theſe drugs, after they have been pounded according to our method, be mixed together for a powder to be kept for uſe.

Virtues.—This powder ſtops the immoderate flux of the hæmorrhoides, and reſolves thoſe which are tumified, when applied upon them: it is mixed

with

with the white of an egg, and the paste it forms spread on flax.

For the *preparation of the powder of verbascum for the same distemper.*—Fill a crucible with green leaves of verbascum, cover it with another crucible, lute the joints, and place the vessel in the middle of lighted coals, to reduce the matter to a sort of coal, which may be easily reduced into powder; take off the crucible, and having pounded the matter, mix with an ounce thereof two drachms of the best rhubarb.

Virtues —— This powder is proper to resolve the hemorrhoides, when applied on them, dissolved in a little saliva, or spittle.

For the *preparation of a powder to cleanse the hands* ——Take the paste of bitter and sweet almonds, after the oil has been extracted from it, and flour of rice, of each six ounces; iris of *Florence*, and prepared chalk, of each an ounce; benzoin, sperma ceti, salt of tartar, of each two drachms; and half an ounce of the wood of *Rhodium*; pounded and mixed together, for a powder to be kept in a pot, because it is a little of the consistence of a paste.

Virtues.——This *powder* cleanses the skin, renders it soft, white and smooth: it is used to cleanse the hands; it may be humected in the hand with some water of orange-flowers, instead of common water; and rub the hands with it, without humecting it any more, till the paste dries and falls off of itself; then the hands are wiped with a linen cloth, wetted with some water of orange-flowers.

TROCHES.

Trochiscus is a *Greek* word which signifies *rotule*. It is also called *placentula*, or *orbis*, or *orbiculus*, or *parvus panis*, or *pastillus*; this last name being appropriated to a sort of troches, which are thrown into the fire, to give an agreeable smell to a room, and correct the malignity of the air.—The *Arabs* have called *sief*, the *troches* used for the maladies of the eyes.—*Troches*, in general, are dried compositions, composed of several medicaments reduced into powder, and incorporated with wine, or some distilled water, or with juices, or with mucilage, or with pulps, or with syrups, in a pretty solid consistence. The mass is well pounded in a mortar, that all the ingredients may be well incorporated together, and is divided into little bits, to which one may give what figure one pleases, sometimes long, sometimes square, sometimes triangular, sometimes round and flat, and sometimes in small grains; and they are dried afterwards, that they may be kept without growing soft.

For the *preparation of the troches of rhubarb.*—Take ten drachms of the best rhubarb, half an ounce of bitter almonds, three drachms of red roses, spikenard, anniseed, wormwood, asarum of each a drachm: pound together the rhubarb, roses seeds, wormwood and asarum; pound in a marble mortar the bitter almonds, blanched, till they be reduced into a paste; mix the powders with it, and with a sufficient quantity of juice of agrimony thicken'd over the fire to the consistence of honey, make a mass solid enough to be formed into little troches, which must be put to dry from the sun.

Virtues.——These *troches* are used for the obstructions of the liver, mysentery, and spleen, and for the looseness. They purge gently in binding. ——The *dose* is from a scruple to four.

For the *preparation of troches of camphire.*——Take a drachm of camphire, myrrh, asafœtida, castoreum, of each half an ounce; three drachms of spikenard; a drachm of saffron, half a scruple of opium; and eight drops of the oil of succin; when all the drugs which are to be reduced into powder have been pounded, let all the ingredients be mixed in a sufficient quantity of the mucilage of gum tragacanth, extracted in water of matricaria, for a mass, of which are formed *troches*.

Virtues.—These *troches* are sometimes prescribed in violent fevers, to temperate the heat of the bile and of the blood; for the pleurisy, and hectick fevers: but their more frequent use is for the vapours and the hystericks.——The *dose* is from a scruple to two: they are also mixed in clysters from half a drachm to two drachms.

From the *preparation of troches of myrrh.*——Take the best myrrh, lupins pared, of each five drachms; dried leaves of rue, dictamnum of *Crete*, cummin-seed, asafœtida, sagapenum, opoponax, of each two drachms: after all these drugs have been pounded together, according to our method, reduce them into a hard mass with the juice of mugwort, or of rue, boiled to the thickeness of a mucilage; whereof you'll form *troches*.

Virtues ——These *troches* provoke the menses, help the delivery, expel the after-birth, and abate the vapours ——The *dose* is from a scruple to a drachm.

Troches for a Gonorrhœa—Take two drachms of bol ammoniack, prepared succin, and the raspings of ivory, of each a drachm and a half; four scruples of plantain seed; agnus castus [illegible], flowers of pomegranate, red roses, of each a drachm; and two scruples of sassafras, pounded according to our method, and mixed together in a mucilage of the seeds of quinces, prepared in water of nenuphar, to form a mass for *troches*.

Virtues.—These *troches* are proper to dry the small ulcers of the urethra, to strengthen the spermatick

matick veſſels, and to ſtop the gonorrhœa.—The *doſe* is from a ſcruple to a drachm.

Troches for the Aſthma.—Take nine ounces of white ſugar-candy; an ounce and a half of ſtarch, iris of *Florence*, and magiſterium of ſulphur, of each half an ounce; three drachms of liquorice, and two ſcruples of flowers of benjoin, pounded according to our method, and mixed in a mucilage of gum tragacanth extracted in roſe water, to form a hard maſs for troches.

Virtues.—Theſe troches are excellent for the aſthma, for an inveterate cough, to help reſpiration, and expectoration.—The *doſe* is from half a drachm to a drachm.

Anodyne troches.—Take half an ounce of laudanum, caſtoreum, myrrh, and ſaffron, of each two drachms; and a ſcruple of camphire, pounded according to our method, and mixed in a mucilage of gum tragacanth, extracted in the juice of henbane, for *troches*.

Virtues.—Theſe *troches* are proper to appeaſe pains in whatever parts of the body they be, to abate the vapours, to promote ſleep and ſweat.—The *doſe* is from four grains to half a ſcruple.

Troches to ſtop the vomiting of blood.—Take red roſes, the ſeeds of henbane, flowers of pomegranate, oriental bol, acacia, gum arabick, opium, an equal quantity of each, pounded or prepared according to our method, and mixed in a mucilage of gum tragacanth extracted in water of porcelain, to form a maſs for *troches*.

Virtues.—Theſe *troches* are proper to ſtop all ſorts of hæmorrhages, and to appeaſe exceſſive pains.—The *doſe* is from eight grains to a ſcruple.

Troches to ſtop the immoderate flux of the piles.—Take ten drachms of bdellium, five drachms of myrabolans, three drachms of the ſeeds of leek, prepared coral, prepared ſuccin, prepared bol ammoniack, calcined ſhells, of each two drachms; pounded according to our method, and reduced into a hard maſs, with a mucilage of gum tragacanth, extracted in roſe-water, for *troches*.

Virtues.—They are aſtringent, and may be uſed to ſtop a looſeneſs, and all ſorts of hæmorrhages.—The *doſe* is from half a drachm to two drachms.

Troches for a Diarrhœa.—Take the ſeeds of ſorrel, barberries, myrtles, cheſnuts, amydon or ſtarch, and ſpodium, of each five drachms; ſuccin and coral, of each three drachms; pounded according to our method, and mixed with a mucilage of gum tragacanth, prepared in roſe-water, to form a maſs for *troches*.

Virtues.—They are proper to ſtop a looſeneſs, and hæmorrhages.—The *doſe* is from half a drachm to two drachms.

Troches for the Diabetes.—Take the berries of the myrtle-tree and the ſeed of ſorrel, of each two ounces; gum arabick and ſtarch, of each an ounce, pounded; and mixed with a mucilage of ſeed of pſyllium, for *troches*.

Virtues.—They ſtop the immoderate flux of the urine, by ſtrengthening the conduits of the bladder, and are alſo good for ſpitting of blood.—The *doſe* is from a ſcruple to a drachm.

PILLS, PILULA, is a diminutive of *pila*, *quaſi parva pila*, becauſe *pills* are formed in little balls. The *Greeks* called them *catapotia*, from the verb *καταπινω*, *devoro*, becauſe they are ſwallowed without chewing.

PILLS, have been invented for two principal reaſons. 1. That in that form ſeveral remedies may be taken eaſily, which would be very inſupportable to the taſte, if taken in another manner, as the aloes, coloquintida, agarick, turpentine, *&c.* or would ſtick to the teeth, and perhaps ſhake them, as the mercurius dulcis, and all other mercurial preparations; and there are even ſo many patients ſo very nice, that they would not take any remedy ever ſo little diſagreeable, if they were not reduced into pills.—2. That the remedy being taken dry, may remain longer in the viſcera, and have more time to communicate its virtues to the diſtant parts, as to the head and joints. Moſt *pills* are *purgative*. but there are alſo ſome *alterative*, *aſtringent*, *ſomniferous*, *diaphoretick*, *aperitive*, *hyſterick*, *cephalick*, *bechick*, *arthritick*. *Pills* are otherwiſe preſerved than *troches*; for inſtead that the *troches* are made as ſoon as the maſs is made, that they may be dried, the maſs of the *pills* is kept, that the drugs it is compoſed of may ferment together; and therefore are only formed as they are wanted. But it muſt be obſerved, that when the maſs of *pills* has been made with juices or other liquors, without ſugar or honey, it grows ſo hard ſoon afterwards, that it muſt be reduced into powder, and mixed anew with a liquor to form *pills* thereof; which happens becauſe the liquors corporify, and dry without growing moiſt again; whereas when ſyrup or honey has been uſed, the maſs cannot dry ſo much, becauſe the honey and ſyrup contain a great deal of ſalt, which take eaſily the humidity of the air, which keeps that compoſition in the conſiſtence it muſt have.——It is much more advantageous that the maſs of *pills* ſhould remain ſoft, than too hard, becauſe the fermentation is much better made in the humidity than in dryneſs. As *pills* could communicate a bad taſte in paſſing through the palate; they are wrapped in wafers, or in gold or ſilver leaves, or in powder of liquorice, *&c.*

Pilulæ cocciæ majores.——Take ſix drachms of jalap

jalap, half an ounce of troches of alhandal, three drachms of ſcammony, two drachms of ſoluble tartar, and a drachm of aloes; reduce all theſe drugs into powder, and form a maſs of them with a ſufficient quantity of ſyrup of ſtechas, or juice of wormwood, for *pills*.

Virtues.—Theſe pills purge all humours, but particularly the pituita; therefore they are preſcribed to purge the brain.—The *doſe* is from a ſcruple to a drachm.

Pilulæ cocciæ minores, ſeu mirabiles.—Take aloes ſuccotrina, the beſt ſcammony, troches of alhandal, equal parts of each: let the ſcammony and aloes be pounded together into a very ſubtile powder, in a mortar anointed with ſome drops of oil, reducing alſo into powder the troches of alhandal; and mixing afterwards all the ingredients together with ſyrup of roſes compoſed with agarick, to form a maſs for *pills*.

Virtues.—Theſe *pills* are proper to purge all humours, but they are chiefly uſed to purge the brain.—The *doſe* is from half a ſcruple to two ſcruples.

Catholick Pills.—Take two ounces of aloes ſuccotrina; an ounce and a half of the beſt rhubarb; troches of agarick and ſenna, of each an ounce; and half an ounce of ſoluble tartar; pounded according to our method, and mixed with ſyrup of violets, or of roſes, into a maſs for *pills*.

Virtues.—Theſe *pills* purge all humours, ſtrengthen the ſtomach and brain, and raiſe the obſtructions.—The *doſe* is from a ſcruple to a drachm.

Pills for the Dropſy.—Take two ounces and a half of aloes ſuccotrina; an ounce and a half of gum gut, reduced into a ſubtle powder, and diſſolved in wine of malmſey; an ounce of diacrydium prepared in the ſame manner; an ounce and a half of the beſt gum ammoniack; and half an ounce of vitriolated tartar; pounded and mixed together in ſolutive ſyrup of roſes to make a maſs for *pills*.

Virtues.—Theſe *pills* are proper to raiſe the obſtructions of the ſpleen, and meſentery; for the hydropſy: they purge powerfully.—The *doſe* is from half a ſcruple to a ſcruple.

The purgative drugs of this compoſition, are the aloes, gum gut, and diacrydium.—A ſcruple of theſe pills, contains ſeven grains of aloes, four grains of gum gut, and about three grains of diacrydium. Half a drachm contains ten grains and a half of aloes, ſix grains of gum-gut, and about four grains and a half of diacrydium. Two ſcruples contain fourteen grains of aloes, eight grains of gum-gut, and about ſix grains of diacrydium.

The preparation given here to the gum gut, and to the diacrydium, by humecting them with wine, to grind them on the porphyry, ſeems to me needleſs; ſince it ſuffices to reduce thoſe gums into a very ſubtle powder, to mix them exactly with the other drugs.

Hyſterick Pills.—Take ten drachms of extract of aloes, prepared with the juice of mugwort, myrrh, vitriol of *mars*, and ſalt of mugwort, of each two drachms; caſtoreum, camphire, and leaves of rue, of each two ſcruples; pounded according to our method; and mixed together with juice of mugwort for *pills*.

Virtues.—They purge and abate the vapours, cleanſe the matrice of its impurities, by unſtopping the obſtructions, and provoke the menſes.——The *doſe* is from a ſcruple to a drachm and a half.

There is properly nothing here but the extract of aloes, which can be called purgative; the other drugs helping only the aloes to rarefy the blood, and raiſe the obſtructions.

Arthritick Pills.—Take two ounces and a half of aloes ſuccotrina; half an ounce of ſcammony; hermodacts, turbith, agarick, troches of alhandal, mercurius dulcis, and ſoluble tartar, of each two drachms; pounded according to our method; and reduced into a maſs for *pills*, with the ſyrup of roſes.

Virtues.—Theſe *pills* are thought proper particularly to purge the joints; they are preſcribed for the gout and rheumatiſm.——The *doſe* is from half a ſcruple to two ſcruples.

The reaſon why the *arthritick pills* purge the joints, is, becauſe being compoſed of dry remedies, and full of volatile parts, they remain a long while in the *viſcera*, and have time to ſpread their ſubſtance on all ſides.

Mercurial Pills.—Take quick-ſilver, and aloes ſuccotrina, of each ſix drachms; half a drachm of troches of agarick; and two drachms of the beſt rhubarb; let the quick-ſilver be extinguiſhed in a ſufficient quantity of turpentine of *Venice*; and mix afterwards the powders with it, to form a maſs for *pills*.

Virtues.—Theſe pills purge the bilious humours, and the ſeroſities; they are preſcribed in the venereal diſeaſe, for the ſciatica, the itch, leproſy, the obſtructions, and the king's-evil.—The *doſe* is from a ſcruple to a drachm.

Pilulæ de duobus.—Take equal parts of troches of alhandal, and of ſcammony, pounded, and reduced into a maſs for pills, with the ſolutive ſyrup of roſes.

Virtues.—Theſe pills purge the coarſe pituita, and the ſeroſities, and diſengage the brain. They are

are prefcribed for the gout and the hydropfy.——The *dofe* is from eight grains to a fcruple.

Cephalick Pills.—Take of the mafs of *pilulæ cocciæ*, and fcammony, of each fix drachms; black hellebore, and vitriolated tartar, of each three drachms; prepared according to our method, and reduced into a mafs with fyrup of rofes compofed with agarick.

Virtues.—Thefe pills purge and ftrengthen the brain; are proper for the hypochondriacks, the mania, epilepfy, and vertigo.——The *dofe* is from half a fcruple to half a drachm.

Pilulæ de opoponacis Mefvé. ℞. *aloes fuccotrina*, ℥ j. fs. *trochifcorum alhandal, hermodactylorum, opoponacis, fagapeni, bdelli, ammoniaci, ā* ʒ v. *myrabolanorum emblicorum, citrinorum, bellericorum, caffiæ ligneæ, piperis nigri, zingiberis, croci, piperis longi, myrrhæ, caftorei, ā* ʒ j. *cum fucco caulium fiat maffa, S. A.*

Virtues.—Thefe pills purge all humours; they are principally ufed to purge the brain and the joints; and are prefcribed for the gout, the convulfions, rheumatifms, and to provoke the menfes.——The *dofe* is from a fcruple to a drachm.

The purgative ingredients which enter this compofition are the aloes, the troches of alhandal, the hermodacts, the turbith, the diacrydium, and the myrabolans.

Several drugs, which are pretty needlefs, could be retrenched for this compofition, the fagapenum, bdellium, ammoniack, caffia lignea, the papers, ginger, faffron and myrrh. I find that the quantity of the opoponax, from which the pills borrow their name, fhould be increafed, and that inftead of the needlefs drugs, fome grains of foluble tartar fhould be introduced into them. Therefore I'm of opinion, that thofe pills fhould be compofed in the following manner.

Pilulæ opoponacis reformatæ. R. *gummi opoponacis*, ℥ jj. *aloos fuccotrinæ* ℥ j. fs. *trochifcorum alhandal, hermodactylorum, āa* ʒ v. *turbith*, ʒ fs. *myrabolanorum citrinorum mundatorum, tartari folubilis, āa* ʒ jjj. *diacrydii*, ʒ jj. *caftorei*, ʒ j. *cum S. q. Syrupi de pomes regis faporis, fiat maffa pilul. dofis erit a* ℈ fs. *ufque ad* ʒ j.

Pills for a quartan ague.—Take an ounce of aloes fuccotrina; diacrydium, agarick, foluble tartar, of each two drachms; afarum and black hellebore of each a fcruple: prepared according to our method, and reduced into a mafs, with a fufficient quantity of fyrup of pale rofes.

Virtues.——They purge the pituita, and melancholy; they are ufed in intermittent fevers, and particularly in the *quartan ague*.——The *dofe* is from one fcruple to two fcruples.

The *quartan ague* being moft commonly caufed and entertained by the coarfe and tartarous humours, which ftop feveral fmall veffels of the fpleen, of the pancreas, or of the other vifcera; it is neceffary to prefcribe for that malady, ftrong and penetrating remedies, fuch as thofe which enter thefe pills, to rarefy thofe humours, and raife the obftructions.

Pills for the iliack paffion, or *miferere*.——Take troches of alhandal, and fagapenum, of each fix drachms, and two drachms of diacrydium; prepared according to our method, and reduced into a mafs, with a fufficient quantity of juice of leeks.

Virtues.——They are proper for the iliack paffion, for the cholick, the migram, and purge the pituitous, and other humours.

Pills for the Cough.——Take the juice of liquorice, and olibanum, of each half an ounce; myrrh, faffron, and opium, of each four fcruples; prepar'd and pounded according to our method, and mixed with a fufficient quantity of fyrup of poppies rhæados to form a mafs for pills.

Virtues.——Thefe pills agglutinate and thicken the acrimonious humour, which fall from the brain on the breaft; they appeafe the cough, and provoke expectoration and fleep.——The *dofe* is from fix grains to a fcruple.

Half a fcruple of thefe pills for the cough contains a grain of opium. *Eighteen grains* contain a grain and a half of opium. A *fcruple* two grains of opium. And *half a drachm*, three grains of opium.

Pilulæ ad gonorrhœam virulentam. ℞. *Antimonii diaphoretici, cinnabaris nativæ & antimonialis, terræ figillatæ, radicis ireos florentiæ, liquiritiæ. Succini albi præparati, oculorum cancror, præparatorum, āa* ℥ fs. *myrrhæ electæ, olibani, maftiches, croci, āa* ʒ ij. *cum terebenthina veneta, fiat maffa pilularum.*

Virtues.—Thefe *pills* are aftringent, and ftrengthen the fpermatick veffels, by correcting the virus.——The *dofe* is from a fcruple to two.

Pilulæ fudorificæ. ℞. *Gummi guiaci* ℥ j. *extracta contrayervæ* ʒ vj. *myrrhæ* ʒ v ℈ j. *croci* ℥ fs. *camphoræ* ʒ ij. ℈ ij *laudani opiati* ℈ ij. *mifce, & cum fyrupo de floribus tunicæ, fiat maffa pilularum.*

Virtues.—Thefe pills refift the malignity of the humours, appeafe the pains, and promote fleep and fweat; they are ufed in malignant fevers.——The *dofe* is from a fcruple to a drachm.

Tabellæ, or Solid Electuaries. *Tabellæ*, or *lozenges*, or *folid electuaries*, have been invented for four principal reafons.——1. To give a good tafte to the remedies, becaufe more fugar is mixed in them than in the other compofitions.——2. That they remain a long while to melt and be diffolved in the mouth, and their virtue

tue be better communicated to the throat and breast.——3. That they may be kept long; for a solid consistence is less subject to corruption than others.——4. To render the composition portative. —*Tabellæ* are prepared over the fire, and without fire. Now powders are introduc'd into those made over the fire; but the *dose* thereof is not so much limited: for in the one no more than an ounce of powder enters on each pound of sugar; on the others, three; and on the others four. The matter of the *tabellæ* which are prepared over the fire is cut in lozenges, or square wise, and those prepared without fire are figured into pastilles or rotulæ.

Tabellæ diaturpethi cum rheo. ℞. *Turbith, rhabarb.* *āa* ʒ x, *hermodactylorum* ℥ j, *diacrydii* ℥ ſs. *ſeminis violarum* ʒ ij. *ſacchari albi* j. lb *fiant tabellæ*, S. A.

Virtues.——These *pills* purge the bile and pituita, and are proper for the rheumatism, the gout, and the worms.——The *dose* is from a drachm to an ounce.

The purgative and essential ingredients which enter this composition are the turbith, rhubarb, hermodacts, diacrydium, and seeds of violets, *i. e.* that they are all purgative except the sugar.

Tabellæ mercuriales. ℞. *Panaceæ mercurialis*, ℥ jj. *cinnamomi acutiſſimi, ireos florentin, zingiberis, āa* ʒ j. *ſacchari albi*, ℥ iv.

The ginger, cinnamon, and iris, must be pounded together; and the sugar by itself; mixing afterwards all the powders with the mercurial panacea in a marble mortar; and corporifying that mixture with a sufficient quantity of the mucilage of gum tragacanth, beating it a long while with a wooden pestle, till it be reduced into a solid paste, to form of it small lozenges or rotules, each of them to weigh a drachm.

Virtues.——These tabellæ excite the salivation; and are given to those of a hard constitution, and that cannot be moved by the common remedies.

Tabellæ pectorales D. gendron abbatis. ℞. *Hordei integri*, j. lb. *uvarum paſſarum mundatarum*, ℥ iv. *liquiritiæ raſæ & contuſæ*, ℥ iij. *ſeminis aniſi*, ʒ j. *caryophyllos*, No. XIV.

Tabellæ de althæa compoſitæ. ℞. *Pulpæ radicis althææ*, ℥ ij. *Seminis papaveris albi, ireos florentin. liquiritiæ, pulveris diatragacanthi frigidi, āa* ʒ iij. *Sacchari albiſſimi in aqua roſarum cocti*, j. *lb. Fiant tabellæ, S. A.*

The iris, liquorice, and seed of poppies, must be pounded together, and the powder mixed afterwards, with that of diatragacanthi frigidi; boiling the sugar afterwards, to the consistence of sugar of roses: and mixing in it, when taken off the fire, the pulp, then the powder, to make of it a solid paste; which shall be extended on an oily paper and cut into lozenges.

Virtues.——These tabellæ are good for an inveterate cough, for the asthma, and the ulcers of the lungs: about a drachm of them is put to melt in the mouth.

If two drachms of magistery of sulphur were added to the composition of these tabellæ, they would be more proper for the ulcers of the lungs, and for the asthma. These tabellæ can also be made without fire, by mixing the powders with pulverised sugar, incorporating the whole mixture in a marble mortar, with a sufficient quantity of pulp of althæa, to be reduced into a solid mass, whereof pastilles or rotulæ are formed. These rotulæ can be render'd more detersive, by adding a scruple of flowers of benzoin to the composition.

Tabellæ lithonthripticæ fernelii, reformatæ. ℞. *Sanguinis hirci præparati*, ℥ j ſs. *Oculorum cancror præparat.* ℥ ſs. *Seminum apii, aſparagi, urticæ, ſaxifragiæ, bruſci, petroſelini, ocimi, āa* ʒ ij. *Radicum cypri, coſti, gummi tragacanthi, chamædryos, ſpicænardi, āa* ʒ j. *Cardamomi, macis, zingiberis āa* ʒ ſs. *Sacchari in aqua parietariæ, cocti*, iij. *lb. Fiant tabellæ, S. A.*

Virtues.——These tabellæ are proper to attenuate the stone, the gravel, and the phlegm, and to expel them by urine.——The *dose* is from a drachm to three.

Opiates, Coneections, and Electuaries.

The name of *opiate* was antiently given but to liquid compositions, where *opium* was introduced, but at present it is given to several *electuaries* where there is no real *opium*.——The names of *confection*, and of *electuary*, denote very near the same thing: the first comes from *conficere*, which signifies to accomplish or perfect; and the last signifies *confectio rerum electarium*; therefore we say *electarium*, as well as *electuarium*. These three preparations have consistences very much like that of honey; and are composed of powders, pulps, sugar, honey, and liquors. They are administered inwardly, and invented by the antients to correct the too violent action of some remedies; to excite and increase the virtues of some others, to unite by mixture and fermentation the qualities of the mixts, that they may form a more perfect compositum; that the remedies may be kept longer, to put them in a condition to be easier and sooner taken, without the patient being obliged to wait for the preparation.

Antidotum aſyncitum, Actuarii. ℞ *Opii* ʒ vi. *Myrrhæ* ʒ v. ℈ ij. *Piperis nigri, ſeminis petroſelini aa* ʒ v. *Opii, ſinapeos aa* ℥ ſs. *Schænanthi* ʒ iij. *Amomi, ſtyracis calamit. aa* ʒ ij. *Magna is* *matis hedyctoi* ℈ v. *Cassiæ ligneæ, piperis albi, seminis sizeleos aa* ℈ iv.

The peppers, seeds, amomum, schænantum, and cassia lignea, must be pounded together; and the myrrh, storax, and the troches of hedyctoi, together; the opium must be cut in small pieces, and pounded in a brass mortar with a little honey to reduce it into a paste; mixing that paste with sixteen ounces of skimmed honey, and incorporating the powders in that mixture, to make of them all an opiate, to be kept in a pot well cover'd, for use.

Virtues.——This *opiate* is proper to resist the malignity of the humours, and to appease pains: it is used for the epilepsy, phrenzy, and the tooth-ach; for the contagious maladies, an inveterate cough, and to provoke sleep.——The *dose* is from a scruple to a drachm.

This preparation is an opiate, whereof *Actuarius* is the author. The name *Asyncritum* signifies *none-such*, to express its great virtues.——In a *scruple* of this *opiate* there is little less than a grain of opium. In *two scruples*, about a grain and a half; and in *two drachms*, two grains and a half.

Theriaca andromachi. R. *Trochiscorum scillitiсorum* lb. ss. *Piperinorum, hedycroi, piperis longi, opii aa* ℥ iij. *Iridis florentin. rosarum rubrarum, succi glycyrhizæ seminis buniados, scordii, opobalsami, vel succedanii, olei nucis moschatæ, cinnamomi, agarici aa* ℥ j. ss. *Nardi Indici, dictamni cretici, radicis pentaphyllii, zingiberis, costi rhapontici, prassii albi, stæchadis arabicæ, schœnanthi, seminis petroselini macedonici, calaminthæ montanæ, cassiæ ligneæ, croci piperis albi & nigri, myrrhæ troglo-diticæ, olibani, terebinthinæ chiæ aa* ʒ vj. *Amomi racemosi, radicum gentianæ acori veri, meu athamantici, valerianæ, nardi Celticæ, chamæpityos, comæ hyperici, seminum ammeos, thalspos, anisi, fœniculi, siseleos massiliensis, cardamomi minoris, malabarthi, comæ polii montani, chamædryes, carpobalsami, succi hypocistidis, acaciæ veræ, gummi arabici, styracis calamitæ, terræ lemnicæ, challitidis veri, sagapeni aa* ʒ ss. *Radicis aristolochiæ tenuis, comæ centaurii minoris, seminis dauci cretici, opoponacis, galbani puri, bituminis, judaici, castorei, aa* ʒ ij. *Mellis optimi despumati & cocti* xiv. lb. ss. *Vini generosi*, q. s.

All the drugs must be pounded together, except the turpentine and opobalsamum, without the least fear that the gums and juices should prove an obstacle to the pulverization; since on the contrary, they hinder by their glutinosity a too great dissipation of the subtle parts of the mixture.

Put the honey and *Spanish* wine in a large bason over a middling fire, and when the honey shall be dissolved, strain it through a sieve; boil gently the colature to the consistence of a thick syrup; then take the bason off the fire, and mix with the matter, when half cold, the powders by degrees, then the opobalsamum or oil of nutmegs, and the turpentine which must have been liquified together over a slow fire; agitating the mixture for a considerable time with a wooden spatula till it be quite cold. This preparation will be the *theriach* or *andromachus*, which must be kept in a pot well cover'd; taking care to stir it from time to time, to excite the fermentation thereof.

Virtues.——This *opiate* or *antidote* is proper against all sorts of contagious maladies, against the plague, malignant fevers, and the small-pox; the bite of a venomous beast, the poison of hemlock, and of the napelus: it is good for the windy colick, and the worms; for the asthma, the intermittent fevers, the palsy, apoplexy, epilepsy, lethargy, and the hystericks; while new it provokes sleep, because the opium is predominant; and then it is good to stop the hæmorrhages, and the looseness; but when it grows old, it loses that somniferous quality; because the viscous parts of the opium have been rarefied and exhaled by fermentation.

Old *theriacle* is preferable to the new, to resist venom, because its parts are subtilized and exalted by fermentation, and rendered capable to dissolve and rarefy the congelations formed in the blood, or other humours, either by the bites or stings of venomous beasts, or by other coagulating poisons, or by the infected air, or by a too great quantity of acids which may chance to be in the body. Old *theriacle* is also preferable to the new, to strengthen the brain and the stomach, and to provoke perspiration, because in a long fermentation there have been formed several subtle parts, proper to produce that effect.

However, though this composition be much respected in medicine, either for its antiquity, or the effects it has produced; it seems to me, that a more efficacious remedy could be prepared with a small number of the most essential drugs it contains, chosen and mixed together according to the idea of the physician, without being at the trouble and expence of making so large and so embarassing a preparation; for it happens very often that certain drugs which enter the preparation of the *theriacle*, are good for one constitution, and contrary to another; for it is difficult to appropriate for all the maladies, where the *theriacle* is administer'd, so great a number of different drugs heaped upon one another; which do not seem to have been introduced into the composition, by the choice of a learned physician.

Theriaca

Theriaca diatessaron, mesué. ℞. *Radicum gentianæ, aristolochiæ rotundæ, baccharum lauri, myrrhæ electæ,* ℥ ij. *Mellis optimi despumati,* lb. ij. *Fiat ex arte electuarium.*

Virtues.— This *theriacle* is good against the bites of venomous beasts, against the epilepsy, the convulsions, colick, to expel the after-birth, to provoke the menses, and strengthen the stomach, ——The *dose* is from a scruple to a drachm.

Diatesseron signifies a composition of four drugs. —This *theriacle* is also called the *treacle of the poor*: because it is made at a little expence, and in a short time.

Electuarium diasulphuris reformatum. ℞. *Magisteris sulphuris,* ℥ j ss. *Olibani, myrrhæ, styracii calamitæ, radicis heleni. tussilaginis, meu athamantici, liquiritiæ, ireos florentin. seminis anisi, āa* ℥ j. *Gum arabici, caryophyllorum, croci, florum benzoini, āa* ʒ ij. *Conservarum capillorum veneris, & tussilaginis per setaceum trajectarum, āa* ℥ ij. *Mellis in decocto hyssopi, & scabiosæ despumati, & ad consistentiam opiatæ cocti,* iij. lb. *Fiat electuarium,* S. A.

Virtues.—This electuary is proper for the asthma, to soften the acrimony of the breast, to rarefy the coarse pituita; and to abate the vapours, and to appease the pains ——The *dose* is from a scruple to a drachm and a half.

Electuarium diascordium fracastorii reformatum, ℞. *Foliorum scordii* ℥ iij. *Rosarum rubrarum exungalatarum,* ℥ j ss. *Cinnamomi, radicis tormentillæ āa* ʒ vj. *Styracis calamitæ foliorum dictamni cretici, radicis gentianæ, galbani, succini, āa* ℥ ss. *Opii, piperis longi, zingiberis, seminis oxalidi, āa* ʒ ij. *Mellis rosati in electuarii mollis consistentiam cocti,* iij. lb. *Vini hispanici,* ℥ ij. *Fiat ex arte opiata.*

Virtues.—This electuary is used in malignant fevers, the plague, to kill the worms, to resist putrefaction, for the colick; and provokes sleep when new.——The *dose* is from a scruple to a drachm.

Confectio alkermes reformata. ℞. *Syrupi kermesini optimi recenter parati, & ad mellis consistentiam cocti,* lb. j. ss. *Santali citrini, & cinnamomi, āa* ℥ j. *Ambræ griseæ,* ʒ j. *Moschi,* ʒ ss. *Oleorum macis & caryophyllorcum, āa gutt.* vj. *Fiat confectio, S. A.*

Virtues—The confection *alkermes* is proper to strengthen the heart, the stomach, and the brain; to resist putrefaction, to raise the spirits, to expel the melancholy, and to provoke the seed. It is prescribed in the palpitations of the heart, and in the sincopes; and it hinders abortion.——The *dose* is from a scruple to a drachm. It is also employ'd in epithem, applied on the region of the heart, and of the stomach.

A confection against worms.—Take of semen contra, one ounce, the best rhubarb, and mercurius dulcis, of each half an ounce: pound the semen contra, and the rhubarb together; and the mercurius dulcis by itself; mix the powders, and incorporate them in half a pint of syrup of juice of porcelain, boiled to the consistence of a soft electuary, for an opiate, which is to be kept in a glass or stone vessel.

Virtues.—This opiate is proper to kill the worms, and evacuate them gently; and to hinder their generation.——The *dose* is from a scruple to two drachms.

Electuarium sassafras reformatum. ℞. *Ligni sassafras odorantissimi,* ℥ ij. *Cinnamomi,* ʒ iij. *Ambræ griseæ,* ʒ ss. *Macis.* ℈ j. *Moschi gr.* iij. *Sacchari albi in aqua fæniculi dissoluti & cocti,* lb. j. ss. *Fiat electuarium, S. A.*

Virtues.—This electuary is proper to resist the malignity of the humours; it is sudorifick; it strengthens the brain, the stomach, and the heart, sharpens the sight, and helps the digestion.—The *dose* is from half a drachm to two drachms.

Electuarium pectorale. ℞. *Pinearum,* ʒ j. *Succi glycyrrhizæ, amygdalarum dulcium, avellanarum, āa* ℥ ss. *Hyssopi, capillorum veneris, seminis urticæ, radicis ireos, & aristolochiæ rotundæ, āa* ʒ j ss. *Enulæ campanæ, piperis nigri, seminis nasturtii, āa* ʒ ss. *Mellis despumati,* lb. j, ℥ ij. *fiat electuarium, S. A.*

Virtues.—This *electuary* is proper to provoke expectoration, to loosen the phlegms fastened to the lungs, to the breast, and to the diaphragm, and to help respiration.—The *dose* is from a scruple to a drachm.

Electuarium scorbuticum. ℞. *Conservarum cochleariæ,* ℥ ij. ss. *Chamædryos, melissæ, rosarum pallidarum, citri, aa* ʒ vj. *Cinnamomi, cardamomi, āa* ℥ j. *Conditorum calami aromatici, zingiberis, radicis pimpinellæ, corticis citri, aa* ʒ iij. *Extractorum absinthij & juniperi, seminis sinapi & erucæ, aa* ʒ ij. *Tartari vitriolati,* ʒ j. ss. *Oleorum cinnamomi,* ʒ ss. *Anisi,* ℈ j. *cum spiritu de cinnamomo & de cochlearia, q. s.*

The cinnamon, cardamum, and the seeds, must be well pounded together; and the powders mixed with the vitriolated tartar, beat in a marble mortar, the lemon peel, and the confect roots, and the conserves, till they be reduced into a paste, humecting them with some syrup of lemons, straining them afterwards into a pulp through a sieve of horse hair; and mixing in that pulp the extracts, the powders, the oils, and a sufficient quantity of the spirits of cochlearia, and cinnamon, to make an electuary, which must be kept in a pot well stopped.

The extracts of juniper-berries, and of wormwood, cannot be made without letting escape the most volatile parts, in which their principal virtue consisted. Therefore it would be better to employ here the juniper-berries, and summits of wormwood pounded only.

Electuarium terebinthinatum. ℞ *Terebinthinæ claræ* lb j. *Radicis bismalvæ, graminis, ononidis, brusci, liquiritiæ āa* ℥ j. *Gummi arabici, & tragacanthi oculorum cancri præparatorum, nitri purificati, salis sulphuris, millepedum præparatorum āa* ℥iij. *Salis volatilis succini, aquilæ albæ āa* ʒij.

The roots and millepedes must be pounded together, the gums in a warm mortar; the salts by themselves, and the mercurius dulcis by itself; then the powders must be mixed with the crab's eyes prepared; and the whole incorporated with the turpentine to make an electuary, which must be kept for use.

Virtues.—This *electuary* is proper to attenuate the stone in the reins and the bladder; to expel the sand and phlegms by urine, for the nephritick; to cleanse and consolidate the ulcers of the reins, and of the bladder, and of the matrice; for the virulent gonorrhœa's, and all retentions of urine. —The *dose* is from a drachm to a drachm and a half in a bolus.

Electuarium lenitivum pharmacopœæ parisiensis. ℞ *Hordei excorticati, radicis polypodii quercini contusæ, passularum enucleatarum, tamarindorum aa* ℥ ij. *Jujubas, pruna, sebesten aa*, xx. *Seminis violarum, liquiritiæ rasæ & contusæ aa* ℥ j. *Foliorum mercurialis, man.* ij. *Adrianti man.* j.

Make a decoction thereof in twelve pints of common water, till they be reduced to seven; then add towards the end *foliorum orientalium mundatorum* ℥ ij. *seminis fœniculi dulcis* ℥ ij. to four pints of the colature add three pounds of the best sugar; letting the whole mixture boil to the consistence of syrup; in which must be dissolved the pulps of of prunes boiled in one part of the decoction left; of tamarinds, and of cassia strained with the rest of the decoction, of each half a pound; five ounces of senna in powder, and two drachms and a half of aniseed, for an electuary.

Virtues.——This *electuary* softens the humours, and purges particularly the bile, without violence. —The *dose* is from half an ounce to an ounce and a half.

Lenitivum aliud excellentissimum. ℞ *Decocti radicis althææ, & ficuum pinguium* lb iv. *Sacchari albi* lb iij. *Coquantur ad consistentiam mellis, tunc misce pulpæ cassiæ recenter extractæ* lb j. *Pulpæ prunorum, pulveris senæ aa* lb ss. *Seminis violarum* ʒ iij. *Tartari solubilis* ℥ i. ss. *Fiat electuarium*, S. A.

Electuarium aperiens A. daquin. ℞ *Foliorum sennæ orientalis mundatorum* ℥ vi. *Diacrydii, trochiscorum alhandal, agarici electi, rhabarbari, & seminis violarum āa* ℥ j. ss *Sagapeni, myrrhæ, gummi ammoniaci, a a* ℥ j. *Antimonii diaphoretici, mercurii dulcis, aa* ʒ vi. *Salis martis, & tamarisci aa* ℥ ss.

The senna, troches of alhandel, agarick, rhubarb, seed of violets, and sagapenum must be reduced together into a subtile powder, the gum ammoniack, the myrrh, and the diacrydium pounded together; and the mercurius dulcis and diaphoretick antimony together; then all those powders must be mixed with the salts; and all together with six pounds of skimmed honey, to make an electuary, which must be kept for use.

Virtues.——This *electuary* purges all humours, rarefies the viscous and coarse matters, raises the obstructions, and provokes the menses. It is prescribed in quartan agues, cachexies, hypochondriacal maladies, and hydropsy.——The *dose* is from one drachm to six.

This composition is a mixture of essential remedies.

Hiera picra simplex Galeni. ℞ *Aloes succotrinæ* ℥ vi. ʒ ij. *Cinnamomi, xylobalsami, vel hujus loco surculorum lentisci, asari, spicæ indicæ, croci, masticbes ana* ʒ iij. *Mellis despumati* lb ij. ℥i ss. *Fiat electuarium*, S. A.

The cinnamon, xylobalsam, or in its stead the lentisewood, the asarum, and the spikenard, must be pounded together, the aloes and mastich together; and the saffron, after it has been dried between two papers by itself; the ingredients thus pounded must be mixed together, and the powder may be kept to be used when wanted: it is introduced into several compositions.

When it is wanted to make the electuary, one part of that powder must be mixed in three parts of skimmed honey boiled to the consistence of a liquid electuary.

Virtues.—The *hiera picra* is employed to purge the stomach, to raise the obstructions, to provoke the menses and the piles, and to purify the blood. ——The *dose* is from a drachm to half an ounce in bolus, by reason of its extreme bitterness. It is also used in clysters for the colick, the hystericks, and the apoplexy; from two drachms to an ounce for each clyster.

Hiera picra are two *Greek* words, the first whereof signifies *great* and *sacred*, and the other *bitter*.

The purgative virtue of the *hiera picra* consists in the aloes.

Hiera picra reformata. ℞ *Aloes succotrinæ* ℥ ij. *agarici trochiscati, & tartaris solubilis ana* ℥ j. *diacrydii* ʒ vi. *Mellis despumati* ℥ xiij. *fiat electuarium*, S. A.

Virtues.

Virtues.—This *hiera picra* purges with violence enough; it is used for the windy colick, the apoplexy, lethargy, and epilepsy.—The *dose* is from half a drachm to three drachms.

Distilled Waters.

I do not design to mention in this place, those which depend purely on Chymistry, as the aqua-fortis, the common brandy, the styptick and phagedenick waters.

Distillation is a rarefaction and exaltation of the most humid and essential parts of the mixts, resolved by fire into vapours, which ascending to the capital, and being cool'd there, are condensed into drops which fall into the receiver.

Distilled waters are divided into *simple* and *composed.*

Simple distilled waters are those extracted from the plant without addition, as plantain, rose, and sorrel-water, *&c.*

Composed distilled waters are those distilled from several ingredients, as treacle-water, imperial-water, aqua mirabilis, *&c*,

The artist must use, as much as possible, glass or earthen vessels for the distillation of waters; but when those vessels are not large enough to contain the matter to be distilled, he must then use copper-alembicks tinned inside.

There are two sorts of *distillations*, one done *per ascensum*, and the other *per descensum.*—The first, and most common, is when the matter is heated underneath. The other is when the fire is put over the matter to be heated: then as the vapour cannot rise, it is precipitated to the bottom of the vessel.

As the mixts, from which the waters are extracted, are of different substances, the one volatile, the other fix'd, some watery and phlegmatick, and others dry and saline; different means must be used to carry off by distillation as much of their most essential parts as possible. I'll give models to succeed in it.

The distilled waters can be kept several years without corruption; because there have been separated from them, by the distillation, the fermenting substances which would spoil them: but they must be renewed every year, because the vitriol they have brought along with them from the plant, is much weaken'd in winter.

Plantain water. Take what quantity you will of large plantain, newly gather'd, in its greatest vigour; have pounded in a mortar enough of it to fill half a large copper-cucurbit, tinned inside: mean while must be extracted by expression, in the usual manner, eighteen or twenty pounds of the juice of other plantain, which you'll pour over the pounded plantain to humect it well, so that it may not stick to the bottom of the vessel during the distillation. Place the cucurbit over a furnace, covering it with its bolt-head, garnished with its refrigeratory, which must be filled with cold water; then adapt to it a receiver, and light a charcoal fire in the furnace, to distil the humidity moderately quick, so that one drop may follow the other.

When about half the humidity is distilled, the fire must be left to go out; and when the vessels are cold, the plantain must be taken out of the alembick, strained by expression, and afterwards thrown away as useless; but the juice extracted from it must be poured back into the same vessel, and the distillation renewed, which should be continued, till there is but little of the liquor left in the vessel.

The distilled *plantain-water* must be exposed for some days to the sun, in glass or stone bottles uncorked, to dissipate the smell of empireum, which proceed from the fire; after which the bottles must be corked: and the water kept for use.

Virtues.—*Plantain-water* is detersive, astringent cooling, proper to stop the looseness, the hæmorrhages, the gonorrhœa's, *&c.*——The *dose* is from an ounce to six.——It is also used outwardly to wash the eyes in the ophthalmicks; and for detersive and astringent injections.

In the same manner can be distilled the waters from all the plants, which abound in humecting and cooling phlegm; and if the juice of some of them cannot be extracted easily, there must be made a strong decoction thereof to humect the pounded herbs.

The waters which can be thus distilled are those of *porcelain*, *lettuce*, *sempervivum*, *bugle*, *henbane*, *mandragora*, *mallows*, *borage*, *buglofs*, *solanum*, *alkekengi*, *verbascum*, *agrimony*, *nenuphar*, *poppies*, *alchimilla*, *senicle*, *chelidonium*, &c.

Sorrel-water.——Take what quantity you will of very green and tender sorrel, gathered in fair weather while it is in its greatest vigour, and before it is grown into seed; pound it or bruise it in a stone or marble mortar, fill with it about half a large copper-cucurbite, tinned inside; pour over the matter a good quantity of juice of sorrel, newly extracted with expression, so that the liquor swim over the matter, adapt to the cucurbite its capital, with its bolt-head, tinn'd likewise inside, and its refrigeratory; place the vessel over a naked fire; adapt a receiver to the cucurbite, and distil the humidity at a pretty strong heat, so that the drops follow close one another.——When about half the humidity has been distilled, the vessels must be left to cool; and when cold, what is left in the cucurbite

bite muſt be taken out and carried to the preſs to extract the juice; that juice muſt be left to ſettle, and having been afterwards ſtrained through a flannel, it muſt be put in an earthen pan, to have evaporated over a ſlow fire about two thirds of the humidity thereof, carrying afterwards the veſſel to a cool place, where it muſt be left for ſome days without touching it; then there will be formed round it ſmall cryſtals which are the eſſential ſalt of the ſorrel, which muſt be ſeparated from the reſt, and kept for uſe.

But if one will not take the trouble to prepare the eſſential ſalt of ſorrel, he may content himſelf with evaporating the juice to the conſiſtence of thick honey; which will be the *extract of ſorrel.*

The ground taken from the preſs muſt be dried, and having mixed with it a good quantity of other dried ſorrel, the whole muſt be burnt, the aſhes thereof calcined, and having made a lixivium of thoſe aſhes, it muſt be filtrated, and afterwards put to evaporate to ſiccity, over a ſlow fire; there will be found at the bottom of the veſſel a ſalt, which is the *fix'd ſalt of ſorrel*, and which muſt be kept for uſe.

Virtues.——The *water of ſorrel* is eſteemed cordial, cooling; proper for violent and bilious fevers. ——The *doſe* is from an ounce to ſix.

The *eſſential ſalt of ſorrel* is inciſive, penetrating, rarefying; it provokes the appetite, and is cordial. ——The *doſe* is from half a ſcruple to half a drachm.

The *extract of ſorrel* has very near the ſame virtues of the eſſential ſalt; but the *doſe* muſt be greater, *i. e.* from a ſcruple to a drachm.

The *fixed ſalt of ſorrel* is aperitive, penetrating, proper to raiſe the obſtructions.——The *doſe* is from eight grains to half a drachm.

In the ſame manner can be diſtilled the other plants which have no ſmell, and are ſaline; as the *carduus benedictus*, *naſturtium*, *ſcabioſe*, *fumitery*, *parietary*, *chicory*, *tobacco*, *ſmall centaury*, *St. John's-wort*, *tuſſilage*, *endive*, *chamædryos*, *chamepityos*, *pæony*, *enula campana*, *cochlearia*, &c. theſe waters muſt be made to diſtil pretty quick, that they may exalt along with them ſome portion of the eſſential ſalt of the plant; for in that ſalt conſiſts all the virtue of thoſe waters which have no ſmell; wherefore thoſe plants are never to be diſtilled in balneo mariæ, nor in balneo vaporis, which would only exalt the pure phlegm. But whatever method and precaution may be obſerved in the diſtillation of thoſe, it always happens that the greateſt part of their active and eſſential principles remain in the bottom of the cucurbite; therefore it would be better to uſe the juice, or of a ſtrong decoction of the plant, while it is in its vigour, than of its diſtilled water; but when we have no more the plant in its vigour, the diſtilled water can be uſed; and to render it more efficacious, there muſt be diſſolved in it, before it is taken, ſome of its eſſential ſalt, or of its extract or fixed ſalt; which will very well ſupply the want of the plant in its vigour. Theſe diſtilled waters muſt be expoſed for ſome time to the ſun, the bottle uncorked, that the empyreumatical ſmell may be diſſipated.

Wormwood-water.——Take a good quantity of common wormwood, green, newly gathered while in its greateſt vigour; pound the leaves thereof in a mortar, and fill with it half a large copper cucurbite tinned inſide; mean while make a ſtrong decoction of other wormwood, ſtrain it boiling-hot, and pour as much of it upon the wormwood in the cucurbite as is neceſſary to humect it leſt it ſhould ſtick to the bottom of the veſſel, which muſt be very well ſtopped, and the matter left in digeſtion for two days; which expired, the veſſel ſhall be unſtopped, placed on a furnace, the bolt-head with its refrigeratory, and a receiver adapted to it, the joints luted, and at a moderate fire, about half the humidity diſtilled; which done, and the veſſels cold, they muſt be opened, the matter left in the cucurbite ſtrained, and the juice extracted from it put to diſtil as before, there will be no more but two or three pounds thereof left. The diſtilled water muſt be kept in bottles well corked.

Virtues.——The *water of wormwood* is proper to incite and attenuate the pituita, to ſtrengthen the ſtomach, to excite the appetite, to help digeſtion, provoke the menſes, abate the vapours, and for the worms ——The *doſe* is from half an ounce to four ounces.

The liquor left in the alembick of the diſtillation may be clarified, and the humidity thereof evaporated to the conſiſtence of honey, which will be the *extract of wormwood.* It is aperitive, and proper for the hyſtericks.——The *doſe* is from a ſcruple to a drachm, either diſſolved in its proper water, or taken in a bolus. The grounds left after they have been dried, can alſo be burnt with other *wormwood*; and the aſhes put in warm water to make a lixivium, which having been filtrated, is put to evaporate to ſiccity, and what is left in the bottom of the veſſel is the *ſalt of wormwood*, which muſt be kept in a bottle well corked. This *ſalt* is very aperitive, proper to raiſe the obſtructions of the liver, of the ſpleen, meſentery, and of the matrice, to provoke the urine, for the yellow jaundice, the hydropſy, and the retention of the menſes.——The *doſe* is from ſix grains to half a drachm, diſſolved in water of wormwood.

By the ſame method are extracted the waters, eſſences, extracts, and ſalts of all odorous plants, *viz.*

viz. of *mint*, *sage*, *marjoram*, *savine*, *rosemary*, *henbane*, *hyssop*, *marrubium*, *mugwort*, *honey-suckles*, *scordium*, *lavender*, *parsley*, *fennel*, *mustard*, *bays*, *rue*, *betony*, *camomile*, *origan*, *melilot*, *matricaria*, *juniper*, &c.

Rose-water. — Take what quantity you will of pale or white roses, newly blown, the most odorus, and gathered soon after sun-rising, in dry weather; pull the leaves off their pecule, and having pounded them in a marble mortar, put them in a copper cucurbite tinned inside. pouring upon them the juice of other roses newly extracted by expression, to humect them well, or else it may be done with rose-water of the preceding year; then place the vessel in balneo mariæ or vaporis, and cover it with its capital garnished with a refrigeratory; adapt a recipient to it, lute exactly the joints, and leave the matter in digestion for two days; which expired, placed to the distillation by a good fire, taking care to change the water of the refrigeratory as it grows hot. When about the two thirds of the liquor is distilled, the fire must be put out; and what is left in the vessel carried to the press to extract the juice, which must be put to distil as before, to have good rose-water, which must be exposed to the sun for two days in uncorked bottles, to sharpen its smell; then the bottles must be well corked.

Virtues.——Rose-water strengthens the breast, heart, and stomach.——The *dose* is from one ounce to six. It is also used in collyres for the maladies of the eyes; and in perfumes.

Instead of white and pale roses, purple roses were used in the distillation, the water drawn from them would be astringent, and proper to stop the looseness, for the spitting of blood, for detersive in ections. It would even be better than the other for collyres; but it would have but very little smell: besides, it would be the most proper rose-water for the maladies in which that remedy is commonly used;, and it could be wished that the world which often will be deceived, would not mind so much the smell of this water to judge of its goodness, the apothecaries would make it of red roses, and then it would produce better effects.

In the same manner can be extracted the water of all flowers, as, of the *flowers of poppies*, of *nenuphar*, of *lilies of the valleys*, of *borage*, of *beans*, of *rosemary*, of *bugloss*, of *violets*, of *jessamine*, of *tussilage*, of *oranges*, of *lavender*, of *thyme*, of *sage*, &c. But as a great number of those flowers are very little succulent to extract the juice thereof, they must be humected before distillation, with a strong infusion of another quantity of the same flowers made sometimes in hot water, and sometimes in white-wine according to their quality.

Water of strawberries.——Take four or five pounds of ripe strawberries, bruise them in a marble mortar, and put them in a large glass cucurbite, which must be placed in balneo mariæ, and having adapted a capital to it, and a receiver, and luted exactly the joints, as much of the humidity of the fruits as possible shall be distill'd by a pretty strong fire.

Virtues——The *water of strawberries* is good to strengthen the heart, the brain, and to enrich the blood.——The *dose* is from an ounce to three. Ladies use it to wash their face.

In the same manner can be drawn the water of the other succulent fruits, as of *cherries*, *plumbs*, *apples*, *mulberries*, *rasberries*, *barberries*, *quinces*, *peaches*, *oranges*, *lemons*, *elderberries*, *melons*, *cucumbers*, *pumpkins*, *gourd*, &c.

Strawberry-water is made in several other manners; some leave the fruit bruis'd to ferment two or three days, that its principal may be exalted before distillation. Others humect their strawberries with white wine to render the water more spirituous and more aperitive; and others humect them with ass's milk, to make it more proper to beautify the skin.

Water of walnuts.——Take a good quantity of flowers of walnut-tree newly gathered, while in their vigour, and let six pounds thereof be pounded in a mortar, and put them afterwards in a copper cucurbite; mean while make a strong decoction of other flowers, and after it has been strained by expression pour twelve pounds thereof hot into the cucurbite. or as much as is wanted to humect the pounded flowers; place the vessel on a furnace, where it must be left in digestion for twenty-four hours, distilling afterwards about half the liquor; which done, the fire must be put out, and when the vessels are cold, what remains in the cucurbite must be strained, and three quarters of the juice extracted by that means, distilled, mixing afterwards both waters together.

Then you must gather six pounds of walnuts, when they are about a third of their usual bigness; and having pounded them in a mortar, you must put them in a large copper cucurbite. pouring upon them all the distilled water of the flowers of walnuts, and leaving the matter in digestion for twenty-four hours; and having distilled the water as before, you'll take next six more pounds of whole walnuts when they are good to preserve; pound them well in a mortar, and having put them in a copper cucurbite, pour upon them the distilled water, and having left the whole in digestion for twenty-four hours, proceed to the distillation as before, and you'll have the water of walnuts, which must be exposed five or six days to the sun, in uncorked bottles, to dissipate the empyreumatical smell, then cork the bottles.

Virtues.——The water of walnuts is sudorifick, proper for malignant fevers, for the plague, the small pox, the windy colick, the hystericks and to strengthen the stomach.——The *dose* is from one ounce to seven.

If after each distillation, the liquor left in the cucurbite be strained through a flannel, the humidity thereof evaporated to the consistence of honey; and those three juices thus inspissated be mixed together, it will be a very good extract of walnuts, which must be kept in a pot.

Virtues.—The extract of walnuts is sudorifick, aperitive, febrifuge, strengthens the stomach, and resists the malignity of the humours.——The *dose* is from a scruple to a drachm, in a bolus, dissolved in its proper water.

The grounds left in the press can also be burnt, to draw from them an alkali salt fix'd, by means of a lixivium.

Virtues.—The *fix'd salt of walnuts* is aperitive, and proper to raise the obstructions.——The *dose* is from six grains to a scruple.

Water of cow-dung.——In the month of *May*, when the grass begins to have some vigour, gather the cow-dung, newly made, and having filled with it half of a glass or stone cucurbite, place it in balneo mariæ, and by a pretty strong fire, distil a clear water, which is called the *water of a thousand flowers*, and which must be exposed to the sun in glass bottles for five or six days, that the disagreeable smell, which it may have, be dissipated. Then the bottles must be cork'd and kept.

Virtues.—This water is aperitive and sweetening; it is prescribed for the hydropsy, rheumatism, and the sciatica.——The *dose* is from an ounce to six. It is also used outwardly, to cleanse, cool, and soften the skin: it is resolutive.

The name of *water of a thousand flowers*, has also been given to the urine of a cow, newly voided from the animal; and it is used with success for several maladies in the spring and autumn; by drinking two or three glasses thereof every morning fasting, for nine or ten days successively, and taking a walk afterwards in the fields——That urine purges very well the serosities without griping; is proper for the asthma, the hydropsy, rheumatism, gout, and vapours.

Water of all flowers.——You must gather in the month of *May* cow-dung, newly made, weigh it and put it in a large cucurbite of glass or stone, mixing with it about the third of its weight of white wine; and having placed the vessel in balneo mariæ, or vaporis, adapt a capital and a recipient to it, and lute exactly the joints, you'll distil the humidity of the matter which is called the water of all flowers.

Virtues.——This water is thought arthritic, good for the rheumatism, the sciatica, gravel, and the suppression of urine.——The *dose* is from an ounce to four. It is also used to cleanse and soften the skin, for pimples, itchings, and ring-worms.

Water of the frey of frogs.—Gather in the spring, about the month of *March*, what quantity you will of frey of frogs, very pure, condensed, or thick, and which has a smell, distil the humidity thereof in balneo mariæ, or in the common manner; and expose the distilled water to the sun for seven or eight days; and afterwards cork the bottles well to keep them for use.

The water of the frey of frogs is very cooling, condensating, proper for the hæmorrhages, to appease the pain of the gout, for cancers, erysipelas, and other rednesses of the skin. It is applied outwardly with linen cloths. It is used to cleanse the face, and keep up a fresh complexion.

In the same manner are distilled, the waters of *milk*, of *blood*, of *human brain*, of *honey*, of *manna*, of *rain*, and of *dew*.

Water of snails.—Take three pounds of snails alive, with their shells, wash them well, and bruise them in a marble mortar, and put them afterwards into a large cucurbite, pouring over them two pints of ass's milk, newly milked; mix well the whole together with a wooded spatula; and having adapted a capital and receiver to the cucurbite, and luted exactly the joints, leave the matter in digestion for twelve hours, proceeding afterwards to the distillation; which done, the water must be exposed for several days to the sun, in a bottle uncorked.

Virtues.——This water is humecting, cooling, proper for the redness of the skin, to wash the face, and render the skin smooth. It can be also administered inwardly, for the spitting of blood, the nephritick, and the heat of urine. The *dose* is from one ounce to six.

Aqua vulneraria. ℞. *Foliorum & radicum consolidæ majoris, foliorum salviæ, arthemisiæ, buglæ, ana man.* iv. *Betonicæ, saniculæ, bupthalmi, symphyti minoris, scrophulariæ majoris, plantaginis, agrimoniæ, verbenæ, absinthii, fœniculi, ana man.* ij. *Hyperici, aristolochiæ longæ, telophii, veronicæ, centaurii minoris, millefolii, nicotian. menthæ.*

After you have gather'd the herbs in their greatest vigour, hatch them and pound them well in a mortar, and having put them afterwards in a vessel of a narrow neck, pour over them white wine, stir the whole, stop the vessel, and put it in the horse-dung, or in another warm place, where it must be left in digestion for three days; which expired, you'll distil the matter in balneo mariæ, or vaporis, extracting above half the humidity, and having left the vessels to grow cold, what remains in the bottom

tom of the cucurbite, muſt be put to the preſs, and the juice extracted from it, diſtilled as before; mixing afterwards the firſt and ſecond water together, to keep it in a bottle well corked for uſe. This water is called *water of arquebuſade*, becauſe uſed for wounds made with fire-arms.

Virtues.——This water is good for the contuſions, diſlocations, to reſolve tumours, to cleanſe ulcers and wounds; and to reſiſt the gangrene, applied outwardly.

Hungary-water.——Fill half of a glaſs-cucurbite with flowers of roſemary, newly gathered in their vigour, pour over them ſpirit of wine till it ſurpaſſes the flowers by two fingers breadth, cover the cucurbite with its capital, and leave the matter in digeſtion for three days; and afterwards, having adapted a receiver to it, and luted exactly the joints, proceed to the diſtillation at a ſand-heat; and keep the diſtilled water in a bottle well corked for uſe.

Virtues.——This water is good for the palſy, apoplexy, lethargy, the hyſtericks, palpitations, for fainting-fits, and the pain of the ſtomach.——The *doſe* is from one drachm to three.——It is alſo uſed outwardly for the tooth-ach, the burns, the cold humours, contuſions, to cleanſe the ſkin, to ſtrengthen debilitated members, for the vapours, being applied to the noſe and temples, and on the wriſts; and for the gangrene.

Aqua theriacalis. ℞. *Radicum gentianæ, angelicæ, imperatoriæ, valerianæ, contrayervæ, āa* ℥ ij. *Corticum citri & arantiorum, caryophyllorum, cinnamomi, baccarum juniperi, āa* ℥ j. *Summitatum ſcordii, rutæ, hyperici, āa man.* j.

Let all theſe drugs be infuſed for three days ſucceſſively in balneo mariæ, in ſpirit of wine and water of carduus benedictus and walnuts, of each two pints; and after you have added to it four ounces of old treacle, put the whole mixture to macerate for the ſpace of twenty-four hours; then proceed to the diſtillation by a ſlow fire; to have the treacle-water, which muſt be kept in a bottle well corked.

Virtues.—This water is proper to ſtrengthen the noble parts, to reſiſt the bad air, to raiſe the ſpirits, to expel bad humours by perſpiration; it is uſed in the apoplexy, palſy, lethargy, and epilepſy.—The *doſe* is from a drachm to ſix.

Aqua mirabilis. ℞ *Cinnamomi electi* ℥ j. *Corticis exterioris citri, nucis moſchatæ āa* ʒ vj. *Caryophyllorum, calangæ, cubebarum, macis, cardamomi, zingiberis āa* ʒ ij.

Having bruiſed all the drugs together, they ſhall be put in a glaſs cucurbite, and the juice of the meliſſa depurated, white-wine and ſpirit of wine poured upon them; and having left the mixture to macerate for three days ſucceſſively; you muſt proceed to the diſtillation at a moderate ſand-heat: then you'll have the *aqua mirabilis*.

Virtues.—This water ſtrengthens all the noble parts, rejoices the heart and the brain, and provokes the menſes.——The *doſe* is from two drachms to ſix.

Aqua carminativa, ſeu ſpiritus carminativus, fr. deleboe ſilvii. ℞ *Summitatum centaurii minoris, foliorum roriſmarini, majoranæ, rutæ hortenſis, baſilici, āa man.* ſs. *Cinnamomi,* ʒ vj. *Seminum angelicæ, leviſtici, aniſi, āa* ℥ ſs. *Baccarum lauri,* ʒ iij. *Nucis moſchatæ, macis, radicum imperatoriæ, galangæ, zingiberis, aa* ʒ j. ſs. *Angelicæ, caryophyllorum, corticis arantiorum, aa* ʒ j. *Conciſis, & craſſe contuſis affunde, ſpiritus vini,* lb. ij. ℥ iv. *Digerantur per biduum in balneo mariæ, hinc ad ſiccitatem diſtillentur; ſervetur diſtillatus ſpiritus ad uſum.*

Virtues.—This ſpirit is proper for the windy colick; it diſunites and rarefies the ſlimy matters, and appeaſes the gripes.——The *doſe* is from half a drachm to two drachms.

Aqua pectoralis, Georgii Batei. R. *Ligni guaiaci pulverizati,* ℥ viij. *Radicum helenii, ariſtolochiæ rotundæ, āa* ℥ iij. *Iridis noſtratis,* ℥ j. ſs. *Petroſelini, fœniculi, glycyrrhiſæ, aa* ℥ j. *Foliorum nicotianæ viridium man.* iv. *Scabioſæ, veronicæ, tuſſilaginis, hyſſopi, ſummitatum marrubii, cardui benedicti, aa man.* 1. *Jujubas, ſebeſten, aa* No. XXX. *Caricas, dactylos, aa* No. XV. *Baccarum lauri,* ʒ vj. *Seminis nicotianæ,* ʒ iij. *Nigellæ,* ʒ j. *Lini, urticæ, naſturtii, ſinapi, aa* ʒ ij.

Put in a large glaſs or ſtone cucurbite the guaiac reduced into a coarſe powder, the roots cut in pieces, the leaves hatched and bruiſed, the fruits open and cut in ſmall pieces, the berries and ſeeds bruiſed, and two ounces of turpentine diſſolved with five or ſix yolks of eggs, and afterwards into white wine. Stir the whole together, cover the veſſel and leave the matter in digeſtion, in a warm place, for three days; then uncover the veſſel, adapt a capital, and a receiver to it; and having ſuſpended in the neck of the alembick a piece of fine linen cloth, containing ſixty millepedes, dried and bruiſed. lute exactly the joints, place the cucurbite in balneo mariæ, and diſtil the matter by a pretty ſtrong fire, and the water in diſtilling paſſing over the knot, will be impregnated with the ſubſtances and quality of the millepedes; which water muſt be kept in bottles well corked.

Virtues. —— This water is excellent for the aſthma, for the difficulty of reſpiration, for the cough, to attenuate the coarſe humours of the lungs and of the reins for the nephritick, for the ulcers of the bladder, and to provoke the urine.

——The dose is from one ounce to two, taken twice or thrice a day.

Aqua nephritica. ℞. *Mellis opitimi*, lb j. *Terebinthinæ claræ*, ℥ ij. *Ligni nephritici, radicis aronidis*, *aa* ℥ j. ß.

Having pounded the woods and roots, all the drugs must be put to macerate in the best white wine, and lemon-juice, newly extracted, of each two pounds; distilling the liquor afterwards by a moderate fire.

Virtues.—This water is proper to expel the gravel from the reins and the bladder; and is given for the nephritick.——The *dose* is from half an ounce to four ounces.

Water to appease the pains of the gout.——Let ox's dung be dried in the sun, and mix it afterwards with freys of frogs, an equal quantity of each, in a glass cucurbite, to which having adapted a capital with its receiver, and luted exactly the joints, proceed to the distillation of the humidity in balneo mariæ; and you'll have a water which must be kept in a cool place for use.

Virtues.—This water is esteemed good to appease the pains of the gout, attended with inflammation of the part, by applying upon it pieces of linen cloth dipped into it.

A very good eye-water.—Take the flowers of cyanus, newly gather'd in their vigour, pound them in a marble mortar, with a sufficient quantity of snow-water to humect them well; put them in a glass or stone cucurbite, and having adapted a capital to it with its recipient, leave the matter in digestion, by a slow heat in balneo mariæ, for a whole day; and having distilled afterwards the humidity, you'll expose the distilled water to the sun, for some days, in a bottle uncorked; and keep it afterwards for use.

Virtues.—This water is proper for inflammations, and other maladies of the eyes; it cools them, and strengthens the fibres thereof, by washing the eyes with it, and suffering some drops thereof to enter them.

Aqua epidemica, Georgii Batei. ℞ *Foliorum chelidoniæ, rorismarini, rutæ, arthemisiæ, absinthi, anagallidis, dracontii, scabiosæ, agrimoniæ, melissæ, scordii, centauri minoris, cardui benedicti, betonicæ, roris solis, ana man.* ij. *Radicum angelicæ, tormentillæ, gentianæ, zedoariæ, glycyrrhisæ, ana* ℥ j. *Macerentur in vini albi* lb. viij. *Per duos dies; deinde distillentur secundum artem.*

Virtues.—This water is used in the epidemical maladies; as in the small-pox, the malignant fever, and the plague.——The *dose* is from half an ounce to two ounces; or from half a spoonful to four.

Aqua lavendulæ composita. ℞. *Florum lavendulæ, lilii convallium, āa man.* vj. *Salviæ, rorismarini, pæoniæ, tiliæ, aa pug.* j. *Radicis pæoniæ, erucæ, aa* ℥ iij. *Galangæ, zingiberis, calami aromatici, nucistæ, cubebarum, cinnamomi, macis, caryophyllorum, visci quercini, aa gr.* xxvj. *Vini optimi, q. s. Fiat infusio & distillatio in balneo mariæ.*

Virtues.——This water is cephalick and arthritick, it strengthens the brain and the joints, and may be used in the epilepsy, palsy, and apoplexy. ——The *dose* is from two drachms to an ounce.

Water to prevent the accidents which may be occasioned by a fright or a fall of a woman with child. ——Take an ounce and a half of cinnamon: half an ounce of cubebs; three drachms of cloves; mace, galanga, ginger, zedoary, saffron, of each two drachms; a handful of flowers of lavender, and two quarts of water of lilies of the valley, distill'd with the best white wine. Bruise well the ingredients, put them into a cucurbite, and having pour'd upon them the water of lilies of the valley, stop well the vessel, and place it in horse-dung, where you'll leave it four days in digestion; which elapsed, open the cucurbite adapt a capital to it with its receiver, lute exactly the joints, and distil the humidity in balneo mariæ, to extract a water which must be kept in a bottle well corked.

Virtues.—This water is proper for women with child which have been frighten'd, or having fallen down; for it prevents abortion, by strengthening both the mother and child: it also helps the digestion—The *dose* is from two drachms to an ounce.

ELIXIRS.

The name *elixir* comes from the *Greek* ἑλκω, *traho*, because in mixing an *elixir*, the purest substance of the mixts is extracted: or from ἀλεξέω, *auxilior*, because of the great benefits received from them in medicine. *Elixir* is sometimes called *enchilana*.

ELIXIR is a spirit or quintissential tincture of several chosen mixts, containing their purest substance. It is designed for inward uses,

Elixir proprietatis. ℞. *Myrrhæ electa, aloes succotrinæ, aa* ℥ ij. *Croci orientalis*, ℥ j.

The myrrh and aloes must be pounded together, and put with the saffron in a matrass, pouring upon them spirit of wine, that it may surpass the matter by a finger's breadth; then the matrass must be well stopped, and carried to a warm place; where the matter is to be left two days in digestion, which elapsed, the matrass is open'd, and the acid spirit of sulphur having been added to the infusion, to the height of four fingers breadth, the matrass must be corked again, and placed in digestion in the sun, or in a lukewarm balneo mariæ, where having

having been left four days, the liquor muſt be filtrated afterwards, and kept in a bottle well corked.

Virtues.——This *elixir* ſtrengthens the heart and the ſtomach, purifies the blood, provokes the menſes, abates the hyſterick vapours, and is ſudorifick ——The doſe is from four to ſixteen drops.

Elixir ſincopticum. ℞ *Corticis exterioris citri* lb ſs. *Croci orientalis* ʒ vj. *Antidoti orvietani* ℥ ſs. *Confectionis alkermes, diambræ, ãa* ʒ ij. *Succi limonum depurati* lb j. *Aquarum roſarum* ℥ ix. *Meliſſæ* lb ſs. *Florum trium cordialium, calendulæ, lilii convallium, roris ſolis, aa* ℥ iv. *Tunicæ* ℥ iij.

You'll take the outward rind of lemon ſeparated from the whole part, and having cut it ſmall, you'll put it with the ſaffron in the matraſs, together with the orvietan and confection alkermes diſſolved in the diſtilled waters; then ſtop exactly the matraſs and place it in the horſe-dung, where the matter muſt be left in digeſtion for fifteen days; pouring afterwards the infuſion into a glaſs or ſtone cucurbite, and having adapted a capital to it with its recipient, lute exactly the joints and put in the pipe of the alembick four ſcruples of powder of diambra, tied in a piece of linen cloth, you'll diſtil the liquor in balneo mariæ.

Virtues.—This *elixir* is good againſt fainting fits, ſincope and the apoplexy.—The *doſe* is from two drachms to an ounce and a half.

Of OILS *in general.*

By the name *oil* is properly underſtood, the unctuous juice or fat ſubſtance extracted by expreſſion from *olives*; for *oleum*, which is the *Latin* name, comes from *olea*, or ἐλαία, which ſignifies *olive tree*, or *olive*: however, all fat and inflammable liquor, from what part ſoever it be extracted, is called *oil*; the greaſe of animals are but congealed *oils*, by the mixture of the volatile ſalts, and of a little phlegm. The fruits, berries, and ſeeds abound in *oil*; and generally all combuſtible matters are no otherwiſe inflammable but by means of the *oil* they contain.

OILS may be divided into natural and artificial. —The *natural* are, as the *liquid amber* and the *turpentine*, which come out through the inciſions made in trees; and the *petroleum* which run through the clefts of rocks. The *artificial* are all the *oils*, extracted by expreſſion, diſtillation, or infuſion.

I'll ſpeak only in this treatiſe of the oils uſed in *Galenical Medicines*; and deſcribe firſt, the *oils extracted by expreſſion*, and paſs afterwards to thoſe *prepared by infuſion*.

The OIL of OLIVES, which is the moſt common of thoſe extracted *by expreſſion*, is prepared in the following manner.

The *olives* are gather'd when they are ripe, *viz.* in the months of *November* and *December*; they are left to depurate of their watery humidity in ſome corner of the houſe, for ten or twelve days, where having heated themſelves, they are bruiſed afterwards under a mill-ſtone, and then put in frails of ruſhes or palm-trees, which being placed at the preſs, one over another, there comes out an oil by the ſingle compreſſion of the frails, which is called *virgin oil*, and is the beſt,

Next the *olives* are moiſten'd with warm water, to render the *oil* more fluid, and by preſſing them as hard as poſſible, a very good *oil* is extracted from them.

The ſqueezed *olives* are ſtirred, and having pour'd over them a great deal of warm water, more *oil* is extracted by a new expreſſion, which being full of fæces, is worſe than the two firſt: theſe *oils* ſwimming over the water, are eaſily ſeparated from it; but there is found precipitated at the bottom, a thick matter, which is what the antients called *amurca*.

There has never been ſuch a thing as the *omphacine oil*, prepared in the manner deſcribed by the antients; for they pretended that it was extracted by expreſſion from *green olives*, wherefore it was called *omphacium*, becauſe *green olives* have ſome reſemblance with *green grapes*, called in Latin *omphatium*, i. e. crude and aſtringent; for if *green olives* were bruiſed and ſtrained, nothing but a viſcous juice could be extracted from them. Thoſe that want to give to the common *oil*, the qualities attributed to the pretended *omphacine oil*, boil in it the ſummits of black berry buſhes, of oak, of lentiſc, of honey-ſuckles, and red roſes.

Old oil is commonly requir'd for plaiſters and unguents, becauſe having received ſome fermentation in its inſenſible parts, it becomes thereby more penetrating, and more emollient. It is alſo uſed for aliment, and in clyſters for the colick, the gripes, and the dyſenteria.

OILS *extracted by expreſſion.*

Oil of ſweet almonds.—Take what quantity you will of new and large almonds, ſeparated from their ſhells, rub them well in a coarſe and rough linen cloth (to cleanſe them of a red ſcurff faſten'd to the ſkin) till no more dirt comes off; pound thoſe almonds in a marble mortar, with a wooden peſtle, till they be reduced into a paſte; wrap that paſte in a ſack, or piece of ſtrong linen cloth, put the ſack to preſs between two thin plates of walnut-tree, and having placed underneath a pewter-diſh, or an earthen one glazed, preſs gently the matter at firſt, to make the *oil* run by degrees without burſting the cloth; but when ſome quantity of *oil* is come out, you must then press the matter as hard as you can; and you'll have a very good *oil of sweet almonds*, which must be kept in a bottle for use.

Virtues.—The *oil of sweet almonds* softens the acrimony of the trachæa, and of the breast, provokes the urine, appeases the pains of the nephritick, by facilitating the evacuation of the stone, gravel, or phlegm, from the reins or bladder; it is good for the after-pains of a lying-in woman, and for the gripes of new-born children.——The *dose* is from two drachms to an ounce and a half. It is used outwardly to soften the parts.

The common method is to blanch the almonds before they are pounded, to extract a finer and clear *oil*; but as it is impossible to blanch the almonds till after they have been put to sleep in hot water, they have been thereby impregnated with that water, which running along with the *oil* makes it grow rank if it be kept a little while. Several heat the pounded almonds before they press them, to extract more *oil*; but as the fire communicates always some disagreeable smell to *oils*, and render them more acid, it is much better to have a less quantity of oil, and good.

The *oil of walnuts* can be extracted in the same manner without fire; which oil is proper to appease the colick and the gripes. Ladies use it to cleanse their skin.

The *oil of bitter almonds* differs no otherwise from that of *sweet almonds*, than in that it is kept longer without growing rank.

The oils of the stones of fruits, and of seeds which contain a great deal of oil, are extracted in the manner of that of almonds; but when it is wanted to extract by expression the oil of a seed which is very little oleaginous, as is that of anis; or when the oil is naturally congealed, as in the nutmeg, the matter, after it has been well pounded, must be heated at the vapour of water or wine, then pressed hard.

Oils, *prepared by infusion, or decoction, or by a simple mixture.*

Oil of roses.——Take a pound and a half of red roses newly gathered, pound them well, and put them into a jug; and having poured on them three pounds of oil of olives, stop the jug, and expose it to the sun for seven or eight days; which elapsed, boil slightly the matter, and having strained it hard through a linen cloth, put the same quantity of red roses in the colature, and proceed to the maceration, coction, and expression as before; and having repeated the same operation a third time, you'll have the oil of roses, which must be kept in a pot for use.

Virtues.——The *oil of roses* strengthens and consolidates, in softening; it resolves the fluxions, temperates the heat of the reins, and of the head, by anointing the part with it hot.

Oleum liliorum compositum, mesvé. R. *Florum liliorum alborum* ℥ viij. *Mastiches, calami aromatici, costi, carpobalsami, āa* ℥ j. *Cinnamomi, caryophyllorum, āa* ʒ ss. *Croci* ʒ iij. *Olei dulcis* ij. lb. *Misceantur & macerentur per dies quadraginta, in vase obturato, deinde bulliant leviter, & exprimantur.*

Virtues.—This oil of white lilies is resolutive in heating; it is used for the pains of the stomach, of the breast, of the abdomen, in anointing the afflicted parts therewith: though this sort of oil is seldom used; the simple oil of white lilies, prepared in the manner of that of roses, being almost always substituted to it.

Oil of St. John's-wort composed.—Take a pound of summits of St. John's-wort, in flowers, newly gathered in their vigour, bruise them, put them in a jug, and pour over them two pounds of common oil, and three ounces of strong red wine; stop the jug, and place it in a warm place, or in balneo mariæ, where the matter must be left in digestion for twenty-four hours; boil afterwards slightly the infusion, strain it with expression, and having put in the colature as much flowers as before, proceed to the infusion, coction, and colature; repeating once more the same operation, except that the third time the infusion must boil longer, to procure the dissipation of the aqueous juice. After the oil has been strained for the last time it must be left to settle, and afterwards decanted gently, to separate the fæces; then you'll dissolve in it at a slow heat a pound of the best turpentine, and pour the oil while yet hot into a jug, to keep it for use.

Virtues.—The *oil of St. John's-wort* attenuates, is digestive and resolutive: it appeases the pains caused by a viscous humour; it is used to strengthen the nerves and the joints, and for the sciatica. It is an efficacious balsam to cure wounds.

Oleum croci. R. *Croci, calami aromatici, seminis carvi, āa* ℥ j. *Myrrhæ* ℥ ss.

Let the ingredients infuse together after they have been pounded in a pint of red wine for six days successively in a glazed earthen pot; then boil the infusion at a slow fire, with a pint and a half of common oil, to the entire consumption of the wine; which done, strain it and keep it for use.

Virtues.——This *oil of saffron* dissipates hardness, appeases the pains of the matrice and other parts; it strengthens the nerves by anointing the afflicted parts with it.

Oleum moschatum. R *Florum liliorum, folii indi, mastiches*

mastiches costi, *spicæ nardi*, *ãa* ℥ ss. *Ligni aloes*, *cassiæ ligneæ*, *myrrhæ*, *croci*, *styracis calamitæ*, *ãa* ʒ ij. *Bdellii*, *cubebarum*, *caryophyllorum*, *aa* ℈ jv, *Nucis moschatæ* ℈ ij. *Moschi* ℈ j. *Olei communis* ij. lb. *Vini generosi* lb ss.

All the drugs except the musk having been slightly pounded, must be put to infuse with the wine and oil for seven or eight days, in a glazed earthen pot, and boiled afterwards to almost the entire consumption of the wine; after which the liquor is strained and kept for use.

Virtues.——This *oil* is proper to strengthen the nerves, matrice, stomach, to expel wind, and to resolve coarse humours, by anointing the parts therewith.

Oleum carminativum reformatum. ℞. *Oleorum distillatorum seminis cymini*, ʒ ss. *Anisi*, ʒ ss. *Carvi*, ʒ j. *Arantiorum*, *chamomillæ*, *ana* ʒ ss.

All these oils must be mixed together in a vial, and the mixture kept for use.

Virtues.——This oil is proper to attenuate the viscosities, to expel winds, to appease the gripes and pains: it is used for the melancholicks.—The *dose* is from three drops to six. The region of the stomach, and of the navel, can also be anointed with it.

Oleum majoranæ. ℞. *Herbarum majoranæ*, *man.* iv. *Serpinæ*, *man.* ij. *Foliorum myrti vel baccarum*, *man.* j. *Abrotani*, *menthæ aquaticæ*, *ana man.* ss. *Olei communis*, lb. iij.

Let all these drugs macerate together for eight days, in a jug well stopp'd, and carried to a warm place; then boil the infusion, strain it by expression, and keep the colature for use.

Virtues—This oil of marjoram is resolutive, strengthens the brain, and the stomach, expels the wind, and worms; is good for the sciatica, and attenuates the viscosities, by anointing the afflicted parts therewith.

Oleum ranarum. Take ten or twelve frogs alive, cut them in pieces, and put them in a glazed earthen pot, pouring immediately upon them a pound and half of linseed oil; cover the pot very close, and place it in a boiling hot balneo mariæ, where it must be left seven or eight hours; strain afterwards the infusion, squeezing hard the frogs; leave the colature to settle, and decant it afterwards to depurate it of its fæces.

Virtues.—The oil of frogs softens, and temperates the inflammations, promotes sleep, being applied on the temples, and appeases the pains of the gout, by anointing the parts with it.

In the same manner can be made the oil of toads, of craw-fish, and other aquatick animals.

BALSAMS.

There is so great an affinity between *balsams* and *oils*, that they are often confounded together; and that the same liquor is sometimes called *balsam*, and sometimes *oil*; though there is notwithstanding this difference, that the *balsams* have generally more consistence than the *oils*.

BALSAMS are divided into natural and artificial. *Natural balsams* are those which come out of trees, thro' incisions made in them, as the *balsam capayba*, or *capivi*, of *Peru*, &c.—*Artificial balsams* are those prepared by Chymistry, and Pharmacy; which balsams are composed of oils and essences, gums, wax, rosine, powder; according to the different virtues to be given to them: there are balsams prepared for wounds, to preserve dead bodies, to strengthen, and rejoice the brain, the heart and the stomach, to resist venom, for the wounds of the breast, and to perfume.

The BALSAM of *arceus* is made (when a considerable quantity is wanted) with two pounds of tallow of goats, *Venice* turpentine, and gum elemi, a pound and a half of each; and a pound of hog's-lard. To the gum elemi, cut into small pieces, and liquify'd on a slow fire, are added the turpentine, goat's tallow, and hog's lard; when these are well dissolv'd, they must be strain'd thro' a piece of new linen cloth, to separate the dregs; the whole must be left to cool, and the balsam is made.

This balsam is incarnative, and consolidates all sorts of wounds and ulcers; 'tis used for the fractures and luxations of the bones, to cure contusions, and the wounds of the nerves.

To make the *Samaritan balsam*, you must take equal parts of oil of olives and good wine, which must be boil'd in a glaz'd earthen pot till the wine be entirely consumed. This balsam mundifies and consolidates simple wounds, especially when they are fresh

The *Spanish balsam* is made by taking wheat, roots of valerian, and carduus benedictus, an ounce of each; all which must be well pounded, and put afterwards, with a pint of white wine, in a glaz'd earthen vessel, narrow a-top, which must be well stopp'd, and placed on hot embers during 24 hours, adding to it afterwards six ounces of St John's-wort, making the whole boil to the consumption of the wine; after which, 'tis strain'd, and a new addition made to it, afterwards, of two ounces of olibanum, in powder, and eight ounces of *Venice* turpentine; which, after it has been mix'd together over a slow fire, the balsam is made.

This balsam was always used by *Aquapendente*; 'tis excellent for all sorts of wounds, even the nervous, which, 'tis said, it will cure in 24 hours. The wound must be washed first with cold white wine,

wine, and then anointed with this balfam hot. If the wound was deep this fame balfam, alfo made hot, muft be fpring'd into it, approaching afterwards the edges of the wound near one another, and anointing them with it. On the wound muft be put a comprefs dipp'd in the balfam, and another over it, dipp'd in ftrong wine, and over this another dry comprefs.

To make the green balfam, you muft take equal parts of linfeed oil, and oil of olives, *viz.* a pound of each, an ounce of oil of bays, two ounces of *Venice* turpentine, half an ounce of diftill'd oil of juniper-berries, three drachms of verdigreafe, two drachms of the beft aloe, two drachms and a half of white vitriol, and a drachm of oil of cloves. The oils of linfeed and olives muft be put together in a frying pan, over a very flow fire, and then muft be incorporated with the turpentine and oil of bays; after which, the pan having been taken off the fire, and the mixture left to cool, there muft be mixed with it, by degrees, the verdigreafe, white vitriol, and aloes, very well pounded; adding to it the oils of cloves and juniper-berries; and the balfam is made.

This balfam is very good for all forts of wounds made either with iron, or fire-arms. The wound muft be wafhed with hot wine, and afterwards anointed with this balfam hot; applying to it pledgets imbib'd with it, and over it a large pledget dipp'd in fome ftyptick liquor. This balfam mundifies, incarnates, and cicatrizes the wound; 'tis good againft the bite of venomous beafts, fiftulous, and malignant ulcers.

Balfamum vulgare. R *Terebinthinæ Venetæ* lb. j. *Gummi elemi* ℥ iv. *Refinæ pini* ℥ ij. *Ariftolochiæ longæ* ℥ i fs. *Sanguinis draconis* ʒ ij.

The dragon's blood and ariftoloche muft be pounded each feparately, and the gum elemi and refine melted with the turpentine over a very flow fire; then the whole mixture is ftrained through a linen cloth to feparate the dirt; and the powders having been mixed with the colature, the mixture muft be kept for ufe.

Virtues.—This balfam is proper for wounds, and old and new ulcers, it cleanfes them, renews the flefh, ftrengthens the nerves, and is good for the diflocations.

Balsam, to make children cut their teeth eafy.—Take three ounces of frefh butter without falt; hen's and duck's greafe, of each two ounces; and an ounce of flowers of wild red poppies, mix together in a glazed earthen pot the frefh butter, the greafe, and the flowers, with the mucilage of roots of althæa, and the juice of craw-fifh, of each two ounces; cover the pot, and place it over a little fire, to make the matter boil gently to the confumption of the watery humidity; ftrain the liquor, and mix with the colature four ounces of white fugar-candy, a fcruple of troches of gallia mofchata reduced into powder, and the yolk of an egg, to make a *balfam* which muft be kept for ufe.

Virtues——This balfam is ufed to foften the gums of little children, by rubbing them often with it; whereby they cut their teeth eafy.

To extract the juice of craw-fifh, you muft bruife five or fix of them in a marble mortar, humecting them with water of borage, and carrying them afterwards to the prefs.

Balfamum Balfaminæ. R *Florum, foliorum, & fructuum balfaminæ,* ℥ iv. *Radicum confolidæ majoris, ophyoglofſi, ariftolochiæ rotundæ, valerianæ majoris, ana* ℥ ij. *Vifci in folliculis, ulmi reperti, fucci cancrorum fluviatilium, foliorum pervincæ & faniculæ, fummitatum floridarum hyperici, galli lutei, ana* ℥ j fs. *Olei olivarum* ℔ iv.

Bruife the leaves, flowers, and mifletoe of elm, and put them together in a glazed earthen pot, pouring over them the oil, and the juice of crawfifh; cover the pot and place it in the fun, where the matter muft be left 12 days in digeftion; boiling afterwards the infufion over a flow fire to the confumption of the wine; ftraining the decoction by expreffion; and after the oil has been left to fettle, you muft pour it by inclination to feparate it from its fæces, and then mix with it half a pound of diftilled oil of varnifh, to make a balfam, which is to be kept for ufe.

Virtues.——This balfam is thought excellent to ftrengthen the nerves, for wounds, burns, the piles, and fore breaft.

Balfamum ftypticum, A. Mynficht. R. *Amplaftri ftyptici, A Mynficht,* ℥ iv. *Olei vitellorum ovorum, q. f. fiat balfamum, cui adde oleorum nucis mofchatæ, caryophyllorum, falviæ, ana* ℈.

You'll melt gently in an earthen difh four ounces of the ftyptick plaifter of *A. Mynficht*, mixing with it, about as much oil of eggs as is neceffary to give it the confiftence of an unguent; and when cool, add to it the oils of nutmeg melted, of cloves, and of fage, making of the whole a balfam to be kept for ufe.

Virtues.—This balfam ftrengthens the ftomach, and the abdomen, it helps digeftion, ftops vomiting, and hæmorrhages, by anointing the ftomach, the abdomen, and other afflicted parts with it.

Balfamum fulphuris fimplex.—Take three ounces of flowers of fulphur, put it in a matrafs, and pour over it eight ounces of fpirit of turpentine, and having ftopped the matrafs, and fhaken it well, place it in digeftion at a flow fand-heat for five or fix hours, or till the oil is grown red; then pour out the tincture by inclination, and keep it: which tincture is the balsam of sulphur.

Virtues.—This balsam is proper to cleanse the ulcers of the lungs and of the breast, it helps respiration, and is given to asthmaticks.—The *dose* is from a drop to six.

Balsamum sulphuris annisatum.——Put an ounce and a half of flower of sulphur in a matrass, pour upon it half a pound of oil of anniseed, stop the matrass, and place it in a sand heat, where the matter must be left in digestion till the flower of sulphur be almost entirely dissolved, and the oil has acquired a red colour, which commonly happens in nine or ten hours; and after the balsam has been left to settle, it must be decanted to separate it from its fæces.

Virtues.——This balsam is good for the ulcers of the breast, and of the lungs, for the asthma, the indigestions of the stomach, and the windy colick.—The *dose* is from three drops to twelve.

Balsamum Lucatelli. ℞ *Olei olivarum, terebinthinæ Venetæ in aqua rosarum ad albedinem, lotæ, ana* ℔ j ſs. *Ceræ citrinæ,* ℔ j. *Santali rubri subtiliter pulverizati,* ℥ ij.

Put in a glazed earthen pot the oil of olives, and eight or nine ounces of canary-wine, place the pot in a boiling hot balneo mariæ, where having been left till the wine be entirely consumed, strain the oil afterwards, and having melted in it over the fire, the wax, and the turpentine, take the matter off the fire, and when almost cold, mix with it the red sanders, reduced into a very subtle powder, to make a balsam which must be kept for use.

Virtues.—The *Lucatellus balsam* is detersive, proper to consolidate green wounds, and to strengthen the nerves.

Balsamum anodynum vel podagricum, Georgi Batei. ℞ *Saponis,* ℥ j. *Camphoræ,* ʒ vj. *Opii,* ℥ ſs. *Croci,* ʒ j. *Spiritus vini rectificati,* ℥ xviij.

The soap must be rasped, the opium cut in small pieces, the camphire bruised, and all the drugs put in a matrass with the spirit of wine; stopping afterwards the vessel, and placing it in digestion on the hot sand, or at some other gentle heat, where it must be left ten days, shaking it from time to time, to facilitate the dissolution of the ingredients; the ten days elapsed, the infusion shall be strained through a flannel, and kept: which colature is the *anodyne balsam.*

Virtues ——This balsam appeases the most excruciating pains, being applied on the part with a piece of linen cloth dipped in it, and renewing it every four hours, till the pain be entirely ceased. It is used for the rheumatism and the gout; it is also taken inwardly from 30 to 50 drops in wine.

The principal quality of this balsam proceeds from the opium.

Balsamum antipodagricum, Phil. Mulleri. ℞. *Mastiches, olibani, myrrhæ, bdellii, gummi ammoniaci, opoponacis, mumiæ, ana* ℥ ij. *Tartari,* ʒ j ſs. *Vitrioli,* ℔ j. *Mellis,* ℔ ij. *Aquæ vitæ,* ℔ iv.

The gums must be coarsely pounded together; and the tartar, and vitriol together, putting afterwards all the powders with the honey and brandy in a large glass or stone cucurbite, stopping the vessel, and leaving it in digestion, in a warm place, for eight days successively; which elapsed, the cucurbite is unstopped, a capital and receiver adapted to it, the joints luted, and the liquor distilled by a graduate fire; keeping the liquor for use, which is the balsam for the gout.

Virtues.—This balsam is excellent for the pains of the gout, and of the rheumatism; a piece of flannel is dipped in it, and applied on the afflicted part.

Balsamum mirabile, Fulleri. ℞ *Thuris* ℥ ij. *Mastiches, caryophyllorum, galangæ, macis, cubebarum, ana* ℥ ſs. *Ligni aloes* ʒ j.

All the drugs must be very well pounded, and having been mixed with the honey and turpentine, the whole mixture must be put in a cucurbite, pouring upon it spirit of wine to the height of two or three fingers, distilling the whole in balneo mariæ, till the liquor appears red; and continuing the fire to extract the balsam, which must be rectified.

Virtues.——This *balsam* is good to cure all sorts of wounds, for old ulcers, cancers, fistula's, and the maladies of the eyes.——The *dose* inwardly is from five drops to ten.

UNGUENTS.

The name of *unguent* derives from the Latin *ungere*, to anoint, and as we anoint with oils as well as *unguents*, the antients called *unguents* the aromatick oils the joints were rubbed with, and those who sold them were called *unguentarii*; but we understand at present by *unguents*, certain compositions of grease, oil, wax, powder, to which are most commonly given consistences much like that of grease.

Liniment comes from the *Latin* word *linire*, to anoint gently; what we call in Latin *linimentum* or *litus*, is a mixture of *unguents*, or of wax and oil of a consistence thicker than oil, but less thick than the *unguent*; it is commonly used to mollify and soften, by rubbing the tenderest parts, as the breast, &c. with it.

The *cerata*, borrow their name from the wax which enter their composition, called in Latin *cera*. Antiently the *cerata* had a more solid consistence than the *unguent*, and softer than the plaister, but at present there is no rule observed with regard to that; for they are sometimes made as soft as *unguents*,

guents, sometimes more liquid, and sometimes harder: they consist of the same drugs the *unguents* are composed of; and we give sometimes the name of *cerat* to compositions where there is no wax; and as there is so little difference between *unguents*, *liniments*, and *cerata*, I'll place them all three under the same article, and not without reason, since it is very well known that to give a consistence to these three compositions, one borrows in part the matter of the *unguent*, which serves here as a medium, and that the oils are the common basis of them all.

Unguentum rosatum. ℞ *Axungiæ porci recentis, purgatæ & sæpius lotæ, rosarum pallidarum recentium contusarum, ana* ℔ vj.

The hog's lard must be new, freed of all its skins, and washed several times in water; and six pounds thereof having been put into an earthen pot, with an equal weight of pale roses newly gathered separated from their calice, and pounded in a marble mortar, and both ingredients well mixed together, the pot is to be covered and placed in digestion at the sun for seven days, stirring the matter from time to time with a wooden spatula; the seven days elapsed, the infusion is put to boil for an hour or two over a small fire, and afterwards strained with a strong expression, putting into the colature as much roses as before; and having left the matter in digestion for seven days more, it must be strained by expression, and the colature is the *unguent of roses*, which must be kept for use. To make it red, add two ounces of the roots of orcanette steeped in the unguent while hot, for four or five hours.

Virtues.—The *unguent of roses* is esteemed proper to resolve and soften; it is used for the hæmorrhoids, the inflammations, and the pains of the joints.

Most Dispensaries require red roses for the composition of this *unguent*, but the Apothecaries wanting to render their *unguent* odorous, employ pale roses, which have a much stronger and agreeable smell; they are besides more resolutive, and more capable to produce the effects expected from the *unguent of roses*.

Unguentum album, seu de cerusa. ℞ *Olei rosati*, ℔ ij. *Ceræ albæ*, ℔ ss. *Cerusæ Venetæ*, ℥ viij. *Camphoræ*, ℥ j.

The white wax must be broken into small pieces, and melted in the oil of roses at a slow fire, mixing with it afterwards with a wooden spatula, the cerus, which has been reduced before into a very subtile powder, and lastly the camphire dissolved in some oil of roses, stirring the *unguent* till the ingredients be very well incorporated together, and keeping the *unguent* for use.

Virtues.—This *unguent* is proper to dry, and cure burns, for the itch, the itching of the skin, and slight wounds.

The Apothecaries employ most commonly oil, and often a stinking sort, in the preparation of this *unguent*, which renders the smell thereof very offensive.

Unguentum mundificativum, Nic. l'Emery. ℞ *Axungiæ porci, terebinthinæ, ana* ℥ viij. *Butyri recentis, olei hyperici, unguenti populei, ana* ℥ iv. *Olei laurini, viridis æris, ana* ℥ iij. *Vitrioli albi*, ℥ iv. *Boracis, realgal, aut arsenici rubri, ana* ʒ ij.

Pound and mix together the verdigrease, white vitriol, borax, and realgal; melt together over a small fire, in a bason, the hog's lard, fresh butter, and populeum; add to it, when off the fire, the turpentine and oil; and when the mixture is almost cold, mix exactly with it the powders, stirring the whole mixture for some time with a wooden spatula; and keep the unguent for use.

Virtues.—This unguent is a powerful detersive; it dries the wounds, consumes the slimy flesh, and resists the gangrene: it may be applied with pledgets on old ulcers, and scrophulous tumours, when open.

Unguentum Neapolitanum simplex. ℞ *Argenti vivi* ℥ vi. ss. *Terebinthinæ Venetæ* ℥ iv. *Axungiæ suillæ* ℔ iv.

The quicksilver must be stired hard with the turpentine for six hours, in a large brass mortar, till it be entirely extinguished, mixing with it by degrees afterwards, the hog's lard to make an *unguent* to be kept for use.

Virtues——This unguent is proper for the itch, ringworms, and other itching of the skin: it kills the lice, fleas, bugs, and crab lice, by anointing the parts of the body with it, forbearing to anoint the breast and stomach, where it could cause some alteration, because of the quicksilver which enters into it. The bedsteads are rubbed with it to kill the bugs.

This preparation of *unguent* is too weak to excite a salivation; though it is proper to examine the constitution of those, on whom it is employ'd; for if they are weak and easy to be moved, it could excite in them a slight one. To each ounce of *unguent* there is a drachm of quicksilver.

A *Pomatum for the itch.*——Mix together four ounces of hog's lard, washed several times, and half an ounce of white precipitate of mercury, for a pomatum.

Unguentum Neapolitanum quadruplicatum mercurio. ℞ *Axungiæ suillæ* ℔ ij. *Argenti vivi* ℥ iv. *Terebinthinæ claræ* ℥ iv. *Olei laurini* ℥ ij. *de spica, styracis liquidæ ana* ℥ j.

The quicksilver must be stirred hard in a large brass mortar with the turpentine, the liquid storax, and ar. … twelve hours, or till it be … ent … d. and mixing afterwards by degre … with it, for an *unguent* to be kept for …

Virtue. … This *unguent* is proper to excite ſalivation, a … to cure the pox, by anointing gradually the fee … the legs, thighs, lower abdomen, back bone, neck, arms, and hands, as explained at large in the articles of *Chymiſtry* and *Surgery*.

Unguentum enulatum. ℞ *Radicis enulæ campanæ* ℔ ſs. *Argenti vivi, terebinthinæ claræ, olei abſinthii, ana* ℥ iij. *Axungiæ ſuillæ* ℔ ij. *fiat unguentum*, S. A.

Virtues.—This *unguent* is proper for the itch, tingworms, and for other itchings of the ſkin.

Unguentum contra vermes. ℞ *Olei abſinthii* ℔ ſs. *Succorum foliorum perſicarum, tanaceti, ana* ℥ j. *Ceræ* ℥ j ſs. *Aloes* ℥ ij. ſs. *Centaurii minoris, corallinæ, ſeminis contra vermes, ana* ʒ j. ſs. *f. unguentum*, S. A.

Virtues.——This *unguent* is proper to kill the worms, by anointing the navel with it.

If a drachm of mercurius dulcis was added to this compoſition, the *unguent* would ſtill be more efficacious.

Unguentum de rapis pro pernionibus. ℞ *Olei raparum* ℥ iv. *Reſinæ pini, ceræ flavæ, terebinthinæ, pinguedinis arietis, ana* ℥ j.

You'll put to melt together over a moderate fire, in the oil of radiſhes, or turnip-ſeeds, extracted by expreſſion, the turpentine, mutton-fat, and roſin, ſtirring the matter till cold, which is the *ungent of radiſh*.

Virtues.—This unguent is proper for chilbains.

The oil of hen-bane is better for chilbains than that of radiſh.

Unguentum anodinum ad hemorrhoides. ℞ *Oleorum roſati & violati, ana* ℥ iij. *Ceræ* ℥ j ſs. *Amyli, lythargyri præparati, tragacanthi, ana* ʒ iij. *Caphuræ, opii, ana* ℈ ij. *Albumina ovorum*, No. ij.

The litharge and ſtarch muſt be pounded together, the gum tragacanth by itſelf in a mortar warm; the opium bruiſed in a mortar, and pulverizing it with a little of the other powder, melting afterwards the wax cut in ſmall pieces, in the oil, and mixing the powders with it off the fire; and the unguent being cold, the whites of eggs, and the camphire diſſolved in a little oil of roſes muſt be incorporated with it, to make of the whole an *unguent* to be kept for uſe.

Virtues.——This *unguent* is proper to ſoften and dry, it appeaſes the pains, and temperates the inflammations; it is applied on the hæmorrhoides.

Unguent for burns of A Mynſicht.——Take two ounces of whites of eggs, and an ounce of oil of olives; mix the whites of new-laid eggs, and the oil in an earthen diſh, ſtir them well together with a wooden ſpatula, till they be well mixed, and are formed into an unguent or nutritum.

Virtues.—This *unguent* is excellent for burns; the Author orders to anoint the burnt part with it ſeveral times a day, without applying any cloth over it, till the cruſt formed on the top falls of itſelf.

Another *Unguent for burns.*——Crumble four ounces of horſe-dung newly voided, and mix with it one pound of hog's lard in a frying pan; fry that mixture over a moderate fire about a quarter of an hour, ſtirring the matter all the while with a ſpatula, and ſtraining it afterwards while hot, by a ſtrong expreſſion; the colature is the *unguent*.

Virtues.—This *unguent* is excellent for all ſorts of burns, by applying it upon them with a piece of brown paper.

Unguentum ad facilitandum partum. ℞ *Axungiæ gallinæ* ʒ vj. *Porci*, ℥ ij. *Butyri recentis, olei irini, ana* ℥ j. *Trochiſcorum de myrrha*, ℥ ſs. *Radicis Ariſtolochiæ rotundæ*, ʒ ij. *Cinnamomi, ſtyracis, ana* ʒ j.

The oil, greaſe, and butter, muſt be liquified together over a little fire; mixing afterwards in it the other drugs reduced into a ſubtile powder, ſtirring the mixture with a wooden ſpatula, till the unguent be cold.

Virtues.—This unguent is proper to facilitate a delivery, and to expel the after-birth, by anointing the lower belly with it, in the region of the abdomen, and in the vagina, when the woman is in labour.

Unguentum de terebinthina. ℞ *Terebinthinæ claræ*, ℥ j. *Maſtiches, myrrhæ, olibani, ana* ʒ ſs. *Vitellos ovorum*, No. iij.

The myrrh, olibanum, and maſtich, muſt be well pounded together, and mixed afterwards with the turpentine, and having added to it the whites of eggs, the mixture muſt be ſtirred with a wooden ſpatula, and the unguent, which is digeſtive, kept for uſe.

Virtues.—This unguent diſpoſes the matters for ſuppuration; it is applied in wounds, newly made, on pledgets, and tents are anointed with it.

An unguent to make the hairs grow.—Take four ounces of bear's greaſe; an ounce and half of laudanum; an ounce of honey; of dried abrotanum, and balſam of *Peru*, of each ſix drachms; three drachms of dried roots of ruſhes, and two drachms of the oil of nutmegs; pound together the roots of ruſhes, and the abrotanum; and the laudanum by itſelf; melt together the bear's greaſe, balſam of *Peru*, and the oil of nutmegs, by a ſlow fire, then mix the powders with it, and laſtly the honey, to make an unguent.

Virtues.—This unguent is proper to make the hairs grow, either by anointing the head with it or the teeth of the comb.

Liniments.

A *liniment for the piles.*—Take of the pulp of millepedes, unguentum populeum, oil of eggs, of each an ounce; and half a drachm of extract of opium.

You'll pound the millepedes alive, in a marble or stone mortar, and strain them afterwards through a sieve turned upside down, to extract the pulp thereof; then you'll mix this pulp with the unguent populeum, and the oil of eggs, stirring the whole mixture a long while together in a mortar, to make a liniment.

Virtues.—This liniment is proper to appease the pains of the piles, being applied upon them

Another *liniment for the piles.*——Take two drachms of flower of sulphur, half an ounce of oil of eggs, and an ounce of oil of roses; mix these drugs together for a liniment, which must be applied on the piles.

Aliud linimentum. ℞ *Salis saturni*, ℥ ſs. *Oleorum chamomillæ & rosati, ſucci umbilici veneris, ana* ℥ ij. *fiat ex arte linimentum ad formam nutriti.*

Linimentum aliud. ℞ *Olei lini, pulpæ cepæ ſub cineribus coctæ, ana* ℥ ij. *Ceræ albæ*, ℥ ſs. *Miſce & fiat ex arte linimentum.*

All these different liniments are very proper to appease the pains of the piles.

A *linament to hinder the face from being scarred by the small-pox.*——Take cerufs, and prepared litharge of gold, of each a drachm; the oils of the four large cold seeds, of sweet almonds, and of eggs, of each half an ounce.

Put in a brass mortar the litharge and cerufs, and mix with it by degrees the oils, and about six drachms of the waters of plantain and of solanum, nourishing and agitating the matter, to make of it a nutritum, which must be kept for use.

Virtues.—This liniment is proper to take off the cicatrices, and fill up the pits left by the small-pox on the skin; by anointing the face, neck, and hands with it, when the small-pox begins to dry.

Cerats.

A *Cerat* should never be made but in a small quantity; since, as it grows old, it loses its virtue.

Ceratum polychreſtum. ℞ *Olei olivarum*, ℔ j. *Lithargyri ſubtiliſſimè pulverizati*, ℥ iv. ſs. *Ceræ novæ*, ℥ j. ſs. *Terebenthinæ claræ, thuris, ana* ℥ j. *Gummi ammoniaci, bdellii, ana* ʒ vj. *Galbani, opoponacis, ana* ℥ ſs. *Myrrhæ, lapidis calaminaris, ariſtolochiæ longæ & rotundæ, ana* ℥ ij.

The aristoloches having been pounded together; the myrrh, bdellium, frankincense, galbanum, and opoponax together; and the litharge, and lapis calaminaris, together; put these two drugs to boil together in a sufficient quantity of water, stirring continually the water with a wooden spatula, till it has acquired the consistence of unguent, mixing then with it the gums reduced into powder, and the wax, which will melt in it in a very short time; then take the vessel off the fire, and when the cerat will be half cold, mix exactly with it the turpentine, and the powders of aristoloche, to make a cerat, which is to be kept for use.

Virtues.——This cerat is emollient, digestive, suppurative, and employ'd to cicatrise wounds.—It is called *polycrest*, because it can serve for several uses.

Cera'um barbarum, Galeni. ℞ *Terebenthinæ, ceræ, reſinæ pini, bituminis judaici, ana* ℔ ſs. *Olei*, lb. viij. *Lithargyri*, ʒ v. *Ceruſæ, æruginis, ana* ʒ ij. ſs. *Opoponacis*, ʒ j. ſs

The pitches and wax must be melted in the oil; and the bitumen judaicum, the litharge, cerufs, verdigrease, and opoponax, having been reduced into a subtle powder. they shall be mixed in the melted matter in proportion as it grows cold, to make a cerat, which must be kept for use.

Virtues.—This cerat is very proper for what is called green wounds, for the scirrhe's, and the gout; it is detersive, emollient, resolutive, and cicatrises wounds.

Ceratum diapyritis, Galeni, reformatum. ℞ *Olei veteris*, ℔ ij. *Ceræ citrinæ*, ℥ iij. ſs. *Terebinthinæ, pyritis præparati, ana* ℥ iij. ʒ j. *Bituminis judaici, lithargyri, ana* ℥ ij. ſs. *Aluminis*, ʒ xv. *Reſinæ, gummi ammoniaci, ana* ℥ j. ſs. *Galbani, aloes, ana* ℥ j. *Æruginis æris, thuris, ana* ʒ v. *fiat ceratum, S. A.*

Virtues.——This cerat is proper for inveterate ulcers, and fistula's, it is detersive, emollient, and resolutive.

Plaisters.

The antient *Greeks* called plaisters *emplaſta*, of the *Greek* verb ἐμπλάττειν, which signifies to form in a mass, to wrap, to stop; but the modern *Greeks* have pronounced *emplaſtra*, and the *Latins* have followed them.

Plaiſter is the most solid composition of all those which are applied outwardly; it was invented of that consistence, that remaining longer fastened on the parts of the body, the remedies it is composed of should have time enough to produce their effects. The drugs used to give a body or consistence to *plaiſters*, are most commonly *wax, roſin, pitch, gum, greaſe, litharge*, and other preparations of lead; which being sulphurous, is easily dissolved in boiling with the grease and oils, which are sulphurs, and gives them a hard consistence.

Emplaſtrum

Emplastrum diachylon album, seu simplex. ℞ *Olei communis* ℔ iij. *Lithargyri auri præparati* ℔ j ſs. *Mucilaginum radicis althææ, fænugreci, & lini, ana* ℔ j.

Three ounces of roots of marſh-mallows newly gathered muſt be cut in ſmall pieces, and put in a glazed earthen pot with two ounces of fœnugreek and lin-ſeeds, and having poured upon thoſe ingredients ſix or ſeven pounds of hot water, the matter muſt be left in digeſtion till the next day, and then put to boil gently, till the liquor becomes thick and mucilaginous, is ſtrained by expreſſion, and mixed afterwards with the oil and litharge in a baſon, and the baſon placed over a pretty ſtrong fire, where the matter muſt boil, ſtirring it continually with a wooden ſpatula, till it has acquired the hardneſs of plaiſter, and the whole watery humidity be conſumed, which will be known at the matter having done boiling; you'll take then the baſon off the fire, and continue ſtirring till it be half cold, and fit therefore to be formed into magdaleons.

Virtues.——This *plaiſter* is proper to ſoften, to digeſt, ripen and reſolve.

Emplastrum diachylon de gummis. ℞ *Maſſæ diachyli ſimplicis,* ℔ iv. *Gummi ammoniaci, galbani, bdellii, & ſagapeni, ana* ℥ j.

The common method is to diſſolve the gums in wine, or vinegar, over a moderate fire, to ſtrain the diſſolution, and thicken the colature about the ſame ſize, to the conſiſtence of plaiſter; but as by that manner of operating the moſt eſſential of the gums is evaporated, I would adviſe to endeavour, as much as poſſible, to reduce the gums into powder; which may be done, if after they have been well choſen, they are put to dry in the ſun, or at a ſlow fire, before they are put in the mortar.

The preparation of this plaiſter is eaſy, in whatever manner the gums be prepared; for nothing elſe is to be done, but to melt the diachylon over a moderate fire, and mix the gums with it; if the gums have been diſſolved, they muſt be put to melt with the plaiſters; but if they be in powder, they are not to be be mixed till the plaiſter is half cold, to avoid its being lumpy.

Virtues.—The *diachylon of the gums* is the moſt powerful of all diachylons, to digeſt, ripen, and reſolve.

Emplastrum de meliloto reformatum. ℞ *Florum meliloti ſiccatorum* ℥ iij. *Radicis iridis, ſeminis fænugræci, foliorum abſinthii ſiccatorum, gummi ammoniaci, myrrhæ, ana* ℥ j. *Radicum cyperi, althææ, nardi celticæ, baccarum lauri, florum chamomillæ croci. ana* ℥ ſs. *Ceræ citrinæ, reſinæ, picis albæ, ſevi hircini, ana* lb. j. *Terebinthinæ claræ* ℥ ix.

The flowers, herbs, roots, ſeeds and berries, muſt be pounded together, the ſaffron by itſelf, after it has been dried between two papers; and the gum ammoniack and myrrh together; mixing afterwards, all theſe powders together, and putting to melt in a baſon, over a little fire, the wax; roſin, pitch, the fat of rams, with the turpentine, and having ſtrained the matter through a cloth, you'll mix the powders in it, when half cold, to make a plaiſter, which muſt be formed into magdaleons.

Virtues,——This plaiſter is emollient, reſolutive, and expels wind.

Emplastrum de minio ſimplex. ℞ *Minii* lb j ſs. *Olei roſarum* lb iij. *Aquæ communis q. ſ.*

The minium muſt be well pounded, and mixed afterwards in a baſon with the oil, and about two pints of water, making the mixture to boil very faſt over the fire, and ſtirring it continually with a wooden ſpatula, till it has acquired the conſiſtence of a plaiſter; and if there was not water enough to finiſh the coction, more ſhould be added to it.

Virtues.—The plaiſter of minium is deſiccative, and proper to cicatriſe wounds.

Some mix eight ounces of yellow wax in this plaiſter, and uſe it then to expel the milk from the breaſts, by applying it upon them.

Emplastrum cephalicum, aut pro commiſſura, aut ſtephainæon. ℞ *Gummi hederæ, tacamahacæ, ſtyracis, benzoini, maſtiches, olibani, labdani, ana* ℥ ij. *Cinnamomi, terebenthinæ venetæ, ana* ℥ j. *Caryophyllorum, & nucis moſchatæ, ana* ℥ ſs.

The gums and laudanum muſt be pounded together, the cloves and nutmeg together, and the cinnamon by itſelf, putting afterwards all thoſe powders together in a braſs mortar, and incorporating them with the turpentine, and with liquid ſterax, enough to give to the mixture a conſiſtence of plaiſter; ſtirring that mixture a long while to mix and incorporate well the ingredients together.

Virtues.—This plaiſter is excellent to ſtrengthen the brain, to rarefy and diſſipate the too coarſe pituita; it is uſed in the epilepſy and lethargy, being applied on the coronal ſuture.

Emplastrum regium ad herniam. ℞ *Picis navalis,* j. lb. *Ceræ flavæ, terebinthinæ claræ, ana* ℥ iv. *Radicis conſolidæ majoris ſiccæ, maſtiches, ana* ℥ ij. *Labdani,* ℥ j. ſs. *Hypociſtidos, terræ ſigillatæ, ana* ℥ ſs. *Nuces cupreſſi,* No. xij. *Fiat emplaſtrum. S. A.*

Virtues.—This plaiſter is excellent for the ruptures, it ſtrengthens the peritoneum, after the inteſtine has been reduced into its place, by applying it on the place of the relaxation, keeping it firm by means of a bandage, and renewing it every tenth day.

Emplastrum de ſpermate ceti. A. Mynſicht. ℞

Ceræ albæ, ℥ iv. *Spermatis ceti*, ℥ ij. *Galbani in aceto diſſoluti, trajecti, & cocti*, ℥ j.

The white wax cut in ſmall pieces, with the purified galbanum, muſt be melted in a glazed earthen porringer, over a little fire, mixing with it afterwards the ſperma ceti, to make a plaiſter, which muſt be kept for uſe.

Virtues.—The plaiſter of ſperma ceti appeaſes the fury of the milk of women newly deliver'd, it hinders it from knotting in the breaſts, and diſſolves it when knotted, it is alſo emollient, and reſolves the ſcrophulous tumours.

Emplaſtrum ſtipticum crollii reformatum. ℞ *Litbargyri præparati*, ℔ j. ſs. *Lapidis calaminaris*, ℔ ſs *Oleorum lini, olivarum, ana* ℔ j. ſs. *Laurini*, ℔ j. *Decocti radicis ariſtolochiæ, q. ſ. Coquantur ex arte ad emplaſtri ſpiſſitudinem, deinde adde, ceræ flavæ, colophoniæ, ana* ℔ j. *Terebinthinæ, vernicis, ana* ℔ ſs. *Opoponacis, ſagapeni, galbani, bdellii, ammoniaci, ana* ℥ iij. *Lapidis hematitis* ℥ ij. ſs. *Olibani, myrrhæ, aloes, ſuccini, ariſtolochiæ longæ, & rotundæ, ana* ℥ j. ſs. *Mumiæ, ſanguinis draconis, terræ ſigillatæ, vitrioli albi, camphoræ, ana* ℥ j. *Florum antimonii*, ℥ ſs. *Fiat emplaſtrum, S. A.*

As the camphire is very volatile, it muſt not be mixed till the plaiſter is almoſt cold.

Virtues.—This plaiſter is proper for wounds made with a ſmall ſword, for prickings, and bites and for all other wounds and ulcers; it digeſts, ripens, mundifies, cicatriſes, and reſolves; it ſtrengthens the nerves, and reſiſts the malignity.

Emplaſtrum baſilicum majus. ℞ *Ceræ albæ, reſinæ pini, ſevi vaccini, picis nigræ, & burgundiæ, terebinthinæ, thuris, myrrhæ, ana* ℥ j. *Olei communis, q. ſ.*

The myrrh muſt be reduced into a ſubtile powder, and having put all the other drugs to melt with about an ounce of common oil, the melted matter muſt be ſtrained, and the myrrh mixed with the colature to make a plaiſter, which muſt be kept for uſe.

Virtues.—This plaiſter helps ſuppuration, agglutinates wounds and cures them.

Emplaſtrum quatuor gummium. ℞ *Gummi ammoniaci, ſagapeni, galbani, opoponacis, ana* ℔. *Colophoniæ* ℔ ſs.

The gums muſt be diſſolved in vinegar over a little fire, the diſſolution ſtrained through a flannel with a hard expreſſion, and put to thicken to a ſolid conſiſtence; mixing afterwards with it the colophon, to make a plaiſter, which muſt be kept for uſe.

Virtues.—This plaiſter is emollient, ſuppurative, and reſolutive.

Emplaſtrum ad ganglia M. Charas. ℞ *Gummi ammoniaci, galbani, opoponacis, ſagapeni, myrrhæ electæ, ana* ℥ iij. *Olei laurini* ℥ j. *Sulphuris vivi, vitrioli Romani, ſalis ammoniaci, ana* ℥ ſs. *Euphorbii* ʒ ij.

The gums ammoniack, galbanum, opoponax, and ſagapenum, muſt be diſſolved in vinegar, and the diſſolution having been ſtrained by a hard expreſſion, the humidity thereof muſt be evaporated till it be reduced to the conſiſtence of plaiſter; mean while you'll pound together the myrrh and euphorbium, the ſulphur by itſelf; and the Roman vitriol and ſal ammoniack together, mixing afterwards all thoſe powders, incorporating with the gums liquified over a very ſlow fire the oil of bays, and afterwards the powders, ſtirring a long while the mixture, and the plaiſter will be done.

Virtues.—This plaiſter is penetrating, attenuating, emollient, and roſolutive, proper for the ſcrophulous tumours, wens, ſkirts of the liver, and of the ſpleen, and for the king's-evil,

In theſe *recipes* or *preſcriptions* the reader meets with ſeveral terms proper to the practitioners in this art; which require ſome explanation Such are the *names* and *characters* of their *weights* and *meaſures*: and thoſe inſtruments and veſſels made uſe of by the Apothecary, with which I ſhall conclude this treatiſe.

The Weights uſed in *medicine*, are, the pound, half-pound, quarter of a pound, ounce, drachm, ſcruple, and grain.

The Pound, in medicine, is of twelve ounces, deſigned by this character ℔ j.—The half-pound by this ℔ ſs.—And the pound and half by this ℔ j. ſs.

The Quarter *of a pound* is of three ounces; formerly deſigned by this character 4 tar j. which is at preſent out of uſe, ſince we mark a quarter of a pound by ounces, thus ℥ iij.

The Ounce in medicine, is the twelfth part of a *pound*, marked thus ℥ j. The half ounce thus, ℥ ſs. and the ounce and half thus, ℥ j ſs. which ounce is compoſed of eight drachms.

The Drachm, which is the eighth part of an ounce, is deſigned by this character ʒ, which is as a 3 in Arithmetick, becauſe it is compoſed of three ſcruples: the *half-drachm* is marked thus ʒ ſs. and the *drachm and half* thus, ʒ j ſs.

The Scruple is the third part of a *drachm*, deſigned by this character ℈ j. and is compoſed of twenty four grains: the *half ſcruple* is marked thus ℈ ſs. and the *ſcruple and half* thus ℈ j ſs.

The Grain is the twenty fourth part of the *ſcruple*, deſigned by *gr.* j or *gn.* i.

The Measures for liquids here, in *England*, are the *pint*, confifting of *twelve ounces*; the *half-pint*, confifting of *fix ounces*; the *quartern* of *three ounces*; and *half-quartern*, of an *ounce and half*, which are moft commonly marked in the prefcriptions by pound, thus lb j. for a *pint*: *half a pound*, thus lb fs. for *half a pint*: a *pound and half*, thus lb j fs. for a *pint and half*: three ounces thus ℥ iij. for a *quartern*; an *ounce and half*, thus ℥ j. fs. for a *half-quartern*. And laftly, *a drachm*, thus ʒ j. or *half a drachm*, thus ʒ fs.

The *meafures* for dry ingredients, *viz.* wood, herbs, fruits, and feeds, are known by the name of the bundle, the handful, and the pinch.

The BUNDLE is, what an arm folded roundwife can contain, marked thus *fafc.* j.

The HANDFUL is as much, as a hand can hold, defigned by *man.* j. or M. j.

The PINCH is, as much, as two fingers and the thumb can hold, defigned thus *pug.* j or thus *p.* j.

The *meafure* of fruits and of feveral animals, is made by *number*, defigned thus *No.* or by *pairs*, defcribed thus *par.*

When we find in prefcriptions *ana*, or *aa*, we muft underftand of each, or as much of one as of the other.

By *q. f.* muft be underftood a fufficient quantity, or as much as is neceffary.

By *f. a.* or *ex arte*, muft be underftood according to the rules of art.

By *B. M.* muft be underftood *balneum mariæ*.

By *B. V.* muft be underftood *balneum vaporis*, or vaporous bath.

The VESSELS ufed for the *coctions* of the *compofitions* in *medicine*, are copper bafons, fimple or tinned, large cauldrons, frying pans, fkillets, iron pots, copper pots tinned, pewter bafons, earthen or ftone pans, earthen difhes, earthen porringers, earthen pots, glafs, and ftone cucurbites, copper cucurbites tinned infide, with their refrigeratories, crucibles, &c.—One muft as much as poffible employ earthen or glafs veffels for the preparations, which are to be taken inwardly; becaufe neither earth nor glafs communicates any impreffion to the drugs, and copper will do it; but as glafs and earthen veffels are moft commonly fmall, and break eafily at the fire; and the earthen ones are very often penetrated by the liquors, one may ufe copper veffels tinned, without any fear that the metal will communicate itfelf to the drugs, becaufe tin does not rarefy itfelf fo eafily as copper.

The *veffels*, employed for the infufions, and to keep the *galenical compofitions*, are pots of gold, filver, pewter, lead, earth, ftone, glazed earthen ware, glafs, cryftal, bottles, jugs, and boxes.

Gold, filver and pewter are the moft proper metals for the fabrication of the veffels which are to ferve for the infufions, and to preferve the remedies; but as they can be penetrated by feveral falts, and moft of the fpirits of the mixtures, they may communicate fome flight impreffion to the veffels put in them, therefore I would prefer glafs and earthen-ware in that occafion to thofe metals; tho' ftone is the moft proper material for thofe veffels.

Mufk is preferved in *leaden boxes*, that being cooler in that metal than any where elfe, lefs of its parts may be diffipated. Several ufe lead preferable to others, to preferve treacle, orvietan, and mithridate, becaufe thofe compofitions retain better their confiftence in leaden pots, or boxes, than in thofe of any other matter: though it is to be feared the particles of the lead mixing with thofe compofitions fhould alter their quality.

The boxes ufed to keep the fimple drugs, as the fenna, agarick, and rhubarb, fhould be made of wood lefs fubject to worms.

The INSTRUMENTS ufed in *medicine*, are *mortars* of bell-metal, with their peftles proportioned to them; mortars of brafs, pewter, lead, and glafs, with their peftles of the fame matter: mortars of marble and ftone, with their wooden peftles: *porphyries* with their *mullers*, *funnels*; *fyringes*, *fpatulas*, *biftorters*, *rafps*, *fpoons*, &c.

The *mortars* of *bell-metal* are great and fmall; the great ferve to make almoft all the powders, to malax the maffes of pills and troches, and to extinguifh the quickfilver; their peftles are of iron.

The *fmall mortars* of the fame matter ferve to reduce into powder a fmall quantity of drugs eafily pounded, and to diffolve the compofitions, which are to enter potions, clyfters, colyres, and injections.

The *leaden-mortars* are ufed to make the unguent *nutritum*, the butter of *faturn*, the deficcative liniments, where it is wanted that the metal fhould communicate its impreffion.

Iron mortars are great and fmall; the great ones ferve to reduce into powder feveral ingredients, which enter the remedies applied outwardly; the fmall ones are employed to receive the matters in fufion, which are thrown into them, &c.

The *mortars* of *marble* are great and fmall; and great ones ferve to pound the almonds, nuts, feed, &c. the oils thereof are to be extracted by expreffion; to bruife the plants, the juice thereof is alfo to be extracted. The fmall ones ferve to pound the almonds, and the cold feeds to make the emulfions.

The *ftone mortars*, very clean can ferve inftead of the marble ones, but they are feldom employed but for the corrofive powders; as to pound red precipitate, to mix crude mercury with corrofive fublimate, to make the mercurius dulcis; mortars of marble and glafs can ferve for the fame ufes.

The *porphyries* and *fea fhells* are ufed to reduce into an impalpable powder the hardeft drugs, as, the

the precious ſtones, the coral, pearls and tutty. They are ground with a muller, which is a little block of porphyry, or other hard ſtone, poliſhed underneath; round, or of a figure to be laid hold on eaſily.

The *funnels* are of copper, tin, earthen ware, ſtone, and glaſs: they ſerve to put the liquors into the bottles, and to ſupport the filtration. Thoſe of glaſs or of ſtone, are preferable to them, either in *Chymiſtry*, or in the *Galenical Pharmacy*.

The *Syringes* are of ſilver, of pewter, or of copper: they are great and ſmall; the great muſt contain a pound of liquor, they ſerve for the clyſters: the ſmall ones muſt contain two or three ounces of liquor; they ſerve for the injections made in the penis, in the matrice, and in wounds.

The *Spatula's* are either of ſilver, or pewter, iron, ſteel, ivory, guaiac, box, or of common wood.

The *Spatula's* of *ſilver* are better than thoſe of any other metal, becauſe they are not ſubject to ruſt; they are uſed for the cordial confections. The *ſpatulas* of *pewter* can ſupply the want of thoſe of ſilver.

The *ſpatulas* of *ſteel* are preferable to thoſe of iron.

The *ſpatulas* of *ivory* are very proper for the confections: thoſe of *guaiac*, of *box*, and of *common wood*, ſerve to ſtir the herbs, and other ingredients, which enter the infuſions and decoctions

The *biſtortes* are rollers of *wood*, which ſerve to mix the remedies, and to ſpread the lozenges.

The *raſps* are of *tin* faſten'd on wood; they are uſed to raſp the agarick, which is to be reduced in powder, and to raſp the fruits and roots, the juice whereof is to be extracted

The *ſpoons* are of gold, ſilver, iron, wood, mother of pearl, ivory, and tortoiſe ſhell.

The *ſpoons* of gold are rare in an Apothecary's ſhop, becauſe of their great value; thoſe of ſilver ſupply their want. The large ſpoons and ſkimmers are commonly of pewter or tin, but thoſe that love neatneſs have them of ſilver.

The *wooden ſpoons* can ſerve for the extraction of pulps.

The *ſpoons* of *mother of pearl*, of *ivory*, and of *tortoiſe-ſhell*, are proper to adminiſter ſyrups, potions, or other liquors to the patients.

The *preſſes* are of different figures; their matter is always of a ſtrong and compact wood.

The *diſpenſaries* are a kind of flat and ſquare boxes, without lids, made in the faſhion of drawers: they ſerve to contain the ingredients which enter a compoſition well prepared, and diſpos'd in order.

METALS.

METALS are hard and ſolid bodies fuſible by fire, and ductile by the hammer.

We commonly diſtinguiſh ſix or ſeven ſorts of *metals*, viz. *Gold*, *ſilver*, *copper*, *tin*, *iron*, *lead*, and *quick-ſilver*: Where we muſt obſerve, that the antients underſtood by the name of *tin*, a certain mixture of ſilver and lead; but what we call tin, at preſent, was by them called white or candied lead.

I have ſaid, that we reckon ſix or ſeven ſorts of *metals*; for *mercury* or *quick-ſilver*, is pretended to be rather a metallick matter, or the ſeed and principle of *metals*, than a *metal*; for it is neither diſſolvable by fire, malleable, nor fix'd: in effect, it ſeems to conſtitute a peculiar claſs of foſſils.

As to the origin and formation of *metals*, various are the ſentiments of philoſophers antient and modern. M. *Tournefort* is of opinion, that *metals* as well as all other minerals, have their origin from ſeeds, like plants; that they have veſſels with juices circulating in them, *&c.*

Plato will have the cauſe of *metals* to be a humid vapour incloſed in the bowels of the earth, which being variouſly intermixed with parts of the earth produces various *metals*. *Plotin* maintains ſulphur to be the father of *metals*, and an oleaginous viſcous humour the mother. *Lidgat* endeavours to prove all *metals*, generated by a ſubterraneous fire; urging among other reaſons, that many *metals* when taken out of the earth, are exceedingly hot. *Du Hamel* ſhews, that *metals* do not take their riſe either from any vaporous exhalation, or from water, or from earth, but are generated of mercury, ſulphur, and ſalt. He adds, that *metals* take their matter and weight from the mercury, and their tincture and form from ſulphur.

Some authors own the firſt rudiment of a metal to be a ſaline ſubſtance ſwimming in water, which is by little and little carried off. By how much the terreſtrial parts are more exquiſitely mixed with the aqueous or humid, by ſo much is the *metal* more heavy and firm, as having fewer and ſmaller pores.

Dr. *Woodward* maintains, that all *metals* now found in the ſtrata of the earth, owe their preſent condition to the deluge, whence he alſo imagines, the ſtrata of ſtone, earth, marble, *&c.* were formed.

The ſame author complains of the great uncertainty and inconſtancy in the mineral and metallick kingdom; neither colour, figure, nor ſituation in the earth, being to be depended on, ſo as to make any poſitive judgment from them.

M. *Tournefort*'s opinion is, that *metals* have their origin from ſeeds like plants, and have their veſſels

vessels with juices circulating thro' them. But there is nothing conclusive in these theories.

As to the species of *metals* there are four imperfect, because their principles are not bound so fast together, but that the force of a common fire destroys them; these are *iron*, *copper*, *lead* and *tin*: and the two which being proof against common fire, is *gold* and *silver*, are called *perfect metals*.

In the *four first*, it is easy to see the principle of inflammability; they become all fusible by the addition of *salt-petre*, either in a greater or less degree.—Iron is that, wherein this is the most visible; next, *tin*, then *copper* and *lead*.

In *gold* and *silver*, the sulphurous principle is not so obvious; no heat, but that of the sun collected into a focus, is able to decompound them: but no doubt they have the same principles with the other *metals*, though not so easily seen.—In gold, as well as in other *metals*, is an earth capable of vitrification, as appears by the glass remaining after the calcination of gold in a burning-glass; and there is reason to believe, that the greatest part of what is exhaled in smoak, during the operation, is the sulphurous principle mixed with salts.

As to *silver*, there is something in it extremely various: when purified with *antimony*, it vitrifies with a burning-glass; but if purified with *lead*, it leaves nothing behind, but grey ashes.—The basis of this *metal* is doubtless an earth, capable of vitrification; and what exhales in smoke, is apparently a mixture of sulphur, salt, and a little earth volatilized by the fire.

From all which, and many more observations of the same kind, M. *Geoffroy* draws the following conclusions, that the substances whereof *metals* are composed, do not differ essentially from those which compose vegetables. That the imperfect *metals* are composed of a sulphur, vitriolick salt, and vitrifiable earth. That this sulphureous principle is more or less strongly joined with the other principles; very strongly in gold and in silver, less in antimony, and very little in mineral sulphur. That the principle of inflammability may be separated from metallick substances, either by cunilary fire, or by the sun. That the *metal*, thus despoiled of its principle, is converted into ashes, and that these ashes, pursued further with a violent fire, vitrify; and that such ashes or glasses, by the application of some inflammable matter, re-assume the metallick form they had lost. That it is by this means linseed-oil turns argilla into iron. That if we knew all the other metallick earths, they might likewise be immediately converted into *metals*, by the projection of some inflammable matter. That it is the saline and earthy parts, found in oil of vitriol, that furnish the earthy vitrifiable part, which makes the basis or ground of iron, and that it receives the *metallick* form from the sulphurous principle of the oil. That the iron found in the ashes of plants, was produced there in the same manner: and, that it is a composition of the vitrifiable earth of the plants, the acid of these plants, and their oily or inflammable principle.

Gold is a yellow *metal*; the heaviest, purest, most ductile, and shining, and on those accounts the most valuable of all *metals*.

The weight of gold is to that of water, as 19636 to 1000.——A cubick inch of pure gold weighs twelve ounces, two drachms, and fifty-two grains; and the cubick inch of silver, six ounces, five drachms, twenty-eight grains. —— The pound weight, or twelve ounces Troy of gold, is divided into twenty-four carats.

The value of *gold* is to that of silver as 14 to 1; indeed, this proportion varies as gold is more or less plentiful: for *Suetonius* relates, that *Cæsar* brought such a quantity of gold from *Italy*, that the pound of gold was only worth seven pounds and a half of silver.—Standard gold is worth 44 *l.* 10 *s.* Sterling the pound weight: standard silver is worth 3 *l.* the pound, or 5 *s.* the ounce.

The first characteristick, or property of *gold*, is that it is the heaviest of all bodies, proceeding from the union or cohesion of its parts, which is closer and more intimate than in any other *metal*.

The second character is, that of all known bodies it is the most ductile and malleable.

The third character of *gold* is its fixedness in the fire, in which it exceeds all other bodies. The Prince of *Mirandola*, Mr. *Boyle*, and other Chymists, furnish divers experiments to illustrate this wonderful fixity. After laying a quantity of *gold* two months in the intensest heat imaginable, it is taken out without any sensible diminution of weight. It must be added however, that in the foci of the large burning glasses of *Tschirnhausen* and *Vilette*, even gold itself volatilizes and evaporates. After this manner we are told from the Royal Academy at *Paris*, a quantity of pure gold was vitrified (which contradicts the sentiment of Mess. *Boerhaave* and *Homberg*, that no salts enter the composition of gold) and that the glass being fused with a quantity of grease was restored into gold: which is a confirmation that there must be some sulphurous particles in the formation of gold, wherein the most acute points of the saline ones are sheathed.

Its fourth character is, not to be dissoluble by any menstruum in nature, except aqua regia and mercury, the basis of aqua regia being sea-salt, which is is the only falt we know of that has any effect on gold.

The feventh character is, that it readily and fpontaneoufly, as by fome magnetick virtue, attracts and abforbs mercury.

The eighth character is, that it withftands the violence both of lead and antimony, *i. e.* being fufed in the coppel along with either of thofe matters, it does not diffipate and fly off with them in fume, but remains fixed and unchanged.

The ninth character is, that of all bodies it is the fimpleft, (the primary elements being here excepted) by fimple we here mean that the minuteft part has all the phyfical property of the whole mafs. Thus if a grain of *gold* be diffolved in aqua regia, and a fingle drop of the diffolution be taken, a quantity of *gold* may be feparated therefrom, which fhall only be the millionth part of the grain, and yet have all the characters of *gold*. Or if you fufe a grain of *gold* with a large mafs of filver, and mix the two together, fo that the *gold* become equally diffufed through the whole mafs; you will have in every particle of the mafs a particle of perfect *gold*; accordingly diffolve any part of the mixture in aqua fortis, and a quantity of *gold* will precipitate to the bottom; bearing the fame proportion to the grain that the part diffolved did to the whole mafs, on which principle depends the art of affaying.

All the known parts of the earth afford this precious *metal*; though with a deal of difference in point of purity, and abundance: *Europe*, fo fertile in other refpects, comes fhort of all other quarters in *gold*. *America* furnifhes the moft; and particularly the mines of *Peru* and *Chili*. That of *Afia* is efteemed the fineft, particularly that of *Meranicabo* in the *Eaft Indies*: though the *Spaniards* affure us, that they get *gold* out of fome of their *Peruvian* mines, twenty-three carats fine, before it be purified. The *gold* of *Axima* on the coaft of *Africa*, is found from twenty-two to twenty-three carats.

Gold is chiefly found in mines; though there is fome, alfo found in the fand, and mud of rivers, and torrents, particularly in *Guinea*: this laft is in form of a fine duft, and for that reafon called *gold duft*.

The *gold* of mines is of two kinds: the one in fmall pieces, or grains of various forms and weights.

The other kind of *gold* is dug up in ftony glebes, which is what they call the *mineral* or *ore of gold*: thefe glebes are of various colour, and ufually one hundred and fifty, or one hundred and fixty fathoms deep. Along with the *gold* they ufually contain fome other mineral matter, as antimony, vitriol, fulphur, copper, or filver, particularly the laft; without fome fhare of which it is fcarce ever found.

To feparate the *gold*, they firft break the *metalline* matter with iron mallets pretty fmall, then carry it to the mills, where it is grounded into a very fine powder; and laftly, pafs it through feveral brafs-wire fieves one after another, the laft as fine as any of our filk fieves.

The powder thus prepared is laid in wooded troughs, with a proper quantity of mercury and water, and there left to knead and faturate in the fun and air, for twice twenty-four hours. After this the water with the recrementitious earth is drove out of the tube, by means of other hot waters poured thereon. This done, there remains nothing but a mafs of mercury with all the *gold* that was in the ore. The mercury they feparate from it by diftillation, in large alembicks: the gold in this ftate is called *virgin gold*, as well as that found in the fand of rivers, or that in grains in the mines, in regard none of them have paffed the fire. After this they ufually fufe it in crucibles, and caft it into plates or ingots.

Silver is a white, rich fort of metal; being the fineft, moft ductile, and moft precious of all *metals* except *gold*. It receives in its compofition a greater number of fulphurous particles than gold, and lefs defecated, whence it is fubject to more mutations; and is diffolved with a greater facility.

There are *filver* mines in all the four quarters of the world. *Europe* has its fhare, nor is *Britain* quite deftitute thereof.

The mines of *Peru*, and fome other parts of *America*, are much the richeft and moft abundant; they appear almoft inexhauftible, particularly thofe of *Potofi*.

The ores or mineral ftones they dig, are fome white or afh-colour, fpotted with red or blue, and called *plata blancha*; others are black, and called *promo ranco*: thefe laft are the richeft, and the eafieft wrought, no mercury have been here needed, nor any thing but to put them in the fire, where the lead evaporating, leaves the filver pure. The *rofficlee* is another black mineral diftinguifhed by whetting and rubbing it againft iron, which turns it red. It is very rich, and the *metal* it yields of the beft fort. The *jorcche* burns like talc, and looks as if filvered, though it does not yield much. The *paco* is a yellow red, very foft, and found almoft broke in pieces; it is not rich. The *cobriffo* is green and half friable. Though the filver of this be vifible, yet it is drawn from it with great difficulty, by reafon of the copper wherewith it is intermixed. Laftly, the *araunea*, which is only found in *Potofi*, and that only in the mine of *Cotamito*, confift of threads of pure filver, interwove like a *filver* galoon, that has been burnt to get out the filk.

The

The moſt uſual way of ſeparating the *ſilver* from the ore, is by what they call *pinea's*. Sometimes, however, they uſe nothing but fire frequently repeated, or aqua fortis.

The manner of doing it by *pinea's*, is to break firſt the ore, or mineral *ſilver* dug out of the veins of the mine; then grind it in mills for the purpoſe, driven by water, with iron peſtles of two hundred pound weight. The mineral thus pulverized, is next ſifted, then worked up with water into a paſte, which when half dry is cut into pieces, called *cuerpo's*, a foot long; weighing each about two thouſand five hundred pounds.

Each *cuerpo* is again kneaded up with ſea ſalt, which diſſolving incorporates with it. They then add mercury, from ten to twenty pounds for each *cuerpo*, kneading the paſte afreſh until the mercury be incorporated therewith.

This amalgamation is continued for eight or nine days: ſome add lime, lead, or tin ore, *&c.* to forward it; and in ſome mines they are obliged to uſe fire. To try whether or no the mixture or amalgamation be ſufficient, they waſh a piece in water, and if the mercury be white, it has had its effect; if black, it muſt be further worked.

When the water runs quite clear out of the baſons, they find the mercury and ſilver at bottom incorporated. This matter they call *pella*, and of this they form the *pinea's* by expreſſing as much of mercury as they can; firſt by putting it in woollen bags, and preſſing and beating it ſtrongly, then by ſtamping it in a kind of wooden mould of an octagonal form, at the bottom whereof is a braſs plate pierced full of little holes.

The matter being taken out of the mould is laid on a trivet, under which is a large veſſel full of water, and the whole being covered with an earthen head, a fire is made around it.

The mercury ſtill remaining in the maſs is thus reduced into fumes, and at length condenſing is precipitated into the water, leaving behind it a maſs of ſilver grains of different figures, which only joining or touching at the extremes, render the matter very porous.

Though the mines of *Potoſi* and *Lipes* ſtill keep up their reputation, yet are there ſeveral diſcovered within theſe few years, that exceed them much in richneſs: ſuch are the mines of *Aruro*, eight leagues from *Arica*, and thoſe of *Alachæ* near *Cuſco*, open'd in 1712. It is remarkable that moſt of the mines in *America*, are found in cold and barren places.

The method of ſeparating *ſilver* from the ore, in *Europe*, is the ſame as that of gold; that is, by means of quickſilver; with this difference, that for *ſilver*, to every fifty hundred weight of ore, is added one hundred weight of rock ſalt, or ſome other natural ſalt.

To ſeparate the *ſilver* from the mercury, wherewith it is amalgamated, they have a furnace open a-top; and the aperture covered with a kind of a capital made of earth, of a cylindrical form that may be clapped on or taken off at pleaſure. The maſs of *ſilver*, and mercury being laid in the furnace, the capital applied, and the fire lighted underneath; the quickſilver raiſed by the action of the fire, in form of vapour, is caught in the capital, and taken thence to be uſed in the ſecond operation.

The ſtandard of fine *ſilver* is 12 penny-weights, each conſiſting of 24 grains: when it is below this, it muſt be raiſed to it by refining.

Copper is a hard, dry, heavy, ductile metal, found in mines in ſeveral parts of *Europe*.

Copper is of all *metals* the moſt ductile, and malleable, after gold and ſilver; and abounds much in vitriol, and an ill-digeſted ſulphur.

Copper is found in glebes or ſtones of various forms and colours; which are firſt beaten ſmall and waſhed, to ſeparate them from the earthy, *&c.* parts wherewith they are melted, and the melted matter run into a kind of moulds, to form large blocks, by ſome called *ſulmons*, and by others *cakes of copper*: this is the ordinary *copper*.

To render it more pure and beautiful, they melt it again once or twice; ſome of its coarſe earthy parts being left at each fuſion, and a quantity of tin and antimony added in each: in this ſtate it is called *roſe copper*, in Latin *æs peloſum*.

Copper is alſo, ſometimes, found native and pure in the mines, either in form of threads, or in flakes, plates, grains, or other makes and lumps: this is called *virgin copper*.

Of a mixture of *copper* and *lapis calaminaris*, is formed braſs.

Iron is a hard, fuſible, and malleable metal, of great uſe in the affairs of life: it conſiſts of an earth, ſalt, and ſulphur, but all impure, ill mixed, and digeſted, which renders it extremely liable to ruſt.

Iron is the hardeſt, drieſt, and the moſt difficult to melt of all *metals*. It may be ſoftened by heating it often in the fire, hammering it and letting it cool of itſelf; and it is hardened, by extinguiſhing it in water.

There is a great number of *iron* works in moſt parts of *England*, thoſe in the foreſt of *Dean* in *Glouceſterſhire* are in moſt repute. The ore is there found in great abundance, differing much in colour, weight, and goodneſs. The beſt called *cruſh ore* is of a bluiſh

bluish colour, very ponderous, and full of little shining specks, like grains of silver; this affords the greatest quantity of *iron*, but being melted alone produces metal very short and brittle, and therefore not so fit for common use: for the remedying whereof the workmen make use of another sort of material termed *cinder*, which is nothing but the refuse of the ore, after the metal has been extracted; and which being mingled with the other, and in a due quantity, gives it that excellent temper of toughness, which causes this *iron* to be preferred before any brought from foreign parts.

After they have provided the ore, they first work it to calcine it, which is done in kilns, much after the fashion of our ordinary lime kilns: this they fill up to the top with coal and ore, one lay upon another; and so putting fire at the bottom they let it burn till the coal be wasted, and then renew the kilns with fresh ore and coal, in the same manner, as before. This is done without fusion of the metal, and serves to consume the more drossy part of the ore, and to make it malleable, supplying the beating and washing, which are used in other metals.

From hence they carry it to their furnaces, which are built of brick or stone, about 24 feet square on the outside, and near 30 feet in height within, not above 8 or 10 feet over where widest, which is about the middle; the top and bottom having a narrow compass, much like the shape of an egg. Behind the furnace are fixed two large pair of bellows, the noses of which meet at a little hole near the bottom; these are compressed together by certain buttons placed on the axis of a very large wheel, which is turned about by water, in the manner of an over-shot mill. As soon as these buttons are slid off, the bellows are raised again by the counterpoise of weights, whereby they are made to play alternately, one giving its blast while the other is raising.

At first they fill the furnace with ore and cinder, intermixed with fuel, which in those works are always wood or charcoal, laying them hollow at the bottom, that they may more easily take fire; but after they are once kindled, the materials run together in a hard cake or lump, which is sustained by the fashion of the furnace; and through this the metal, as it melts, trickles down into the receivers set at the bottom, where there is a passage open, by which the men take away the scum and dross, and let out the metal, as they see occasion. Before the mouth of the furnace, there lies a great bed of sand, wherein they make furrows of the shape, into which they would have their *iron* cast. As soon as the receivers are full, they let in the metal, which is made so very fluid by the violence of the fire, that it not only runs to a considerable distance, but stands afterwards boiling for a good while.

When the furnaces are once at work, they keep them constantly employ'd for many months together, never suffering the fire to slacken night or day, but still supplying the wasting of the fuel, and other materials, with fresh poured in at the top: charcoal is used altogether in this work, sea-coal will scarcely do.

From these furnaces the workmen bring their *sows* and *pigs* of *iron*, as they call them, to their forges, where it is wrought into bars.

Tin is a whitish metal, softer than *silver*, yet much harder than *lead*.

The constituent parts of *tin*, and those of *silver*, are no otherwise different from one another, but in their preparation, which is less perfect in *tin* than in *silver*, and in their cohesion, which is less intimate in *tin* than in *silver*.

Mr. *Boyle*, and others, give us several instances of silver being actually produced in considerable quantities from *tin* ore.

There are mines of *tin*, as well as other metals; the best are in *England*, in the counties of *Cornwall* and *Devonshire*; from whence the greatest part of the *tin* consumed in *Europe* is procured.

The mineral stone or ore, being dug and drawn out of the mine, is there broke into pieces with large iron mallets; then brought to a stamping mill, where it is still pounded smaller with stampers, much like those of paper-mills; and the water passing through it, washes away the earthy parts, leaving the metallick ones behind: the lotion is repeated twice to make the better separation.

This done, they dry it in a furnace on iron plates, and grind it very fine in a crasing mill; then wash it again and dry it: in this state the metallick matter is called *black tin*.

To convert it into tin, *i. e.* into *white tin*, they carry it to a furnace or blowing-house, where, by means of a charcoal fire, kept up by huge bellows worked with water, it is melted; after it has passed all these preparations and is become cold, they forge it, which is the last thing done to it in in the works.

The dross or scoria scummed off the *tin* in fusion, being melted down with fresh ore runs into metal, and even the *casualty*, i. e. the matter washed and separated from the metal in the mill, being thrown up in heaps, aftet resting six or seven years they fetch it over again, and it yields as good tin as any of that of *Germany*.

The workmen distinguish several kinds of *tin*, as *moor tin*, which is the best sort, a foot whereof weighs 80 pounds; and *mine tin*, which is the next,

a

a foot whereof weighing about 50 or 52 pounds. The *tin* got from the soft gravelly earth, they call *pryan tin*, to distinguish it from that got from the stones, which is better by almost half. Two pounds of *black tin* when melted yield about one of *white*.

To find whether *tin* be soft and ductile, or harsh and ductile, there are two kinds of essays: the *first* is, by putting the *tin* in a mould of cast brass, and there melting it; if the metal be harsh, it will be taken out heavier than before, otherwise it will be lighter. The *second* is, by casting the melted *tin* into a little mould made of the Thunder-stone. This mould has a little canal of moderate length, which conducts the matter into a cavity capable of containing half a billiard ball; if the *tin* be harsh it appears whitish towards the entry of the mould, otherwise it is tinged superficially with a very faint bluish brown.

LEAD is a coarse, heavy, impure metal, of all others the safest and most fusible when purified.

They who have made an analysis of *lead*, find it to contain a little mercury, some sulphur, and a great deal of bituminous earth.

Lead is found in various countries, but abounds particularly in *England*; it is found too in several kinds of soils and stones, some whereof besides, contain gold, some silver, others tin, *&c.*

It is melted in a furnace, with a strong coal-fire; as it melts it runs through a canal on one side, leaving the earth, stones and scoria with the ashes of the coals. It is purified by skimming it ere cold, and throwing suet and other fat bodies into it.

Lead is found of a lighter or deeper colour, according as it is more or less purified, though some make a difference in the colour of the ore, always esteeming that most which is the whitest.

Some very able Naturalists observe, that the weight of *lead* increases either in the open air, or under ground.

Lead is a metal of much use, it easily melts, and mixes with gold, silver, and copper, and communicates its humidity to them; but not being able to endure the fire, which they undergo, it retires and carries with it all that was heterogeneous in them so as neither gold nor silver are refined without *lead*. To which may be added, that the coarser kind of precious stones boiled in *lead* are thereby rendered much more brilliant.

When the lead ore is dug out they beat it small; then wash it clean in a running stream, and sift it in iron rudders. Their hearth or furnace is made of clay or fire-stone; this they set in the ground, and on it build their fire, when they light their charcoal, continuing it with young oaken gads blown with bellows, by men treading on them. After the fire is lighted and the fire-place hot, they throw their *lead* ore on the wood, which melts down into the furnace, and then with an iron ladle they take it out, and upon sand cast it into what form they please.

The ore runs sometimes in a vein, sometimes is dispersed in banks; it lies many times between rocks, some of it is harder, others milder; sometimes they have branched ore in the spar about the ore is spar and caulk, and another substance which they call crootes.

MERCURY, or QUICKSILVER, is an imperfect *metal*, neither ductile nor malleable, but only a fluid matter perfectly resembling silver in fusion.

The common name among the antients was *hydrargirum*, q. d. water of silver.

Boerhaave observes, that it is very improperly called a *metal*, inasmuch as it has not all the characters of such a body, nor scarce any thing in common with the other *metals* except weight and similarity of parts.

The characters of *mercury* are, first, that of all bodies it is the heaviest after gold; and still the purer it is the heavier; nay some of the Philosophers even hold, that *mercury* well purged of all its sulphur, would be heavier than gold itself. The ordinary proportion is, that of fourteen to nineteen.

The second character of *mercury*, is to be of all bodies the most fluid, that is, its parts separate, and recede from each other by the smallest force.

The third property of *mercury* is, that in whatever manner it be divided, it still retains its nature, and is the same specifick fluid.

The fourth character is to be extremely volatile, being convertible into fume, even by a sand heat.

The fifth property is, that it easily and intimately adheres to gold, less easily to the other metals, with difficulty to copper, and not at all to iron. On this account it is that such as have occasion to handle *quicksilver*, always make choice of iron instruments for that purpose. We have known women in a salivation, to have their ear-rings grow white and soft with the effluvia of the *mercury*. And hence the gilders, to lay gold on any other body, dissolve it in hot *mercury*, which done, they apply the solution on the body to be gilt, suppose silver; then setting it over the coals the *mercury* flies away, and leaves the gold adhering like a crust to the silver. Lastly, rubbing the crust with *lapis hæmatites*, the silver is gilt.

The sixth character is, that of all fluids it is the coldest, and the hottest, supposing the circumstances the same.

The seventh property is, that it is dissolubie by almost all acids, and unites itself with them, at least with

with all foffil acids. Thus it is diffolved in oil of vitriol, fpirit of fulphur *per campanam*, fpirit of nitre and aqua regia.

Only vinegar does not diffolve it, and hence we are furnifhed with a method of detecting the frauds of druggifts, &c. who make a practice of fophifticating quickfilver with lead. Do but take a mortar, and pound the *mercury*, with vinegar therein; if the vinegar grow fweetifh, it is a proof there is a mixture of lead: if copper have been mixed with it, the *mercury* will turn bluifh or greenifh; if there be no adulteration, the *mercury* and vinegar will both remain as before.

The eighth property is, that it is the moft fimple of all bodies next after gold, accordingly we find it the fame in all its parts, fo far as our obfervation goes. If a fingle grain of *mercury* be diffolved in fpirit of nitre, a proportionable part of the grain will be diftributed into every minute particle of the menftruum; and by diluting the whole with an ounce of aqua ftygia, the whole grain of *mercury* will be revived.

The ninth property of *mercury* is, not to be in any meafure acrid, for it fhews no acrimony to the tafte, nor does it corrode any body; and if a carcafe were to be buried in quickfilver, it might doubtlefs remain there without being any way hurt.

Mercury is found in mines, the chief of which are thofe of *Hungary*, *Spain*, *Friuli*, and *Peru*: the greateft part of our *quickfilver* is brought us from *Friuli*, where there are abundance of mines belonging to the Queen of *Hungary*, though mortgaged to the *Dutch*. It is found under three feveral forms: 1. In ruddy glebes, or clods, called *cinnabar*. 2. In hard ftony glebes, or a mineral fubftance of a faffron, and fometimes a blackifh colour. 3. It is alfo found pure; for upon opening holes in the beds of ftones, &c. there fometimes gufhes a vein or ftream of pure *mercury*, call'd *virgin mercury*. This laft fort is moft valued.

To procure or feparate *mercury* from the ore or earth, they firft grind the glebe into powder; this done they pour a great quantity of water upon it, ftirring and working the whole brifkly about till the water becomes exceeding thick and turbid: this water having ftood till it be fettled, they pour it off, and fupply its place with frefh, which they ftir and work as before: this they repeat, and continue to do, till the water at length comes away perfectly clear, then all remaining at the bottom of the veffel is *mercury*, and other metalline matter.

To this *mercury*, &c. they add the fcoria of iron, putting them together in large earthen retorts, and fo diftilling it; by which means all the heterogeneous, metallick and ftony part is feparated therefrom, and the *mercury* left pure.

As to the earthy matter wherewith the *mercury* is mixed, that of *Spain* is red, and fpeckled with black and white, and fo hard that it is not to be broken up with gun-powder. In *Hungary* it is frequently a hard ftone, but ordinarily a reddifh earth. In *Friuli* there is a foft earth where the *virgin quickfilver* is found; and a hard ftone which yields the common *mercury*.

The mine of *Idria*, one of thofe belonging to *Friuli*, is fo rich, that it yields always half *quickfilver*, fometimes two thirds.

The mine of *Juan Cabelaca* in *Peru*, is ftill more confiderable; the earth is of a whitifh red, like bricks half burnt; it is firft broke, then expofed to the fire, by fpreading it on a layer of common earth, wherewith the grate of an earthen furface is covered. under which is lighted a little fire of an herb, called by the *Spaniards icho*; which is of that neceffity in thofe works, that the cutting of it is prohibited for the fpace of 20 leagues round. In proportion as the mineral heats, the *mercury* rifes volatilized into fmoak; which fmoak finding no vent through the capital of the furnace, which is exactly luted, efcapes through a hole made for the purpofe, communicating with feveral earthen cucurbites fitted within one another. The water at the bottom of each cucurbite condenfing it to fmoak, the *quickfilver* precipitates, and is taken up when the operation is over. In this procefs there are three things remarkable; the firft, that the further the cucurbites are from the furnace, the more they are filled with quickfilver. The fecond, that at laft they all grow fo hot, that they would break, were they not fprinkled from time to time with water. Thirdly, that the workmen employ'd never hold it long, but become paralytick, and die hectick. The precaution they ufe is, to hold a piece of gold in their mouth, to imbibe the effluvia, and interrupt their paffage into the body. Dr. *Pope* tells us of one he faw in the mines of *Friuli*, who in half a year's time was fo impregnated with the metal, that putting a piece of brafs in his mouth, or even rubbing it in his fingers, it would turn as white as filver.

The method of purifying mercury is, by wafhing it feveral times in vinegar, wherein common falt hath been diffolved; or by paffing and repaffing it frequently over a fhammy fkin. *Am. Paræus* tells us, that the beft way is to make a dog fwallow a pound at a time, and afterwards to feparate it from the excrement, and wafh it in vinegar.

I'll conclude this treatife, by obferving that the common radical character of *metals* is, that of all known bodies they are the heavieft. By Dr. *Halley*'s experiments, the weight of gold to that of glafs is determined to be as 9 to 1; and the weight of tin the

the lighteſt of all metals to that of gold, as 7 to 19; which conſiderably ſurpaſſes the weight of all ſtones, marbles, gums, and other the moſt ſolid bodies, as appears from the tubes of ſpecifick gravity: nor is there any body in nature but a *metal*, that is one third of the weight of the gold.

The Royal Society furniſhes us with various experiments of that kind. The weights of the ſeveral *metals* and other ſolids, they have examined hydroſtatically, by weighing them in air and in water; and the weights of the fluids by weighing an equal portion of each. By ſuch experiments they find, that taking the ſame weights of water and gold, the bulk or magnitude of the former is to the latter as 19636 to 1000; conſequently that the weight of gold is to water nearly as 19 to 1.

The ſpecifick weight of the ſeveral *metals* by this means determined ſtands thus:

GOLD - -	19636	IRON - -	7852
QUICKSILVER	14019	TIN - - -	7321
LEAD - -	11345	GRANATE -	.978
SILVER - -	10535	WATER - -	1000
COPPER - -	8843	AIR - -	$\frac{3}{12}$

The cube inch of

		Ounces.	Drams.	Grains.
GOLD	whighs	12′	2	52
QUICKSILVER		8	6	8
LEAD		7	3	30
SILVER		6	5	28
COPPER		5	6	36
IRON		5	1	24
TIN		4	6	17

METALLURGY See *MINERALS.*

METAPHYSICKS.

METAPHYSICKS is a ſcience that treats of *being*, as ſuch in the abſtract; that is, it conſiders beings, only as beings.

All other ſciences have a neceſſary dependence on this; for, it ſupplies them with a foundation and a method to proceed upon; without which, our knowledge of any ſubject muſt be very confuſed and imperfect.

This was probably the reaſon that made *Ariſtotle* ſtyle this ſcience *the true beginning of philoſophy*, and the moſt noble of all the ſciences. As it is wholly converſant in the acts of the underſtanding, it raiſes itſelf above the verge of ſenſe and matter, by its abſtracted views.

The quantity of bodies it refers to the conſideration of *geometry*, and their ſenſible qualities to *natural philoſophy*, applying itſelf only to beings ſeparated from their individual ſingularity, ſuch as ſubſtances, accidents, relations, and whatever elſe may be conceived abſtractly from matter; but particularly *beings purely ſpiritual*, ſuch as GOD, *angels*, and the ſoul of man: hence *Ariſtotle* terms it *natural theology*.

The end of this ſcience is the ſearch of pure and abſtracted truth. It caſts a light upon all the objects of thought and meditation, by ranging every being with all the abſolute and relative perfections and properties, modes and attendants of it, in proper ranks or claſſes; and thereby it diſcovers the various relations of things to each other, and what are their general or ſpecial differences from each other; wherein a great part of human knowledge conſiſts: and, by this means, it greatly conduces to inſtruct us in method, or the diſpoſition of putting every thing into its proper rank and claſs of being, attributes or actions; and hence its proper affinity with *Logic*. See METHOD in LOGIC.

This will appear more ſatisfactorily, by laying before you the following *analyſis* of the *metaphyſical ſcience*.

The object of this ſcience, or that about which it is converſant, is therefore *being* in general. For, the underſtanding not being confined to one thing, as the ſenſes are to the proper objects, has a diffuſive power to comprehend whatſoever is intelligible. To avoid confuſion, which would inevitably flow from the great variety of things which fall within the compaſs of the underſtanding, it is found neceſſary to reduce the ſpecies of beings to one genus, in order to make them the object of any *art* or *ſcience*; ſo all the conceptions in *natural philoſophy* are reduc'd to that one of a natural body; all the obſervations concerning proportion, figures, and quantity to *mathematicks*; and all the ideas concerning the various modes of being, ſubſiſting, and inhering, are reduc'd to one object, which is called *being*.

Being is ſeveral ways divided. 1. *Being* taken in its utmoſt latitude is either compound or ſimple, which involves many ideas, or ſimple, which only takes in one.

2. *Being* is either *poſitive* or *negative*. *Poſitive* is that, which has a real exiſtence in the courſe of nature. *Negative* deſtroys this exiſtence. If it deſtroys it abſolutely then it is a perfect negative *being*;

being; but if it only prevents its being in a subject, which was capable to receive it, then it is still'd a privative being. For privation may be properly defin'd, to be the want or absence of some natural perfection, from a subject capable to receive it, in which subject it either was before, or at least ought to have been: besides, as this privation is either greater or less, so it is either called total or partial. Total is the worst, for it deprives the subject of its natural perfection, both as to the exercise of any present action, and the power of regaining it for the future; as when the eye is perfectly put out. Partial is only in some particular respect, and relates principally to its present actions, or some degree of them; as when one shuts his eyes, or is purblind.

3. *Being* is either *rational* or *real*. *Rational being*, which is the mere product of reason, has no existence but in the mind in idea, and when none thinks upon it, it ceases to be. A *real being*, which is not produc'd by the strength of imagination or fancy, has a real existence in the course of nature, antecedent to any thought or conception of the mind.

4. *Being* is either *actual* or *potential*. *Actual* is that, which actually exists in the order of nature, whether it depend upon any cause in order to produce it, as an infant; or whether it be antecedent to all cause, as God. *Potential being* is that, which can be produced by the power of some agent.

These are the principal nominal distinctions of *being*, and from these we may collect that that *being* which is the object of *metaphysick*, is a *simple*, *positive*, *real*, and *actual being*.

Metaphysick is divided into two parts, general and particular.

The general part of *metaphysick* gives an account of *being* in its most abstracted nature; under which notion it may be thus defin'd; *being* is that, which in itself has a real and positive essence.

Being may be considered either with respect to those words, which are synonymous or equivalent to it; or in reference to its affections or modes.

Words synonymous to *being*, are terms, which simply have the same signification, or else, at the same time, do imply a respect to some other thing. Upon this ground they are divided into two classes; some in every respect implying the same with *being*, others either from the *philosophical* or *grammatical* use of the words, imply a relation to some other *being*.

In the first class, are ranked *essence*, *thing*, *something*.

Essence is the same with *being*, tho' some would make a distinction to lie betwixt them in this, that *being* has the same respect to *essence*, that the concrete has to its abstract. But *essence* in *metaphysick* is taken in its most abstracted nature, and so it must of necessity be the same with *being*.

Thing is the same with *being*; for there is nothing in the notion of *being*, but what *thing* implies in its idea, and on the contrary.

Something, as well as *thing* and *essence*, is equivalent to *being*. And this may be further proved from these following axioms. For, *if it be impossible for the same thing to have essence, and not to have essence at the same time*; *to be a thing and not to be a thing*; *to be something and not to be something*, are maxims equivalent to this first principle of knowledge, *that it is impossible for a thing to be, and not to be at the same time*; then *essence*, *thing*, and *something* are words synonymous to *being*.

Synonymous words of the second class are, *existence*, *quiddity*, *nature*, *form*. These are the same with *being*, yet imply some respect in the philosophical way of using them, which respect is form'd by the operation of the mind upon hearing these words.

Existence, besides the signification of *being*, implies a reference to its cause, whether it positively had its original from some cause, as an house; or negatively was antecedent to all cause, as God.

Quiddity is the same with *being*, but infers a relation to our understanding; for the very asking what a thing is, implies that it is the object of knowledge; upon which account that, which really exists in the course of nature, is accidentally made the object of knowledge.

Nature is the same with *being*, but includes a respect to its operations and properties.

Form is of the same signification; for every *being* as by its *essence*, so by its *form*, is what it is. Yet this term involves this respect that it is more generally by philosophers apply'd to particular and determinate beings.

The *modes* or *affections* of *being*, are three general ideas or conceptions of *being*, which naturally flow from it, and are reciprocated with it, yet represent it in different states and conditions.

- *Affections*
  - *United*
    - *Primary*
      - *Unity,*
      - *Truth,*
      - *Goodness.*
    - *Secondary*
      - *Duration,*
      - *Ubicty.*
  - *Disunited*
    - *Primary*
      - *Immediate*
        - *Necessity and Contingency,*
        - *Power and Act,*
        - *Corruptibility and incorruptibility,*
        - *Dependent and independent,*
        - *Created and increated,*
        - *Finite and infinite,*
        - *Cause, and the Thing caus'd.*
      - *Mediate*
        - *Simplicity and Composition,*
        - *The Whole and Part,*
        - *Identity and Diversity,*
        - *Communicability and incommunicability,*
        - *Natural and artificial,*
        - *Complete and incomplete,*
        - *Permanent and successive,*
        - *Definite and indefinite.*
    - *Secondary*
      - *Subject and adjunct,*
      - *Absolute and Relative,*
      - *Sign, and the Thing signified,*
      - *Measure and the Thing measur'd.*

The *united affections* of *being* are such as singly and solitarily are predicated of *being*, and without any conjunction are convertible with it; as every *being* is good, and all good is a *being*

The *disunited affections* of *being* are predicated of it with a disjunction, and by taking in both parts of the sentence are convertible with it. As *being* is either necessary or contingent, and whatever is necessary or contingent is a *being*.

The PRIMARY UNITED *affections* of *being* are *unity*, *truth*, and *goodness*.

Unity is either *real* or *rational*. *Real* is, which without any operation of the mind is really in every particular *being*. *Rational unity* is that common nature which is diffus'd in all the particulars of any kind, yet by the operation of the understanding is made one.

Unity is the indivision of any *being*; i. e. the division of its essence impiying such a contradiction, that without we can divide a thing from itself it is impossible to divide it.

Union is the concourse of many *beings*, in order to the making of one individual.

Union is either *verbal*, *real*, *essential*, *personal*, or *accidental*.

Verbal union consists in the bare agreement of words.

Real in the concourse of many distinct *beings*, in order to the forming of one individual.

That is an *essential union* when many *incomplete beings*, adapted to one another, do concur to make one essential individual: so matter and form are essentially united in the composition of a body. And this *union* is not only visible in essential compositions, but in integral, because even in such a composition there is one essence; so the elements in all mixt bodies are united by an *essential union*.

Personal union is by which two natures are so united as to make one person. The only instance that can be given of this is, in the *union* of the divine and human nature in the person of our Saviour.

Accidental union is by which many causes accidentally concur to make one thing by accident.

The *second of the united primary affections of being* is *truth*.

Truth is either *metaphysical*, *logical*, or *moral*.

Metaphysical truth is the conformity of the thing with the divine understanding.

Logical is the conformity of the idea with the thing itself.

Moral

Moral is the conformity of our words, gestures, and actions with our hearts.

Logical truth is particularly seen in true propositions, such as agree with their rule, which is the things themselves of which they treat. That is a *moral truth* when a man's heart and mouth go together, when he speaks what he thinks, and is in reality what he would seem to insinuate himself to be by his shew and appearance. It is not absolutely required to this *truth*, that things should exactly agree with the relation of them, upon condition that he that tells 'em knows nothing to the contrary; so that one need not doubt to affirm that a man at once, in the same thing, may speak *truth* and tell a *lye*.

Another division of *truth* is into *truth*, in *being*, *signifying*, and *knowing*.

In *being* is the agreeableness of the essence of any thing to the understanding of God.

In *signifying*, when there is an exact correspondence between the sign and the thing signified.

In *knowing*, when the understanding by its ideas represents the thing, which is to be understood exactly, as it is.

The third of the *united primary affections is goodness*.

Goodness is the agreeableness of any thing.

Goodness is either such as is absolutely so in itself, or with reference to something else. That *goodness*, which is absolutely so itself is called *perfection*.

Perfection is either *essential* or *accidental*.

Essential perfection is, when a thing has no essential defect in its nature.

Accidental perfection, when a thing is invested with all those accidents, which usually accompany its *species*.

Again, *perfection* is either *absolute* or *comparative*.

Absolutely, every being is perfect, which wants nothing to the compleating of its essence.

Comparatively, one being is more perfect than another; as God is more perfect, than his creatures; a man, than a plant.

That *goodness*, which is *relative*, and bears a reference to something else, is either *real* or *apparent*.

Real goodness is such as is intrinsically so in its nature; as virtue.

Apparent is made so by the false reasonings of men: thus many look upon idleness to be *good*.

Again, *goodness* is either *metaphysical*, *physical*, or *moral*.

Metaphysical is the agreeableness of any thing with the divine will.

Physical is the agreeableness of any particular to the whole *species*.

Moral is the agreeableness of our actions with the law of nature, and is the same that is meant by *moral virtue*.

The Secondary United *affections* are *duration*, *ubiety*.

Duration is either *imaginary* or *real*.

Imaginary, which is only fram'd by the working of fancy, there being no such thing in nature.

Real is either *extrinsical* or *intrinsical*

Extrinsical is the comparing *duration* with something else, making that thing to be the measure of it; so in *natural philosophy*, time, by the heavenly bodies is divided into years, months, and days. This is improperly called *duration*.

Ubiety is the presence of any thing in its *ubi*, or *place*.

Ubiety is either *infinite* or *finite*.

Infinite ubiety is the indeterminate presence of a thing in every place; it is called in one word *ubiquity*. This is the property of God.

Finite ubiety is the determinate presence of a being in a place. It is *definitive* or *circumscriptive*.

Definitive ubiety is, when a thing, without any circumscription, is so in a place, as to be no where else. After this manner spirits, material forms and accidents are in a place. It is called *definitive*, because we can define it to be here and not there.

Circumscriptive ubiety is that, by which a thing is exactly circumscrib'd in its *ubi*, and this is properly called place; this is the condition of all bodies.

The Disunited primary *immediate affections* of beings are; *necessity and contigency*, *power*, *and act*, *corruptibility and incorruptibility*, *dependent and independent*, *created and increated*, *finite and infinite*, *cause and the thing caus'd*.

Necessity is that, by which a being is put into such a condition, that it cannot be in any other.

Necessity is either *absolute* or *hypothetical*.

Absolute necessity is, when it is contrary to the very nature of the things, and its principles to be otherwise. This is either *simply absolute* or *respectively so*.

Simple absolute necessity is, which upon no terms will let a thing be in another condition than what it is in. This is never met with but in an independent being, *i. e.* God.

Respective absolute necessity is when, according to the order of the creation, and the settled course of second causes, a thing will continue as it is.

Power is, by which a being is able to effect or do something. It is either *active* or *passive*. *Active* by by which it is able to do ſomething. *Paſſive* by which it is made capable to ſuffer.

Act is that, by which a *being* is in real action: ſo walking is an *act*, not as it is in any ones power, but as it is really perform'd.

Corruptibility is a power not to be. *Corruptibility* proceeds either from *without* or from *within*. *Corruptibility* from *within* is when a thing contains the principles of its own deſtruction. From *without* when a thing may be deſtroyed by an external principle,

Incorruptibility is an inhability not to be.

Dependent is a previous want, whereby one thing depends upon another as its cauſe.

Independent is whereby one thing does not depend upon another as its cauſe.

Creation is the production of a thing out of nothing, or out of indiſpos'd or unqualified matter, by the influence of an Almighty power.

Created is that, which by *creation* has its dependance upon another, as all finite beings.

Increated, which does not depend upon another by creation; as God.

Finite, which has terms or bounds of its *eſſence*.

Infinite is either ſo *in itſelf*, or with *reſpect to us*. That, which is infinite in itſelf, is what properly belongs to *metaphyſicks*; not that, which is only ſo with reference to us, as the ſtars, and ſand; becauſe their number cannot exactly be diſcovered by any man.

Infinite is that which implies a contradiction to have terms or bounds to its *eſſence*; ſuch God is only.

A *cauſe* is an active principle influencing the thing cauſed. A *cauſe* is either *internal*, which partakes of the eſſence of the thing cauſed, *viz.* *matter* and *form*. Or *external*, which has an outward influence, viz. *efficient* and *final*.

Matter is an *internal cauſe*, out of which a thing is made.

Form is an *internal cauſe*, by which a material being is conſtituted what it is.

Efficient is an *external cauſe*, from which any thing by a real action derives its being or eſſence.

The *end* is an *external cauſe*, upon whoſe account the *efficient* acts.

The *thing cauſed* is that, which derives its being or eſſence from its cauſes.

So far we have conſidered the *primary*, *immediate*, *disjoin'd*, or diſunited affections of being. We come now to conſider thoſe, which flow from *being*, thro' the mediation of the *united affections*.

From *unity* flows *ſimplicity and compoſition*; the *whole and part*; the *ſame and different*; *communicability and incommunicability*.

Simplicity is an indiviſible unity. It is either *abſolute* or *limited*. *Abſolute ſimplicity* is when a thing is independently indiviſible. This is the property of God.

Limited ſimplicity, when a thing is really indiviſible; but yet that depends upon ſome external being.

Compoſition is a diviſible unity.

The *whole* is that, which is made up of parts united in due order and diſpoſition. The *whole* is either *eſſential* or *integral*.

Eſſential, which conſiſts of ſuch parts as compleat the eſſence of that being; ſo man is made up of ſoul and body.

Integral, which has the ſame nature with its parts; as every drop of water is called water.

Part is that, which conſtitutes the *whole*.

Identity is the agreement of two or more things in another.

Communicability is, when one being can partake of another.

Incommunicability, when one being cannot partake of another.

From *truth* follows *natural* and *artificial*.

Natural is that, of whoſe truth the underſtanding of God is the immediate rule.

Artificial, the immediate rule, of whoſe truth is the underſtanding of the artificer.

From *goodneſs* flows *compleat* and *incompleat*.

Compleat is that, whoſe eſſence is bounded in itſelf, and is not deſign'd to perfect any thing elſe.

Incompleat, whoſe eſſence is not bounded in itſelf, but is ordain'd of itſelf to the completion and perfection of another being.

From *duration*, proceeds *permanent* and *ſucceſſive*.

Permanent, the parts of whoſe eſſence are not in a perpetual flux.

Succeſſive, the parts of whoſe eſſence are in a continual flux.

From *ubiety* flows *definite* and *indefinite*.

Definite, which has a finite *ubiety*, or place.

Indefinite, which has an infinite *ubiety*, or place. Such a being God is, whoſe eſſence is boundleſs.

The SECUNDARY DISUNITED *affections*, are *ſubject* and *adjunct*; *abſolute* and *relative*; *ſign, and the thing ſignify'd*; *meaſure, and the thing meaſur'd*.

Subject is a being, which has another thing join'd to it, which other thing does not enter into its eſſence.

The *adjunct* is that, which is join'd to another thing, ſo as not to conſtitute part of its being.

A being is then *abſolute*, when it has no reſpect to any thing elſe.

Relative, when it has a reſpect to ſomething elſe.

A *ſign* is that, which repreſents any thing to the faculties of knowledge; under which faculties, are comprehended ſenſe, as well as underſtanding. The thing *ſignify'd* is whoſe *idea* by its *ſign* is repreſented to the faculties of knowledge.

Meaſure is that, by which the quantity of any thing is found out.

The thing *meaſur'd* is, whoſe quantity is determined by another.

Thus we have run through all the *affections* of *being*, which is the general part of *Metaphyſicks*. We proceed now to the *particular part*, which is concerning the diviſion of *being*.

BEING is divided into *ſubſtance* and *accident*,

Subſtance is a *being* ſubſiſting by itſelf. *Subſtance* is either *compleat* or *incompleat*.

Compleat ſubſtance, whoſe eſſence is bounded in itſelf, and is not ordain'd to the intrinſical perfection of any thing elſe. As God, an angel, a man, *&c.*

Compleat ſubſtance is that, which is ordained to the perfection of another thing, and is a part of ſome compound. As the ſoul, a hand, a vein, *&c.*

Subſtance is divided into *material* and *immaterial*. A body is a ſubſtance made up of matter and form, and is the object of a particular ſcience, *viz natural philoſophy*, by which it is divided into *ſimple* and *mix'd*, *animate* and *inanimate*, &c. Spirit is a *ſubſtance* void of matter and form, and is the object of *pneumaticks*.

Accident is a being inhering in a ſubſtance. *Accident* is either *entitive* or *modificative*. *Entitive* is either *primary* or *ſecundary*: *primary* is *abſolute*, as *quantity* and *quality*, or *reſpective*, as *relation*. *Secundary action*, paſſion. *Modificative accidents* are, *quando*, *ubi*, *ſitus*, *habitus*.

Quantity is either *continu'd* or *divided*. Continued *quantity*, which properly belongs to this place, is whoſe parts are join'd together by a common term.

Divided quantity is that, whoſe parts are not linked together by a common term, but are divided. *Divided quantity* is number, which may be defin'd, a multitude compos'd of units.

Quantity is an accident, by which material ſubſtance is extended.

The ſpecies of continu'd *quantity* are a *line*, a *ſuperficies*, and a *body*; for *quantity* is extended either into bare *longitude*, and then it is call'd a *line* not a material one, but ſuch an one as the mind can frame by idea; or elſe it is extended into *longitude* and *latitude*, and that is called a *ſuperficies*; or elſe into *longitude*, *latitude*, and *profundity*, and that makes a mathematical body, which is not to be underſtood as if it were a corporeal *ſubſtance*.

Quality is an *accident*, which influences its ſubject after the manner of an eſſential form. There are four *ſpecies*, or kinds of it. *Habit* (and *diſpoſition*;) *natural power* and (*weakneſs*;) *paſſion*; *figure or form*.

Habit is a *quality* ſuperadded to a natural power, which makes it very readily and eaſily perform its operations. *Diſpoſition* is an imperfect *habit*, or a *habit* juſt begun.

Natural power is a *quality* rooted in our very nature which renders a ſubject fit to do or ſuffer any thing. *Weakneſs* is a diminutive power.

Paſſion is a *quantity*, which affects the ſenſes and the ſenſitive appetite, but is quickly over.

Figure or form is the outward determination and diſpoſition of *quantity*, as roundneſs.

Relation is an accident, by which one thing is referr'd to another.

Action is an *accident*, by which a thing is ſaid to act. It is either *immanent* or *tranſient*. *Immanent*, which does not go from the agent to another ſubject; as *underſtanding*, *thinking*, *meditating*.

Tranſient, which goes from one ſubject to another, as *beating*.

Paſſion is the receiving of *action*. *Paſſion* is either *perfective*, by which the ſubject receives ſome additional perfection, as, *to be inform'd*: or *corruptive*, by which the patient is either wholly, or in part corrupted, as, *to be wounded*.

Quando is the duration of a being in time.

Ubi is the preſence of a being in a place.

Situs is the reſpect of the parts of the body to a place.

Habitus is the application of a body to that which is near to it.

This ſcience, however it may ſeem to have been laboured, is yet capable of being farther improved: but it has many obſtacles in its way. If we are ſhort-ſighted in *phyſical* matters, which are nearer our ſenſe, and in a manner within our view, how much more muſt we be bewildered in our ſearch after ſpiritual abſtracted truths, in the conſideration of univerſals, and of things of a tranſcendant nature, ſuch as fall properly under the conſideration of *metaphyſicks*.

This ſcience proceeds in unfrequented and almoſt unknown paths, containing very few doctrines of allowed and eſtabliſhed certainty; few principles, in which men are univerſally agreed; ſcarce any juſt definition, any exact and complete diviſion; and conſequently affords large matter for doubts and diſputes. For though *metaphyſical* truths may be certain enough in their own nature, yet they are not uſually ſo to us; but being abſtruſe things and lying deep and remote from ſenſe, it is not every one that is capable of underſtanding them and there are fewer yet who underſtand their true uſe.

Ariſtotle

Aristotle seems to have been the first founder and inventor of this abstracted method of reasoning, and the consideration of immaterial beings: for his predecessors in philosophy, scarce delivered any thing that was good and solid upon these subjects; and, indeed, antiquity affords nothing upon it composed with so much strength of reason as *Cicero's* book of the Nature of the Gods. We have but few modern works of this kind, the chief of which are *Descartes*, *Mallebranch*, Dr. *Willis*, *Locke*, *S. Gravesande*, Dr. *Moor*, Bishop *Butler*, &c.

METEOROLOGY.

METEOROLOGY is the doctrine of *meteors*; explaining their origin, formation, kinds, phænomena, &c.

METEOR is an imperfect mixt, consisting of sublimated exhalations, and formed in the superior region of the air, or of our *atmosphere*.

There are three kinds of *meteors*, viz. *igneous*, or *fiery*; *aerial*, or *airy*: and *aqueous*, or *watery meteors*.

Igneous, or *fiery* METEORS, such as *lightning*, *thunder*, *ignis fatuus*, *draco volans*, *falling stars*, and the like, seem to be nothing else but sulphureous and nitrous exhalations, set on fire in the air, by the violent motion of the parts. Therefore, the matter of *thunder* and *lightning*, as well as that of gun-powder, is particularly nitre and sulphur: the effects of both being entirely semblable. For the hollow cloud, wherein the sulphurous and nitrous exhalation is contained, is like the cannon, and the exhalation like the gun-powder; which, when it lacerates the cloud, produces *thunder* and *lightning*. *Thunder*, according to the manner the matter kindled, falls on the earth; whether in a direct or oblique line; and lightning or fulguration, when it blazes through the air, but it cannot break the cloud, with a great violence, without making a very great noise: for *thunder* is a sound, occasioned by a violent commotion of the subtile matter, issuing out of a lacerated cloud.

Sir *Isaac Newton* is of opinion, that *thunder* is not occasioned by the falling of clouds, but by the kindling of sulphureous exhalations, in the same manner as the noise of *aurum fulminans*.

He says, that there are sulphureous exhalations, always ascending into the air when the earth is dry; there they ferment with the nitrous acids, and sometimes taking fire, generate *thunder*, *lightning*, &c.

That besides the vapours raised from water, &c. there are also exhalations carry'd off from sulphur, bitumen, volatile salts, &c. is past all doubt; the vast quantity of sulphureous and bituminous matter all over the surface of the earth, and the volatile salts of plants and animals, afford such an ample stock thereof, that it is no wonder the air should be filled with such particles (say those who espouse Sir *Isaac's* opinion) raised higher or lower, according to their greater or lesser degree of subtility and activity, and more copiously spread in this or that quarter, according to the direction of the winds, &c.

If what we call *lightning*, acts with extraordinary violence, and breaks or shatters any thing, it is called a *thunder-bolt*, which the vulgar, to fit it for such effects, suppose to be a hard body, and even a stone.

The phænomena of the *thunder-bolt* are, that it oftner strikes on high places, than on low: that it often burns people's cloaths, without touching their bodies; as it happen'd to *Amurath* IV. Emperor of the *Turks*, who, while asleep, in an afternoon, had his shirt burnt by thunder, and his body not in the least touch'd: that it sometimes breaks their bones without hurting their flesh or their cloaths: that it has even melted the sword without injuring the scabbard, &c.

On medals when the *thunder-bolt* is found to accompany the *Emperor's* heads, (as that of *Augustus*) it is a mark of sovereignty, and of a power equal with the gods.

Appian informs us, that the *thunder-bolt* was the principal divinity of *Seleucia*; adding that it was adorned even in his time, with various hymns and ceremonies.

IGNIS FATUUS is a popular *meteor*, chiefly seen in dark nights, frequenting meadows, marshes, and other moist places.—Known among the people by the appellations, *Will with a Wisp*, and *Jack with a Lanthorn*. It seems to arise from a viscous exhalation, which being kindled in the air, reflects a sort of thin flame in the dark without any sensible heat. It is found flying along rivers, hedges, &c. because it there meets with a stream of air to direct it.

DRACO VOLANS is a fat, heterogeneous, earthy, *meteor*, appearing long and sinuous, something in the shape of a *flying dragon*. This shape is supposed to arise from the hind part of the matter of the meteor being fired with greater impetuosity, than what comes first out of the cloud; and it is supposed the broken parts of the cloud and the sulphureous matter, which adheres to them, forms the apparent wings of this imaginary dragon.

The *aerial*, or *airy meteors*, conſiſt of flatulent and ſpirituous exhalations; ſuch are *winds*, *whirl-winds*, and *hurricanes*.

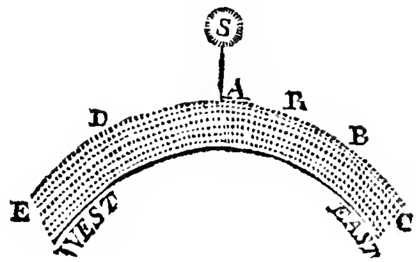
Wind is a ſenſible agitation of the air, whereby a large quantity thereof flows out of one place, or region into another.

As the air is a fluid, its natural ſtate is that of reſt, which it endeavours always to keep or retrieve by an univerſal equilibrium of all its parts. When, therefore, this natural equilibrium of the atmoſphere happens by any means to be deſtroyed in any part, there neceſſarily follows a motion of all the circumjacent air towards that part, to reſtore it; and this motion of the air is what we call *wind*.

Hence, with reſpect to that place where the equilibrium of the air is diſturbed, we ſee the wind, may blow from every point of the compaſs at the ſame time; and thoſe who live northwards of that point, have a north wind; thoſe who live ſouthwards, a ſouth wind; and ſo of the reſt: but thoſe who live on the ſpot, where all theſe winds meet and interfere, are oppreſſed with turbulent and boiſterous weather, whirl-winds, and hurricanes; with rain, tempeſt, lightning, thunder, &c. For ſulphureous exhalations from the ſouth, torrents of nitre from the north, and aqueous vapours from every part, are there confuſedly huddled, and violently blended together, and rarely fail to produce the phænomena above-mentioned.

Many are the particular cauſes, which produce wind by interrupting the equipoiſe of the atmoſphere; but the moſt general cauſes are two, *viz.* *heat*, which, by rarefying the air, makes it lighter in ſome places than it is in others; and *cold*, which, by condenſing it, makes it heavier. Hence it is, that in all parts over the torrid zone, the air being more rarefied by a greater quantity of the ſolar rays, is much lighter than in the other parts of the atmoſphere, and moſt of all over the equatorial parts of the earth. And ſince the parts at the equator are moſt rarefied, which are near the ſun; and thoſe parts are, by the earth's diurnal rotation eaſtward, continually ſhifting to the weſt; it follows, that the parts of the air which lie on the weſt ſide of the point of the greateſt rarefaction, and, by flowing towards it, meet it, have leſs motion than thoſe parts on the eaſt ſide of the ſaid point, which follow it; and therefore the motion of the eaſtern air would prevail againſt that of the weſtern air, and ſo generate a continual eaſt-wind, if this were all the effect of that rarefaction. But we are to conſider, that as all the parts of the atmoſphere are ſo greatly rarefied over the equator, and all about the poles greatly condenſed by extreme cold, this heavier air from either poles is conſtantly flowing towards the equator, to reſtore the ballance deſtroyed by the rarefaction and levity of the air over thoſe regions; hence, in this reſpect alone, a conſtant north and ſouth wind would be generated.

To illuſtrate the cauſe of this perpetual current of air from eaſt to weſt, or of a conſtant *eaſt-wind* under the *equator*, I ſhall add this Figure.



Let C B A D E be part of a ſection of the atmoſphere over the equator, C the eaſt, E the weſt, A the point to which the ſun S is vertical, and R the point of greateſt rarefaction, or that where the air is moſt of all heated, and, conſequently, lighteſt. And, becauſe the air at R is by ſuppoſition lighter than where it is colder at C and D, it is plain that in order to obtain an equilibrium (which is neceſſary in a fluid body) the air by its greater weight will have a tendency from C and D towards R, and riſe to a height there greater than at C or D, in proportion as its denſity is leſs.

This being the caſe, it is evident, the ſun, being always between the points R and D, will be heating the air on that part; and thoſe regions between R and C, having been deſerted by the ſun, will grow cold; conſequently, the air between C and R, as it is colder, will likewiſe be heavier than that between R and D which is hotter, and ſo will have a greater momentum, or quantity of motion, towards the point R; and ſince this point R is conſtantly moving after the point A weſtward, the motion of the weſtern air towards it, will be in part diminiſhed by that means; and being alſo inferior in quantity to the motion of the eaſtern air, the latter will prevail over it, and be conſtantly following the ſaid point R from eaſt to weſt, and thus produce a continual eaſt wind.

It may, perhaps, be here ſaid, that though the motion of the air be leſs from D to R, yet it is ſomething, and ſo there ought to be a weſtern wind, at leaſt in ſome degree, and to ſome diſtance weſtward of the point R. To which we anſwer, that the nature of a fluid will not permit two contrary

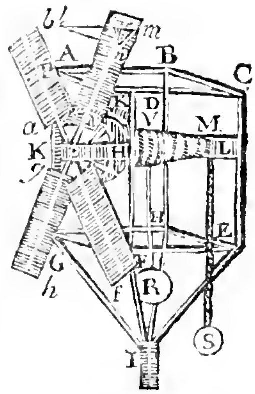
trary motions to reſtore or ſuſtain an equilibrium (we mean in regard of the whole body of it) for wherever one part of the fluid is determined to move, all the reſt muſt neceſſarily follow it; otherwiſe the equilibrium of the air would be deſtroyed in one part to make it good in another a defect which nature cannot be guilty of. Thus, we ſee the tides of the ocean always follow the courſe of the moon from eaſt to weſt, without any motion of the waters from the weſt towards the moon, in the open oceans; and the point R can only be conſidered as the aerial tide, or fluid of high air; and has nearly the ſame phænomena with aqueous tides.

This being clearly underſtood, all the reſt is eaſy; for no one can find it difficult to conceive how the cold air from each pole muſt neceſſarily ſet in towards the equator directly, where meeting and interfering with the eaſtern current, it does with that compound a new direction for the moving air which lies between both the former, *viz.* a north-eaſt current on the north ſide, and a ſouth-eaſt on the ſouth ſide: all which naturally reſults from the doctrine of the compoſition of oblique forces.

And this we find to be verified in the general trade-winds, which conſtantly blow from the north-eaſt and ſouth-eaſt, to about thirty degrees on each ſide the equator, where thoſe parts are over the open ocean, and not affected with the reflection of the ſun-beams from the heated ſurface of the land; for in this caſe the wind will always ſet in upon the land, as on the coaſt of *Guinea*, and other parts of the torrid zone, we know it does.

Velocity and force of the WIND. As the motion of the air has a greater or leſſer velocity, the wind is ſtronger or weaker; and it is found from obſervation, that the velocity of the wind is various, from the rate of 1 to 50 or 60 miles *per* hour. The beſt way to prove this, is to chuſe a free open place, where the wind or current of air is not at all interrupted, but flows uniformly, or as much ſo as the undulatory ſtate of the atmoſphere will admit: in ſuch a place, a feather, or other very light body, is to be let go in the wind; and then by a half-ſecond watch, or pendulum, you muſt obſerve nicely to what diſtance it is carried in any number of half-ſeconds, or in how many half-ſeconds it has paſſed over a given or meaſured ſpace. This will give the rate of velocity in the wind *per* ſecond, and of courſe *per* hour; which has been found, at a medium, to be 1 or 15 miles *per* hour: even the moſt vehement wind does not fly above 50 or 60 miles *per* hour; and ſometimes the wind is ſo ſlow as not to exceed the velocity of a perſon riding or walking in it; and in that caſe, if the perſon goes with the wind, he finds no wind at all, becauſe there is no difference of velocity, or no relative wind, which is that only which we are ſenſible of, whilſt in motion.

The method to eſtimate the force of wind preciſely, is to try it by the following *Anemometer*.



ABCDEFGHI is an open frame of wood firmly ſupported by the ſhaft or poſtern I. In the croſs-pieces HK, LM, is moved an horizontal axis QM, by means of the four ſails *ab*, *cd*, *ef*, *gh*, in a proper manner expoſed to the wind. Upon this axis is fix'd a cone of wood MNO, upon which, as the ſails move round, a weight S, is raiſed, by a ſtring on its ſuperficies, proceeding from the ſmall to the largeſt end NO. Upon the great end or baſe of the cone is fixed a ratchet-wheel *ik*, in whoſe teeth falls the click X, to prevent any retrograde motion from the depending weight.

From the ſtructure of this machine, it is eaſy to underſtand, that it may be accommodated to eſtimate the variable force of the wind, becauſe the force of the weight will continually increaſe, as the ſtring advances on the conical ſurface, by acting at a greater diſtance from the axis. And therefore, if ſuch a weight be put on, on the ſmalleſt part at M, as will juſt keep the machine in equilibrio with the weakeſt wind; then, as the wind becomes ſtronger, the weight will be raiſed in proportion, and the diameter of the baſe of the cone NO, may be ſo large in compariſon of that of the ſmaller end or axis at M, that the ſtrongeſt wind ſhall but juſt raiſe the weight to the great end.

Thus, for example, let the diameter of the axis be to that of the baſe of the cone NO, as 1 to 28, then if S be a weight of 1 pound at M, on the axis, it will be equivalent to 28 pounds, or $\frac{1}{4}$ of an hundred, when raiſed to the greateſt end. If, therefore, when the wind is weakeſt, it ſupports 1 pound on the axis, it muſt be 28 times as ſtrong to raiſe the weight to the baſe of the cone. Thus may a line of 28 equal parts be drawn on the ſide of the cone, and the ſtrength of the wind will be indicated by that number on which the ſtring ſhall at any time hang

The ſtring may alſo be of ſuch a ſize and the cone of ſuch a length, that there may be ſixteen revolutions of the ſtring betwixt each diviſion of the ſcale on the cone, whence the ſtrength of the wind will be expreſſed in pounds and ounces. And of greater exactneſs be required, let the periphery of the cone's baſe be divided into 16 equal parts; then, whenever the equilibrium happens, the ſtring will leave the conic ſurface againſt one of thoſe diviſions, and thus ſhew the force of the wind to a dram avoirdupoiſe weight.

As to *the qualities and effects of the* wind.—1. A *wind* blowing from the ſea is always moiſt: in ſummer it is cold, and in winter warm, unleſs the ſea be frozen up.

2. *Winds* blowing from the continent, are always dry; in ſummer warm, and cold in winter.

The *winds* are divided into *perennial*, *ſtated*, and *variable.*—They are alſo divided into *general* and *particular.*

Perennial, or *conſtant winds*, are ſuch as always blow the ſame way. Of theſe we have a very notable one between the two tropicks, blowing conſtantly from eaſt to weſt; called the *general trade wind.*

Stated, or *periodical winds*, are ſuch as conſtantly return at certain times. Such are the ſea and land breezes, blowing from land to ſea in the evening, and from ſea to land in the morning: though this rule is not general.

Such are alſo the *ſhifting*, or *particular trade winds*, which for certain months of the year, blow one way, and the reſt of the year, the contrary way.

Variable, or *erratick winds*, are ſuch as blow, now this, now that way.

Such are all the *winds* obſerved in the inland parts of *England*, *&c.* though ſeveral of theſe claim their certain times of the day. Thus the *weſt wind* is moſt frequent about noon; the *ſouth wind* in the night; the *north* in the morning, *&c.*

General wind, is ſuch a one, as, at the ſame time, blows the ſame way, over a very large tract of land, almoſt all the year. But even this has its interruptions: for, 1. At land it is ſcarce ſenſible at all, as being broke by the interpoſition of mountains, valley, *&c.* 2. At ſea, near the ſhore, it is diſturbed by vapours, exhalations, and particular *winds*, blowing from landward; ſo that it is chiefly conſidered as general only at mid-ſea: where, 3. It is liable to be diſturbed, by clouds driving from other quarters.

Particular winds include all others, excepting the general *trade winds*. Thoſe peculiar to one little cantoon, or part, are called *topical* or *provincial winds.*——Such is the north *wind*, on the weſtern ſide of the *Alps*, which does not blow above one or two leagues lengthwiſe, and much leſs in breadth: ſuch alſo are the *Pontia's* in *France*, &c.

WHIRL-WIND is a *wind* that riſes ſuddenly, is exceedingly rapid, and impetuous when riſen, but ſoon ſpent.

There are divers ſorts of *whirl-winds*, diſtinguiſhed by their peculiar names; as the *preſter*, *typho*, *ecnephias*, *exhydria*, and *turbo.*

The *preſter* is a violent *wind*, breaking forth with flaſhes of lightning.

The *ecnephias* is a ſudden and impetuous *wind*, breaking out of ſome cloud, frequent in the *Ethiopick* ſea, particularly about the cape of *Good Hope.*—The ſeamen call them *tornados.*

The *exhydria* is a *wind* burſting out of a cloud, with a great quantity of water.

A *typho*, or *vortex*, moſt properly called a *whirlwind*, or *hurricane*, is an impetuous *wind*, turning rapidly every way, and ſweeping all around the place.—It is frequently in the eaſtern ocean, about *Siam*, *China*, &c.

HURRICANE, a furious ſtorm of *wind*, ariſing from a contrariety or oppoſition of ſeveral *winds.*

They begin in the north, ſome ſay, in the weſt, but turn round; and in a little time are through all the points of the compaſs.

All *hurricanes* come either on the day of the full, change, or quarter of the moon; each of which is diſcover'd by a number of phænomena, the preceding quarters, as a turbulent ſky, ſun red, univerſal calm, the ſtars appearing red, noiſes in hollows, or cavities of the earth, ſtrong ſmell of the ſea, a ſettled weſterly wind, *&c.*

The *aqueous* or *watery* METEORS, are compoſed of vapours or watery particles, variouſly ſeparated and condenſed by heat and cold; ſuch are *clouds*, *rainbows*, *hail*, *ſnow*, *rain*, *dew*, and the like.

CLOUD is a collection of condenſed vapours, ſuſpended in the atmoſphere, the particles whereof, collected together, intercept almoſt the whole heat of the ſun, whence thoſe who inhabit the higheſt mountains of the *Pyrenees*, or of the *Alps*, when they are arrived at the region of the *clouds*, are not inſenſible of their entring a thick and opake *cloud.*

AURA SEROTINA, or *evening-dew*, is a *penetrating vapour*, which exalted together with the vapours, by the diurnal heat of the ſun, falls ſoon after ſun-ſet.

The MORNING DEW is a thin, light, inſenſible miſt, or rain, falling while the ſun is below the horizon.—Among the diſſertations of M. *Huet*, is a letter, to ſhew that *dew* does not fall, but riſes.

MAY-DEW whitens linen and wax; the *dew* of autumn is converted into a white froſt. Out of *dew*, putrified by the ſun, ariſes divers inſects, which change apace from one ſpecies into another. What remains is converted into a fine white ſalt, with angles like thoſe of ſalt-petre, after a number of evaporations, calcinations, and fixations.

There

There is a ſpirit drawn from *May-dew*, which has wonderful virtues attributed to it. It is to be gather'd in clean linen cloths, expoſed to the ſun in cloſe vials. *Stolterfold*, a Phyſician of *Lubeck*, thinks *May-dew* may be gather'd in glaſs plates, eſpecially in ſtill weather, and before ſun-riſe. It may likewiſe be collected with a glaſs-tunnel, expoſed to the air, having a crooked neck to bring the *dew* into a vial in a chamber.

Rain is form'd of the concretion of vapours, and deſcending from above in form of drops of water.

But the agent of this formation of the clouds into *rain*, &c. is a little controverted: the common *Peripateticians* will have it, the cold, which conſtantly occupying the ſuperior region of the air, chills and condenſes the veſiculæ, at their arrival from a warmer quarter, congregates them together, and occaſions ſeveral of them to coaleſce into little maſſes: by this means their quantity of matter increaſing in a greater proportion than their ſurface, they become an over load to the thin air, and accordingly deſcend in rain.

Mr. *Derham* accounts for the precipitation, hence; that the veſiculæ being full of air, when they meet with a colder air than that they contain, the air is contracted into a leſſer ſpace, and conſequently the watery ſhell or caſe render'd thicker, ſo as to become heavier than the air, *&c.*

Others only allow the cold a part in the action, and bring in the winds as ſharers with it.

Yet the grand cauſe, according to *Rohault*, is ſtill behind; that author conceives it to be the heat of the air, which after continuing for ſome time near the earth, is at length carried up on high by a wind, and there thawing the ſnowy villi, or flakes of the half-frozen veſiculæ, reduces them into drops, which coaleſcing, deſcend, and have their diſſolution perfected in their progreſs through the lower and warmer ſtages of the atmoſphere.

Others, as Dr. *Clark*, &c. aſcribe this deſcent of the clouds, rather to an alteration of the atmoſphere, than of the veſiculæ, and ſuppoſe it to ariſe from a diminution of the ſpring or elaſtick force of the air.

This elaſticity, which depends chiefly or wholly on the dry terrene exhalations being weakened, the atmoſphere ſinks under its burden, and the clouds fall on the common principle of precipitation.

As to the *quantity of rain* that falls, its proportion in ſeveral places at the ſame time, and in the ſame place at ſeveral times, we have ſtore of obſervations, journals, *&c.* in the memoirs of the *French* Academy, the *Philoſophical tranſactions*, &c. an idea whereof will not be unacceptable.

Upon meaſuring then, the *rain* falling yearly, its depth at a medium, is found as in the following tables.

Depth of the Rain *in* falling yearly, *and its proportion in ſeveral places.*

At *Paris*, in *France*, obſerv'd by M. *de la Hire*	19 *Inch.*
At *Liſle*, in *Flanders*, by M. *Vauban*	24
At *Piſa*, in *Italy*, by Dr. *Mich. Ang. Tilli*	43 ¼
At *Townly* in *Lancaſhire*, by Mr. *Townly*	42 ½
At *Upminſter*, in *Eſſex*, by Mr *Derham*	19 ¼
At *Zurich*, in *Switzerland*, by D. *Scheuchzer*	52 ¼

Proportion of the Rain *of* ſeveral Years *to one another.*

At Paris.			At Upminster.	
21 *Inch.*	38 *cent.*	1700	19 *Inch.*	03 *cent.*
27	78	1701	18	69
17	42	1702	20	38
18	51	1703	23	99
21	20	1704	15	81
14	82	1705	16	93

Proportions of the Rain *of the* ſeveral ſeaſons *to one another.*

1708	Depth at Piſa.	Depth at Upminſt.	Depth at Zurich.	1708	Depth at Piſa.	Depth at Upminſt.	Depth at Zurich.
	Inch.	*Inch.*	*Inch*		*Inch.*	*Inch.*	*Inch.*
Jan.	6 41	2 88	1 64	*July*	0 00	1 11	3 50
Febr.	3 28	0 46	1 65	*Aug.*	2 27	2 94	3 15
March	2 65	2 03	1 51	*Sept.*	7 21	1 46	3 02
April	1 25	0 96	4 69	*Octob.*	5 33	0 25	2 24
May	3 33	0 02	1 91	*Nov.*	0 13	0 86	0 62
June	4 90	2 32	5 91	*Dec.*	0 00	1 97	2 62
Half year	28 81	10 67	17 31	*Half year*	14 94	8 57	15 35

Preternatural Rains, or *ſhowers*, as of blood, *&c.* are very common in our annals, and even natural Hiſtories, yet if ſtrictly pry'd into, will be all found no other things than *rain.*

Snow, *nix*, ſeems to be nothing elſe but a meteor formed in the middle region of the air; of vapours raiſed by the action of the ſun or ſubterraneous fire, there congealed, its parts conſtipated, its ſpecifick gravity increaſed, and thus returned to the earth in form of little white villi or flakes.

The *ſnow* we receive may properly enough be aſcribed to the coldneſs of the atmoſphere, through which it falls. When the atmoſphere is warm enough to diſſolve the *ſnow* before it arrives at us, we we call it *rain*; if it preſerves itſelf undiſſolved, it makes what we call *ſnow*.

Dr. *Grew*, in a diſcourſe on the nature of *ſnow*, obſerves, that many parts thereof are of a regular figure, for the moſt parts are ſo many little rowels or ſtars of ſix points, and are perfect and tranſparent ice, as any we ſee on a pond, &c. Upon each of theſe points are other collateral points ſet at the ſame angles as the main points themſelves: among which there are divers other irregular troops, which are chiefly broken points, and fragments of the regular ones.

But when the little cluſters or flakes of the congealed vapour, are liquified by a warm air, and meet afterwards in their deſcent with a colder air, they are then changed into *hail*, whoſe grains acquire a different figure, according to the different ſolutions of the flakes. Sometimes it is round, ſometimes angular, triangular, pyramidal, &c. ſometimes thin and flat, ſtar-like, with ſix equal points, &c.

HAIL is obſerved frequently to attend thunder and lightning; the nitre that contributes to the one, having likewiſe a large ſhare in the production of the other.

Natural Hiſtories furniſh us with various inſtances of extraordinary ſhowers of *hail*.

From theſe I'll paſs to the rainbow, and other *amphatical* impreſſions, as the *halo*, *par. lium*, and *paraſelene*.

The RAINBOW is a meteor in form of a party-coloured arch or ſemicircle, exhibited in a rainy ſky, oppoſite to the ſun, by the refraction of its rays in the drops of falling rain.

There is alſo a ſecundary or fainter *rainbow*, uſually ſeen inveſting the former at ſome diſtance; and among naturaliſts we read of lunar *rainbows*, marine *rainbows*, &c.

The *rainbow*, Sir *Iſaac Newton* obſerves, never appears, but where it rains in the ſun-ſhine, and may be repreſented artificially, by contriving waters to fall in little drops like rain, through which the ſun ſhining, exhibits a *bow* to the ſpectator, placed between the ſun and the drops; eſpecially if a dark body, *e. gr.* a black cloth be diſpoſed beyond the drops.

To conceive the origin of the *rainbow*, we muſt conſider what will befal rays of light, coming from a very remote body, *e. gr.* the ſun: and falling on a globe of water, ſuch as we know a drop of rain to be.

Suppoſe than A D K N, See *table* of OPTICKS, *Fig.* 12. to be a drop of rain, and the lines E F, B A, O N, to be rays of light coming from the center of the ſun; which by reaſon of the immenſe diſtance of the ſun, we conceive to be parallel. Now the ray B A being the only one that falls perpendicularly on the ſurface of the water, and all the reſt obliquely; it is eaſily inferred, that all the other rays will be refracted towards the perpendicular.

Thus the ray E F, and others accompanying it, will not go on ſtrait to G; but as they arrive at H I, deflect from F to K, where ſome of them, probably, eſcaping into the air, the reſt are reflected upon the line K N, ſo as to make the angles of incidence and reflection equal.

Farther, as the ray K N, and thoſe accompanying it, fall obliquely upon the ſurface of the globule; they cannot paſs out into the air, without being refracted, ſo as to recede from the perpendicular L M; and therefore will not proceed ſtrait to Y, but deflect to P.

It may be here obſerved, that ſome of the rays arriving at N, do not paſs out into the air, but are again reflected to Q; where being refracted like the reſt, they do not proceed right to Z, but declining from the perpendicular T V, are carried to R; but ſince we here only regard the rays, as they may affect the eye, placed a little below the drop, *e. gr.* at P, thoſe which deflect from N to Q, we ſet aſide as uſeleſs, becauſe they never come at the eye. On the contrary, it is to be obſerved, that there are other rays, as 2, 3, and the like; which being reflected from 3 to 4, thence to 5, and from 5 to 6, may at length arrive at the eye placed beneath the drop.

Thus much is obvious; but to determine preciſely the quantities of refraction of each ray, there muſt be a calculation; by ſuch calculation it appears, that the rays which fall on the quadrant A D, are continued in lines, like thoſe here drawn in the drop A D K N; wherein there are three things very conſiderable: *Firſt*, that the two refractions of the rays in their ingreſs and egreſs, are both the ſame way, ſo that the latter does not deſtroy the effect of the former. *Secondly*, that of all the rays paſſing out of A N, N P, and thoſe adjoining to it, are the only ones capable of affecting the ſenſe: as being ſufficiently cloſe or contiguous; and becauſe coming out parallel; whereas the reſt are divaricated, and diſperſed too far to have any ſenſible effect, at leaſt to produce any thing ſo vivid as the colours of the *bow*. *Thirdly*, that the ray N P has ſhade or darkneſs under it; for ſince there is no ray comes out of the ſurface N 4, it is the ſame thing as if the parts were cover'd with an opake body. We might add, that the ſame ray N P, has darkneſs above it; ſince the rays that are

are above it are ineffectual; and ſignify no more than if there were none at all.

Add to theſe, that all the effectual rays have the ſame point of reflection, *i. e.* the parallel and contiguous rays, which alone are effectual after refraction, will all meet in the ſame point of the circumference; and be reflected thence to the eye.

Farther it appears by calculation, that the angle O N P, included between the ray N P, and the line O N, drawn from the center of the ſun, which is the angle whereby the *rainbow* is diſtant from the oppoſite point of the ſun, and which makes the *ſemidiameter of the bow*, contains 41° 30′.

But ſince, beſides thoſe rays coming from the center of the ſun to the drop of water, there are many more from the ſeveral points of its ſurface: there are a great many other effectual rays to be conſidered; eſpecially that from the uppermoſt, and that from the loweſt part of the ſun's body.

Since then the apparent diameter of the ſun, is about 16 ſeconds, it follows that an effectual ray from the upper part of the ſun, will fall higher than the ray E F, by 16 ſeconds: this does the ray G H, *Fig.* 13. which being refracted as much as E F, deflects to I, then to L, and at length emerging equally refracted with the ray N P, proceeds to M; and makes an angle O N M, of 41°, 14′, with the line O N.

In like manner the effectual ray Q R, coming from the loweſt part of the ſun, falls on the point R, 16 min. lower than the point F, on which the ray E F falls; and being refracted declines to S; whence it is reflected to T; where emerging into the air, it proceeds to V; ſo as the line T V, and the ray O T, contain an angle of 41°, and 46′.

Again, upon computing the deflections of the rays, which like that 23, *Fig.* 14. coming from the center of the ſun, and being received into the lower part of the drop, we have ſuppoſed to be twice reflected, and twice refracted, and to enter the eye like that 67, *Fig.* 16. we find that which may be accounted effectual, as 67, with the line 86, drawn from the center of the ſun, contains an angle 867, of about 62 degrees: whence it follows, that the effectual ray from the higheſt part of the ſun, with the ſame line 86, includes an angle leſs by 16 min. and that from the loweſt part of the ſun, an angle greater by 16 min.

Thus ſince A B C D E F, is the path of the efficacious ray, from the higheſt part of the ſun to the eye in F: the angle 86 F becomes of about 51°, 44′. In like manner, ſince G H I K L M is the way of an effectual ray from the loweſt part of the ſun to the eye, the angle 86 M, becomes nearly of 52°, 16′.

Since then we admit ſeveral rays to be effectual, beſides thoſe from the center of the ſun; what we have ſaid of the ſhade, will need ſome alteration: for of the three rays deſcribed, *Fig.* 12, and 13. only the two extreme ones will have a ſhadow joined to them, and that only on the outer ſide. Hence it is evident, that theſe rays are perfectly diſpoſed to exhibit all the colours of the priſm.

For the great quantity of denſe or intenſe light, *i. e.* the bundle of rays collected together in a certain point, *v. gr.* in the point of reflection of the effectual rays, may be accounted as a livid or radiant body, terminated all around by ſhade. But the ſeveral rays thus emitted to the eye are both of different colours, and are differently refracted out of the water into air, notwithſtanding their falling alike upon the refracting ſurface.

Hence it follows, that the different or heterogeneous rays will be ſeparated from one another, and will tend ſeveral ways; and the homogeneous rays will be collected, and tend the ſame way; and therefore this livid point of the drop wherein the refraction is effected, will appear fringed or bordered with ſeveral colours; that is, red, green, and blue colours will ariſe from the extreams of the red, green, and blue rays of the ſun tranſmitted to the eye from ſeveral drops, one higher than another; after the ſame manner as is done in viewing livid, or other bodies through a priſm.

Thus, adds Sir *Iſaac Newton*, the rays that differ in refrangibility, * will emerge at different angles; and conſequently, according to their different degrees of refrangibility, emerging moſt copiouſly at different angles, will exhibit different colours in different places,

A great number then of theſe little globules being diffuſed in the air, will fill the whole place with theſe different colours; provided they be ſo diſpoſed, as that effectual rays may come from them to the eye; and thus will the *rainbow* at length ariſe.

Now to determine what that diſpoſition muſt be; ſuppoſe a right line drawn from the center of the ſun, through the eye of the ſpectator, as the line V X, *Fig.* 13. called the line of aſpect; being drawn from ſo remote a point, it may be eſteemed parallel to all other lines drawn from the ſame point: but a right line falling on two paral-

* *Refrangibility* of light is the diſpoſition of the rays to be refracted. That a *greater* or *leſs refrangibility*, is a diſpoſition to be more or leſs refracted, in paſſing at equal angles of incidence, into the ſame medium.

lels, makes the alternate angles. If then an indefinite number of lines be imagined drawn from the fpectator's eye to a part oppofite to the fun where it rains; which lines make different angles with the line of afpect, equal to the angle of the refraction of the differently refrangible rays, *e. gr.* angles of 41°, 46′ and of 41°, 30′, and of 41°, 40′. Thefe lines falling on drops of rain illuminated by the fun, will make angles of the fame magnitude, with rays drawn from the center of the fun to the fame drops. And therefore the lines thus drawn from the eye, will reprefent the effectual rays that occafion the fenfation of any colour.

That, *e. gr.* making an angle of 41°, 46′, reprefenting the leaft refrangible or red rays of the feveral drops, and of 41°, 40′, the moft refrangible or violet rays: the intermediate colours and refrangibilities will be found in the intermediate fpace.

Now it is known that the eye being placed in the vortex of a cone, fees objects upon its furface as if they were in a circle; and the eye of our fpectator is here in the common vortex of feveral cones, formed by the feveral kinds of efficacious rays, with the lines of afpect. And in the furface of that whole angle where the vortex or eye is the greateft, and wherein the others are included, are thofe drops or parts of drops which appear red: and in the furface of that cone whofe angle is leaft, are the purple drops: and in the intermediate cones are the green, blue, &c. drops. Hence then feveral kinds of drops muft appear as if difpofed into fo many circular colour'd fafciæ or arches, as we fee in the *rainbow*.

This part of the folution, Sir *Ifaac Newton* expreffes more artfully, thus: fuppofe O, *Fig.* 15. *optic.* the eye, and O P a line parallel to the fun's rays, and let P O F, P O F be angles of 40°, 17′, and 42°, 2′. And fuppofe the angle to turn about their common fide O P, with their other fides O E and O F, they will defcribe the bounds or verges of the *rainbow*.

For if E F, be drops placed any where in the conical furface defcribed by O E, O F; and be illuminated by the fun's rays S E, S F, the angle S E O being equal to the angle P O E or 40° 17′ fhall be the greateft angle in which the moft refrangible rays come after reflection be refracted to the eye; and therefore all the drops in the line O E, fhall fend the moft refrangible rays moft copioufly to the eye, and thereby ftrike the fenfes with the deepeft violet colour in that region.

And in like manner the angle S F O being = to the angle P O F = 420° 2′ fhall be the greateft, in which the leaft refrangible rays, after one reflection, can emerge out of the drops; and thefe rays fhall come moft copioufly to the eye from the drops in the line O F, and ftrike the fenfes with the deepeft red colour in that region.

And by the fame argument the rays, which have intermediate degrees of refrangibility, fhall come moft copioufly from drops between E and F, and fo ftrike the fenfes with the intermediate colours, in the order which their degrees of refrangibility require; that if the progrefs from E to F, or from the infide of the bow to the outfide, in this order, *violet*, *indico*, *blue*, *green*, *yellow*, *orange*, *red*; though the violet, by the mixture of the white light of the clouds will appear faint, and incline to a purple.

And fince the lines O E, O F may be fituated any where in the abovementioned conical furface; what is faid of the drops and colours in thefe lines is to be underftood of the drops and colours throughout the whole fuperficies. Thus is the primary or *inner bow* formed.

As to the *fecundary* or *fainter bow*, ufually furrounding the former; in affigning what drops would appear coloured, we exclude fuch as lines drawn from the eye, making angles a little greater than 40° 2′ fhould fall upon; but not fuch as fhould contain angles much greater.

For, if an indefinite number of fuch lines be drawn from the fpectator's eye, fome whereof make angles of 50° 57′ with the line of afpect *e. gr.* O G, otherwife angles of 54° 7′ *e. gr.* O H; thofe drops whereon thefe lines fall, muft of neceffity exhibit colours, particularly thofe of 50° 57′.

E. gr. the drop G will appear red, the line G O being the fame with an effectual ray; which after two reflections and two refractions, exhibits a red colour. Again, thofe drops which receive lines of 54° 7′ *e. gr.* the drop H will appear purple, the line O H, being the fame with an effectual ray, which after two reflections and two refractions, exhibits purple.

Now there being a fufficient number of thefe drops, it is evident there muft be a fecond *rainbow*, formed after the like manner as the firft.

Thus Sir *Ifaac Newton*, in the leaft refrangible rays, the leaft angle at which a drop can fend effectual rays after two reflections, is found by computation to be 50° 57′, and in the moft refrangib'e the leaft angle is found 54° 7′.

Suppofe then O the place of the eye, as before, and P O G, P O H to be angles of 50° 57′ and 54° 7′; and thefe angles to be turned about their common fide O P, with their other fides O G, O H, they will defcribe the verges or borders of the *rainbow* C H D G.

For

For if G H be drops placed any where in the conical superficies described by O G, O H, and be illuminated by the sun's rays; the angle SGO, being equal to the angle P O G or 50° 57′ shall be the least angle, in which the then less refrangible rays shall come most copiously to the eye from the drops in the line O G, and strike the senses with the deepest red in that region.

And the angle S H O, being equal to P O H, 54 shall be the least angle, in which the most refrangible rays after two reflections, can emerge out of the drops; and therefore those rays should come most copiously to the eye from the drops in the line O H, and so strike the senses with the deepest violet in that region.

And by the same argument, the drops in the region between G and H shall strike the senses with the intermediate colours, in the order which their degrees of refrangibility require, that is, in the progress from G to H, or from the inside of the bow to the outer, in this order; *red*, *orange*, *yellow*, *green*, *blue*, *indico*, *violet*.

And since the lines O G, O H, may be situated any where in the conical surface; what is said of the drops and colours in those lines, is to be understood of the drops and colours every where in these superficies.

Thus are formed two *bows*, an interior and stronger, by one reflection; and an exterior and fainter by two; the light becoming weaker and weaker by every reflection.

Their colours will lie in a contrary order to one another, the first having the red without, and the purple within; and the second, the purple without and red within, and so of the rest.

This doctrine of the *rainbow* is confirmed by an easy experiment; for upon hanging up a glass globe full of water in the sunshine, and viewing it in such a posture as that the rays which come from the globe to the eye, may with the sun's rays, include an angle either of 42°, or 50°; if, *e. gr.* the angle be about 42°, the spectator supposed at O, will see a full red colour in that side of the globe opposite to the sun, as at F. And if that angle be made a little less, suppose by depressing the globule to E, the other colours, yellow, blue, and green, will appear successively in the same side of the globe, also exceedingly bright.

But if the angle be made about 50°, suppose by raising the globule G, there will appear a red colour in that side of the globe towards the sun, though that somewhat faint; and if the angle be made greater, suppose by raising the globe to H, the red will change successively to the other colours, yellow, green, and blue.

The same thing is observed in letting the globe rest, and raising or depressing the eye to make the angle of a just magnitude. This is called an *artificial rainbow*.

Des Cartes was the first who took the *dimensions of the rainbow*, and determined the diameter thereof, by laying it down, that the magnitude of the *bow* depends on the degree of refraction of the fluid, and assuming the ratio of the sine of incidence to that of refraction, to be in water as 250 to 187.

But Dr. *Halley* has since, in the *Philosophical Transactions*, given us a simple direct method of determining the diameter of the *rainbow* from the ratio of refraction of the fluid being given; or *vice versâ*; the diameter of the *rainbow* being given to determine the refractive power of the fluid. The praxis is as follows.

First, The ratio of refraction being given, to find the angles of incidence, and refraction of a ray which becomes effectual after any given number of reflections. Suppose any given line, as A C (*ibid. Fig.* 17.) which divide in D, so as that A C be to A D, in the ratio of refractions; and again divide it in E, so as A C be to A E, as the given number of reflections increased by what unity is to unity; with the diameter C E describe a semicircle C B E, and from the center A with the radius A D, describe an arch D B intersecting the semicircle in B: then drawing A B, C B, A B C, or its complement to two right angles, will be the angle of incidence, and A C B the angle of refraction required.

Secondly, The ratio of refraction and any angle of incidence being given, to find the angle which a ray of light emerging out of a refracting sphere, after a given number of reflections, makes with the line of aspect, or an incident ray; and consequently to find the diameter of the *rainbow*. The angle of incidence and the ratio of refraction being given, the angle of refraction is given; which angle being multiplied by double the number of reflections increased by 2, and double the angle of incidence subtracted from the product, the angle remaining is the angle sought.

Thus supposing the ratio of refraction to be, as Sir *Isaac Newton* has determined it, *viz.* as 108 to 81, in the red rays, as 109 to 81 for the blue rays, *&c.* the preceding problem will give the distance of the colours in the

1st Rainbow	Red,	42° 11′	the spectator's back being turn'd to the sun.
	Violet,	40 16	
2d Rainbow	Red,	50 58	
	Violet,	54 9	

If the angle made by a ray after three, or four reflections, were required, and therefore the dia-

 meter.

meter of the third and fourth *rainbow* (which are ſcarce ever ſeen, by reaſon of the great diminution of the rays, by ſo many repeated reflections) they will be found,

3d Rainbow	Red,	41°	37′	the ſpectator being turned towards the ſun.
	Violet,	37	9	
4th Rainbow	Red,	43	52	
	Violet,	49	34	

Hence the *breadth of the rainbows* is eaſily found: for the greateſt ſemi-diameter of the firſt *bow*, i. e. from red to red, being 42°, 1′, and the leaſt, *viz.* from violet to violet, 40°, 16′; the breadth of the *faſcia* or *bow*, meaſured a-croſs from red to violet, will be 1°, 45′; and the greateſt diameter of the ſecond *bow*, being 54°, 9′, and the leaſt 50°, 58′. the breadth of the *faſcia* will be 3°, 10′; and hence the diſtance between the two will be found 8°, 15′.

In theſe meaſures the ſun is only eſteemed a point; wherefore as its diameter is really about 30′, ſo much muſt be added to the breadth of each *faſcia* or *bow*, from red to violet, and ſo much be ſubtracted from the diſtance between them.

This will leave the breadth of the *primary bow*, 2°, 15′; that of the *ſecondary bow*, 3°, 40′: and the interval between the two *bows* 8°, 25′; which dimenſions deduced from calculation, Sir *Iſaac Newton* aſſures us from his own obſervations, agree very exactly with thoſe found by actual menſuration in the heavens.

The moon ſometimes alſo exhibits the phænomenon of an *iris* or *bow*; by the refraction of her rays in the drops of rain in the night-time.

Ariſtotle ſays, he was the firſt that ever obſerved it; and adds, that it never happens, *i. e*, is never viſible, but at the time of the full moon.

Halo, called alſo *corona*, is a *meteor* in form of a luminous ring or circle. It differs from the rainbow in that it is almoſt always of one colour, and is oftner round the moon than round the ſun.

The *halo* is ſuppoſed to ariſe from a refraction of the rays of light in their paſſing through the fine, rare veſiculæ of a thin nubecula or vapour, towards the top of our atmoſphere; which account is confirmed hence, that a quantity of water being thrown up againſt the ſun, as it breaks and diſperſes into drops, it forms a kind of *halo* or *iris*, exhibiting the colours of the natural ones.

Parelium, or *parhelion*, is a mock ſun or meteor, in form of a very bright light, appearing aſide of the ſun, formed by the reflection of his beams, in a cloud properly poſited.

The *parelia* uſually accompany the coronæ or luminous circles; are placed in the ſame circumference, and at the ſame height. Their colours reſemble thoſe of the rainbow, the red and yellow on the ſide towards the ſun, and the blue and violet on the other. Though there are coronæ ſometimes ſeen entire, without any *parelia*; and *parelia* without coronæ.

M. *Des Cartes* is of opinion, *Diſſert. ultim. Meteor.* that *parelia* are formed by the ſun, painting his image either double or triple, &c. in a high circle drawn round a congealed and poliſhed cloud, by means of a reflected or refracted light.

The Paraselene, or *mock moon*, is a meteor or phænomenon encompaſſing or adjacent to the moon, in form of a luminous ring; wherein is ſometimes obſerved one, ſometimes two apparent images of the moon.

The *paraſelenes* are formed after the ſame manner as the *parelia*.

I think it not improper to join to this treatiſe of the different phænomena, which appear in the *air*, a conciſe diſſertation on thoſe, which appear on *earth*, and particularly on that extraordinary one of the *flux* and *reflux* of the ſea.

The Flux and Reflux, or *ebb* and *flow* of the ſea, are two periodical motions of the waters of the ſea.

Dr. Halley has deduced a theory of the *tides* from the *Newtonian* principles, in the following manner: and ſays,

1. That as the ſurface of the earth and ſea is naturally globular; if we ſuppoſe the moon perpendicularly over the ſurface of the ſea; it is evident, that the water neareſt the moon will gravitate towards it more than any other part of the earth and ſea in that hemiſphere. That part of the waters therefore muſt by this means be raiſed towards the moon, *i. e.* it will be lighter than uſual, and therefore will ſwell there.

For the ſame reaſon, the water the moſt remote from the moon, will gravitate leſs towards the ſame, than any other part of the earth or ſea in the ſame hemiſphere. The water here, therefore, muſt approach leſs towards the moon than any other part of the globe, *i. e.* it muſt be raiſed contrariwiſe, as being lighter than uſual, and will therefore ſwell in that remote part.

By this means, the ſurface of the ocean muſt neceſſarily form itſelf into a ſpheroidal or oval figure; having a diameter longer than the other, as already obſerved in *Des Cartes*'s Syſtem. And thus the moon ſhifting her poſition in her diurnal motion round the earth, this oval of water muſt ſhift with her; by which means are affected thoſe two floods and ebbs, obſervable every 25 hours.

2. Since

2. Since in the conjunctions and oppositions of the sun and moon, the gravitation of the water to the sun conspires with its gravitation towards the moon; but in the quadratures, the water raised by the sun is depressed by the moon: hence it is that the *tides* are greater in the *syzyges* than in the quadratures.

That in effect there are two *tides* every natural day, from the action of the sun, as there are in the lunar day from that of the moon; all governed by the same laws: only those caused by the sun are much less than those caused by the moon; because though the sun be ten thousand times bigger than both the earth and moon, yet he is at so immense distance, that the earth's semi-diameter bears no proportion thereto.

Hence the different *tides* depending on the particular actions of the sun and moon, are not distinguished but confounded. The lunar tide is somewhat changed by the action of the sun; and this change varies every day, by reason of the inequality between the natural and lunar day.

3. Since the greatest *tides* about the equinoxes (*viz.* those happening in the syzyges) arise from the sun and moon being in the equinoctial, and those about the solstices from the sun an moon being in the tropicks; for this reason those greatest *tides* about the equinoxes are greater than those about the solstices; since the greater the circle is, wherein the waters move, the greater is their agitation. And if the moon stood still in the pole, the swelling would become immoveable above the pole, and the high water be fixed therein.

4. Since the *tides* are somewhat changed by the libration of the waters, which us'd to retain a motion impressed on them for some time; for this reason the highest *tides* are not precisely in the very conjunction and opposition of the moon, but two or three *tides* afterwards.

5. Since the sun is somewhat nearer the earth in winter than in summer; hence it is that the greatest equinoctial *tides* are observed to be a little before the vernal equinox, and a little after the autumnal one.

6. Since the greatest of the two tides happening in every diurnal revolution of the moon, is that wherein the moon is nearest the zenith or nadir: for this reason, while the sun is in the northern signs, the greater of the two diurnal *tides* in our climates, is that arising from the moon above the horizon; when the sun is in the southern signs, the greatest is that arising from the moon below the horizon.

7. Such would the *tides* regularly be, if the earth were covered with sea very deep; but by reason of the shoalness of some places, and the narrowness of the streights in others, by which the *tides* are propagated, there arises a great diversity in the effects not to be accountable for, without an exact knowledge of all the circumstances of the place; as the position of the land, and the breadth and depth of the channels, &c.

For a very slow and imperceptible motion, of the whole body of water, where it is (for example) two miles deep, will suffice to raise its surface 10 or 12 feet in a *tide*'s time; whereas if the same quantity of water were to be conveyed through a channel of 40 fathom deep, it would require a very great stream to effect it in so large inlets as are the channel of *England*, or the *German* ocean; whence the tide is found to set strongest in those places where the sea grows narrowest, the same quantity of water being in that case to pass through a smaller passage.

This is most evident in the *Streights* between *Portland* and cape *de la Hogue* in *Normandy*, where the *tide* runs like a sluice; and would be yet more between *Dover* and *Calais*, if the *tide* coming round the island did not check it.

And this force being once impressed between the water, continues to carry it above the level of the ordinary height in the ocean, particularly where the water meets a direct obstacle, as it does in St. *Malo*; and where it enters into a long channel, which running far into the land, grows very strait at its extremity, as it does at the *Severn* sea, at *Chepstow*, and *Bristol*.

This shoalness of the sea, and the intercurrent continents, are the reasons that in the open ocean, high-water is not at the time of the moon's appulse to the meridian, but always some hours after it, as it is observed upon all the western coast of *Europe* and *Africa*, from *Ireland* to the cape of *Good Hope*; in all which a south-west moon makes high-water, and the same is reported to hold in the west of *America*.

It would be endless to recount all the particular solutions, which are only corollaries from this doctrine; as why the lakes and seas, such as the *Caspian* sea, and the *Mediterranean* sea, the *Black* sea, and *Baltick*, have no sensible *tides*.: for lakes having no communication with the ocean, can neither increase or diminish their water, whereby to rise and fall; and seas that communicate by such narrow inlets, and are of so immense an extent, cannot in a few hours time receive and empty water to raise or sink their surface any thing sensibly.

To demonstrate the excellency of this doctrine, the example of the *tides* in the port of *Tonquin* in *China*; which are so extraordinary, and different from all others we have yet heard of, may suffice. In this port there is but one flood and ebb in 24 hours, and twice in each month; *viz.* when the moon is near the equinoctial, there is no *tide* at all, but the water is ſtagnant; but with the moon's declination there begins a *tide*, which is greateſt when ſhe is in the tropical ſigns; only with this difference, that when the moon is to the northward of the equinoctial, it flows when ſhe is above the earth, and ebbs when ſhe is under, ſo as to make high water at moon-ſetting, and low-water at moon-riſing: but on the contrary, the moon being to the ſouthward, makes high-water at riſing, and low-water at ſetting, it ebbing all the time ſhe is above the horizon.

The cauſe of this odd appearance is ſuggeſted by Sir *Iſaac Newton*, to ariſe from the concurrence of two *tides*, the one propagated in ſix hours out of the great *South Sea* along the coaſt of *China*, the other out of the *Indian Sea* from between the iſlands, in twelve hours, along the coaſt of *Malacca* and *Camboya*—The one of theſe *tides* being produced in north latitude, is, as has been ſaid, greater, when the moon being to the north of the equator, is above the earth; and leſs, when ſhe is under the earth.—The other of them, which is propagated from the *Indian Sea*, being raiſed in ſouth latitude, is greater when the moon declining to the ſouth, is above the earth; and leſs, when ſhe is under the earth: ſo that of theſe *tides*, alternately greater and and leſſer, there come always ſucceſſively two of the greater, and two of the leſſer together every day, and the high-water falls always between the arrival of the two greater floods; and the moon coming to the equinoctial, and the alternate floods becoming equal, the *tide* ceaſes, and the water ſtagnates; but when ſhe has paſſed to the other ſide of the equator, thoſe floods which in the former order were the leaſt, now becoming the greater, that which before was the time of the high-water, now becomes the low-water, and the converſe: ſo that the whole appearance of theſe ſtrange *tides* are, without any forcing, naturally deduced from theſe principles, and is of great argument, ſay the *Newtonians*, for the certainty of the whole theory.

The next conſiderable phænomenon which happens in the terraqueous globe, is an *earthquake*.

Earthquake is a vehement ſhake or agitation of ſome conſiderable place, or part of the earth, from natural cauſes; attended with a huge noiſe like thunder, and frequently with an eruption of water, or fire, or ſmoak, or wind, &c.

Earthquakes are the greateſt and moſt formidable phænomena of nature.—*Ariſtotle* and *Pliny* diſtinguiſh two kinds, with reſpect to the manner of the ſhake, *viz.* a *tremor*, and a *pulſe*; the firſt being horizontal, in alternate vibrations, compared to the ſhaking of a perſon in an ague; the ſecond perpendicular, up and down: which latter kind are alſo called by *Ariſtotle* Βρασται from the reſemblance of their motion to that of boiling.

Naturaliſts are divided on the cauſes of *earthquakes*. Some aſcribe *earthquakes* to water, others to fire, and others to air; and all of them with a great appearance of reaſon. To conceive which it is to be obſerved, that the earth every where abounds in huge ſubterraneous caverns; veins, and canals, particularly about the roots of mountains: that of theſe cavities, veins, &c. ſome are full of water, whence are compoſed gulphs, abyſſes, ſprings, rivulets; and others full of exhalations; and that ſome part of the earth are replete with nitre, ſulphur, bitumen, vitriol, &c.

This premiſed. Some are of opinion, 1. That the earth itſelf may be the cauſe of its own ſhaking; when the roots or baſis of ſome large maſs being diſſolved, or wore away by a fluid underneath, it ſinks into the ſame, and with its weight occaſions a *tremor* of the adjacent parts; produces a noiſe, and frequently an inundation of water.

2. That the ſubterraneous waters may occaſion *earthquakes*, by their overflowing, cutting out new courſes, &c. and that the waters being heated, and rarefied by the ſubterraneous fires, may emit fumes, blaſts. &c. which by their action, either on the water, or immediately on the earth itſelf may occaſion great ſuccuſſions.

3. That the air may be the cauſe of *earthquakes*; for air being a collection of fumes and vapours raiſed from the earth and water; if it be pent up in too narrow viſcera of the earth, the ſubterraneous, or its own native heat, rarefying, and expanding it, the force wherewith it endeavours to eſcape, may ſhake the earth: hence there ariſe divers ſpecies of *earthquakes*, according to the different poſition, quantity, &c. of the impriſoned air.

Laſtly, that fire is a principal cauſe of *earthquakes*; both as it produces the aforeſaid ſubterraneous aura, or vapour: and as this aura, or ſpirit, from the different matter or compoſition, whereof ariſe ſulphur, bitumen, and other inflammable matters, is kindled either from ſome other fire it meets withal, or from its colliſion againſt hard bodies, or its intermixture with other fluids; by which means burſting out into a greater compaſs, the place becomes too narrow for it; ſo that preſſing againſt it on all ſides, the adjoining parts are ſhaken; till having made itſelf a paſſage, it ſpends itſelf in a volcano, or burning mountain.

This laſt ſentiment is very near that of Dr. *Liſter*, who ſays, that the material cauſe of thunder, lightning, and *earthquakes*, is one and the ſame, *viz.* the inflammable breath of the pyrites, which is a ſubſtantial ſulphur, and takes fire of itſelf.

The

The difference between these three terrible phænomena's he takes only to consist in this; that this sulphur in the former is fired in the air; and in the latter under ground: which is a notion that *Pliny* had long before him; *quid enim*, says he, *aliud est in terrâ tremor, quam in nube tonitru?*

MIDWIFRY.

MIDWIFRY, is the art of helping or assisting a woman in labour, so as to facilitate her delivery, without any danger to the woman or to her fruit.

To proceed with the same order on this important subject, as I have done on all others, I must begin by *pregnancy*, the *different sorts thereof*, and the *signs of a true*, or *false pregnancy*, &c. all that could be previous to it has been explained in my treatise of *Anatomy*.

PREGNANCY, properly taken, is a tumour of the belly, caused by the infant situated in the womb.

The symptoms of a *pregnancy* are, when in a few days after the conjugal act, a small pain is perceived about the navel, attended with some gentle commotions in the bottom of the abdomen, the suppression of the menses, or their flowing in less quantity than usual, vomiting, loathing, longing, &c. the breasts beginning to swell, grow hard and painful, and contain a little milk. The nipples also becoming larger, firmer, and darker coloured, a livid circle appearing round them, the eyes seeming sunk and hollow: but the most certain sign is, if by introducing the finger in the *vagina*, the inward orifice of the matrice is found exactly shut, without any hardness, and in a good situation, as likewise a considerable distension of the body of the matrice.

The embrio is percived to move about the fourth month, sometimes sooner, sometimes later, according to its strength; for some women feel it as soon as the second month, or even sooner; and others about the third month only, or later.

Women who have a *false conception*, have their belly equally distended on all sides; and those big of a *true conception* have theirs prominent in the middle, and the navel much more raised: therefore in the doubt of a *pregnancy* of four or five months or more, if the navel of the woman is found sunk, and the orifice of her womb small and hard, it is almost an infallible sign that she is not big of a natural conception.

These false *pregnancies* happen commonly to women who are not regular as they should be, in the evacuation of their menses, either for quantity or quality, and for the time they must flow; but particularly from 35 to 40 years of age; because that evacuation begins at that age, not to be so regular as before: therefore in those suspicions of *pregnancy*, one must above all things inform himself of the manner women used to have their menses, as well as of all other dispositions which preceded and accompanied the swelling of the belly, but particularly of the disposition of the navel, and of the internal orifice of the matrice.

The just, and more certain judgment that can be formed of *pregnancy*, proceeds from the inward orifice of the matrice, which the nearer her term a woman is, grows thinner, shorter, and more flattened.

Thus it is very easy to gratify the curiosity of a woman, who desires to know if she be with child or not; but it is absolutely impossible to discover if it be with a boy or a girl.

We must next instruct the pregnant woman, *in what manner she is to govern herself during the whole course of gestation, when accompanied with no considerable accidents, and how to avoid those she is exposed to.*

I'll confine myself, in this place, to caution them against the most dangerous accidents they are exposed to; beginning by a concise and general regimen.

That regimen consists principally in refraining as much as possible, the depraved appetite they are troubled with during the time of gestation; which they may do by avoiding with care, all they are conscious could occasion or indulge those depraved appetites, vulgarly called *longings*; and consulting, in those occasions, their reason, the health and preservation of their fruit, rather than their depraved imagination, or their sensuality.

It would be very proper, that a woman should abstain from *coition*, for several days after she has conceived, for the great emotions, during the amorous embraces, may be a great obstacle to the formation of the fœtus; according to this advice of *Hippocrates, lib. de sterelibus, Si mulier*, says he, *se concepisse cognoverit, primo tempore non amplius ad virum accedat, sed quiescat.*

A woman with child must also avoid, if possible, all sorts of violent exercises, particularly dancing, jumping, riding, &c. because those violent exercises cause often an abortion, by relaxing the ligaments of the matrice. Though a moderate exerciſe, contribute more to a ſafe and quick delivery, than all the means art can ſupply us with. A moderate exerciſe, beſides, renders the preparation and coction of the aliments the fœtus is fed with in the womb. more laudable, and free from that great quantity of terreſtrial and phlegmatick particles, a bad digeſtion, occaſioned by the inaction of the mother, would leave them loaded with; whereby the fœtus itſelf would become heavy, lumpiſh, and almoſt uncapable of moving in the womb; and at laſt fix on one ſide rather than the other, to which laſt accident the little quantity of the water it floats in contributes.

So ſoon as a woman knows herſelf with child, ſhe is not to lace herſelf too cloſe, for while ſhe expects to ſave her fine ſhape, ſhe prejudices her child, by confining him within thoſe ſtays, and thereby either hindering him from growing, or forcing him to come before his time, or rendering him counterfeit; and miſſing beſides her chief end; for thoſe women, who thus endeavour to appear of a fine ſhape, though they be big with child, ſpoil their belly, which after their delivery, remains hanging as a bag; for the belly, by being thus confined, finding no room to dilate itſelf equally on all ſides, is forced to dilate only towards the bottom, which bears all the burden.

Women with child being often ſubject to be hard bound, becauſe the matrice, by its weight preſſing hard on the inteſting *rectum*, is an obſtruction to the natural evacuation of the excrements, thoſe afflicted with that incommodity, muſt abſtain from all ſorts of aliments which could contribute towards it, by increaſing the heat of the entrails, a pregnancy is but too often accompanied with it; but above all, from the immoderate uſe of ſpirituous liquors. The frequent uſe of roaſted apples, of boiled prunes, of figs, and of all that can open the body, proves very beneficial to women who find themſelves extremely conſtipated, during geſtation: and if thoſe things are not ſufficient, gliſters muſt be adminiſtered to them; of a decoction of marſhmallows, parietary and annis-ſeeds, in which muſt be diſſolved two ounces of brown coarſe ſugar, adding to it a ſpoonful of ſweet oil; avoiding above all things thoſe irritating glyſters which would excite a looſeneſs, or a too great evacuation, which would cauſe an abortion or miſcarriage.

A pregnant woman ſhould never be frightned nor ſurprized by any bad news, capable to excite within her an exceſſive uneaſineſs, or ſorrow; for thoſe paſſions, when violent, are capable to throw the whole Oeconomy of the generation into a diſorder or confuſion, and even make a woman miſcarry at that very inſtant.

Vomiting and the ſuppreſſion of the menſes, are often the firſt ſigns whereby women perceive that they are with child. That vomiting is not always excited, as it has been falſly imagined, by the humours gathered in the ſtomach by the ſuppreſſion of the menſes, eſpecially in the firſt days of their pregnancy; but it is occaſioned by the ſympathy which is between the ſtomach and the matrice, by reaſon of the ſimilitude of their ſubſtance, and that the nerves inſerted in the ſuperior orifice of the ſtomach, have communication by the ſame continuity, with thoſe which run to the matrice, which are portions of the ſixth pair of thoſe of the brain; ſo that the matrice, which by reaſon of its membranous compoſition, has a very exquiſite ſenſe, happening to dilate itſelf in the pregnancy, is then ſuſceptible of ſome pain, which being communicated at the ſame time by means of the continuity of the nerves, to the ſuperior orifice of the ſtomach, cauſes thoſe vomitings and nauſea's which commonly happen, eſpecially in the firſt month of geſtation.

In the firſt month of geſtation, *vomiting* is but a ſimple ſymptom, not at all dangerous; but if it continues longer, it extremely debilitates the ſtomach, renders the digeſtion of the aliments imperfect, which generates a great quantity of humours in the viſcera, which muſt be purged. Add to this, that the continual ſubverſions of the ſtomach, cauſing a great agitation and compreſſion of the belly of the mother, would procure an abortion.

The remedies preſcribed by ſome Phyſicians, to ſtop theſe vomitings when they laſt too long, and are too violent, are all ſorts of gentle catharticks, which purge gently downwards, as manna, rhubarb, tamarind, caſſia, ſyrup of violets, of chichory, &c. For my part, though I approve this practice, I would preſcribe previouſly to it ſome drops of laudanum, to appeaſe the convulſive motions of the ſtomach, and then preſcribe the catharticks, to evacuate the humours which debilitate the digeſtive faculty of its diſſolvent.

The pains cauſed by the *extenſion*, *dilatation*, or even *laceration* of the ligaments of the matrice, are often remedied by the woman keeping her bed for ſome days, by bleeding, and by ſome fomentations on the part, made with emollient herbs, boiled in lees of wine. If thoſe pains, eſpecially thoſe in the *loins*, are accompanied with ſome excretions of the matrice, which had not appeared before, and thoſe excretions are tinged with blood, it is certain that the matrice begins to open, and there will be a miſcarriage. If by ſome violent ſhake or fall the ligaments of the matrice be broken, and the woman cannot be perſuaded to keep her bed, her belly muſt

be

be supported by a bandage made for the purpose, and wait as patiently as she can for the time of her delivery.

As to the pains in the breasts. So soon as a woman has conceived, her monthly evacuations being stopped, though she continues to make daily new blood, it is necessary, that as there is none consumed during the first month of gestation, the vessels which are too full, should overflow those parts which are the most disposed to receive it: as are the glands and glandulous bodies, particularly the breasts, which receive abundance of it, which filling and swelling them extremely, causes those pains which women with child feel in them, to which those who have only a suppression of their menses are subject likewise.

In those beginnings a woman must only take care not to hurt those parts by lacing her stays too close, to avoid contusions, which would perhaps degenerate into inflammations, and those inflammations into abscesses: but when after the third month of gestation, the blood flows thither in too great abundance, it must be evacuated by bleeding in the arm, which is the surest remedy on those occasions.

The most dangerous symptoms a woman with child is subject to, are a *cough*, and a *difficulty of respiration*, especially if the cough be very violent, which often causes a miscarriage.

Whatever may be the cause of the *cough* of a woman with child, she must abstain from all the aliments which could increase it, such as salt, pepper, and all sorts of acids; using those which can help towards sweetning the mass of the blood. I would prescribe to her every other night, when she goes to bed, a large glass of emulsion, made with the four large cold-seeds, and the syrup of maidenhair, and a dyet drink made with jujubes, dates, and liquorice.

If the difficulty of respiration and cough proceeds from the matrice pressing too hard on the diaphragm, there is no better remedy than a moderate exercise. All other remedies prescribed on that occasion are needless.

As to the *various swellings and pains in the thighs and legs*, some begin the cure of this distemper by bleeding the arm, which cannot be disapproved, provided it does not exceed three ounces.

The same superfluous blood, stopped by the suppression of the menses, which causes the various swelling of the thighs and legs, causes likewise the *hæmorrhoides* or *piles*, almost all breeding women are afflicted with.

If they be small and without pain, whether internal or external, it suffices to hinder them from growing bigger; which may be done by remedies proper to dissipate the fluxion, but the cure of those extremely swelled, must be began by appeasing the pain; which is done by *bleeding* the woman once or twice in the arm, and ordering her to abstain from coition, or any thing else which can contribute towards over-heating her. But if the excrements stopped in the rectum, be the cause of the *hæmorrhoides*, they must be evacuated by a glyster made only with a decoction of bran, and some leaves of marsh-mallows, adding to it a spoonful of honey, and another of oil of sweet almonds; lining the canule or clyster-pipe with the gut of a chicken, for fear it should hurt the anus. The *piles*, if they be external, must also be anointed with an ointment made of *populeum*, and an oyster-shell calcined, very well pounded, and mixed afterwards with the *populeum*.

If the tumour be not dissipated by the aforesaid remedies, *leeches* must be applied to the anus, which by their sucking will empty the blood stopped in those parts.

It happens also, that a woman with child is often afflicted with an *immoderate flux of the belly*, or *looseness*.

There are three different sorts of these *fluxes*, the first called *lienterick*, in which the aliments are evacuated with very little appearance of digestion, proceeding from the imbecillity of the stomach: the second *diarrhæick*, when the excrements are evacuated without any considerable pain in the intestines: and the third, which is the most dangerous, is the *dysenterick*, whereby the patient voids blood together with the humours and excrements, with violent pains caused by the ulceration of the intestines.

Of what sort soever be the flux of the belly, if it be immoderate, and continues long, it always puts the woman with child in great danger of abortion. If it be a *lienterick flux*, caused by the immoderate and extravagant appetite of the pregnant woman; that appetite must be refrained above all things; in lieu thereof she must make use of good aliments of an easy digestion, and in a small quantity at once, till the stomach has recovered its former strength.

When the flux is *diarrhæick*, and nothing else is evacuated but the excrements contained in the intestines, there is not the least danger, provided it be not attended with pains, and does not continue long, when one must content himself then with moderating that flux without stopping it. But if it lasts longer than four or five days, it must be stopped by degrees, in purging, by means of gentle cathartick, the acrimonious humours, which are the cause thereof.

But if notwithstanding the aforesaid regimen and

and remedies, the flux continues, and is changed into a *dyſenteria*, the ſtools of the patient being very frequent, painful, and bloody, then ſhe is in great danger of miſcarrying; which muſt be avoided if poſſible, by preſcribing to her, beſides the remedy above mentioned, ſome drops of laudanum, and clyſters made with a decoction of the leaves and roots of plantain, of red roſes, and pomegranate-peel, boil'd in the water of a forge, to which may be added two drachms of ſanguis draconis, or an infuſion of rhubarb in good old red wine, the extract of mars aſtringent, and a julep made of plantain water, and ſyrup of quinces, an ounce of each, and fifteen drops of laudanum. But the purgatives muſt be uſed before the aſtringents, ſince they are preſcribed to carry off the cauſe of the diſtemper, which otherwiſe would return, even with more violence than before, if we minded nothing elſe but how to appeaſe its ſymptoms.

If the flux ſhould continue, a revulſion muſt be made, by bleeding in the arm, if the ſtrength of the woman will allow it; preſcribing afterwards ſome pleaſant ſtyptick.

There is a great difference betwixt the flux abovemention'd, and what is called *a loſs of blood*, or *flooding*; for in this the blood flows from the bottom of the matrice, with pain in abundance, and without interruption, unleſs ſome clods of congealed blood, ſeem ſometimes to diminiſh the accident, by ſtopping, for a ſhort time, the place whence it flows; but ſoon afterwards, thoſe clods of blood being expelled, or falling of themſelves into the matrice, it begins to flow anew, with ſtill greater violence than before; which ſoon cauſes the death both of the mother and child, unleſs it be remedied, by the quick delivery of the woman; or if ſhe be not far gone in her pregnancy, by the expulſion of the embrio, which I know by experience gives immediate relief; and for which I have preſcribed with great ſucceſs, *a few drops of oil of guaiacum.*

As to *the weight, and bearing down, or relaxation of the matrice in women with child.* Whatever may be the cauſe of the *bearing down of the matrice*, the beſt remedy is for the woman to keep her bed; for while ſhe is up, the weight of the part increaſes the relaxation of the ligaments; and if her circumſtances will not allow it, ſhe muſt wear a peſſary, to keep the part in its natural ſituation: and if her belly be very high, it muſt be ſupported by a large bandage made for that purpoſe.

As to the *hydropſy of the matrice*, it is nothing elſe but a quantity of water gathered in the capacity of the matrice. This accident has often deceived Phyſicians, Surgeons, Midwives, and the patients themſelves, who expecting to be delivered of a child, void only abundance of water.

The beſt remedy for thoſe ſorts of hydropſies, if there be a child with it, is to wait with patience the hour of the delivery, uſing at the ſame time deſiccative remedies. If there be nothing but water contained in the matrice, the half-bath is very proper to make it open, as are likewiſe all the remedies which provoke the menſes, and if thoſe remedies have no effect, the woman muſt be preſcribed the uſe of mineral waters.

As to the *œdematous ſwelling of the labia of the pudendum.* The matrice is often ſo full of humidities, that they overflow on the outward parts, eſpecially on the *labia* of the *pudendum.*

This ſwelling of the labia of the matrice is lucid and almoſt tranſparent, much like an hydrocelle; it muſt be remedied by opening the ways of the urine, with ſome diureticks.

I'll conclude this conciſe account of the maladies a woman with child is ſubject to, *by the abortion, and cauſes thereof.* When the child is already formed, and has began to have life, let it be ever ſo little, if it happens to come out before the time appointed by nature, it is an *abortion*; which can happen from the end of the ſecond month, or even before, to that of the ſeventh only; for after that time, it is always a true labour; becauſe the child being then ſtrong enough, and having a ſufficient perfection, can live, which it cannot before that time.

All ſorts of violent maladies, can be the cauſe of *abortion*, becauſe they kill the child, who being dead cannot remain long in the matrice; which alſo puts the mother in danger of her life, who often periſhes ſoon after her miſcarriage, or even before. Even intermittent fevers alone, can cauſe an *abortion*, by exciting falſe pains in the womb, which occaſion a real labour. A violent and frequent vomiting, and the pains in the loins, and the violent cholicks, can cauſe the ſame accident. Likewiſe the ſtrangury, becauſe there happens then continually, very ſtrong compreſſions of the abdomen, for the evacuation of the urine.—A violent cough by its frequent agitation, puſhing ſuddenly and with great efforts the diaphragm downwards, gives, likewiſe, violent ſhakes to the matrice.—A violent looſeneſs puts a woman with child in danger of miſcarrying; and much ſooner, if afterwards there happens a teneſma, *i. e.* frequent and violent motions to go to ſtool.

If the menſes flow much during geſtation, it is impoſſible the child ſhould be ſtrong, ſince in that evacuation,

evacuation, there happens a very great diſſipation of the ſpirits of the mother; and the matrice being too much humected, relaxes and opens eaſily.

But one of the moſt dangerous accidents, which cauſe an *abortion* or miſcarriage, is the ſeparation of the after-birth from the matrice.—The hydropſy of the matrice hinders the child from being brought to perfection.

All that agitates, and ſhakes violently the body of a woman with child, is capable to cauſe a miſcarriage; as a violent work, a ſtrong contuſion, or motion, either in falling, jumping, dancing, running a foot, or on horſeback, riding in a coach, or in a cart, hollowing, laughing immoderately, or ſome blow received on the belly. — A ſudden and unexpected violent noiſe, like that of thunder, cannon, &c. can alſo cauſe an abortion, if it be attended with fear, eſpecially in young women. — Fœtid and ſtinking ſmells, can alſo contribute to a miſcarriage, and particularly that of charcoal.

There are alſo indiſpoſitions of the matrice, which produce the ſame accident; as when it is callous or ſo ſmall, or ſo much compreſſed by the epiplon, that it cannot extend itſelf ſo much as it is neceſſary to lodge the child at eaſe, with the after-birth, and the water it ſwims in. —This can happen, likewiſe, if the woman, to appear a fine ſhape, laces herſelf too cloſe, or makes uſe of a buſk.—The frequent uſe of coition, eſpecially towards the latter months of geſtation, can produce the ſame accident; becauſe the matrice then being extremely full, inclines much downwards, and its internal orifice being very near, is puſhed upwards by the penis, which thereby excites it ſometimes to open ſooner than it ſhould.

There are likewiſe, cauſes of abortion, which proceed from the children themſelves, as when they are monſtrous; when they have not a natural ſituation; which diſturb them ſo much, that they force the matrice to expel them; and likewiſe when they are ſo big that it cannot contain them till term, nor the mother ſupply them with a ſufficient quantity of aliments.

As to *the ſigns of an approaching miſcarriage.* —If one perceives, that after one, or ſeveral of the accidents above ſpecified, a woman has a great pain in her belly, and about her loins, and with it, ſome clods of blood are voided through the matrice, and the membranes of the child are broken, *they are ſure ſigns* of an approaching miſcarriage, which in that caſe cannot be prevented by any remedy whatever. If a woman feels a great weight in her belly, which falls as a lump on that ſide the child lies, and her matrice voids ſtinking and cadaverous humidities, it is a ſign that ſhe is to miſcarry ſoon of a dead child.

It is certain, that a woman who miſcarries, is in a much greater danger of her life, than one who goes her full time; becauſe, *abortion* is entirely againſt nature, and is very often accompanied with a great loſs of blood, which is more or leſs dangerous, according as the cauſe of abortion is more or leſs violent, whether it has been occaſioned by remedies taken inwardly, or by ſome blow, fall, &c.

The beſt and moſt ſpecifick remedies for all the external accidents, which can cauſe an abortion, is the repos; which muſt be proportioned to the violence of the accident. If a woman is to be let blood, after a violent fall, blow, &c. to prevent a miſcarriage, it ſhould be done as ſoon as poſſible.

From this *theoretical* part of *Midwifry*, I'll paſs to the *practical* part thereof; where I'll treat of a *natural labour*, and of thoſe which are *againſt nature*, teaching the manner of helping a woman in the former, and how to remedy all the others; beginning by informing the reader what we underſtand by *delivery*, *the differences, and different terms thereof.*

We underſtand by delivery the emiſſion, or extraction of a child at term. out of the matrice; which definition includes both the *natural labour*, and thoſe *againſt nature.*

A *natural labour*, muſt be *at term*; it muſt be quick, and without any conſiderable accident; the child muſt be *alive*, *well form'd*, preſenting himſelf in a *natural ſituation*; for if there be any of thoſe four conditions wanting, the labour is againſt nature: and much more ſo, if ſeveral of them are wanted.

The *ſigns which precede a natural labour*, and which happen a few days before, are, that the woman begins to feel ſome uncommon pains in her loins, and the tumour of her belly which was very high, falls down all on a ſudden, which hinders her from walking ſo eaſily as ſhe uſed to do, and cauſes her frequent motions of making water; there flows then from the matrice certain ſlimy humidities, deſigned by nature to humect the paſſage, and render it ſlippery, that the inward orifice thereof may be eaſily dilated when wanted.

The *ſigns which accompany a preſent labour*, i. e. indicate that a woman is really in *labour*, are that ſhe feels great pains towards the region of the reins and loins, which coming and growing ſtronger by intervals, are felt in the bottom of her belly. All her privy parts are tumefied, becauſe the head of the child when near the paſſage puſhes forward the neighbouring parts, which appear tumefied likewiſe; and when a vomiting happens, it is commonly a ſign that the woman ſhall be ſoon

 delivered,

delivered, becauſe thereby the pains grow more frequently greater and longer; ſhort and ſmall pains, though frequent, rendering moſt commonly a labour very tedious, and exhauſting the ſtrength of a woman. When the humidities, voided at that time through the matrice, are tinged with blood, it is an infallible mark that the woman will ſoon be delivered; and then if the finger be introduced into the neck of the matrice, its inward orifice will be found open, and the mouth thereof; the membranes in which the child is contained, preſent themſelves, which membranes are ſtrongly compreſſed, at every pain the woman feels, during which they are felt to reſiſt, and appear to the finger more or leſs hard, as the pains are more or leſs ſtrong. Afterwards the pains growing continually ſtronger and ſtronger, the membranes break by the ſtrong impulſion of the waters, which are evacuated in an inſtant; and then the child is eaſily felt, ſince it preſents itſelf at the aperture of the inward orifice of the matrice.

When all thoſe ſigns, or part of them, meet together, whether the woman be at term or not, one may be ſure that ſhe'll ſoon be delivered. She muſt not be put in labour, before the neceſſity thereof be known by thoſe ſigns; otherwiſe it would be tormenting the mother and her child in vain, and put them both in danger of their lives; for though the inward orifice of the matrice, be ſometimes enough dilated, for the introduction of the finger into it, and the head of the child is even felt through the membranes, and the woman feels ſome pains in the abdomen, one muſt not always conclude hence, that ſhe is then really in labour; for though there be a great appearance of it, the thing notwithſtanding is not entirely ſure, unleſs thoſe pains be felt at the bottom of the belly, and the waters to range themſelves between the head of the child and the membranes: therefore that circumſtance muſt be carefully obſerved, to avoid miſtakes in the prognoſtick.

As to the membranes of the fœtus, are the parts which are formed firſt, after the conception, in order to preſerve the ſeed of the man, and hinder the diſſipation of the ſpirits it is impregnated with, whereby the intention of nature would be fruſtrated; they are likewiſe thoſe, which together with the waters, preſent themſelves firſt at the paſſage in the time of the delivery.

The waters gather'd in the membranes, ſerve to facilitate the motion of the child, by its ſwimming in them, and leſt by his frequent motions he ſhould wound the matrice, in ſtriking againſt it, which would ſometimes cauſe abortion. They defend him, beſides, againſt external injuries, in eluding the violence of the blows which the woman could receive on her belly; and contribute much towards rendering the extraction of the child eaſy in the delivery, becauſe they render the paſſage very ſlippery; and humecting the orifice of the matrice, makes it to dilate itſelf much better, when they come to flow, when the child is ready to come into the world, or a little before: for otherwiſe the delivery would be attended with more difficulties, and the mother more tormented.

I'll paſs to the parts, by means whereof the child receives its food in the matrice; which parts are the *placenta*, and the *umbilical veſſels*.

The Placenta is a fleſhy and ſpongeous maſs, ſemblable, in ſome meaſure, to the ſubſtance of the melt, for the greateſt part is compoſed of an infinity of veins, arteries, and lacteal veſſels.

The *placenta*, is formed of an accumulation of the menſtrual blood of the matrice.

When there are two children in the matrice, and even where there are three, if they be true twins, *i. e.* generated of one and the ſame coition, they have commonly but the ſame *placenta* with only as many ſtrings terminated to it, as there are children; which notwithſtanding are entirely ſeparated from one another by their particular membranes, in which each child is contain'd with his waters a-part; unleſs they have their bodies adherent to one another; in which caſe, twins of that nature, who, therefore are monſtrous, have likewiſe the ſame waters, and the ſame common membranes. But if there be a *ſuperfetation*, there will be as many *placenta's* as there are children. But tho' a ſingle after-birth be oftener common to ſeveral children, it has been obſerv'd, that the veſſels of the navel-ſtring of each child, both the veins and arteries, diſtributed or ramified throughout the whole ſubſtance of that common after-birth, are always entirely ſeparated from one another; ſo that the veſſels, which ſerve to feed one child, have no communication by *anaſtomocis*, nor otherwiſe, with thoſe deſtined to feed the other children. Which is the cauſe that each child having his principle of food and life, ſeparately from one another, and being lodg'd in different membranes and waters, one of thoſe children, can ſometimes be dead in the womb, while the other remains alive; provided the dead child does not remain long enough in the matrice to be corrupted.

From the middle of the after-birth ariſes a ſtring, compoſed of ſeveral veſſels join'd together. Some authors reckon four of thoſe veſſels, *viz.* two veins, and two arteries; and others five, adding the ouraque to it: but it is very certain, that there are but three veſſels to the human fœtus, *viz.* a vein, and two arteries.

Thoſe

Those three vessels which compose the string are enveloped with a pretty strong and thick membrane.

All children, whether males or females, are commonly situated in the middle of the matrice. Their postures and figures, are different according to the times of the pregnancy. For in the first months, the embrio is always found of a round figure, a little oblique, having its back-bone moderately bowed inward, the thighs folded, and a little rais'd. to which the legs are joined; so that the heels approach the buttocks, and the extremities of the feet are turned inwards; its arms are bowed, and its hands near the knees, towards which its head inclines, leaning forwards in such a manner, that its chin touches the breast. The embrio has then its backbone turn'd towards that of its mother, its head upwards, its face forwards, and its feet downwards, and in proportion as it grows, extends its members, which it had exactly folded during the first months.

We must not imagine, notwithstanding, that the child is always precisely in the posture above described, since it changes sometimes that of its arms and legs, in bending or extending them more or less, throwing them from one side to the other, according as it is excited to it, by several different causes, as women with child can witness, who feel it move its parts in a different manner after which it generally re assumes its former situation above described.

The child keeps commonly that first situation, till the seventh or eighth month, when its head being grown very big, it tumbles downwards by its own weight, against the inward orifice of the matrice, its feet being then upwards, and its face turn'd towards the buttocks of the mother; and when it is turned contrariwise, that is not not natural; for besides that, the face of the child coming outward, would be much bruised by the bones of the woman; the labour-pains could not push the child so easily out of the matrice, as they do when it has its body and face downwards; in which case the matrice, as well as the muscles of the abdomen of the mother, contracting themselves at the time of the pains, on the back of the child, who resists the pain by that situation, its head is much easier forced through the passage.

When a woman with child is happily gone her full time, and falls in labour, she must be succoured in the following manner.

When by the signs heretofore mentioned, which precede and accompany the labour, one is convinced, that a woman is ready to lay in. The midwife is to begin by making the patient walk in her apartment, if her strength permits, giving her from time to time, especially immediately after she has took a pain, two or three spoonfuls of white wine, burnt with cinnamon, but never any spirituous liquor, unless it be when the labour is tedious, two spoonfuls of cinnamon water, though I would prefer to it a drachm of confection alkermes; recommending her, above all things, to reap all the fruit she can of her pains, by stopping her breath, and forcing strongly downwards, while she feels them.

The midwife must feel from time to time the inward orifice of the matrice, to discover if the waters are ready to break, and if the delivery will soon follow; keeping all the while near the patient, to observe narrowly her motions, and complaints, for thereby one may judge well enough if the work goes forward, without being obliged to feel the woman often downwards.

There are some women, the inward orifice of whose matrice cannot be felt at the beginning of their labour. Because they have that orifice situated very high towards the *rectum*. Notwithstanding which, if the child be well turn'd, and the woman be really in labour, the head of the child is felt, through the substance of the matrice, to come down by degrees, and to resist strongly enough, to feeling, when the woman takes her pains.

The patient may lie down by intervals, to recruit her exhausted spirits, but she must take care not to lie long; though when a woman begins to be in labour, and her pains are small and tedious, without any preparation of the water, she must not be fatigued by making her set up too long. It is much better to make those sort of women lie down, and keep them very warm in their bed, to ripen their labour, till the waters begin to form themselves, as it should be; after which she may get up, if the midwife judge proper, to increase, by that situation, the strong pains, which come at that time.

When the waters of the child are well prepared and formed, the midwife must let them break of themselves, without attempting to do it; for under pretence of forwarding her work by thus lacerating the membranes, she on the contrary retards it, by that accelerated evacuation of the waters, which must serve to make the child slide with more facility, and leaves it dry; which afterwards hinders the pains from forcing it out so easily, as they would have done.

When the waters are broken of themselves, the midwife will easily touch the child by the part which presents itself first, and be sure if it comes naturally, *i. e.* the head foremost, which she'll feel hard, big, round, and even; but if it be another part, she'll feel something uneven, and hard, or soft, more or less, according to the part, which presents itself.

Immediately after she must make haste to put the woman to bed, if she is not there already, to help her in her delivery, which commonly happens soon after, if it be natural. But if she finds that the child presents itself in a situation quite different from the natural, and knows herself not capable to perform the operation, so as to save the mother and the child, she is obliged in conscience to send as soon as possible for a man midwife, without waiting to the last extremity.

The woman in labour being placed in a proper posture, and the waters broken, the man midwife or midwife, shall introduce a finger into the inward orifice of the matrice, to know if it be the head of the child, which presents itself; then having anointed his hand with pomatum or fresh butter, or otherwise he'll put, at the time of the pains, the ends of his fingers into the orifice of the matrice to dilate it, in parting them from one another. When the head of the child shall begin to appear, the midwife must push up the sides of the matrice towards the back part of the head of the child, who when advanced forward as far as to the ears, must be taken with both hands on the two sides, and, at the first great pain, draw, not in a direct line, but wavering, and his face downwards; observing carefully, that the naval-string may not be turned round the child, for it would be broke, and one would pull too hard on the matrice. When the shoulders shall appear, the midwife must slide her fingers under the arms, and draw the child, who must be put on its side, its face towards her, lest the blood and waters, which flow immediately, should suffocate it, by falling into its mouth and nose.

The next thing a man-midwife or midwife must do, is to see if there be no other child left in the matrice, for it happens often, that there are two, and sometimes more; which is easily discovered by that the labour's pains continue after the birth of the child, and the woman's belly is still extremely big; but to be better convinced of it, if she introduces her hand into the entrance of the matrice, she'll feel other waters in other membranes, with a child presenting itself at the passage.

In that case the woman must not be delivered of the after-birth till after she has been delivered of her other children, because twins having most commonly but the same placenta for all, though there be several navel-strings with as many separations of the membranes, if it was extracted after the birth of the first child, the other children would be in some danger of their lives, because that part is absolutely necessary to them while they are in the matrice; and that extraction would cause a great loss of blood to the mother. Therefore the navel-string of the first child must be cut off, after it has been tied with a strong thread four times double, fastning the end thereof to the thigh of the woman, not for fear it should re-enter the matrice, but to hinder it from discommoding the woman, in hanging between her legs, making likewise another ligature at its extremity, to hinder the evacuation of the blood: after which, having given that first born child to another person, the midwife shall make no difficulty to break immediately the membrances of the other child, for the evacuation of the waters (in case they are not broken of themselves) because the first having made the passage, the birth of the second is thereby accelerated, of whom she must be delivered, observing all the same circumstances, prescribed for the first; which done, she must be delivered of the after-birth.

A woman must be delivered of the after-birth, as soon as the child is out of the matrice, and even before the naval-string is tied and cut; for fear the matrice, which as soon as delivered of its burden, contracts itself as fast as possible to re-assume its natural situation, should close itself, and thereby hinders (as it happens but too often) the extraction of the after-birth, which corrupting soon in the matrice, if it be left in it, either entire, or in part, causes very dangerous symptoms to the mother, and sometimes her death.

To deliver the woman of the after-birth, the midwife must make two turns round her left-hand with the navel-string, or with the same hand lay hold of it with a dry cloth, lest it should slip between her fingers, and with the right take it only, above the left, near the pudendum, drawing likewise very softly with that hand, and leaning the ends of two fingers joined together, or only that of the index of the same right hand, extended and carried to the entrance of the vagina, on that navel-string, according to its length; observing always to draw, and lean particularly towards the side where the after-birth is less adherent, and not to take the navel-string covered over with the membranes of the child.

To facilitate the expulsion of the after-birth, the woman must blow hard into one of her hands shut, as she would do into a bottle, to discover if it be flawed, or blow her nose hard, or thurst a finger into her mouth, as if she would excite herself to vomit; or stopping her breath, force downwards, as if she would go to stool; since all these different motions and agitations produce the same effect.

If notwithstanding all these efforts, the woman cannot be delivered of the after-birth, the nurse or some other skilful woman, must pass softly her hand over the belly of the patient, drawing it downwards in manner of friction, and if all this will not do, the hand must be introduced at last into the matrice, to extract it. There are sometimes

likewise

likewiſe, after-births ſo monſtrouſly big, that it is impoſſible to extract them, though the navel-ſtring holds faſt to them.

In thoſe caſes the man-midwife having well anointed his hand with oil or pomatum, and pared his nails, muſt introduce it into the matrice, to ſeparate the after-birth from it as gently as poſſible, and draw it out together with the clods of blood, which might be along with it. When the navel-ſtring is not broken, it ſerves to guide the hand to the place where the after-birth is ſituated; but when it is broke, the operator muſt take a particular care not to miſtake one part for the other, and draw the matrice; which will be eaſily avoided, if one has learned, that having introduced his hand into the matrice, he'll ſoon diſcover the difference between it and the after-birth, in that the after-birth is full of little inequalities, produced by the roots of the umbilical veſſels on that ſide they terminate in it; beſides, the veſſels ramified throughout its whole ſubſtance are eaſily felt, which ſubſtance is much more ſoft than that of the matrice.

But if notwithſtanding all theſe endeavours, the after-birth cannot be extracted, and if the matrice, becauſe of its inflammation, cannot be dilated enough to go and fetch it without an extreme violence, or if it be ſo adherent that it cannot be ſeparated from it; then to avoid a greater evil, moſt phyſicians and men-midwives are of opinion, that the operation ſhould be left to nature, helping it by means of remedies which can bring the after-birth to ſuppuration.

The remedies uſed in thoſe caſes are injections into the matrice made with a decoction of mallows, marſh-mallows, parietary, and lin-ſeed, to which muſt be added oil of ſweet almonds, or of white lilies; adminiſtring beſides to the patient pretty ſtrong glyſters, that the efforts ſhe'll make to go to ſtool, may accelerate the evacuation of the after-birth, by which means ſeveral evacuate it with the ſtools, without being ſenſible of it.

At the ſame time to avoid a fever or any other dangerous accidents, ſhe may be let blood in the arm or in the foot, according as it will be judged proper or neceſſary; ſtrengthening her the while with good cardiacks, good broth, made with veal and chickens, and now and then a glaſs of very good wine, mixed with water, provided ſhe has no fever.

Theſe inſtructions are ſufficient for *natural delivery*, I'll paſs to thoſe *relating to preternatural ones.*

There are three ſorts of *preternatural deliveries*, viz. the *laborious*, the *difficult*, and that entirely *againſt nature.*

A *laborious delivery* is that whereby the mother and her child (though he comes into the world in a natural ſituation) ſuffer much.—The *difficult* is no otherwiſe different from the *laborious*, than by its being attended with ſome accidents which retard it, and render it difficult.

But the *delivery againſt nature*, is that which by reaſon of the ſituation of the child, can never be done without the aſſiſtance of the operation of the hand.

The difficulties a delivery is attended with, happen either from the part of the mother, or from the child, and often from both.

If the difficulty proceeds from the part of the mother, ſhe being too young, and too ſtrait; ſhe muſt be handled gently, and her paſſages ſoftned with oil, pomatum, or freſh butter, anointing them with thoſe things long before the hour of her delivery, to relax them, and render them more eaſy to be dilated, leſt a laceration of ſome parts would happen when the child comes into the world.

If the woman be advanced in years, and pregnant of her firſt child, ſhe muſt likewiſe anoint her parts, to ſoften the inward orifice of the matrice, which being harder, cannot be ſo eaſily dilated as in young women, which renders the labour of women advanced in years always much more tedious than that of others.

Little, or ill-ſhaped women, muſt not be put to bed to be delivered, till after the waters are broken; but are to ſtand up, and walk in the room, if their ſtrength permits it, being ſupported under the arms; for thus they will have their reſpiration more eaſy and free, and take a far greater advantage of their pains, than if they were on their bed.

A lean woman muſt humect her parts, by anointing them with oil, pomatum, *&c.* to render them ſofter, and more ſlippery, that the head of the child may not remain long in the paſſage, nor be compreſſed or bruiſed, by the hardneſs of the bones of the mother which form the paſſage.

A weak woman muſt be cheared up, that ſhe may ſupport the pains of her labour, with ſome good burnt wine or other comfortable things, according to the exigency of the caſe. If ſhe is fearful, ſhe muſt be comforted with the hope of being ſoon delivered, if on the contrary her pains be ſmall, ſhort, with long intervals between, and of a bad ſort, flying back towards the reins, or if ſhe has none, they muſt be provoked by giving her pretty ſtrong glyſters, and other proper remedies: for I moſt commonly preſcribe in thoſe caſes a large ſpoonful or two of a ſtrong tincture of cinnamon, to which I add a few drops of that of ambergreaſe, and three drops of oil of guaiacum; which remedy ſerves likewiſe, when the pains which, were very good at the beginning, are quite gone.

If

If the woman has a violent flooding, or convulsions, she must be delivered as soon as possible. If the excrements be retained, and she cannot void them of herself, the expulsion thereof must be excited by glysters. for they cause violent pains which are needless and bad, because they are dispersed throughout the belly, without forcing downwards. And if she cannot make water because of the excessive compression of the matrice on the neck of the bladder, the woman herself must lift up her belly a little with her hands, and if it cannot be done otherwise, a hollow probe must be introduced into the bladder to facilitate the evacuation of the urine. If the difficulty of the delivery proceeds from the bad situation of the woman, she must be put into another agreeable to her shape, observing all the circumstances heretofore mentioned.

If the woman be surprized with some malady, the cure thereof must be undertaken according to the nature thereof, but with still more precaution than at another time:—If it be by reason of the indispositions of the matrice alone, as of its obliquous situation, one must remedy it as well as he can by that of the body. If it be by its vicious conformation, having its neck hard, callous, and too narrow, it must be anointed with oil or pomatum, as above-mentioned. If it was by some strong cicatrice which could not be softened, proceeding from an ulcery which had preceded, or of some laceration made by a violent delivery, which had likewise been glutinated, the separation thereof must be made with a proper instrument, lest another laceration should happen in another place, which would render the case worse afterwards; and which must be made in the place that is judg'd most convenient; avoiding to do it towards the superior part, because of the bladder.

If the membranes of the waters be so strong, that they cannot break at the time of the delivery, they may be broken with the fingers, provided the child be then very far advanced at the passage, and follows soon after that laceration, the inward orifice of the matrice being sufficiently dilated and well softned; for otherwise there would be some danger, that the waters being evacuated, the child should remain a long while dry, and one would be obliged to supply to it, by humecting those passages, with fomentations of emollient herbs and oils; which has never so good an effect as when nature operates of itself, by means of the waters.

Those membranes sometimes advance so far out at the pudendum before the child comes out, that they hang the length of more than four fingers breadth, resembling a bladder full of water; there is then no very great danger to break them, if they be not broken already; for the child is always at the passage ready to come out when that happens. One must take care not to draw those membranes with the hand, because thereby the after birth, to which those membranes are very adherent, would be separated from the matrice before its time. Sometimes also, the waters are insensibly evacuated thro' a laceration made inwardly to the membranes of the child, which remaining whole at the fore part of its head, to which they serve as a forehead cloth, and line it immediately, hinder it from being forced out by the pains; in that case the membranes must be broke, provided the passage be sufficiently dilated, that the head of the child may be at liberty to advance into it.

If the *navel-string* falls out of the matrice, it must be immediately pushed back into it, hindering it, if possible, from falling out again, otherwise the woman must be delivered as soon as possible: but if the after birth falls out, it must never be pushed back into the matrice, because, when once out of it, it is of no use to the child; on the contrary, it would be an obstacle to its birth, if it was pushed back; in that case it must be cut off after the navel-string has been tied, and the child taken out as soon as possible; for if the child was left in the matrice it would be soon suffocated, if it was not dead already, as it almost always happens, when the after-birth, or even the navel-string comes out first

When the difficulty proceeds only from the part of the child who is dead, one must observe the same method as in the natural delivery; besides which the woman must make all the efforts she can to force it out, for a dead child cannot help itself, no more than when it is extremely weak; taking at the same time some comfortatives, lest the putrid vapours which exhale from a dead child, should cause her some syncops. But if the child be so hydropsical in its belly or head, that it can never come out because of the great distension and bulk of these parts; then the membranes must be broke to evacuate the waters; and if it be of a monstrous bigness in its whole body, or head only, or there be two heads, or it be joined to another child; in those cases (to save the mother) one must either dilate the passage, in proportion to the bigness of the monstrous child (if such a thing be possible) or extract it with the instruments, if one be indispensably obliged to it, to hinder the mother from perishing with her child.

Instruments should never be used but in case of an extreme danger; and when all other means have proved ineffectual, or are judged entirely needless.

The observations a man-midwife is obliged to make before he undertakes to deliver a woman, are first, to take care that the woman has strength enough

enough to undergo the operation; which he will discover, if by feeling her pulse, he finds it strong or weak, unequal and intermittent: examining besides her face, and particularly if her eyes be heavy and sunk, and her speech weak; if the matrice, and all the lower part of her belly be extremely high and inflamed, if all the extremities of her body be cold, if she has frequent sincops attended with cold sweats, if she falls into convulsions with loss of knowledge; and lastly, if all her countenance indicates that the operation would be needless, and is not to be undertook without the imminent danger of the woman dying in the man-midwife's hand.

When a woman has all her strength, the man-midwife conscious that she is capable to undergo the operation, he must place her on her back across the bed, that he may work with more ease, her buttocks a little higher than her shoulders, or at least her body equally situated, when it is necessary to turn the child to make it take another situation.

But when the child is to be extracted, the woman must be placed in the situation mentioned, when I have spoke of the natural delivery, so as to have her head and breast a little higher than the rest of her body, to ease her respiration, and that she may act her part in the expulsion of the child, by straining and forcing downwards, when the midwife bids her. Thus situated, she must have her legs folded in such a manner that her heels be pretty near her buttocks, and her thighs separated from one another, and kept in that posture by two pretty strong persons; another holding her under the arms lest her body should follow in the extraction of the child, which is most commonly attended with a great effort on the part of the man-midwife, who should make all the deliveries against nature, setting on a chair of a height proportioned to the situation of the woman, the outward entrance of whose matrice must answer to very near the height of the man-midwife's elbow while setting, that he may operate with a greater security and facility, without fatiguing himself to excess; for when he has once fatigued himself in operating, he cannot work afterwards with the same dexterity, nor so quick.

Thus done, he must anoint the whole matrice with oil or pomatum, that he may easily introduce his hand into it, which must be anointed likewise, and have the other conditions above-specified.

In all the *deliveries against nature*, which proceed only from the bad situation of the child, without being accompanied with any other considerable accident, one must wait to extract the child, till the matrice be passably open, and its inward orifice sufficiently prepared and softned, particularly if it be a first child. Therefore when it is perceived that the child presents itself in a bad situation at the beginning of the labour, the membranes which contain the waters must not be broken, but at the time the passages are found disposed to permit the extraction of the child without much violence; and if the waters are evacuated before the matrice can be sufficiently open, one should notwithstanding wait a little the preparation of the passages, if there be any appearance of it, without however suffering the parts to grow dry by the entire evacuation of the waters. For though the child be in a bad situation, it is notwithstanding sufficiently vivified by the navel-string while it remains in the matrice, and is not yet much engaged in the passage in its bad situation; and the mother on her side is no otherwise incommoded thereby, than by the tediousness of her labour. If a man-midwife should act otherwise, the child would be in a much greater danger to perish in the passage at the time of the operation, because of the narrowness of the space, which would detain it longer, the operation itself be attended with much more difficulty, and the mother treated with more violence.

If by the motion of the child, a man-midwife cannot be sure that it is alive, when the waters are broke, he must slide as soon as possible his hand gently into the matrice, where he'll feel the pulsation of the umbilical arteries, which will be much stronger if he touches it very near the belly of the child; or having found one of the child's hands, he'll feel the artery of the wrist, but it has not then so sensible a motion as that of the umbilical arteries; if then he feels the pulsation of those arteries, he may be sure that the child is alive; as likewise, if having put the extremity of his finger into its mouth, he feels the tongue stir.

But on the contrary, the child is dead, if it has not stirred for a considerable time; if the matrice voids fetid and cadaverous humidities; if the woman feels excessive pains, and a great weight in her belly; if the child falls like a lump always on the side she lays; if she has syncops, and frequent convulsions; if it is long since the navel-string, or after-birth is come out; if introducing the hand into the matrice the child is felt cold, his umbilick without pulsation, and its tongue immoveable; and if feeling its head, it is found soft, and the bones vacillent; the brain being without pulsation when the child is dead.

But we can only draw conjectures of the death of the child, if the woman has been wounded, if she has a great flooding, if she is not at term; if there be four or five days since her waters are broken; if she has a leaden colour, her eyes much sunk; and a dejected look; if her breath be very bad, her breasts flabby, and the bigness of the bottom of her belly has been diminishing for some time, without the evacuation of the waters.

Most of the signs above-mentioned, as well the most sure, as those by conjectures, must meet together to certify that a child is dead, for several of them are equivocal, when they are alone.

How to help a woman when the child presents one or two feet foremost.

If a child presents one or two feet foremost, place the woman in the posture heretofore described for preternatural deliveries, and draw it out in that posture, in the manner I am going to describe, taking care that both feet belong to one child.

So soon as the man-midwife has found the two feet of the child, he must bring them out; then taking them with both his hands, above the ankles, and holding them near one another, he'll draw them equally in that manner, till the thighs and hips of the child be extracted, laying hold sometimes, likewise, of the thighs above the knees, so soon as there will be room to do it, taking care to envelope those parts with a piece of dry cloth, lest his hands which are greasy, should slip on the body of the child, very slippery of itself. Which done, holding always the child by its two feet, and above the knees, he'll draw it thus, till the top of the breast; after which, he'll pull down, on each side, the two arms of the child along its body; observing to take them rather by the hands towards the wrist, than by any other place, and to disengage them gently, from the passage one after another, without forcing them too much, for fear of breaking them; and taking care, then, that the belly and face be directly downwards; to avoid the head being stopped at the chin by the *os pubis*; therefore if it was not in that situation, it should be turned; which may be easily done, if when one begins to draw the child by the feet, they be inclin'd, in turning them by degrees, in proportion as the extraction is made, till its heels regard directly the belly of the woman; and if they were not quite in that situation, when the child has been drawn as far as to the top of the thighs, before it be drawn further out, the man-midwife must introduce one of his hands, as flat as possible, so far as to the pubis of the child, and with his other hand hold the two feet, to turn, at the same time, its body on that side it is the most disposed to receive a good situation, till it has its breast and face downward; and having thus brought it up as far as towards the top of the shoulders, he must take great care to take his time (bidding the woman to make some effort at that very instant) that its head may take the place of the feet at the same moment they have quitted it, whereby it will not be stopped at the passage.

When the head of the child separates from its body, and remains alone in the matrice, either by reason of putrefaction, or for another cause; the man-midwife must immediately, without delay, and before the matrice closes itself, introduce his right-hand into it, and search the mouth of the head (which is the only hold remaining then) and having found it, thrust one or two fingers into it, and his thumb under its chin, after which he'll draw it softly, holding it thus by the inferior jawbone. But if that bone was to part from the head, in the efforts made to extract it, as it happens often when there is putrefaction; in that case he must take his right-hand out of the matrice, to slide the left into it, with which he'll support that head, and with the right take a narrow, but very strong hook, and with a single branch, which he'll slide along the inside of his other hand, turning the point towards it, for fear of wounding the matrice; and thus introduced shall turn it towards the head, to run it into the orbit of the eye, or into the holes of the ears, or into that of the occiput, or between the sutures, according as he'll find it most practicable, endeavouring always to lay hold of the place he'll fix it to, as fast as possible, after which drawing that head thus fasten'd to the hook, and helping with the left hand to guide it, he must make the entire extraction thereof; taking care, when brought near the passage, to draw his hand out of the matrice, lest the passage should be streighten'd therewith, leaving only some fingers towards the side of the head, to disengage it with more facility, and to hinder the matrice from being wounded by the hook, in case it should chance to lose its hold.

In a case of necessity, and for want of a hook, take a piece of soft tape, three fingers broad, and two yards long, or thereabout, folded in two, and laying hold of both ends with the left-hand, introduce with the right the middle thereof into the matrice, so that it may be placed on the hind part of the head, as a stone in a sling; and then drawing the tape by the two ends joined together, make the extraction of the head, without the least fear that the tape should stop the passage, since it takes but very little room.—And, I am of opinion, that this is the safest manner of making that extraction, and have always preferred it to a hook, with very great success.

If notwithstanding all these different manners the man-midwife cannot extract the head, because it is too large, he must diminish the bigness thereof with a bowed knife; introducing first his left hand into the matrice, and with the right sliding likewise that knife into it, taking great care in doing it, it, that the point of the knife be turn'd towards the inside of his left-hand, for fear of wounding the matrice; which done, he'll turn it again towards the sutures of the head, and particularly towards the place of their junction, where he'll make an incision with that instrument; whereby having separated some pieces thereof, he may with a greater facility draw the rest; or at least having emptied part of the brain through the aperture he had made, the bigness of the head being thereby much diminished, the extraction may be less penible.

If the after-birth be quite separated from the matrice, it must be extracted first, otherwise it would be an obstacle to the extraction of the head: but if it be yet adherent to the matrice it must be left in it, till after the extraction of the head; for if the man-midwife was to separate it then from the matrice, there would ensue a very great flooding, which would be increased by the agitation of the operation; for the vessels to which it is joined remain commonly open, while the matrice remains in the distension caused by the head retained in it, and do not close till after it has been delivered of that foreign body; besides which, the after-birth remaining thus fastned during the operation, hinders the matrice from being easily contused and wounded.

How to assist a woman whose child presents itself by the side of the head; *and likewise when it presents itself* with the face foremost.

As soon as it is found that the child presents itself in that bad posture, the woman must be bid to lie down, for fear it would be very difficult to push in the child (as it must be done, to make it take a natural situation) if it was advanced further into the passage.

To perform this operation, the woman must be put in a commodious situation, making her to lean a little on the side opposite to the bad one of the child; then the man-midwife shall slide his hand, well anointed with oil, on the side of the head of the child, to set it right; bringing it, gently, with his fingers, placed between it and the matrice, to a right situation; but if the head was so much engaged, that the thing could not be effected in that manner, he must slide his hand as far as the shoulders of the child, that pushing them back a little into the matrice, he may put him in a natural and convenient situation.

But if the head cannot be reduced, because of the bad situation of the body of the child, which hinders its being set right; then one must have recourse to the last remedy to save the child's life, which is to turn it entirely, by going to fetch the feet, to draw it by them in that same moment.

At other times *the child presents itself with its face foremost*, having its head bent backwards, in which posture it is very difficult to bring it into the world; and if it remains long in it, becomes so livid and puffed up, that he appears monstrous.

A man-midwife must proceed in this delivery in the manner prescribed, when the child presents its head sideways, which must be set right with the hands, observing always to do it as gently as possible, for fear of hurting the face of the child.

The method of delivering a woman, when the body of the child is stopped at the passage by the shoulders, *after the head is come out.*

If the shoulders don't pass after the head has been pulled in a proper manner, the man-midwife must slide one or two fingers of each hand under each arm-pit, with which, bending them inwards, the shoulders will be drawn by degrees; but when they have entered the passage, and are entirely disengaged from it, if he cannot have the child yet, holding it thus under the arm-pits, then it is sure that it is stopped by some other impediment, and is certainly monstrous in some part of its body; or, as it happens often on that occasion, it is hydropsical in the abdomen, which hinders it from being extracted from the matrice, by reason of the eminence and bigness of its belly, without a punction to procure the evacuation of the water; which is done by introducing the left-hand into the matrice, as far as to the place where the belly is, and then running along the inside of the same hand with the right, a hook, or a bowed knife, the point thereof turned towards the belly of the child, that point must be thrust into it at once; and when it is extracted from the hole it has made, two fingers must be introduced into it to dilate it, whereby all the waters are evacuated in an instant; after which the rest of the body of the child stopped in the matrice, is extracted without difficulty.

The manner of assisting a woman in a labour where the child presents one or both hands together with the head.

To give her assistance, if a midwife, or man-midwife, finds that one of the hands presents itself thus, together with the head of the child, he must not be suffered to advance further, and to engage itself more in the passage in that situation; therefore having made the woman to lay down, so as to have her buttocks a little risen, he must push back with his hand, as far as possible, that of the child, or both, if they both present themselves, giving room by that means to the head of the child to advance forwards alone; which done, if the head was sideways, he must reduce it to the natural situation,

ſituation, *i. e.* place it in the middle of the paſſage, to make it come out in a ſtrait line.

How to aſſiſt a woman in labour, when the child preſents one or both hands alone.

This is one of the worſt and the moſt dangerous poſtures it can preſent himſelf in, either for itſelf, or for the mother.

Therefore the woman having been placed in a proper ſituation, the hands or arms of the child which preſent themſelves at the paſſage, muſt be quickly puſhed back into the matrice, the man midwife ſliding afterwards his hand into the matrice, under the breaſt and belly of the child, and ſo far that he may reach the feet, which he'll draw gently to himſelf to turn it, and extract it by them; taking care to do it with as little violence as he can; without amuſing himſelf to give the child a natural ſituation; which it would be very difficult to do, becauſe he has his whole body croſs-wiſe, when he preſents thus an arm alone, as far as the elbow or ſhoulder; obſerving when he thus introduces his hand into the matrice, that he muſt ſlide it inſide of the membranes of the child, and not between the membranes and the matrice; for thoſe membranes, which line the whole inſide of the matrice, facilitate by their poliſhed ſlippery ſubſtance, the turning of the child, and hinder, by their interpoſition, the matrice from being hurt by the hand of the man-midwife in the operation.

As ſoon as the man-midwife has thus turned the child by the feet, if he was to lay hold but of one, he muſt ſearch the other to bring it along with the firſt; that holding both, he muſt govern himſelf in the extraction of the child, in the manner deſcribed for the delivery where the child preſents his feet foremoſt.

But if the arm was ſo far advanced, ſo big and ſo tumefied, that he could not be put back without much difficulty, *Ambroſe Pare* adviſes, if the child is dead, to cut the arm, as far as poſſible; though it is far better, and ſafer to wring it off, becauſe its being very tender, it will be eaſily ſeparated from the body, at the articulation of the *humerus* with the ſhoulder-bone. But when a child is to be mutilated thus, or extracted with a hook, the man-midwiſe muſt be very ſure that it is dead.

How to deliver a woman when the child preſents its feet and hands.

If the child preſents its hands and feet together, it is abſolutely impoſſible it ſhould come out in that ſituation; therefore the man-midwife carrying his hand towards the orifice of the matrice, will feel nothing but a quantity of fingers near one another; and if the matrice be not well open yet, he will not be ſo ſoon able to diſtinguiſh preciſely the feet from the hands, becauſe they are ſo cloſe together, that they ſeem almoſt all of the ſame figure. But ſo ſoon as the matrice will be dilated enough for to introduce the hand into it, he'll diſtinguiſh eaſily which are the hands, and which the feet; and then he'll ſlide it as far as towards the head of the child, which he'll find pretty near, he'll puſh it back gently, together with the hands towards the bottom of the matrice, leaving the feet in the ſame place where he has found them; then placing the woman in a commodious ſituation, *i. e.* her buttocks a little riſing, he'll take the child by both feet, and draw it in the manner heretofore deſcribed, when I treated of extracting a child by the feet.

How to deliver a woman when the child preſents its knees.

Having diſcovered that it is the knees the child preſents, don't ſuffer it to advance further; but having placed the woman in a convenient ſituation, puſh the knees of the child gently back into the matrice, to be more at liberty to unfold its legs one after another; which to effect, put one or two fingers under the ham, and guiding it ſlowly along the hind part of the leg, which draw always a little obliquely, till you have found the foot, that having diſengaged one of them, do the ſame to the other, proceeding in the ſame manner, as done to the firſt, after which having drawn them both out, make the extraction of the child, as if it was to come the feet foremoſt; obſerving always to extract it the face downwards.

Of a delivery where the child preſents the ſhoulder, back, or buttock.

To perform the operation, where the ſhoulder preſents itſelf firſt, the man-midwife muſt puſh, with his hand, the ſhoulder a little back into the matrice, that he may with greater facility introduce his hand into it; and ſliding it afterwards along the body of the child on the ſide he'll find the thing more eaſy, he'll ſearch the feet, to turn the child entirely in bringing them to the paſſage; after which he'll extract it, as it is done when the child preſents the feet foremoſt.

If the child preſents its back foremoſt, the man-midwife muſt ſlide his hand along the back towards its lower part till he has found the feet of the child, extracting it afterwards, as when it preſents its feet.

But when the child comes the buttock foremoſt:- if it be ſmall or of a middle ſize, and the mother tall, having the paſſage pretty large, it can very well come out in that poſture, with a little help; for though it has then its body bent, the thighs being folded towards the belly, which is ſoftiſh, force

force their paſſage over-againſt it, without much difficulty. Which, notwithſtanding, as ſoon as the man midwife has diſcover'd that the buttock of the child preſents itſelf foremoſt, he muſt next puſh back the buttock, if he can do it without violence; and ſliding afterwards his hand along the thighs, as far as the legs and feet of the child, he muſt bring them gently, one after another, out of the matrice, unfolding, extending and turning them towards the moſt eaſy ſide; taking great care to do it, without any contorſion or diſlocation; and extracting the reſt of the body, as if the child was to come with its feet foremoſt.

The child is ſometimes ſo far advanced into the paſſage with its buttock foremoſt, that it is abſolutely impoſſible to puſh it back, and therefore muſt neceſſarily come into the world in that bad ſituation; but to help the child to it, the man-midwife muſt ſlide one or two fingers of each hand on the ſide of the buttocks, to introduce them towards the groin, as ſoon as he'll be capable to do it without violence, and having bent them inwards, he muſt draw the backſide out as far as the thighs; then drawing them a little obliquely on one ſide and the other, he'll diſengage them from the paſſage, as likewiſe the legs and feet one after another, without fracture or diſlocation, ending afterwards the extraction of the reſt of the body, as if it was to come the feet foremoſt.

A man-midwife muſt take particular care, when he extracts a child, who preſents the backſide foremoſt, to bring it out with its face downwards; for commonly when it comes out the backſide foremoſt, it has the face and feet towards the belly of the mother: and if it was drawn in that manner, in a direct line, without turning it by degrees, in proportion as the extraction goes forwards, the face being thus upward, the chin of the child would be faſten'd underneath the *os pubis*, and the head ſtopped at the paſſage, where it would ſoon periſh.

Of a delivery, where the child preſents the belly, the breaſt, or the ſide.

To prevent all the dangerous conſequences ſo unſafe a labour could be attended with; the operator, after he has placed the woman in a convenient ſituation, muſt run gently his hand well anointed with oil or pomatum, towards the middle of the breaſt of the child, to turn it quite, (becauſe in that ſituation it is half turned) then ſlide his hand under the belly, till he has found the feet of the child, which he muſt bring to the paſſage, to draw it out in the ſame manner, as if it had preſented its feet foremoſt.

When the child preſents the breaſt, or the belly foremoſt, the man-midwife muſt proceed in the ſame manner, in both occaſions.

The child can alſo preſent itſelf ſideways; which is not ſo dangerous a ſituation as the two others, becauſe it does not die ſo ſoon. To deliver a woman when the child preſents itſelf in that ſituation; the woman being placed in a convenient poſture, the operator muſt puſh a little back the body of the child, that he may introduce his hand with more facility into the matrice, which he ſhall ſlide along the thighs till he has found the legs and feet, by which he'll turn it, and extract it afterwards.

Of a labour where there are ſeveral children, who preſent themſelves in the different poſtures heretofore mentioned.

When two children preſent themſelves both in a bad ſituation; or when but only one of them preſents itſelf in a bad ſituation, as it moſt commonly happens, the firſt coming head foremoſt, and the ſecond the feet foremoſt, or in ſome other ſtill worſe poſture, the operator muſt, as ſoon as poſſible, procure the birth of the firſt, that immediately after, he may go ſearch the ſecond, to draw it by the feet, without attempting to give it a natural ſituation, was he even diſpoſed to it, becauſe the child has been ſo much fatigued and debilitated, and likewiſe the mother, during the coming out of the firſt, that it would be often in danger of dying before it could come out.

Sometimes, likewiſe, after the firſt is come out naturally, the ſecond preſents itſelf the head foremoſt. In that caſe, nature muſt be left to accompliſh the reſt, providing ſhe be not too long about it; for the child might chance to die, though in a natural ſituation, through the tediouſneſs of the labour: and the woman who has been much tormented to bring the firſt child into the world, is commonly ſo fatigued, and ſo much diſcouraged, when ſhe knows, that after ſhe has ſuffer'd ſo much, ſhe has done yet but half her work, loſes courage, and is beſides ſo much weaken'd and debilitated, that ſhe has no more pains, or but very ſmall ones. Therefore, when the man-midwife ſees that the labour is too long, he muſt introduce his hand into the matrice, to ſearch the feet of the child, to bring it out that way; and if the waters were not broke yet, he muſt make no difficulty to lacerate the membranes with his fingers; and it is even better to do it ſoon after the firſt is come out, who having then made the paſſage, the coming out of the ſecond is thereby accelerated.

So ſoon as the operator ſhall have brought the firſt child into the world, he muſt ſeparate it from the after-birth, by tying and cutting the navelſtring, thing, taking afterwards the feet of the other to bring it out in the same manner: after which he'll draw the after-birth to extract it with the help of its two navel-strings.

Of the delivery where the navel-string comes foremost.

Every time the *navel-string* comes out first, the child does not always present the belly; for though it comes out naturally, as to the figure of the body, *i. e.* the head foremost, the navel-string notwithstanding falls sometimes, and comes out first; and then the child is in a great danger of his life, unless the woman be quickly delivered.

To remedy that accident, and prevent, if possible, the fatal consequences it is attended with, the patient must be kept in her bed very warm, and the navel-string immediately put back into the matrice to hinder it from cooling, endeavouring to thrust it quite behind the head of the child, if the head presents itself foremost, lest it should be pressed and contused by it, and the motion of the blood intercepted: keeping it fast, by means of the ends of the fingers of one hand, in the place whereinto it has been pushed, keeping always those fingers on the side it comes out at, till the head be entirely come down and lodged at the passage, can hinder it from falling another time, taking the occasion of a good pain, to bring it to it with more facility; or if the operator draws out his hand, he must thrust a small piece of very soft linen between the side of the head and the matrice, to stop the place through which the string could fall, observing to let one end of that linen hang out, that it may be extracted when it is judged proper; putting likewise a compress dipped in hot wine, before the entrance of the matrice, to hinder the navel-string from cooling, in case it was to fall again.

But, notwithstanding all those precautions, it happens sometimes, that the navel-string falls at every pain, which the woman takes: in which case the operation ought not to be deferred, but the child must be extracted as soon as possible by the feet, which the man-midwife must go to search, was even the head to present itself first, since there is but that sole remedy, which can save its life.

Therefore having placed the woman in a commodious situation, he must push back gently the head of the child, which presents itself first, if it be not too far advanced between the bones of the passage, and he can do it without tormenting the woman too much; in which case it is best to leave the child in danger of its life than to expose that of the mother. Afterwards he'll slide his hand (we l anointed with oil or pomatum) under the breast and belly of the child to search its feet, by which he'll draw it out.

Of a delivery where the after-birth presents itself foremost, or is entirely come out before the child.

When the after-birth presents itself first at the passage, nothing is felt but a soft body, without any solid part; and the blood flows in abundance from the matrice with several clods, the woman fainting away often. — In that deplorable case, the operator must make haste to deliver the woman, if he will save her life, and that of her child, if it be yet alive. If the operator was to find that the after-birth is almost quite out of the matrice, and the membranes thereof entirely broken, or lacerated, he must extract it quite.

Of a delivery accompanied with a great loss of blood, or, with convulsions.

A quick delivery is the most salutary remedy in that dangerous case, and the man-midwife must procure it as soon as possible; which should be done in the following manner.

If the child be supposed alive, though it presents itself in a natural posture, the operator must turn it entirely in the matrice, to draw it out by the feet, after having broke the membranes of the waters, if they were not broke already.

If on the contrary the child is known to be dead, and its head is too strongly engaged in the passage, the operator must make no difficulty to draw it with the hook.

To avoid and prevent so dangerous an accident, those sort of women must be let blood twice or three times during their pregnancy, and likewise at the beginning of their labour, in order to diminish the quantity of blood of which their vessels are too full, and which is the cause in part of the convulsions, by flowing to the head, by reason of the extensive pains a labour is attended with.

How to deliver a woman when the child is hydropsical, or monstrous.

If the hydropsical child be alive at the time of the delivery, its life cannot be saved; for to save that of the mother, its head must be pierced, or its breast, or its belly, *i. e.* that part where the water is contained, to procure the evacuation thereof, without which it could not be extracted, and remaining in the matrice, would kill its mother: therefore to save her life, it is absolutely necessary to extract the child by art, which is done in the following manner.

Of the extraction of a dead child.

Before the man-midwife undertakes the operation, he must endeavour to excite some labour pains, by means of strong glysters, to facilitate the expulsion of the child, if it be in a good situation;

tion; but if thoſe remedies have no effect, he muſt proceed to the extraction of the child; which is the ſureſt means; for all the other remedies taken inwardly, and preſcribed by ſome phyſicians, to facilitate the expulſion of a dead child out of the matrice, being commonly very hot, and purgatives, can cauſe afterwards very dangerous accidents, as a fever, looſeneſs, dyſentery, loſs of blood, relaxations, and bearing down of the matrice.

The extraction of a dead child is made, by puſhing back the head of the child (if it comes foremoſt, and is not too much engaged in the paſſage) into the matrice, that the operator may have the liberty to introduce his right hand into it, ſliding it under the belly of the child, to ſearch its feet, in order to turn and draw it in the manner abovemention'd: taking great care that the head ſhould not be ſtopped, nor ſeparated from the body at the paſſage.

But if the head of the child was ſo much engaged in the paſſage, that it could not be puſhed back, then the operator, if he be very ſure that it is dead, ſhall extract it in that poſture, by means of a hook, which he muſt puſh as far as poſſible, without violence, between the matrice and the head of the child, guiding it along the inſide of one of its hands, its point turned towards the head, which he'll hook in, by fixing it, if poſſible, on the ſkull; in ſuch a manner, that it may not ſlip, or part from its hold. This hook being thus well faſten'd to the head, he muſt draw it out, placing the extremity of the fingers of his left hand on the ſide oppoſite to the hook, to help to diſengage it better, in ſhaking it a little by degrees, and to guide it more directly out of the paſſage; uſing then, if it be neceſſary, a ſecond hook, in the ſame manner as the firſt, and placing it on the oppoſite ſide of the head, that the extraction be made equally on both ſides

But the extraction of a dead child is made with a ſtill greater facility, by means of an inſtrument of the invention of the famous M. *Mauriceau*, which he calls *a head ſcrew*.

But if the dead child was to preſent an arm as far as the ſhoulder, and ſo much ſwelled and tumefied, that it could not be puſhed back into the matrice, without hurting much the woman, it muſt be ſeparated from the body, by twiſting it three or four times, as already deſcribed; whereby occupying no longer the paſſage, the operator will have more room to introduce his hand into the matrice, to fetch the feet of the child, to extract it by them; obſerving always, when he has made the extraction of a dead child, to re-aſſemble into one all the parts he has ſeparated, to ſee if he can compoſe a whole body of them, and diſcover thereby if nothing remains in the matrice.

So ſoon as the woman has been delivered of her after-birth, the midwife muſt take great care that its ſeparation be not followed by a too great loſs of blood; and place before the entrance of the matrice a pretty ſoft cloth, folded into five or ſix doubles, leſt the cold air penetrating into it, ſhould ſtop the evacuation of the lochia, by a too ſudden obſtruction of the veſſels; the ſuppreſſion whereof would be unavoidably attended with very dangerous accidents, as exceſſive pains, and gripings in the belly, inflammation of the matrice, a fever, pleuriſy, and ſeveral others, and perhaps death itſelf.

The entrance of the matrice being thus well ſtopped, if the woman has not been deliver'd in her bed, ſhe muſt be immediately carried into it, unleſs there was a flooding, as it happens ſometimes, for then ſhe ſhould be left above a quarter of an hour, in the place where ſhe has been deliver'd, leſt by moving her ſo ſoon, the loſs of blood ſhould increaſe: which, on the contrary, is moderated, by the air, which introduces itſelf into the matrice; while other remedies are adminiſter'd to the ſame purpoſe. But if there be no fear of that accident, the woman muſt be carried to her bed, by one or two perſons, rather than be ſuffer'd to walk to it; though if there was ſome part of the after-birth left behind, that walking (provided it was not too far) would contribute to the expulſion thereof. The bed having been made, as requiſite in thoſe occaſions, and well warmed before ſhe is put to it: where ſhe muſt be placed in a ſituation, with her head and body a little riſing, as well to facilitate her reſpiration, as to procure the evacuation of the blood, which flows then, and which, being intercepted, would cauſe violent pains to the poor patient.

The moſt common cuſtom, is to give to the woman, ſoon after ſhe is in bed, a ſpoonful of *ſperma ceti*. Others give her only ſome good broth, which they think better. Then the patient is left to take ſome reſt.

If the woman is not to ſuckle her child, there muſt be remedies applied on her breaſts, to diſſipate the milk; but if ſhe deſigns to do it, her breaſts ſhould be only kept cloſe, and cover'd with ſoft and warm cloths for fear the milk ſhould grow knotted; and if it flows into it with too much impetuoſity, embrocations are to be made on them, with oil and a little vinegar mixed together, dipping in it ſome cloths to apply on them; obſerving, if the woman will ſuckle her child, that ſhe ſhould not give it the breaſt but three, or even five days after ſhe is deliver'd, *i. e.* till the humours,

mours, which have been in a great ferment, and flow in great abundance to the breaſts, in the firſt days, be much abated.

As to the regimen a lying-in woman is to obſerve, when no accidents happen.—She muſt be treated in the firſt days, with regard to her diet, as if ſhe had a fever; therefore ſhe ſhould be fed, particularly during the three or four firſt days, with chicken broth, jellies, and the like; and likewiſe ſome boiled and even roaſted chickens, provided it be in a moderate quantity.—As for her drink, ſhe may be ſuffer'd, if ſhe has no fever, to drink ſome white wine, mixed with warm water, for ſhe is not to drink any thing cold.

The loſs of blood is an accident more dangerous than all the others, which can happen to a woman newly deliver'd, and ſometimes cauſes her death, before one has time to remedy it: therefore proper remedies muſt be adminiſter'd to the patient, as ſoon as poſſible, examining what can be the cauſe of ſuch a flooding; for if it be a falſe conception, or a portion of the after-birth, or ſome clods of blood left behind in the matrice, they muſt be immediately extracted, or the expulſion thereof procured by ſome ſpecifick remedy; ſuch as *a few drops of the oil of guaiacum in plantain-water.* But if the blood flows immoderately, though there be nothing left behind in the matrice, the woman muſt be let blood in the arm, if her ſtrength will permit Her belly muſt not be kept tight at all, eſpecially if ſhe feels pains in it; neither is ſhe to be much cover'd in her bed; and care ſhould be taken, that the air of her chamber be a little cooled; warming, likewiſe, the region of the heart with hot cloths, aromatized with *Hungary* water, or ſome other proper liquor. She muſt take every half hour, a few ſpoonfuls of good broth, or one or two of good old red wine.

The fall of the matrice, which happens immediately after the delivery, can cauſe the death of the woman in a few hours, if it be not immediately reduced into its proper place.

For the cure of this dangerous malady, a man-midwife muſt have regard to two things:—The firſt is to reduce the matrice in its proper place:—And the ſecond to keep it up and ſtrengthen it.

To *reduce the matrice*, if it be entirely fallen, the operator muſt, previouſly to any thing elſe, procure the evacuation of the urine, and likewiſe that of the coarſer excrements by means of a gentle glyſter, that the reduction thereof may be performed with more facility. Afterwards, the woman muſt be placed on her back, with her thighs a little higher than her head: then all that comes out at the pudendum, muſt be fomented with warm wine or milk; and afterwards it muſt be puſhed back gently with a ſoft cloth, and if the thing be very painful, by reaſon that what is already come out is very big and tumefied, it muſt be anointed with oil of ſweet almonds, to make it ſlide eaſier; obſerving, after the reduction is made, to wipe off that oil as clean as poſſible, to prevent a recidive.

The beſt means to keep the matrice in its natural ſituation, is to place a *peſſary* in the vagina, obſerving notwithſtanding that the bearing down of the matrice, where the inward orifice does not come out at the labia of the pudendum ſo as to be ſeen, wants no *peſſary*.

When the matrice evacuates its lochia, the beſt remedy to ſtrengthen it, is to keep it in its natural ſituation, by means of a *peſſary*; abſtaining in thoſe caſes from keeping her belly tight; obſerving likewiſe to abſtain from coition during the whole time.

It happens alſo, ſometimes, that by the violent efforts the woman makes during her labour, the anus is entirely puſhed out; in that caſe, if the child be very far advanced in the paſſage, the midwife ſhall content herſelf, before that accident happens, to hinder it, if ſhe can, by deſiring the woman not to make ſuch violent efforts; but if it be entirely fallen, as ſoon as the woman is delivered, the reduction thereof muſt be made in the ſame manner of that of the matrice, by fomenting, ſtewing, and anointing the part, if it be neceſſary.

As to the *hæmorrhoides* or *piles*, wherewith lying-in women are troubled, they muſt be anointed morning and evening with an unguentum made of populeum, and oyſter-ſhells calcined; which I know to be a ſpecifick remedy in that caſe.

As ſoon as the woman is delivered, if there be but ſimple contuſions and ſcratches, there muſt be applied on the lower parts to appeaſe the pains, a ſmall cataplaſm made with new-laid eggs, the yolk and white mixed with oil of ſweet almonds, done on hot embers, or on a very ſlow fire, and ſtirred till the whole be pretty well mixed together; then having been ſpread on very ſoft tow or linen, it muſt be applied over all the outſide of the vulva, and remain there during five or ſix hours; after which it muſt be taken off to apply on each labia, ſmall pieces of cloth dipped in oil of St. John's-wort, renewing them four or five times a-day, and waſhing thoſe parts with barley-water and honey, to cleanſe them of the excrements, which flow from the matrice; and when the woman ſhall want to make water, they muſt be covered with a piece of cloth, to hinder the urine from hurting them. But if thoſe lacerations be very painful, the balſam of *Peru* is, in my opinion, preferable to any other remedy.

It happens ſometimes, that all the inferior part of the fleet is lacerated, by the child coming out, as far as the anus, whereby both holes are made into one. To rectify this great diforder, which otherwiſe would be very troubleſome to the woman, and loathſome to the huſband, the re-union of the parts thus lacerated muſt be made immediately after the delivery, by waſhing firſt with ſtrong red wine, made warm, all the place lacerated, and making to it afterwards, a pretty ſtrong ſuture, of one, or two, or more ſeparated ſtitches, according to the length of the ſeparation, and taking at every ſtitch a pretty deal of fleſh, to hinder it from parting. This done, the wound muſt be dreſſed with the balſam of Peru, or that of arceus, covering the whole with a cloth, to prevent the urine from reaching to the part. And that thoſe parts may re-unite with more facility, the woman muſt keep always her thighs joined together, till the cure be perfected.

All ſorts of *after-pains* are to be remedied, according to their different cauſes.—Therefore to prevent the *after-pains*, *excited by wind*, the woman muſt take, ſoon after ſhe is delivered, either half an ounce of oil of ſweet almonds, and an equal quantity of ſyrup of maiden hair, mixed together, or ſome ſperma ceti, or fifty drops of oil of anniſeed, with ſome ſyrup of marſh-mallows; or ſome good broths.

Women of quality in *France*, take moſt commonly, after they are delivered, ſome broth, made of an old partridge, boiled together, pretending that ſuch broth has a particular virtue to appeaſe the *after-pains*; others prefer boiled milk, in which are mixed two or three walnuts, pounded with ſome ſugar; ſtraining the whole mixture, very hot, through a cloth.

If the *after-pains* proceed from a foreign body being left in the matrice, the expulſion thereof muſt be procured, or it muſt be extracted by introducing the fingers into its entrance, as I have ſaid, in ſpeaking of the extraction of a falſe conception; or if it be great clods of blood, which being likewiſe ſtopped in the matrice, cauſe thoſe pains, they infallibly ceaſe, ſo ſoon as they are expelled or extracted.

When a woman has a ſudden ſuppreſſion of her lochia, which flowed at firſt in abundance, that ſuppreſſion cauſes always *after-pains*; and the moſt ſalutary remedy is to procure the evacuation thereof; which is done by hot glyſters, and aperitive fomentations on the genital parts, and by bleeding in the foot.

As to the pains which the woman may feel *in the loins and groins*, proceeding from the too great diſtenſion, or rupture in that part of the ligaments faſtened towards thoſe places, repoſe alone, and a good ſituation of the body, will ſuffice to ſtrengthen and conſolidate them, without any other remedy.

To procure or facilitate the evacuation of the lochia, the woman muſt be eaſy in her mind; lie on her back, with her head and breaſt a little riſing, keeping herſelf very ſtill, that the humours may be the eaſier carried downwards by their natural propenſity; ſhe muſt alſo obſerve a good regimen, uſing rather boil'd than roaſted meat, for fear of a fever, abſtaining from all things which are aſtringent; and drinking by intervals, ſome glaſſes of hyſterick and penny-royal waters, mixed together, and warm glyſters ought to be adminiſter'd to them to draw the humours downwards; bathing the lower parts with an emollient and aperitive decoction; made of mallows, parietary, camomile, melilot, roots of aſparagus, and linſeeds; making, with the ſame decoction, an injection into the matrice; and of the herbs, after they have been well boiled, ſo as to be eaſily ſtrained through a ſieve, a cataplaſm, to which muſt be added oil of white lilies, or axonge of pork, which muſt be applied hot on the lower abdomen, heating it from time to time, in the ſame decoction: beſides which, ſtrong frictions ſhall be made on her thighs and legs, particularly towards the inſide; without forgeting bleeding in the foot, or in the arm, according as the accidents cauſed by the ſuppreſſion of the lochia require it. Though, in my opinion, a few drops of oil of cinnamon, in a glaſs hyſterick and penny-royal waters, ſeveral times reiterated, if the accidents require it, anſwer very well in thoſe caſes all the intentions of a man-midwife.

The *ulcer of the matrice*, is abſolutely incurable, either becauſe it cannot be extirpated, as that of the breaſts, or becauſe the matrice receives continually the ſuperfluities of the whole body of the woman; whereby the malignity of the ulcer increaſes daily, notwithſtanding all the remedies which can be uſed during that cruel malady, which never ends but by the death of the patient.

Of what nature ſoever the *looſeneſs* of a woman newly delivered may be, and from what cauſe ſoever it may proceed, it is always of a bad conſequence, and often puts the woman in great danger of her life, becauſe it hinders the evacuation of the lochia of the matrice; which being ſuppreſſed cauſes always very dangerous accidents, and but too often death itſelf. What's the moſt fatal in this malady is, that all remedies proper to ſtop a looſeneſs, increaſe always the ſuppreſſion of the lochia; and theſe which can procure the evacuation of the ſuppreſſed lochia, increaſe the looſeneſs; therefore a phyſician don't dare to preſcribe ...

aſtringent to be taken inwardly; neither is the patient to be purged at the beginning of her lying-in. Notwithſtanding which, one muſt endeavour as much as is poſſible at that time, to adminiſter ſome remedies proper for that malady, by giving the patient ſome good broth to reſtore her ſtrength, much impaired by the looſeneſs. Some ſpoonfuls of mutton juice (extracted in balneo mariæ, or between two deep diſhes without water, and without the leaſt Fat) given by intervals to the patient, I know by practice to be a ſpecifick in that malady; giving her likewiſe, if the looſeneſs continues, ſome drops of laudanum. But if the looſeneſs be accompanied with a fever and other accidents, the patient muſt be let blood in the arm to ſupply the want of purgatives; and if the looſeneſs puts her in greater danger of her life than would do the ſuppreſſion of the lochia, all the remedies uſed at other times for that malady, are to be adminiſtred then; and the looſeneſs being ſtopped, the evacuation of the lochia, which had been ſuppreſſed, is to be procured as well as one can.

Whatever may be the cauſe of the *inflammation of the breaſts* of a lying-in woman, proper remedies muſt be applied to it, as ſoon as poſſible, leaſt they ſhould break out, or for want of ſuppuration, remain in them a ſcirrhous hardneſs, which, in proceſs of time, would degenerate into a cancer.

The principal and ſureſt means to hinder the humours from being carried in too great abundance to the breaſts, is to procure a good and ample evacuation of the lochia, through the matrice; for by that evacuation, all the humours will take their courſe towards the lower parts.

The cure is began by bleeding in the arm, to empty the too great plenitude of the veſſels of the whole body; proceeding to that in the foot, for a greater diverſion of the humours, and to make the lochia flow in greater abundance; during which, topick remedies are to be applied on the breaſts, *viz.* at the beginning, embrocations of oil of ſweet almonds and vinegar mixed together, applying afterward emplaſters of the cooling cerat of *Galian*, with one third of populeum; and if the pain was very great, a cataplaſm muſt be made of crumbs of bread and milk, adding to it oil of ſweet almonds, and ſome yolks of eggs, putting over it compreſſes dipped in *oxycrat*, or plantain water; obſerving, however, that the remedies applied on the breaſts be only cooling and refraining, without any great aſtriction; otherwiſe they would cauſe a ſcirrhous tumour, which would continue a long time, and perhaps degenerate at laſt into a worſe malady.

When the greateſt rage of the inflammation is over, and moſt of the antecedent humour is evacuated, one muſt uſe reſolutive remedies, to digeſt, diſſolve, and conſume the milk, which is in the breaſt in too great abundance; for fear it ſhould be corrupted by ſojourning in them. Therefore it muſt be evacuated, either by the child, or ſome other perſon ſucking it, or by reſolution, otherwiſe it ſhould be evacuated by ſuppuration. Though it is beſt to diſſolve it, than draw it in that manner, when the women does deſign to ſuckle her child; for ſuckling draws other milk to the part, which would cauſe the ſame accident, if it was not evacuated in its turn —But if the milk chances to flow of itſelf from the breaſts, it muſt not be ſtopped; becauſe then an evacuation thereof is made without attraction.

The diſſolution of the milk is made by applying on the breaſts a cataplaſm of honey alone; or by rubbing red cabbage leaves with it, which muſt be applied on the breaſts, after they have been a little ſoften'd over the fire, and have been ſeparated from their large ribs; taking great care not to preſs the breaſt too hard, and that the cloths put upon it be very ſmooth, without any pleats or ſeams. A very good remedy for the ſame diſtemper, is to boil a red cabbage whole in river water, till it be very ſoft, and there be but very little water left, after which it muſt be pounded a little in a wooden or marble mortar, to ſtrain it through a ſieve, like pap, and make it afterwards into a cataplaſm, adding to it ſome honey, and oil of camomile, which cataplaſm is to be put on the breaſts.

While the woman is under cure, ſhe muſt obſerve a cooling regimen, and very little nouriſhing, to hinder the generation of too much blood and humours, of which there is already a too great abundance. Her body ought to be kept open, that the humours, which otherwiſe would flow to the breaſts, may be carried downwards. During the whole time the inflammation will laſt, ſhe muſt keep her bed, and lay on her back, that ſhe may reſt better.

So ſoon as a woman perceives that ſhe begins to have ſore nipples, it would be very proper ſhe ſhould abſtain from ſuckling her child, till they be quite cured; during which the milk muſt be diſſipated for ſome time, for fear of an inflammation in her breaſt, proceeding from a too great abundance of milk; notwithſtanding which, if there was but one nipple ſore, ſhe could very well give the other to her child.

There muſt be applied on the ſore nipples, ſome oil of eggs, or oil of new wax, for ſeveral days ſucceſſively; uſing afterwards deſiccative remedies, as aluminous, and lime-water; bathing them firſt

first with plantain-water only, and applying over it bits of very soft cloth, dipped in the aluminous and lime-water; but, in my opinion, the best remedy is either cream, or honey of roses, especially when the nipples are not yet excessively sore.

No better remedy can be administer'd to a lying-in woman, during the paroxisms of the hysterick passion, than a glass of hysterick, or cinnamon water, or if such a thing is not to be found, a spoonful or two of brandy, or a glass of wine; I have also prescribed with great success, twelve drops of spirit of sal-ammoniack, more or less, according to the violence of the paroxism.

So soon as the woman is delivered of the after-birth, the midwife having put at the entrance of the matrice a cloth folded into several doubles to hinder the air from penetrating into it, shall take a strong thread in four or five doubles, of the length of a quarter of a yard or thereabout, tied with a single knot, at each end; with this thread she shall tie the navel-string, at a finger's breadth from the belly, with a double knot, at first, then turning the two ends of the thread on the opposite side, she'll make there another double knot, reiterating the same thing, if it be necessary, for a greater safety; which done, the navel-string must be cut at another finger's breadth from the ligature, on the side of the after-birth, so that there remains of the navel-string only the length of two fingers breadth, in the middle whereof the ligature is made; which must be so tight, that not one single drop of blood may run from the vessels, but not too much, for fear the ligature should cut the said vessels; therefore the thread should be a little big for that purpose, and tied with some sort of mediocrity, tho' it is best it should be rather tight than loose. The end of that umbilick, thus tied and cut, must be wrapped in a dry piece of cloth, anointed with some fresh butter, or oil of roses; then having put another small piece of cloth, in double, on the belly of the child, towards the superior part thereof; the umbilick, thus wrapped, must be placed upon it, the end thereof upwards, that, in case the vessels were not tied tight enough, the blood should not so soon be lost, and unperceived, as it would if that end was placed downwards; for it happens, sometimes, that the navel-string is so big, in some children, that though it has been tied ever so tight, at first, the ligature, notwithstanding, happens to slack, when it begins to wither and dry, whereby the blood would issue, if it was not well minded. In that case, therefore, in proportion as the umbilick withers, it must be tied with a new knot.

The umbilick thus tied withers daily, and most commonly falls out at the end of six or seven days, sometimes sooner, and never later than the eighth or ninth day. It must always fall of itself, without exciting it to it, for fear that was it to fall too soon, and before the vessels are entirely closed and re-united, there should happen a flux of blood, which would prove very dangerous; or an ulcer should be left, very difficult to cure. With which observation I conclude this treatise.

M I N E R A L S.

MINERALS are compound fossils, wherein there is something discovered in all respects like metal, only that it is not malleable; joined or compounded with some other fossil, as *salt*, *sulphur*, *stone*, or *earth*.

Those *minerals* are *antimony*, *cinnabar*, *bismuth*, *calaminaris*, *vitriol*, *pyrites*, *marcasites*, *cobalt*, *oker*, the *magnet*, *lapis hæmatites*, *armenus*, and *stellatus*.

ANTIMONY is what we properly call a *semimetal*; being a fossil glebe, composed of some undetermined metal, combined with a sulphureous and stony substance. So that I consider it as the dross or scoria of other metals, separated from them in their preparation in the matrice.

Antimony is found in mines of all metals, but chiefly those of silver and lead: that in gold mines is usually held the best. It has also its own mines: that of *Hungary* is the best, being full of long needles.

Antimony is found in clods or stones of several sizes, bearing a near resemblance to black lead, only that it is lighter and harder; whence also it is called *marcasite of lead*, but very improperly, and its metalline parts supposed to be of that species: its texture is somewhat particular, being full of little shining veins or threads like needles, brittle as glass. Sometimes there are veins of a red or golden colour intermixed, which is called *male antimony*, that without them being denominated *female*. It fuses in the fire, though with some difficulty, and dissolves more easily in water.

When dug out of the earth it is put into large crucibles, fused by a violent fire, and then poured into cones, the apex whereof is always the best and purest part, as the basis or broadest part is the foulest.

The uses of *antimony* are very numerous and important. – It is a common ingredient in specula, or burning concaves, serving to give them a finer polish. It makes a part in bell metal, and renders the sound more clear. It is mingled with tin to make it more hard, white and sounding, and with lead in the casting of printers letters, to render them more smooth and firm. It is a general help in the melting of metals, and especially in the casting of cannon balls.

Cinnabar is a mineral stone, red, heavy, and brilliant, found chiefly in the quicksilver mines.

Cinnabar is either *native* or *factitious*.

Native, or *mineral cinnabar*, which is that abovementioned, is found in most places where there are quicksilver mines; yet it has mines of its own.

It may be esteemed as marcasite of quicksilver, or rather as quicksilver petrified and fixed, by means of sulphur, and a subterraneous heat; for the globulous particles of quicksilver being put into a natural motion, by the subterraneous heat roll themselves in the sulphur, already softened by the same heat, wherein being wrapped, at last their whole motion is intercepted; and the whole composition being hardened afterwards by the same gradual heat, becomes that red, heavy, and brilliant stone, we call *native cinnabar*.

Each pound of good *cinnabar* yields fourteen ounces of good mercury.

The best *mineral cinnabar* is of a high colour, brilliant, and free from the stone. It is used by Physicians in venereal cases, and others occasioned by sharp serosities: it is also esteemed a good cephalick, accounted of service in epilepsies, and other nervous distempers: add, that it is reckoned of efficacy in cutaneous cases, as the scurvy.

Factitious, or *artificial cinnabar*, is formed of a mixture of mercury and sulphur sublimed, and thus reduced into a kind of fine red glebe. The best is of a high colour, full of fibres like needles.

The *factitious cinnabar* is prepared, by melting one part of sulphur in a pipkin; then putting to it by a little at a time, three parts of quicksilver, stirring them together till no mercury appears: then letting them cool, they grind the mixture, put it in a bolt head, bake it, and place it over a naked fire, which they augment by degrees, a coloured fume arises first to the top of the subliming vessel, which in the further progress of the heat, becomes at length of a red crimson blue; taking it off the fire, the *cinnabar* is found above the fæces.

This serves for the same medicinal purposes with the *native cinnabar*; besides which, it is likewise used by the farrier, to make pills for their horses, and by painters as a colour; as being a very vivid red, but drying with some difficulty.

The *cinnabar*, called also by the painters *vermillion*, is rendered more beautiful by grinding it with gum-water, and a little saffron, those two drugs preventing its growing black.

There is likewise a blue *cinnabar*, made by mixing two parts of sulphur with three of quicksilver, and one of sal ammoniack; those being sublimed produce a beautiful blue substance, whereas quicksilver and sulphur alone produce a red.

Bismuth is a mineral body, half metallick, composed of the first matter of tin, while yet imperfect; and found usually in tin mines, sometimes also in silver mines.

Its substance is hard, ponderous, and brittle, of a large grain, glossy, white, and shining. It is also called *tin glass*, because when broke it shews a vast number of little polished laminæ like glass: it is also called *marcasite*. by way of excellence, because surpassing all others in whiteness and beauty.

Bismuth contains an arsenical salt, very dangerous to take inwardly,

Calamine stone, or *lapis calaminaris*, is a kind of fossil, bituminous earth, of some use in medicine, but of more in foundry; being used to dye copper yellow, *i. e.* to convert it into brass. It is either of a brownish colour, as that of *Germany* and *England*; or reddish, as that about *Liege*, and in some parts of *France*, accounted the best, because turning yellow by calcination.

When dug it is washed, or buddled, as they call it, in running water, which carries off the impure and earthy parts, leaving the lead, calamine, and other sparry parts at bottom; they then put it in a sieve, and shaking it well in water, the lead mixed with it sinks to the bottom, the sparry parts get to the top, and the *calamine* lies in the middle: thus prepared they bake it in an oven four or five hours, the flame being so contrived as to pass over, and so to heat and bake the calamine, stirring and turning it all the while with iron rakes: this done, they beat it to powder and sift it, picking out of it what stones they find; and thus it is fit for use.

Vitriol is a mineral substance, composed of an acid salt, intermixed with something metalline.

It is defined by *Boerhaave* a saline, metallick, transparent glebe, dissoluble in water, and fusible and calcinable by fire.

It acquires different names, according to the different places where it is dug, and the *vitriols* of those also, differ from each other in denomination and colour, some being white, others blue, and others green.

Roman and *Cyprus* vitriol, for inſtance, is blue; and that of *Sweden* and *Germany* greeniſh; beſides which there is alſo a white kind.

White vitriol partakes but little of any metal; *blue* partakes of copper, and *green* of iron.

According to *Boerhaave*, *vitriols* conſiſt of a metallick part, with a ſulphur adhering, a menſtruous acid, and water. In *blue vitriol*, the metal wherewith the acid, *&c.* is joined, is copper. In *white vitriol*, called alſo *white copperas*, it is mixed with lapis calaminaris, or ſome ferruginous earth, intermixed with lead or tin. In *green vitriol* the acid is joined with iron.

Roman vitriol is made by expoſing the pyrites to the air, till ſuch time as they calcine, and change into a greeniſh, and vitriolick calx or duſt; in which ſtate they are thrown into the water, and afterwards, by boiling and evaporation, reduced into that kind of cryſtals ſent us from *Italy*.

All other *vitriols* are made after the ſame manner; that is much after the ſame manner as allum is made in *England*, or ſaltpetre in *France*.

For green vitriol, they add a great number of pieces of iron to the liquor in the boiling; theſe raiſe a great ebullition. As ſoon as the iron is diſſolved they evaporate the diſſolution to a certain degree, and ſo let it cryſtallize. The cryſtals being furniſhed, there remains a thick, reddiſh, unctuous ſtyptick and aſtringent liquor.

The powder of this *vitriol* is exceedingly ſtyptick, and excellent for the cure of wounds, and the ſtopping of blood. It is this that makes the baſis of the famous ſympathetick powder.

PYRITES, from the *Greek* πυρίτης, q. d. fireſtone, is a ſulphureous inflammable kind of *mineral*, compoſed of an acid ſalt, incorporated with an oily or bituminous matter,

Pyrites bears an affinity to *marcaſite*, with which the generality of authors confound it.

Pyrites has always a metalline part in it, and ſometimes a cretaceous or okerous part—In proportion as any of theſe prevails, the body commences a ſulphur, allum, or vitriol.

The metal in *pyrites* is chiefly iron; ſometimes there is copper in it, and always a little gold, rarely ſilver, and never lead or tin.

Dr *Liſter* attributes thunder, earthquakes, *&c* to the ſulphureous and inflammable breadth of the *pyrites*.

MARCASITE is a ſort of metallick mineral, making as it were the ſeed or firſt matter of metals.

On this principle there ſhould be as many different *marcaſites* as metals; which is true in effect; the name being applied to every mineral body, that has metalline particles in its compoſition, though not enough to make it worth working, in which caſe it would be called ore.

There are only three kinds in the ſhops, *viz.* *Marcaſite* of gold, which is in little balls or nodules, about the bigneſs of nuts, nearly round, heavy, of a brown colour without.——*Marcaſite* of ſilver, which is like that of gold, only paler coloured within, the colour differs much, the one having a gold colour, and the other a ſilver colour, both ſhining and brilliant.——The *marcaſite* of copper, which is about the bigneſs of a ſmall apple, round or oblong, brown without, yellow and cryſtalline within, brilliant and ſhining.

Marcaſites are found in mines of metals; they all contain ſulphur and a vitriolick ſalt, eſpecially that of copper: ſome of them alſo contain antimony and biſmuth.

COBALT is a kind of marcaſite, ſuppoſed to be the *Cadmia* of the antients, out of which is drawn arſenick and ſmalt.

Cobalt uſually contains a little ſilver, ſome copper, but much arſenick. There are various mines of *cobalt*, eſpecially in *Saxony*, ſome in *France*, and *England*.

OKER, or OCHER, a yellow, dry, foſſil earth: harſh to the touch; found in copper and lead mines, ſometimes in thoſe of ſilver, and ſometimes in mines of its own.

Oker is always impregnated with iron, and is what generally gives to the chalybeate ſprings their medicinal virtues. Its chief uſe is in painting.

Only the yellow *oker* is natural; the red is prepared from the yellow, by calcining it in the fire, till it has acquired its redneſs.

The beds are uſually from one hundred and fifty to two hundred feet deep; and their thickneſs from four to eight inches, between a white ſand which covers them a-top, and a yellow argillous earth underneath.

LAPIS HÆMATITES, called alſo *blood-ſtone*, is a kind of ruddy mineral in a form of a ſtone; thus called, either on account of its reſembling dry, curdled blood, or of the faculty it has of ſtanching of blood.

The native or foſſil kind comes from *Egypt*, *Bohemia*, &c. It has divers uſes in medicine; being held cooling and aſtringent, and in that quality preſcribed in hæmorrhages. It is given in ſubſtance, in form of a fine powder.

The gilders uſe it for burniſhers, to poliſh their gold withal.

The

The Armenian Stone, *lapis Armenus*, is a mineral stone or earth, of a blue colour, spotted with green, black, and yellow; antiently brought only from *Armenia*, but now found in *Germany*, and *Tyrol*.

The *Armenian stone* bears a near resemblance to *lapis lazuli*, from which it seems only to differ in degree of maturity: they are distinguished by this, that the *lapis Armenus* is softer, and instead of sparks of gold, is speckled with green.

Boerhaave ranks it among semi-metals; and supposes it composed of metal and earth. *Woodward* says it owes its colour to an admixture of copper.

Its chief use is in Mosaick work, though it has some place also in Physick.

Besides the above-mentioned *minerals* or *fossils*, there are others, as all kinds of *bitumen*, which in a general sense, is a fatty, tenacious, mineral juice, very inflammable; or a fossil body, which readily takes fire, yields an oil, and is soluble in water.

Naturalists distinguish three kinds of *bitumens*, *hard*, *soft*, *liquid*, or *oily*; each of which they subdivide into several others.

Among the *hard bitumens* are ranked *yellow amber*, sometimes *amber-grease*, *jet*, *asphaltum* or *Jews-pitch*, *pissasphaltum*, *pit-coal*, *black stone*, and *sulphurs*.

Yellow Amber, *succinum*, or *karabe*, is a yellow transparent substance, of a bituminous form or consistence, but a resinous taste, or smell like oil of turpentine; chiefly found in the *Baltick sea*, and along the coasts of *Prussia*, &c.

Naturalists are infinitely divided as to the origin of *amber*: some referring it to the vegetable, others to the mineral, and some even to the animal kingdom.

The most remarkable property of *amber* is, that when rubbed, it draws or attracts other bodies to it. See the treatise of *Chymistry*.

Jet, *gagates*, called also *black amber*, is a light, smooth, pitchy, fossil stone, extremely black; formed of a bituminous juice in the earth, in the manner of coal.

It works like amber, and has most of its qualities: it readily catches fire, flashes, and yields a bituminous smell.

Asphaltum, or Asphaltos, is a solid, brittle, black, inflammable, bituminous substance, resembling pitch, brought from the east, and particularly *Judea*; whence it is also called *Jews-pitch*.

The *asphaltos* of the *Greeks*, is the bitumen of the *Latins*. It is chiefly found swimming on the surface of the *Lacus Asphaltites*, or Dead-sea, where antiently stood the cities of *Sodom* and *Gomorrah*. It is cast up from time to time, in the nature of a liquid pitch, from the earth, which lies under this sea; and being thrown upon the water, swims like other fat bodies, and condenses by little and little, through the heat of the sun, and the salt that is in it: it burns with great vehemence; in which it resembles *Naphtha*; but is thicker, as to consistence.

The *Arabs* use it to pitch their ships withal, as we do common pitch. There was a deal of it employed in the embalming of the antients.

It is supposed to fortify, and resist putrefaction; resolve, attenuate, cleanse, and cicatrize wounds: but is little used among us, either externally or internally.

Pissasphaltum denotes a native, solid bitumen; found in the *Ceraunian* mountains of *Apollonia*; of an intermediate nature between pitch and asphaltum.

Pit-coal is ranked among the number of minerals, and the places it is dug out of are called *coal-mines*, or *coal-pits*.—The *English* coal is of most repute, even in foreign countries.

The goodness of coal consists in its being as free as possible from sulphur, in its heating iron well, and in its burning a long time in the smith's forge.

The strata, or veins of coals in coal-pits, are numerous, and their order, quality, &c. different in different places.

In those at *Dudley*, in *Staffordshire*, the strata below the turf, two or three clays, a grey stone, and a hard grey rock, are expressed in the *Philosophical Transactions*, to be, 1. *Coal*, called *bench-coal*. 2. *Slipper-coal*, less black and shining than the former. 3. *Spin-coal*, more black and shining. 4. *Stone coal*, much like *canal coal*.

These strata's have between each of them a bat, or bed, of a peculiar sort of matter, about the thickness of a crown-piece. Below these are divers metalline strata's, as a black substance, call'd *dun-row-bat*; a grey iron ore, called the *dun-row iron-stone*; a bluish bat, called *white-row*; a blackish iron ore, called *white-row grains*, or *iron-stone*; a dark grey iron ore, called *bubble iron-stone*; lastly, the *table bat*.

Then, 5. Comes a coarse sort of *coal*, called *foot coal*; a black brittle bat. 6. The *heathen-coal*. 7. A substance like coarse *coal*, though called a *bat*, because it does not burn well. And, 8. *Bench coal*.

Black-

Black-stone, or Black-lead, is a kind of mineral ſtone, of a black colour, but ſilver'd, and ſhining, found chiefly in lead-mines, and appearing to be nothing elſe but lead, nor yet arrived at maturity; much uſed for pencils, or crayons for deſigning. It is melted like the common lead.

Sulphur is a fat, unctuous ſort of mineral ſubſtance, fuſible, and inflammable by fire. See *Chymiſtry*.

Soft Bitumens, are the *maltha*, *bitumen* of *Calco*, of *Surinam*, and *Copal*. The *naphtha* of *Italy*, *Petroleum*, and *Zacinthius*.

The Maltha is a kind of bitumen, wherewith the *Aſiaticks* plaiſter'd their walls. When this is once ſet on fire, water will not quench it, but ſerves rather to make it burn more fiercely.

The Naphtha is a kind of liquid bitumen, very oily and inflammable, exuding out of the earth, or ſwimming on the ſurface of the water of ſome ſprings. It is uſually of a black colour; though that found in certain ſprings about *Babylon*, is ſaid to be whitiſh.

That of *France* is ſoft and black, like liquid pitch, and of a fœtid ſmell; that of *Italy* is a kind of *petrol*, or a clear oil, of various colours, oozing out of a rock, ſituated on a mountain, in the dutchy of *Modena*.

The *naphtha* is eſteemed penetrating, reſolutive, and vulnerary; but its virtues are little known in medicine. Its chief uſe is in lamps, &c. on account of its inflammability.

Petrol, Petroleum, q. d. *petræ oleum*, rock-oil, is an oleaginous juice, ſuppoſed to iſſue out of the clefts of rocks; and found floating on the water of certain ſprings.

Olearius ſays, he ſaw above 30 ſprings near *Scamachia* in *Perſia*: there are alſo *petrols* in the ſouthern provinces of *France*; but the beſt are thoſe in the dutchy of *Modena*, firſt diſcovered by *Arioſto*, a Phyſician, in 1640, in a very barren valley, twelve leagues from the city of *Modena*.

From a mixture of oleaginous, and ſaline juices with the earth, ariſe ſeveral concretions, as *ſand*, *argilla*, *bole*, *ſtone*, *flint*, &c. and each of them is a kind of *foſſil*.

Sand is a fine, hard, gravelly ſort of earth, or rather ſtones divided into ſmall grains.

Sand is formed of a perfect diſſolution of a ſmall portion of earth, made by ſaline juices, which have formed themſelves with that earth, into little globules, which men have been pleaſed to call *ſand*, which having been liquid in its formation, or perforated on all ſides, by the particles of light, retain ſtill, after it is harden'd, the ſame faculty of tranſmitting light.

The production of Argilla (which is a white dry earth, like chalk, but more friable) is almoſt the ſame with that of ſand; unleſs that *argilla* being compoſed of much ſmaller grains, ſeems to contain more oleaginous juice than ſand.

Biſhop *Wilkins* divides *ſtones* into *vulgar*, *middle price*, and *precious*.

Vulgar Stones, or ſuch as are of little price, are diſtinguiſhable by their different magnitudes, uſes, and conſiſtence, into the

- Greater magnitudes of *ſtone* uſed either about
  - Buildings, whether of
    - Walls; chiefly being of a
      - Softer conſiſtence, whether natural or factitious,
        - 1. *Free-ſtone*, *Brick*.
      - Harder conſiſtence; not eaſily yielding to the tool of the workman, growing either in
        - Great maſſes,
          - 2. *Raggs*.
        - Leſſer maſſes; whether ſuch as are for their figure,
          - More knobbed, and unequal, uſed for ſtriking of fire, either the more common, which is leſs heavy; or leſs common, which is more heavy; as having ſomething in it of a metalline mixture,
            - 3. *Flint*, *Marcaſite. Fire-ſtone.*
          - More round and even,
            - 4. *Pibble*, thunderbolt.
    - Roof, or pavement, being of a laminated figure, either natural or factitious.
      - 5. *Slate*, *Tyle*.
  - Metals, either for the
    - Sharpening or trying of them,
      - 6. *Whet-ſtone*, *Touch-ſtone*.
    - Poliſhing, or cutting them; being either of a more ſpungy and ſoft, or of a more hard conſiſtence.
      - 7. *Pumice*, *Emery*.
- Leſſer magnitudes, either more, leſs, or minute.
  - 8. *Sand*, *Gravel*.

2. Middle

2. *Middle priced* STONES, are either of a
Shining politure, or capable of it; whether of a
simple white colour, and more soft consistence,

1. *Alabaster.*

Sometimes white, sometimes black. or green, and sometimes variegated with veins, growing in greater or less masses,

2. *Marble*, *porphyry*, *Agat*.

Spotted with red, upon a greenish colour, or with spots of gold colour upon blue,

3. *Jaspis*, *heliotryx*, *Lazuli*, *azure stone*.

Transparency, either
brittle; whether natural or factitious,

4. *Crystal*, *Glass*,

Fissilk into flakes, either greater or lesser,

5. *Seletine*, Muscovia *glass*, *isinglass*, *spar*, *Talc*.

Relation to metals, attracting iron, or making of brass.

6. *Load-stone*, *Cadmia*, *calaminaris*.

Incombustible nature,

7. *Amiantus*, *asbestus*.

Strange original; not being properly minerals, tho' usually reckoned among them; but either a submarine plant, or supposed to proceed from a liquid bitumen,

8. *Coral*, *coralline*, *Amber*.

Precious STONES he subdivides into *more* and *less transparent*.

The *less transparent* he distinguishes by their colours, into red, as the *sardian* and *cornelian*; pale, fleshy colours, like that of a man's nail, as the *onyx*; bluish, as the *turquois*: pale purple, as the *chalcedony*; and those of various colours, as *opal*, and *cat's eye*.

The *more transparent* he distinguishes into such as are colourless, as the *diamond* and *white sapphire*; and coloured, which are either red, as the *ruby*, *carbuncle*, and *granate*; yellow, as the *chrysolite* and *topaz*; green, as the *emerald*, *smaragd*, and *beryl*; bluish, as the *sapphire*; and purple or violaceous, as the *amethyst* and *hyacinth*.

EARTH, as we take it in this place, is also a fossil or terrestrial matter, whereof our globe principally consists; whose character is to be neither dissoluble by fire, water, nor air; nor transparent, more fusible than stone, and generally containing some degree of fatness.

Of such *earths*, some are simple and immutable; others compound and fatty. Of the first kind is *chalk*, *pumice*, and *rotten-stone*. Of the second or compound kind, are *boles* of all kinds, red, white, and brown; *fuller's earth*, the divers kinds of medicinal earth, as the *Cretica*, *Hungarica*, *Turcia*, *Suecia*, *Lemnian earth*, *Malta earth*, *terra sigillata*.

With regard to the *simple earths*. CHALK, is a white fossil substance, usually reckoned as a stone; but Dr. *Slare* thinks, without reason; since when examined by the hydrostatical ballance, i is found to want much of the weight and consistence of a real stone: so that he thinks it more justly ranked among the earths.

PUMICE, reckoned by a great number of Naturalists, as a kind of spongeous stone, very porous and friable: is by others considered as a kind of earth: neither are they agreed about the nature and origin of *pumice*. Some look on it as pieces of rock half-burnt and calcined, cast up in eruptions of vulcano's, particularly *Æana* and *Vesuvius*, into the sea; and which being there washed in the salt-water, lays aside the black colour, that the impression of the subterranean fires had given it, and becomes whitish, or sometimes only greyish, according as it has floated more or less in the sea.

Dr. *Woodward* considers *pumice*, as only a sort of slag, or cinder; and affirms, it is only found either where forges of metals have antiently been, or near some vulcano or burning mountain.

Other authors will have the *pumice* to rise from the bottom of the sea; whence they suppose it detached by subterraneous fires. And hence account both for its lightness and porosity, and its saline taste: alledging, in confirmation hereof, that *pumice* is frequently found in parts of the sea far remote from all vulcano's; and adding, that several parts of the *Archipelago* are frequently found cover'd with it, all at once, after a few inward shakes and heavings of the bottom of the sea.

Pumice makes a very considerable article in commerce, and is much used in the arts and manufactures, to polish and smooth several works.

Its pieces are of several sizes: the parchment-makers and marblers use the largest and lightest. The Curriers the heaviest and flattest. The Pewterers the smallest.

Pliny observes, that the antients made considerable use of *pumice*, in medicine; but it is out of the present practice.

As to the second, or *compound kind of earths*. BOLES abound with salts of different forms or figures. For the spirit of vitriol, which is an acid, poured upon the *Armenian bole*, causes no ebullition; but if it be poured upon the *terra sigillata*, or *Lemnian bole*, it will excite a very great effervescence,

vescence, or ebullition; which denotes a very great variety of salts in those earths, or boles.

The *Armenian* BOLE, popularly, though corruptly called in *English*, *bole ammoniack*, is a soft, friable, fatty earth, of a pale red colour; easily pulverized, and which adheres to the tongue; esteemed a good dryer, styptick, and vulnerary; and in these qualities used in divers diseases, both internally and externally.

This *bole* is easily falsified; and the Druggists frequently sell *Lemnian*, or other earth in lieu thereof. *Matthiolus* says, it is found in gold, silver, and copper-mines.

BOLE *of the Levant*, is a medicinal earth brought from the *Levant*; nearly of the same nature, and having the same uses with the *Armenian bole*.

FULLERS-EARTH is a fatty, fossil earth, abounding in nitre; of great use in the woollen manufacture; and I believe peculiar to *England*, where its exportation is prohibited.

Terra sigillata is a kind of earth or bole, dug in the Isle of *Lemnos*, and thence also called *Lemnian* earth, of considerable use in Painting and Medicine.

It is of different colours, but most commonly red; heavy, soft, and friable; held very astringent, and as such used in hæmorrhages; as also against the plague and poison. *Pliny* attributes to it several other virtues. It is an ingredient in Venice-treacle.

It was antiently found in a mountain, in the neighbourhood of the city *Hephæstia*; where *Diana*'s priests went at certain times with great ceremony to dig it up. After a little preparation they made it up in *troches*, and sealed them with *Diana*'s seal; whence the appellation of *sigillata*, *sealed*.

It is now brought from *Constantinople* in little flat cakes, round on one side, flat and sealed on the other.

MINERAL-WATERS, are those, which at their springing forth from under ground, are found impregnated with some *mineral* matter, as salt, sulphur, vitriol, *&c* and the divers mixtures made in them of several of those matters together, constitute so many different kinds of *mineral-waters*.

The waters of the same springs, can, in divers times, receive notable alterations or changes, by new mixtures, or by those which have been made being entirely exhausted.

To discover the nature and qualities of *mineral-waters*, the following method is to be observed.

1. From what place they are.—2. In what time, or disposition of the air they have been taken in their springs.—3. If they are sent in bottle to the physician who is to examine them, he must enquire how long they have been in bottles, and if the bottles were clean, and have been well corked.—4. If they have made some sediment in the bottles, and of what kind.—5. If these waters are limpid or muddy.—6. If they have some smell and some manifest flavour.—7. If their weight differs notably from that of simple and common water.—8. If they change colour by being mixed with galls, or oak leaves, or pomegranate's peel, myrabolans, *&c.*—9. If having been exposed to the air, or a little heated, they are no longer susceptible of colour.—10. If being put in distillation through the alembick, in balneo-mariæ, there arises and distils first some liquor more subtile than the rest, and if there be found some differences between the diverse portions of the same water distilled, received separately.—11. If in the evaporation or distillation of those waters, at a very moderate heat, some pellicles be formed on the surface of the water; or if some terrestrial concretions be made floating by flakes in the water, or adhering to the sides of the vessels, or settling at the bottom, and which.—12. If after an almost total distillation or evaporation of those waters, some saline, fibrous, granulated, or otherwise figurated concretion, be made in the liquor left, and exposed in a cold place.—13. If the water being all evaporated, or distilled dry, leaves a setting, how much, and what sort of settling.—14. If the terrestrial settling contains some portion of salt or not.—15. To which salts, of those commonly known, the salts of those waters can have a report.—16. If they precipitate into a red, or yellow colour sublimate mercury dissolved in common water; and if they precipitate likewise, the sulphureous earths of common vitriol, as do the true nitre of the antients, the natron of *Egypt*, the white lode, and the fossil borax.—17. If they change green the colour of syrup of violets, and if they restore the blue colour of the tournesol, turned red by some alluminous vitriolick acid or other, as the true nitres do.—18. If they turn red the tournesol, as the allum and vitriol do.---19. If they thicken and coagulate quickly, the liquor of the fixed salt of tartar, as does the succulent and second portion of common salt, which is not concerned but by a total evaporation of the water in which that salt has been dissolved.---20. If they cause no changes in the waters of the dissolutions of sublimate mercury and vitriol, nor on the syrup of violet, nor on the liquor of the salt of tartar resolved, no more than do saltpetre, and the first portion of common salt, which is crystallized when exposed

expoſed in a cold or damp place.—21. If the earthy ſettlings of thoſe waters, after the ſeparation of their ſalts, are entirely, or in part diſſoluble in diſtilled vinegar, and with ſome ebullition, as certain ſorts of chalks, as does the white earth of the curds of nitrous and alkali ſalts, produced by the mixture of the ſecond portion of common ſalt.—22. If thoſe terreſtrial ſettlings diveſted of ſalts, put to the fire and ſtrongly heated in *German* crucibles, be fixed if they change colour, if they are vitrified or calcined, and if by means of the reductive ſalts, ſomething metallick can be extracted from it or not.—23. And if their ſalts purified, after they have been melted at the fire in crucibles of a good vitrified earth, aſſume ſome extraordinary colour.

All *mineral-waters* are either hot, or luke-warm, or cold; they alſo differ in the taſte, for ſome of them are ſour or vinous, ſome auſter or ferruginous, and others without any manifeſt flavour, or inſipid.

All thoſe ſenſible differences, joined to thoſe which are the moſt remarkable in the ſettling of thoſe waters, after diſtillation or evaporation, and particularly in the participation of certain ſalts, ſome of which have ſome report to common ſalt, and others to the nitre of the antients, have given occaſion to diſtribute *mineral-waters* into ſeveral claſſes, to diſpoſe in ſome order the hiſtorical detail of the obſervations made in examining them.

In the firſt of theſe claſſes are the *hot waters*, in which is found a ſalt which has a report to common ſalt.

In the ſecond are the hot waters, whoſe ſalt is found like to the nitre of the antients.

In the third are the inſipid *luke warm waters*, which participate of ſome ſalt, either common or nitrous, and ſome which have no ſalt at all.

In the fourth, are the *luke warm waters* of a ſouriſh or vinous taſte, which participate ſomething of the true nitre.

In the fifth, are the inſipid *cold waters*, which participate of ſome ſalt like to common ſalt, and ſome in whoſe analyſis no ſalt is found.

In the ſixth, are the *cold waters*, whoſe flavour is ferruginous or auſter.

In the ſeventh, are the *cold waters* of a ſouriſh or vinous taſte, which participate of common ſalt.

And in the eighth, are the *cold waters*, of a ſouriſh or vinous taſte likewiſe, which participate of the true nitre.

In the ſeveral experiments which have been made on *mineral waters*, none of the hot ones have been found ſouriſh, and none of the inſipid cold ones nitrous.

The chief hot mineral ſprings in *England*, are thoſe near *Wells* in *Somerſetſhire*, and thoſe others at *Buxton* and *Maltock* in *Derbyſhire*; which latter however, are rather warm or tepid than hot.

In the city of *Bath* are four hot baths; one triangular called the *croſs-bath*, from a croſs that formerly ſtood in the midſt of it; the heat of which is more gentle than the others, becauſe it has fewer ſprings. The ſecond is the *hot-bath*, which heretofore was much hotter than the reſt, when it was not ſo large as it now is. The other two are the king's and queen's baths, divided only by a wall; the laſt having no ſpring, but receiving the water from the king's bath, which is about ſixty feet ſquare, and has in the middle of it many hot ſprings, which render its healing quality more effectual. Each of theſe is furniſhed with a pump to throw out water upon the diſeaſed, where it is required.

Theſe waters abound with a mineral ſulphur; they are hot, of a bluiſh colour, and ſtrong ſcent, and ſend forth thin vapours. They do not paſs through the body like moſt mineral waters, though if ſalt be added, they purge preſently. On ſettlement they afford a black mud, which is uſed by way of cataplaſm in aches, of more ſervice to ſome than the waters themſelves; the like they depoſite on diſtillation and no other.

Dr. *Aſtendoff* found the colour of the ſalt drawn from the king's and hot bath, yellow; and that from the *croſs-bath*, white; whence he concludes, that the *croſs-bath* has more allum and nitre than the hot, which, tho' it abounds more with ſulphur, I conclude hence that it is all nitre and no allum. The *croſs-bath* is ſuppoſed to prey on ſilver, and all of them on iron, and none on braſs.

The uſe of theſe baths is found beneficial in diſeaſes of the head, as palſies, &c. in cuticular diſeaſes, as leproſies, &c. obſtructions and conſtipations of the bowels, the ſcurvy and ſtone, and in moſt diſeaſes of women and children. The baths have performed many cures, and are commonly uſed as a laſt remedy in obſtinate chronick diſeaſes; where they ſucceed well, if they agree with the conſtitution of the patient.

M U S I C K.

MUSICK (from *musa*, muse, the Muses being supposed to be the inventors thereof) is a science that teaches how sounds, under certain measures of tune, and time, may be produced, and so order'd or dispos'd, as either in consonance or succession, or both, they may raise agreeable sensations.

MUSICK divides itself naturally into *speculative* and *practical*.

Speculative MUSICK is that which consists in the examen of the nature, properties, effects, *&c.* of the sounds, and in reasoning on them.

Practical MUSICK is that which shews how the knowledge acquired by the speculative part is to be applied; or how sounds in the relations they bear to *Musick*, may be order'd, variously put together, in succession, and consonance, so as to answer the end. And this we call *the art of composition*, which is properly the practical part of *Musick*.

The first branch, which is the contemplative part, divides itself into these two, *viz.* the knowledge of the *relations and measures of tunes*, and the *doctrine of time*.

The former is properly what the antients called *harmonica*, or the *doctrine of harmony in sounds*, as containing an explication of the grounds, with the various measures, and degrees of the agreement of sounds, in respect of their tune.

The latter is what they call *rhythmica*, because it treats of the numbers of sounds, or notes with respect to time; containing an explication of long and short, of swift and slow, in the succession of sounds.

The second branch of the *practical part of Musick*, as naturally divides into two parts, answering to the parts of the first.

That corresponding to the harmonica, the antients called *melopœia*, because it contains the rules of making songs, with respect to time and harmony of sounds; though we have no reason to think the antients had any thing like composition in parts.

That which answers to the rhythmica they call *rhythmopœia*, containing rules for the application of the numbers and time.

The *speculative* or *theoretical Musick*, has for object the *sound*; which in *Musick* denotes a quality, in the several agitations of the air, considered as their disposition, measure, *&c.*

The principal affection of *sound*, whereby it is fitted to be the object of *Musick*, is that whereby it is *acute*, or *high* and *grave*, or *low*.

This difference depends on the nature of the sonorous body; the particular figure and quantity thereof; and even in some cases, on the part of the body where it is struck, and is that which constitutes what we call different tones.

The cause of this difference appears to be no other than the velocities of the different vibrations of the sounding bodies.

From the same principle arise what we call *concords*, &c. which are nothing but the result of frequent unions and coincidences of the vibrations of two sonorous bodies, and consequently of the waves and undulating motions of the air occasioned thereby.

On the contrary, the result of less frequent coincidences of those vibrations, is what we call a discord.

Sounds are again distinguished into *long* and *short*, not with regard to the sonorous bodies retaining a motion once received, a longer, or a less time, though gradually growing weaker; but to the continuation of the impulse of the efficient cause on the sonorous body, for a longer or a shorter time, as in the notes of a violin, *&c.* which are made longer or shorter, by strokes of a different length or quickness.

This continuity is properly a succession of several sounds, or the effect of several distinct strokes, or repeated impulses of the sonorous body, so quick that we judge it one continued sound; especially if it be continued in the same degree of strength: and hence arises the doctrine of *measure* and *time*.

Another distinction of *sounds* is into *simple* and *compound*, and that two ways.

A *simple sound* should be the effect of a single vibration, or of so many vibrations as are necessary to raise in us the idea of *sound*. In the second sense of *composition*, a simple sound is the product of one voice, or one instrument, *&c.*

A *compound sound* consists of the *sounds* of several distinct voices, or instruments all united in the same individual time and measure of duration, that is, all striking the ear together, whatever the other differences may be, but in this sense again, there is a two fold composition, a natural and artificial one.

The natural composition is that proceeding from the manifold reflections of the first *sound* from adjacent bodies, where the reflections are not so sudden as to occasion echo's, but are all in the same tune with the first note.

The artificial compoſition, which alone comes under the Muſician's province, is that mixture of ſeveral *ſounds*, which being made by art, the ingredient *ſounds* are ſeparable, and diſtinguiſhable from one another.

Sounds are diſtinguiſhed again into *ſmooth* and *even*, or *rough* and *harſh*, alſo *clear* and *hoarſe*.

Smooth and *rough ſounds* depend principally on the ſounding body; of this we have a notable inſtance of ſtrings that are uneven, and not of the ſame dimenſion or conſtitution throughout.

As to *clear* and *hoarſe ſounds*, they depend on circumſtances which are accidental to the ſonorous body; thus a voice or inſtrument will be hollow and hoarſe, if raiſed within an empty hogſhead; that yet is clear and bright out of it: the effect is owing to the mixture of other and different *ſounds* raiſed by reflection, which corrupt and change the ſpecies of the primitive *ſound*.

Harmonical ſounds are produced by the parts of chords, &c. which vibrate a certain number of times while the whole chord vibrates once. By this they are diſtinguiſhed from the third, fifth, &c. where the relations of the vibrations are four to five, or five to ſix, or two to three.

The relations of ſounds had only been conſidered in the ſeries of numbers, 1 : 2, 2 : 3, 3 : 4, 4 : 5, &c. which produced the intervals, called *octave*, *fifth*, *fourth*, *third*, &c. M. *Sauveur* firſt conſidered them in the natural ſeries, 1, 2, 3, 4, &c. and examined the relations of the *ſounds* ariſing therefrom.—The reſult is, that the firſt interval, 1 : 2, is an octave; the ſecond, 1 : 3, a twelfth; the third, 1 : 4, a fifteenth, or double octave; the fourth, 1 : 5, a ſeventeenth; the fifth, 1 : 6, a nineteenth, &c.

The difference between two ſounds, in reſpect of *acute* and *grave*, or that imaginary ſpace terminated by two ſounds, differing in acuteneſs or gravity, is called *interval*.

When two or more ſounds are compared in this relation, they are either equal or unequal in the degree of time: ſuch as are equal are called *uniſons*, with regard to each other, as having one tune; the other being at a diſtance from each other, conſtitute what we call an *interval* in *muſick*; which is properly the diſtance in tune between two ſounds.

Intervals are diſtinguiſhed into *ſimple* and *compound*.

Simple Interval is that without parts, or diviſion: ſuch are the *octave*, and all that are within it; as the *ſecond*, *third*, *fourth*, *fifth*, *ſixth* and *ſeventh* with their varieties.

Compound Interval conſiſts of ſeveral leſſer *intervals*; ſuch are all thoſe greater than the *octave*; as the *ninth*, *tenth*, *eleventh*, *twelfth*; which diſtinction of *intervals* is clearly ſeen, at one view, in the following table:

1	2	3	4	5	6	7	*Simple.*	Intervals.
8	9	10	11	12	13	14	*Double.*	
15	16	17	18	19	20	21	*Triple.*	
22	23	24	25	26	27	28	*Quadruple.*	
29	&c.							

Thoſe of the upper rank mark the *ſimple intervals*; and the other three, the *compound* ones, *viz.* either *double*, as thoſe of the third rank; or *quadruple*, as thoſe of the fourth rank, &c.

To reduce at once a *compound* to a *ſimple interval*, there's nothing elſe to do, but to take 7 off the number which gives it the name; if nothing remains, the *ſeventh* will be the *ſimple interval*; if ſomething remains, the figure left will be the name of the *ſimple interval*. As for example, if one will know what is a *thirteenth*, he muſt take off 7 from the number 13, and there remains 6; a *thirteenth* therefore is properly a 6th doubled. Or if we want to know what is a *twenty-ſixth*, we muſt take off three times 7, or 21, and there remains 5, the 26th therefore is a fifth quadrupled. All *compound intervals* are always reputed of the ſame nature with the *ſimple*, which anſwer to it.

Of the twenty-nine *intervals* which compoſe our table, ſome are called by the *Italians*, *conſonanti*, conſonants; others *diſſonanti*, diſſonants.

The *conſonanti*, or Consonants, are all the *intervals* which pleaſe the ear, whether they be perfect, as the *octave*, and the *fifth*; or *imperfect*, as the *ſixth* and *third*.

The *diſſonanti*, or Dissonance, is in general a falſe *conſonance*, or concord. A *diſſonance* is properly the reſult of a mixture, or meeting of two ſounds, which are diſagreeable to the ear; and the epithet given to all the *ſuperfluous* or *diminiſh'd intervals*, as the *ditones*, *tritones*, *falſe fifth*, *redundant fourth*, *ſeventh*, &c. *Diſſonances* are uſed in *Muſick*, and have a good effect therein, though it be only by accident.

Others they call *vitiati*, or *prohibiti*, i. e. *forbidden*, or which are never to be made in the ſequel of a piece of *Muſick*, through the difficulty of tuning them one after another, either in *aſcending* or *deſcending*. Such are, for example, the *ſixth major*, the *tritone*, the *fifth*, and all the other *ſuperfluous intervals*, the *ſeventh*, the *ninth*, or all thoſe which are at ſo great a diſtance, that the voice cannot naturally reach it. Some are *forbidden* in

aſcending

ascending, and *permitted* in *descending*, such are the *fourth*, the *fifth*, the *seventh* diminished, *&c.*

A *compound interval*, or an interval composed of several lesser, is called SYSTEM, in *Musick*; such is the *octave*, *&c.* The word is borrowed from the antients, who called a simple interval *diastem*, and a compound one *system*.

There are several distinctions of *systems*; the most remarkable is into *concinnous* and *inconcinnous*.

Concinnous SYSTEMS are those consisting of such parts as are fit for *Musick*; and those parts placed in such an order between the extremes, as that the succession of sounds, from one effect to the other, may have a good effect.

Inconcinnous SYSTEMS are those where the simple intervals are *inconcinnous*, or ill disposed betwixt the extremes.

Systems, again, are either *particular* or *universal*.

Particular SYSTEMS (at least called so by the antients) were a compound at least of two *diastems*, or intervals, and consequently of three sounds at least; such as all kinds of *thirds*; and more all the compounds of three, four, five, *&c.* Diastems or intervals, such as are the *fourth*, *fifth*, *sixth*, and *octave*.

Whence *Boœtius* calls the *modes* or *tones*, *constitutions* or *systems*; since in effect a *mode* is properly an assemblage of several sounds, of several intervals, and of several particular systems, which constitute a whole, called *melody* or *song*.

Hence we commonly call *general* SYSTEM, a *gamut*, a *scale*, an assemblage of several *words*, *syllables*, *letters*, *figures*, &c. which serve to denote the *grave* and *acute sounds*, their *differences*, *intervals*, *proportions*, &c. so that *system* and *gamut* are very near the same thing in *Musick*, *alphabets* are in Grammar; and as there have been different alphabets, according to the diversity of languages, times, places, *&c.* there have been likewise several systems of sounds.

The first, or at least the most antient we have knowledge of, is that of the *Greeks*, which began at first by a tetrachord, *i. e.* a sequel, of four chords only, the lowest whereof answer'd to our *mi*, and the two others to the notes *fa*, *sol*, *la*, which is what *Boœtius* calls the order or system of *Mercury*, to whom the invention thereof is attributed about the year of the world 2000.

It was soon perceived, that that *tetrachord* was not sufficient to express all the sounds; therefore several persons added, at different times, three other chords underneath the four above, which answer'd to what we call, at present, *si ut*, *re*, and which formed with them two *tetrachords*, but two *tetrachords* joined; since the *mi* served as highest chord to the first or lowest; and of the lowest chord to the highest, as in the following example:

Mi fal sol la
Si ut re mi.

Some time afterwards, *Pythagoras*, according to the most common opinion, having established rules to find the proportion of sounds, perceived soon, that the two extremes of those two tetrachords, *viz. si*, and *la*, making the interval of a seventh were *dissonants*, which obliged him to add underneath the most *grave chord* of those two *tetrachords* an eighth chord which made the *octave* with the highest, *viz. la*, whence it was called *proslambanomenos*, or *added*.

Lastly, as in process of time, it was found that those eight sounds were not sufficient to express all the sounds of the human voice, several persons added, by degrees, other chords, enough to form, besides, two other *tetrachords* joined together, the sounds whereof were an *octave* higher, than the sounds of the two first; thus the *system* was found composed of fifteen chords, or four *tetrachords*, the two extremes whereof made between themselves the *dis-diapason* or double *octave*; of which, to please the curious, I give in the following tables, the *order*, *proportions*, with the name given them in the *modern system*.

TABLE *of the fifteen* diatonick chords *of the* system *of the antients.*

Tetrachord *of the most* acute, *or* highest.

The last of the most excellent, or most acute.	——	LA	*Tone minor.*
The penultieme of the excellents.	*Key of*	SOL.	
The third of the excellents.		FA	*Semi-tone.*

Tetrachord *of the* disjoined.

The last of the disjoined.		MI	*Tone minor.*
The penultieme of the disjoined.		RE	*Tone major.*
The third of the disjoined.	*Key of*	UT	*Semi-tone.*
Paramese.	——	SI	*Tone major.*
Trite synemenon.			

It is now the *si mi*.

Tetrachord *of the* mese.

Mese	——	LA	*Tone minor.*
Meson-diatonos		SOL	*Tone major.*
Parhypato-meson	*Key of*	FA	*Semi-tone.*

Tetrachord *of the* principals.

Hepatemeson	MI	*Tone minor.*
Hypaton-diatonos	RE	*Tone major.*
Parhypame-hypaton	UT	*Semi-tone.*
Hypate hypaton	SI	
Proslambanomenos	LA LA.	

For

For the intelligence of this table, it muſt be obſerved, 1 That as the *proſlambanomenos*, or added, does not contribute towards forming the firſt or loweſt of the four *tetrachords*, it is ſeparated from it, and was added only to perfect the loweſt octave, and make the *meſe* the middle of that ſyſtem, according to its ſignification, and to join ſo well the two octaves which compoſe that ſaid ſyſtem, that it be the higheſt chord of the loweſt octave; and the loweſt chord of the higheſt octave, according to *Boetius*'s obſervation.

2. That between the two loweſt chords of each *tetrachord*, i. e. between *mi*, *fa*, and *ſi*, *ut*, there is an interval of five comma's, or of a *ſemi-tone major*; that between the two higheſt, as *re*, *mi*, and *ſol*, *la*, there is a *tone minor*; and between thoſe which make the middle, ſuch as *ut*, *re*, and *fa*, *ſol*, there is a *tone major*, at leaſt in the opinion of the antients.

3. That to diſcover better the conjunction of the *tetrachords*, I have on purpoſe redoubled the *mi* of the two octaves, where that conjunction is made, ſo that the firſt terminates above the loweſt of the *joined tetrachords*, and the ſecond, which notwithſtanding is but the emiſſion of the firſt, begins under the higheſt of thoſe *tetrachords*. This the antients called the greateſt of all *ſyſtems*, the *immutable ſyſtem*, *diatonick*, *pythagorical*, &c.

Thus far, in fact, the ſyſtem is purely *diatonick*, is compoſed only of *major tones* and *ſemi tones*; which nature alone, without the aſſiſtance of art, teaches the moſt ignorant how to tune, provided they have the ear, and the organs of the voice well diſpoſed. But as it was obſerved, in proceſs of time, that between the *meſe* and the *parameſe* there was a full tone, which render'd the fourth from *fa* to *ſi* ſuperfluous, and very diſagreeable. a fifth *tetrachord* was invented to make full a middle chord, to divide the interval from the *meſe* to the *parameſe*, into two *ſemi-tones*, one *major*, and the other *minor*, called at preſent *ſi b*, and which has been marked ſince by a *b mol*.

This, without doubt, gave occaſion to *Timothy* the *Mileſian*, to divide likewiſe in two intervals *ut re*, and *fa ſol*, which make the middle of each *tetrachord*, and a *tone major*, and that by means of a double *diezes*, which has been the origin of the chromatick gender; and has been the cauſe that thoſe ſounds or chords, have been called moveable ſounds. But he did not divide in the ſame manner the intervals *re mi*, and *ſol la*, which terminate above each *tetrachord*, becauſe they make but one *tone minor*; whence they are called *ſtable* ſounds or chords.

Laſtly, one *Olympius*, refining on that diviſion, pretended, that at the example of the *tones-major*, the *ſemi tones major* ſhould alſo be divided in two; which engaged him to put, 1. A middle chord, between the two loweſt chords of each *tetrachord*, viz. betwixt *ſi ut*, and *mi fa*. And, 2. Another middle chord, betwixt the ſecond *diatonick* chord of each *tetrachord*, and the *chromatick* chord, which was a *ſemi-tone* higher than the *diatonick*; which was the origin of the *enharmonick* gender, and conſequently of the *enharmonick* and *chromatick* diezes.

The *enharmonick* is one of the three genders of *Muſick*, in which the modulation proceeds by little intervals leſs than the ſemi-tone, *i. e.* by *quarters of tones*; therefore it has two *diezes* or ſigns to raiſe the voice, which are peculiar to it, *viz.* the *diezes* enharmonick minor, marked by a croſs thus +; and the major, or triple diezes marked by a triple croſs thus ⁂. This gender was antiently much in uſe in the *Muſick* of the *Greeks*, eſpecially for the *dramatick*, or *reſitative* muſick.

Therefore having gathered thoſe three genders into a ſingle ſyſtem, each tetrachord was compoſed, 1. Of four diatonick chords, ſuch are, for example, *ſi*, *ut*, *re*, *mi*. 2. Of one chromatick chord, which was a ſemi-tone above the *ut*, called at preſent *ut diezis*. 3 Of two enharmonick chords, the firſt whereof divided the ſemi-tone from the natural *ut*, to the *ut diezis*, into four quarters of a tone. With regard to the intervals from the *ut diezis* to *re*, and from *re* to *mi*, they were not divided in the antient ſyſtem, becauſe they were thought then *minor intervals*, incapable therefore of that diviſion.

There is to be ſeen in our plate of *Muſick*, Fig. 1. an example thereof by the common notes of *Muſick*, where the four white notes are *diatonick*; the two firſt black, *enharmonick*; and the third black and ſquare *chromatick*.

In proceſs of time the *Latins* finding that thoſe characters, either by reaſon of the variety and extravagance of their figures, or becauſe of their multitude (which, according to ſome authors, amounted to 1240) were too difficult to retain, or remember, ſubſtituted in their place, the firſt 15 letters of their alphabet, *viz.* A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, which formed as a *ſecond ſyſtem*, which notwithſtanding differed in nothing from the former but in the number of figures.

Some time afterwards Pope St. *Gregory*, according to *Gaffurius* and *Kircher*, having obſerved that the letters H I K, *&c.* were properly nothing elſe but a repetition of a higher octave of the firſt ſeven ſounds, A, B, C, D, *&c.* reduced all the characters of the ſounds to the firſt ſeven letters of the alphabet, which were repeated more or leſs, either high or low, according to the extent of the voices, inſtruments, ftruments, &c. but then they contented themfelves ftill with marking them, as the *Greeks* ufed to do, above each fyllable of the text, which were to be fung, and always on the fame line.

But in the eleventh century, about the year 1024, according to *Baronius*, *Guido Aretin* a benedictine monk, born in the city of *Arezzo* in *Tufcany*, invented a third *fyftem*, for which the two preceding ones were foon abandoned, and this univerfally received, having ferved befides for foundation to the modern one.

This author then, having obferved, that the names the antients gave to the chords of their *fyftem* were too long, fubftituted in their place the fix famous fyllables, *ut*, *re*, *mi*, *fa*, *fol*, *la*.

He alfo introduced the ufe of feveral parallel lines, on which, and between which, he placed certain round or fquare points, immediately above each fyllable of the text, called fince *notes*, and which by the high or low fituation of the degrees they occupied on, or betwixt thofe lines, made at once the diftinction of the *grave founds* from the acute.

But to mark more precifely which found each of thofe points reprefented, he took the firft fix letters of the *Latins*, a-top of which he placed the Γ or *gamma* of the *Greeks*, he named thofe letters *keys*, becaufe they were to ferve to open, or give the knowledge of the founds, and having joined them with thofe fix fyllables, *ut*, *re*, *mi*, *fa*, &c. he formed a table of them, part whereof may be feen in our plate of Mifcellany, *Fig.* 1. and which has been called ever fince *gamma* or *gamut*, becaufe of the addition of the *gamma* of the *Greeks*, and fcale for its figure.

He placed, firft, at the head of each line, and between each of them, one of thofe feven letters, which marked the name to be given to all the points or notes, found on or betwixt thofe lines, as *Fig.* 2. in our plate of *Mufick*.

Fa mi fa re ut re la fa la re ut re mi fa mi re.

Each *key* giving the opening for the name of the notes, for the quality of their found, and for the forts of voices which are to fing them. When immediately after there are feveral ♭ ♭, or feveral ✕ ✕, they are called *tranfpofed keys* and when there is nothing, *natural*.

To prevent any confufion which might arife from ufing the fame word in different fenfes, M. *Malcolm* propofes the word *mode* to be fubftituted inftead of the word *key*, in the former fenfe; that is, where it expreffes the melodious conftitution of the octave, as it confifts of feven effential or natural notes, befides the fundamental; and in regard there are two fpecies of it, he purpofes, that that with a third G, be called the greater *mode*; and that with a third L. the leffer *mode*, appropriating the word *key* to thofe notes of the piece in which the cadence is made; all of which may be called different *keys*, in refpect of their different degrees of tune. To diftinguifh then, according to him, between a *mode* and *key*, he gives us this definition, *viz.* an octave, with all its natural and effential degrees, is a *mode*, with refpect to the conftitution, or manner of dividing it; but with refpect to its place in the fcale of mufick, *i. e.* the degree, or pitch of tune, it is a *key*, though that name is peculiarly applied to the fundamental. Whence it follows, that the fame *mode* may with different *keys*, i. e. an octave of founds, be raifed in the fame order and kind of degrees, which makes the fame *mode*, and yet be begun higher or lower, *i. e.* be taken at different degrees of tune, with refpect to the whole, which makes different *keys*; and *vice verfâ*, that the fame *key* may be with different *modes*, i. e the extremes of two octaves may be in the fame degree of tune, yet the divifion of them be different.

Guido Aretin, finding that the *Greeks* had good reafons to divide in two femi-tones the intervals between the *mefe* and *paramefe*, which he calls in his fyftem A and B, and the modern *la* and *fi*, that obliged him, 1. To put fome time on the degree of B or *fi*, *a b* to fhew that from A to B, the voice fhould not be raifed but of a femi-tone, and as that intonation has fomething more fofter and fweet than when the voice is raifed of a full tone, he gave to that *b* the epithet of *mol*; which engaged him, 2. To put in his *gamma* or *gamut*, a column, to be feen in our plate of *Mifcellanies*, called for that reafon the column of *b-mol*.

Laftly, not fatisfied with having added under the *proflambanomenos*, or loweft chords of the antients, a chord marked with the Γ, and which he called *hypo-proflambanomenos*, i. e. *fubadded*, he added to *netehyper-boleon*, or higheft chord of the *fyftem* of the antient *fyftem*, four other chords, which formed a fifth *tetrachord*, which he called *tetrachord* of the *fur-acutes*. So that his *fyftem* was compofed of 22 chords, *viz.* of 20 *diatonick*, which make what has been called fince the order *b-quarre*, or natural; and the two lowered a femi-tone lower than the natural, which changing the natural order of fome notes in the order of *b-quarre*, have produced the order called *diatonick b-mol* or fimply *b-mol*.

Tho' this was the only one followed during very near fix centuries fucceffively, it had three or four very great inconveniences.

To remedy which, it was neceffary to form a fourth, which I call the modern *fyftem*, therefore,

1. Fa

1. As the sounds are not naturally found every seventh degree, precisely in the same intervals, and can be repeated every *octave*, as it were, *in infinitum*, a seventh syllable has been added, *viz. si*, to the six of *Aretin*, which give the facility to express all the degrees of the octave, to fill all the intervals thereof, and consequently to make that endless repetition without changing, but very seldom, the name of any of the notes.

2. As it was found that between the chords which are distant, or make the interval of a tone, a partition-chord could as well be placed to divide them into two semi-tones, as between the *mese* and *paramese* of the antients, or which is the same thing, betwixt the *la*, and the *si*; they have not been contented with adding to the system of *Guido Aretin* the chromatick chord, commonly called *b mol*; but have added to it besides the chromatick chords of the antients, *i. e.* those which divide the major tones or intervals which are in the middle of each tetrachord, into two semi-tones, which is effected by raising of a semi-tone, the lowest of these chords, which is marked with a double diezes, thus, ✕✕, placed on the left side, on the same degree, and immediately before that lowest note. And as it was observed, that the tones minor, or intervals, which terminate upwards, each tetrachord is no less susceptible of that division, than the tones major, those chromatick chords which were wanted in the systems of the *Greeks*, have been added to them; so that each octave is composed at present, of 13 sounds or chords, or of 12 intervals or semi-tones, *viz.* of 8 diatonick or natural sounds, marked with white notes; and of 5 chromatick or diezes, *i. e.* raised of a semi-tone, marked with black notes, as *Fig.* 6.

3. To remedy the narrowness of the antient systems, and to have different chords enough to multiply the parts which make harmony, the number of those chords has been increased by degrees, as far as 29, diatonick or natural; and 20, chromatick. So that instead of four tetrachords, or two octaves of the antients, we have at present 8 tetrachords, all composed like those of the example, *Fig.* 6. of 8 diatonick, and 5 chromatick sounds.

Those four octaves make the ordinary extent of the modern system, or of the organs, or harpsical; and the first touch or march of the keys on the left side, are commonly called, for that reason, *C*, *sol*, *ut*, or simply, *ut*.

4. Lastly, as the notes of the system of *Guido Aretin*, rendered the tunes so uniform, that it deprived them of that variety of motion, sometimes slow, sometimes quick, which make all the grace or charm thereof, and obliged often to pronounce in a very disagreeable manner, the syllables of the text, the famous *John des Murs*, a *Frenchman*, and a Doctor of *Paris*, invented about the year 1330, or 1333, the different figures of the notes, which shew at once how long precisely each sound must last.

There are most commonly eight sorts of notes, the *names*, *figures*, and *measures* thereof are as *Fig.* 7.

The ninth figure was of antient use, but has been rejected by the moderns.

Mathematicians compute, that one may make 720 changes or varieties with six notes, without ever repeating the same twice; and that of the notes of each octave, one may make 40320 different tunes or songs.

The large note, which is, as it may be seen by the figure, a long *square* note, with a tail on the right side, and is worth 8 binary measures, *i. e.* at two times, is not of any use in the modern *musick*, ever since the usage has prevailed to separate the measures, and to bind the rounds with a semi-circle to mark the continuity of their sound. The long, which by inspection appears to be a square note with a tail on the left side, and is worth four binary measures, or at two times, and consequently eight times, unless it be bound with a breve or square. The breve of a square figure, called for that reason, *square*, by the *French*, is worth under the signs of the measure at two or four times, two measures, under the signs of a triple major, or perfect time, is worth three times, when followed by one or several like squares, thus ⌗ ⌗ ⌗ or by a point thus ⌗. But when it is followed by a note of less value, as by one ○ or two whites, it is worth but two times. That a *minim*, or white, under the sign *C*, is worth half a measure. In the triple is worth, sometimes one time, sometimes two: sometimes also, there want two to make one time.

As to the notes bound together, we must observe, 1. That none but the square notes and the breves are capable of being bound together, their figure allowing that they should be approached so near one another, that they appear to make but one figure, only placed on different degrees, thus  without it be necessary to put a semicircle, above or under it, to mark the binding. 2. That it is only a question here of the binary measure, or at two times. 3. That they may be consider'd as simple, as having a tail. 4. As being of different colours.

If they be simple, they either go in ascending, and then they are all worth their natural value, *i. e.* two measures each. See A. But if they go in in defcending they'll be worth each four meafures, if there be but two together as B. But if there be three or four together, then the firft and laft will be worth each four meafures; and thofe in the middle will be worth but two, as A B C, *Fig.* 8.

If they have a tail, either that tail afcends upwards, and then all the breves or fquares, as well in defcending, as in afcending, are worth each but one meafure, as D, which was invented becaufe the rounds and minims are not of a figure to be bound together, and that the ufe of the demi-circle or ligature, was not yet introduced. But if that tail hangs downwards, then it gives the breve its natural value of two meafures, as well in defcending, as in afcending, like E, *Fig.* 9.

Laftly, if they be of different colours, *i. e.* if the firft be white, and the fecond black; then the firft is worth one meafure, and the fecond one white pointed, or a time and a half; for example, *Fig.* 10.

From thofe different *fyftems* I'll pafs to the *genders of mufick*.

GENUS, in *mufick*, is a manner of running through different degrees or founds, and the fenfible intervals, which compofe the extent of the octave, or of its replies.

The antients diftinguifhed commonly three kinds of genera's, *viz.* the *diatoniek*, *chromatick*, and *enharmonick*.

The DIATONICK is that genus, the leffer intervals whereof, are the femi tone majors and the tones; and is when the modulation follows the natural order of the founds, *i. e.* that diftance put in it by nature, and which the moft ignorant obferve naturally, if they have a good ear, and the organs of the voice juft. According to that natural order there is a tone between all the notes of mufick, except between *mi*, *fa*, and *fi*, *ut*, which are femi-tones major.

The CHROMATICK is when the modulation proceeds by femi-tones major and minor, and generally as often as the *diatonick* or natural order which is between the founds is changed in altering them, *i. e* raifing them by degrees, or lowering them by *b-mols*.

The *enharmonick* genus is of no ufe at prefent.

The next thing which falls under our confideration, are the *modes* or *tones*,

MODE, in *mufick*, is a particular manner of beginning, continuing, and ending a fong, whereby we are engaged to make ufe of certain notes, or chords, preferable to, or oftner than others.

Mode, is defined by fome authors the particular manner of conftituting the octave, or the melodious conftitution of the octave, as it confifts o feven effential, or natural notes befides the key, or fundamental.

To underftand well what a *mode* is, according to our firft definition, we muft obferve, that in every tune or fong there is three principal chords; the firft, is that whereby a fong is almoft always begun, and where it muft be always ended, wherefore it is called the *final*. The fecond, is that which is repeated, and which is heard oftner than any other, wherefore it is called the *dominante*. And the third, as being between the other two, is called the *mediante*, and is commonly a third above the *final*. Thefe three chords are otherwife called the *effential founds* of the *mode*.

Among all the fongs comprized in the extent of the *octave*, there is always one which divides it *harmonically*, i. e. which is juft a fifth above its loweft chord; and another which divides it *arithmetically*, i. e. which is a fourth higher than its lower chord; for inftance, *Fig.* 11.

This double divifion has formed the two claffes of *modes*, fo often mentioned in authors, *viz.* that of the *authentick modes*, and that of the *modes plagal*. For when in a fong, the found, which is one fifth above the loweft chord of the octave of a *mode*, is repeated and often heard, then a *mode* is *authentick*; and when that which is but of one fourth diftant from it, or another which makes a third againft its final is repeated, it is a *plagal mode*; for inftance, *Fig.* 12.

But as among the feven fpecies of *octaves* abovementioned, there are but fix which can be divided *harmonically*, or by the juft fifth, *viz.* the *octaves*, C, D, E, F, G, A, becaufe the fifth of the *octave* B or from *fi* to *fa* in afcending, is *diatonically* falfe or diminifhed: there are alfo but fix *authentick modes*; as on the other fide there are but fix octaves which can be divided *arithmetically*, or by the juft fourth, *viz.* the octaves C, D, E, G, A, B, becaufe the fourth of the octave F, or from *fa* to *fi*, in afcending, is fuperfluous. There are likewife but fix *plagal modes*; therefore the octaves, C, D, E, G, A, have each two *modes*, one *authentick* and the other *plagal*; the octave F has but one which is *authentick*; and the octave B has but one likewife, which is *plagal*; which makes up twelve in number. In *Fig.* 13. is a table which contains all that in a very clear manner.

That which the moderns call *modes*, the antients called *tune*.

TUNE, or *tone*, in *mufick*, is taken for one of its intervals, and even for the firft, the foundation,

the

the source, rule, and measure of all other intervals. In that sense the antients, and the mathematicians distinguish two sorts of tunes, *viz.*

The Tone *minor*, whose proportion is *sesquininth*, as from 10 to 9, and which is always the third interval of each tetrachord. And,

The Tone *major*, whose proportion is *sesquieighth*, as from 9 to 8, and which is always the interval of the middle of each tetrachord; as in the following example:

for 8 to 9. from 9 to 10.
Mi ——— Fa ——— Sol ——— La.
Semi-tone. Tone-major. Tone-minor.

It is also in that sense, that the moderns (supposing that all the tones in the temperate system be very near equal, (say, that the *tone is the interval between all the degrees or diatonick and natural notes of the octave, except between* mi, fa, *and* si, ut, *which are naturally but* semi-tones.

Lastly, in that sense it is said, that the tone is a second major, because it is the distance from one sound to another, which are distant from one another of 9 comma's, *&c.*

The word *mutation* signifies one of the accidents, which happens in the order of the sounds that compose a song, or a melody; which accident happens by a change; which change is made in four manners.

The first in changing the genus, *i. e.* passing from the *diatonick* to the *chromatick*, or *enharmonick*, and reciprocally from the *chromatick* to the *diatonick*, &c. which is called *mutation by genus.*

The second in making the tune of a very acute sound, to descend to a grave one, the better to express some words of the text: That's called *mutation by system.*

The third is, when to express some passion, *&c.* one passes from a mode into another, as from the mode major to the mode minor, *&c.* which is called *mutatione per tuono o modo.*

The fourth is, when one passes from a manner of singing male and vigorous, called *maniera distendente,* to a sweeter, more languishing, softer, and more effeminate, called *maniera restringente*; or to a tranquil manner which keeps a medium between the two, and is called *maniera quieta.* All these manners, and the other changes, are pathetick, *i. e.* very proper to express the different passions or motions of the soul and heart.

Having thus far consider'd and explained the first branch of the *contemplative part of musick,* I'll pass to the second branch, which treats of the numbers of sounds or notes with respect to time.

The word Time has several significations in *musick*, 1. It signifies in general one of those three signs of the measure, which the *Italians* call *gradi*, viz. *time*, *relation*, and *sincope.*

Time, according to the antients, was a certain sign placed after the key, to mark how many semi-breves or rounds were contain'd in one breve or square. They distinguished two sorts of times, *viz.* perfect and imperfect. A circle whole or cut, perpendicularly, but without a point, was the mark of a perfect time, under which a breve, even without a point, was worth three semi-breves, as A Fig. 8. A semi circle, either whole or cut, was the sign of an imperfect time, under which a breve was worth but two semi-breves or rounds; as B, Fig. 38.

Others more modern, though they agreed with the antients on the division of time into perfect and imperfect, pretended; 1. That the signs of the perfect time, or the example A, had not the virtue of rendering the breve more perfect, unless they were followed by the figures $\frac{3}{1}$ or $\frac{3}{2}$ and 2, that by means of those figures the signs of the example B, had the power to render the breve more perfect, or to give it the value of three semi-breves, as well as those of the example A.

But if the signs of the example B, were not followed by figures, they made them serve not only for the measure of the breve, with regard to the semi-breve, but, likewise, for all notes of less value without distinction; and admitted two kinds thereof, *viz.* the simple C, which the *Italians* call simply *tempo*, and the C cut perpendicularly, which they call *tempo tigliato.*

The simple C is seen in two manners, 1. Turned from the left to the right thus C, and then the *Italians* call it *tempo ordinario*, because it is oftener used than any other; or *tempo allo semi-breve*, because under that sign a semi-breve or round O is worth a measure, or four times, and the other figures in proportion. 2. But it is sometimes found turned from the right to the left, thus Ͻ, then all the figures are diminished of half their value; thus one round O is worth but two times; one minim or white but one time, and thus of the rest.

The C cut, is found likewise either turned from the left to the right, thus ₵, or from the right to the left, thus ↃI. When on the left, the *Italians* call it, *tempo alla breve*, because antiently, all the figures under that sign were diminished of half their value: but at present it marks that the measure must be beat at two times grave, or at four times very quick, unless there be *largo*, *adagio*, *lento*, or some other term, which advises to beat the measure slowly. And when with that sign the words *da capella*, and *alla breve*, are seen, it marks two very quick times; which it marks, likewise likewife, when turned upfide down; but it is feldom found in that fituation.

Laftly, others ftill more modern, divide times into two fingle fpecies; the firft is *tempo maggiore*, or *time major*, which is marked by a ₵ cut, and fignifies, that all the notes can be fung *alla breve*, i. e. in making them worth but half their value. The fecond is *tempo minore*, or *time minor*, which is marked by a fingle C, under which all the notes are worth their natural value. And if one and the other of thofe two times are followed by three, or any of the other figns, I'll mention when I fpeak of the *triple*, then they are called *ternary major*, or *minor time*.

2. The word *time* fignifies not only one of the figns of the meafure, but likewife the aliquot parts it is compofed of: therefore we fay, that there are meafures at *two*, at *three*, at *four times*, &c. becaufe the hand by its different motions marks as many parts in each meafure.

But it muft be obferved, that among the different times which compofe the meafure, there are fome more proper than the others, to place a *confonance* or a good *accord*; which for that reafon, are called *tempo*, or *tempi di buono*, i. e. a certain *time* of the meafure which is good, and more proper to certain things than another.

3. We find fometimes after the *recitative* of the *Italians*, thefe words *a tempo, or a tempo giufto*, which mark that the meafure muft be beat juft, and the times thereof rendered very equal; when as in the *recitative* a greater regard is to be had to the expreffion, than to the juftnefs or equality of the *times* of the meafure.

As *time*, among the antients was properly the meafure of the *breve* and *femibreve*; *prolation*, or the point thus called (which was marked either in a circle or femicircle, thus, ⊙ ☉) was the meafure of the *femibreve*, and of the *minim*.

There were two forts of *prolations*, viz. the *perfect*, and *imperfect*.

The *perfect prolation*, was marked after the key, by a point within a circle, thus ⊙, or within a femi-circle, thus ☉, and then the *femi-breve* or round was worth three *minims* or whites; wherefore that circle was commonly accompained with 3. or $\frac{3}{2}$ or $\frac{3}{1}$. which are the figns of three times for each meafure; and which is demonftrated in A, fig. 39.

The *imperfect prolation* was marked like the *time*, either by a circle, thus O, or by a femi-circle, thus C, both without a point; and then the *femi-breve* or *round*, was worth but two *minims* or *whites*, as is feen in B, fig. 39.

The modern *Italians* have ftill often in their mufick two forts of *prolations*, very near like to that of the example A, fig. 39. The firft, which they call *prolazione moggiore perfetta*, is marked with a ⊙ and $\frac{3}{1}$;

The fecond, they call *prolazione minore perfetta*, is marked with a C and $\frac{3}{1}$ or $\frac{3}{2}$, and fometimes with a ☉ and $\frac{3}{2}$. but in both the round O, is worth three times, even without a point; and its

paufe a meafure, The white is worth a time, and its paufe a time; and the reft of the figures in proportion, as in our plate Fig. 40.

From this I'll pafs to the *meafure*, which is the interval, or fpace of time, which the perfon who beats time, takes between the raifing and falling of his hand or foot, in order to conduct the movement, fometimes quicker and fometimes flower, according to the kind of mufick, or the fubject that is fung or played.

The *meafure*, is that which regulates the time we are to dwell on each note.

The ordinary or common *meafure*, is one fecond, or fixtieth part of a minute, which is nearly the fpace between the beats of the pulfe or heart; the fyftole or contraction of the heart anfwering to the elevation of the hand, and its diaftole or dilation to the letting it fall. The *meafure* ufually takes up the fpace that a pendulum of two feet and a half long, employs in making a fwing or vibration.

There are *meafures* at two times or *binary*; at three times, or *triple*; at four, fix, eight, nine, and twelve times; and *meafures* for all forts of times.

Binary, or *double meafure*, is that wherein the rife and fall of hand are equal.

Ternary, or *triple meafure*, is that which is beaten in three equal times, either *fimple* or *compofed*; the *firft* whereof is made by one fall of the hand; the *fecond*, by turning it a little afide, and the *third* in raifing it.

Towards the middle of the laft century, fo many fpecies of *triples* were invented, that to give the explication thereof with fome order, I am obliged to difpofe them under three different claffes, viz. of *fimple*, *compofed*, and *mixt triples*.

First Class.

Of fimple triples.

I call *fimple triples* thofe which have but three *fimple times*, i. e. whofe times cannot be fub-divided into three other equal notes. I find five different forts of them in authors, to mark five degrees of flownefs or quicknefs. The firft is that called the *grand triple*, or *triple of the rounds*, or of *three for one*; thus called becaufe the *breves* or *fquares*, and the *femibreves*, or *rounds*, are predominant in it, and the meafure thereof muft be beat *flowly* and *gravely*, fo that each time be conquently greater and longer than thoſe of the other following *triples*.

Our antients, and ſome *Italians* ſtill, have four different ſigns to mark the *tripola maggiore*; according to which they gave it four different names, as in the table, *Fig.* 40. *Muſick plate.*

Of thoſe four ſigns, the moderns have retained but this $\frac{3}{1}$ without putting before, either the circle O, or the ſemi circle C, &c thoſe two figures of arithmetick denoting clearly enough, that three rounds, inſtead of one, are wanted for one *meaſure*; and that a *breve* being worth two *rounds*, is conſequently worth by itſelf two times, and three when followed by a point; and the other figures in proportion.

The ſecond ſort of *ſimple triple*, is that called by the Italians, *tripla minore*, or *triple minor*. Our antients had likewiſe four different ſigns for that ſort of *triple*, according to which they gave them three different names; as is ſeen in the table, Fig. 21.

Of thoſe four ſigns the moderns have retained but this $\frac{3}{2}$ C, whence in all appearance it has borrowed its name of *double triples*, even without putting before, the ſemi-circle C; thoſe two figures being ſufficient to mark that three whites, inſtead of two, are wanted for a meaſure; and that a *ſemi-breve*, or *round*, having by itſelf the value of two whites, is conſequently worth two times and three times, if it be followed by a point; and thus in proportion of the other figures.

The third kind of *ſimple triple*, is that called by the Italians, *tripola picciola*, *ſmall triple*: it is marked thus C $\frac{3}{4}$, or ſimply $\frac{3}{4}$, or more ſimply 3.

When that *triple* is marked by $\frac{3}{4}$, it is proper for tender expreſſions, and the movement thereof muſt be moderate, neither *too quick*, nor *too ſlow*, &c. When marked by a ſingle 3, the movement thereof is moſt commonly a little merry; wherefore it is moſt commonly uſed for merry and lively dances.

The fourth kind of *ſimple triple* is that called by the Italians *tripola crometta*, or *triple of crotchets*; becauſe, without doubt there is no other ſign, but theſe two figures thus C $\frac{3}{8}$ or thus $\frac{3}{8}$, which mark that three crotches make a meaſure, whenas eight are wanted in the *binary meaſure*; that therefore ſix *double crotchets*, and twelve *triple crotchets*, make likewiſe a meaſure; and that a *ſingle black* is worth two times, and three times are a meaſure when it is punctuated.

Laſtly, the fifth kind of *ſimple triple*, is that which the *Italians* call *tripola ſemi crometta*, or *triple of double crotchets*. Its ſign is compoſed of theſe two numbers thus C $\frac{3}{16}$, or thus $\frac{3}{16}$, which mark that three double *crotchets* make one meaſure, whenas 16 of them are wanted in the binary meaſure: therefore that ſix *triple crotchets*, and one punctuated *crotchet* make alſo a meaſure; that a ſingle *crotchet* is worth but two times, &c. for example, Fig. 35.

This *triple* is proper for very *quick* and *rapid expreſſions*, ſince each time of the meaſure muſt laſt no longer than a double *crotchet* laſts in the *ordinary meaſure*.

Second Class.

Of the compoſed triples.

I call *compoſed triples*, thoſe which have not only, and are but at three times, like the ſimples; but each time whereof can likewiſe be ſub-divided into three other equal times or notes, and are called in general, by the Italians, *nonupla*, of which there are but three ſorts in uſe.

The *firſt* is that called by the Italians *nonupla di ſemi-minima*, and by the French *triple of 9 for 4*, or *nine four*; becauſe it has for ſign thoſe two numbers thus, C $\frac{9}{4}$, or thus $\frac{9}{4}$, which mark that 9 black notes are wanted in each meaſure, *viz.* three at each time inſtead of two: this triple is proper for tender expreſſions, and is to be beat moderately, neither too ſlow or too quick; as in Fig. 29.

The *ſecond* is that which the *Italians* call *nonupla di crome*, or *ſeſqui ottava*, and the *French* triple of 9 for 8, or only *nine eight*; becauſe that *triple* has for ſign thoſe two numbers thus, C $\frac{9}{8}$, or thus $\frac{9}{8}$, which mark that there wants *nine crotchets*, viz. three in each time, to make up the meaſure inſtead of four. This *triple* is proper for merry expreſſions, and ought to be beat *quickly* and *merrily*.

The *third* is that called by the Italians *nonupla di ſemi-crome*, or *triple of 9 for 16*; becauſe it has for ſign thoſe two numbers, thus C $\frac{16}{9}$ or thus $\frac{16}{9}$; which mark that there wants *nine double crotchets* for a meaſure, *viz.* three at each time inſtead of eight. This triple is proper for very quick and very rapid expreſſions. As is ſeen, Fig. 32.

Five other kinds of *ſimple triples*, have been invented to mark the different degrees of ſlowneſs or quickneſs, which muſt be given to the meaſure; I believe that it would be proper to introduce two other kinds of *compound triples*, and add to the three ſigns here above $\frac{9}{4}$ $\frac{9}{8}$ $\frac{9}{16}$ theſe two other ſigns $\frac{9}{1}$ and $\frac{9}{2}$. The firſt whereof could be very well called *triple* of 9 for 1; becauſe it would have thoſe two numbers for ſigns, thus $\frac{9}{1}$, which would ſhew, 1. That for a meaſure there ſhould be wanted 9 ſemi breves or rounds, *viz.* three at each time. 2. That for one time, a breve, or ſquare with

with a point ſhould be wanted; becauſe without a point it would be worth but two thirds of a time, &c. 3. That the batoon would be worth but two meaſures; the ſemi-batoon one meaſure; the pauſe one time of the meaſure; and the half pauſe one third of a time, or a ninth part of the meaſure, &c.. That kind of triple would be very proper for ſorrowful and languiſhing expreſſions, and generally for all thoſe, which want a ſlow meaſure, ſee Fig. 33.

The ſecond would be called triple of 9 for 2, becauſe it would have thoſe two numbers for ſigns, thus $\frac{9}{2}$; which would ſhew, 1. That for one meaſure, 9 minims or whites ſhould be wanted, *viz.* three for each time. 2. That for one time there ſhould be wanted a ſemi-breve or round, with a point, becauſe without a point it would be worth but two thirds of a time, &c. 3. That the batoon would be worth but two meaſures; the ſemi-batoon one meaſure; the pauſe one time; and the half-pauſe one third of a time, or a ninth part of the meaſure; as in Fig. 34. This triple would be very proper for the movements which the *Italians* expreſs by the words *lento*, *adagio*, &c.

Third Class.

Of triples mixt.

I call *triples mixt*, thoſe which participate of two ſorts of meaſures, *i. e.* which, for the manner of beating the meaſure thereof, follow the binary meaſure; and for the value of their notes or figures, follow the ternary meaſure. But there are two ſorts of binary meaſures, *viz.* a ſimple one compoſed of two times; and one compoſed which has four times; which obliges me to divide this claſs into two articles.

Article I.

Of triples at two times.

Theſe we call a *meaſure at ſix times*, though improperly, for they ſhould rather be called binary triples, &c. we find but three kinds of them in authors; but we have ſome reaſon to add two more to them; therefore, I'll explain them all five in this article.

The firſt is that which we could very well call triple of 6 for 1, becauſe it ſhould have for ſign thoſe two numbers thus, $\frac{6}{1}$.

The ſecond ſort is that, which could be called triple of 6 for 2; becauſe it would have for ſign thoſe two numbers, thus, $\frac{6}{2}$.

The third kind of binary triple is that which we call of 6 to 4, becauſe it has for ſign thoſe two numbers thus, C $\frac{6}{4}$ or $\frac{6}{4}$. This triple is commonly uſed for tender affectuous motions; for inſtance, *Fig.* 38.

The fourth ſort of binary triple is that we call of ſix for eight, becauſe it has for ſigns thoſe two numbers, thus C $\frac{6}{8}$ or $\frac{6}{8}$. This triple is proper for merry, lively, and animated expreſſions; and conſequently beat pretty quick. See *Fig.* 39.

The fifth ſort of binary triple, is that called of ſix for ſixteen; becauſe it has for ſign thoſe two numbers, thus, C $\frac{6}{16}$ or $\frac{6}{16}$. This triple is for movements and expreſſions of the greateſt rapidity, which the *Italians* mark by the ſuperlative term *preſtiſſimo*. See *Fig.* 40. and *Fig.* 41. is a table of the ſeſtuple, or binary triples.

Article II.

Of triples beaten at four times.

The firſt is that which could be called in *Italian*, *dodecupla di ſemi-brevi*, and in *Engliſh*, triple of 12, for 1, becauſe it ſhould have for ſign thoſe two numbers, thus $\frac{12}{1}$, which would be very proper for very melancholick, and ſlow expreſſions, &c. See *Fig.* 43.

The ſecond ſpecies of triples at four times, is that which could be very well called in *Italian*, *dodecupla di minime*, and by us triple of 12 for 2. Becauſe it would have for ſign thoſe numbers, thus $\frac{12}{2}$, which would be proper for grave and ſlow expreſſions, &c. See *Fig.* 44.

The third ſpecies of triples at four times, is that which the *Italians* call *dodecupla di Semi-minime*, and we triple of 12 for 4. Becauſe it has for ſign thoſe two numbers, thus C $\frac{12}{4}$ or $\frac{12}{4}$; which is proper for tender and affectuous expreſſions, and ſometimes for thoſe which are lively and animated, &c. See *Fig.* 45.

The fourth ſpecies of triples at four times, is that which the *Italians* call *dupla di chrome*, and the *French*, triple of 12 for 8, becauſe it has thoſe two numbers for ſign, thus C $\frac{12}{8}$ or thus $\frac{12}{8}$. This triple is very proper for lively and merry expreſſions; which notwithſtanding the *Italians* uſe it very often for tender and affectuous expreſſions, adding to it the words *adagio*, *affettuoſo*, or ſome other, for of itſelf it denotes mirth. See *Fig.* 46.

Laſtly, the fifth ſpecies of triple at four times, is that called by the *Italians*, *dodecupla di ſemi-crome*, and by thus, triple of 12 for 16; becauſe it has for ſign thoſe two numbers marked thus C $\frac{12}{16}$, or thus $\frac{12}{16}$. This triple is proper for very quick, and very rapid expreſſions; which the *Italians* mark by the ſuperlative *preſtimiſſimo*. See *Fig.* 47.

From the triples I'll paſs to *ſyncope*, called alſo *ſyncopation*.

Syncope ſignifies the diviſion of a note, uſed when two or more notes of one part anſwer to a ſingle one of the other, as when the ſemi breve of the one anſwer to two or three notes of the other.

But

But to have a right underſtanding of the word *ſyncope*, it muſt be obſerved firſt, that every bar in common time has two parts, one of which is when the hand falls, the other when it riſes.

Secondly, that any note which contains two times, or a riſe and fall of the hand, is diviſible into two parts, for the firſt whereof the hand goes down, for the laſt it riſes.

Thirdly, that every note (though of leſs value than a ſemi breve) is diviſible into two others, the firſt whereof muſt be during the firſt part of the meaſure, or with a riſe or fall of the hand, the other part in the ſecond.

The following is a table from *Documenti Armonici di Angelo Bernardi*; which ſhews at once what the concords are, that reſolve each diſtance the more naturally, whether the upper or lower part of the *ſyncope*.

When the treble or upper part ſyncopes.	*When the baſs or lower part ſyncopes.*
The 2d is reſolved by uniſon.	The 2d is reſolved by the 3d.
The 4th by the 3d.	The 4th by the 5th.
The 7th by the 5th or 6th.	The 7th by the 8th.
The 9th by the 8th.	The 9th by the 10th.
The 11th by the 10th.	The 11th by the 12th.

When two ſucceſſive notes of equal value, as to time, are uſed, one of which being a diſcord, ſupplies the other a concord, it is called *ſuppoſition*.

There are ſeveral kinds of *ſuppoſition*. The firſt, when the parts proceed gradually from concord to diſcord, or *è contra* from diſcord to concord, the intervening diſcord ſerving only as a tranſition to the following concord.

Another kind is, when the parts do not proceed gradually from diſcord to concord, and *vice verſâ*, but deſcend to it by the diſtance of a third.

A third kind like the ſecond, is, when the riſing to the diſcord is gradual, but the deſcending from it to the following concord is by the diſtance of a fourth.

A fourth kind very different from all the reſt, is, when the diſcord falls on the accented part of the meaſure, and the riſing to it is by the interval of a fourth; in which caſe it is abſolutely neceſſary to follow it immediately by a gradual deſcent into a concord, which has juſt been heard in the harmony, to make the preceding diſcord paſs without notice, and only ſeem a tranſition into the concord.

When three notes are played to one, they muſt all be of equal value, as in the meaſure $\frac{6}{4}$ $\frac{6}{8}$, or $\frac{12}{8}$, *&c.*

If theſe three notes of equal value, be preceded by a pauſe equal to one of them, the firſt of thoſe left may be a diſcord, becauſe the pauſe is reckoned, in the place of the concord. See *Fig.* 49.

To diſpoſe to practice the rules heretofore deſcribed, into airs, ſongs, *&c.* either in one or more parts, to be ſung by a voice, or played on inſtruments, is the *practical part of Muſick*, or the art of *compoſition*.

Zarling defines *compoſition*, the art of joining and combining concords and diſcords together.

Under *compoſition* are comprehended the rules, 1. Of *melody*, or the art of making a ſingle part, that is, contriving and diſpoſing the ſimple ſounds, ſo as that their ſucceſſion and progreſſion may be agreeable to the ear.

2. Of *harmony*, or the art of diſpoſing and concerting ſeveral ſingle parts together; ſo as that they make one agreeable whole.

The words *concord* and *harmony* do really ſignify the ſame thing, though cuſtom has made a little difference between them; *concord* is the agreeable effect of two ſounds in conſonance, and *harmony* the effect of any greater number of agreeable ſounds in conſonance.

Harmony is well defined the ſum of concords, ariſing from a continuation of two or more concords; *i. e.* three or more ſimple ſounds ſtriking the ear altogether, and different compoſitions of concords make different *harmony*.

To underſtand the nature, and to determine the numbers and preference of *harmonies*, it is to be conſidered, that in every compound ſound, where there are not more than three ſimple ones, there are three kinds of relations, *viz.* primary relation of every ſimple ſound to the fundamental or graveſt, whereby they make different degrees of concord with it; the mutual relations of the acute ſounds, each with the other, whereby they mix concord or diſcord into the compound; and the ſecondary relation of the whole, whereby all the terms unite their vibrations, or coincide more or leſs frequently.

Suppoſe, *e. g.* four ſounds, A, B, C and D, whereof A is the graveſt, B the next, then C and D the acuteſt; here A is the fundamental, and the relations of B, C, and D, are primary relations: ſo if B be a third greater above A, that primary relation is 4 : 5; and if C be a fifth to A, that primary relation is 3 : 2; and if D be an octave to A, that is 2 : 1: for the mutual relations of the acute terms, B, C, D, they are had by taking primary relations to the fundamental, and ſubtracting each leſſer from each greater, thus B to C is 5 : 6, ſo a third leſſer; B to D, 5 : 8, a ſixth leſſer, *&c.* And laſtly, to find the ſecondary relations of the whole, ſeek the leaſt common dividend to all the leſſer terms or numbers of the primary relations,

i. e.

i. e. the leaſt number that will be divided by each of them exactly, this is the thing ſought; and ſhews that all the ſimple ſounds coincide after ſo many vibrations of the fundamental, as the number expreſſes.

So in the preceding example the leſſer terms of the three primary relations are 4, 2, 1, whoſe leaſt common dividend is 4, conſequently at every fourth vibration, of the fundamental, the whole will coincide.

HARMONY is divided into *ſimple* and *compound.*

Simple HARMONY is that to which there is no concord to the fundamental above an octave.

The ingredients of *ſimple harmony*, are the ſeven original ſimple concords, of which there can be but eighteen different combinations that are *harmony*; which are given in the following table from Mr. *Malcolm.*

The TABLE *of ſimple* harmonies.

Secondary Relations.						*Secondary Relations.*		
5th	8ve	2	3d grt.	5th	4	3d grt.	5th	8ve
4th	8ve	3	3d leſs.	5th	10	3d leſs.	5th	8ve
6th greater	8ve	3	4th	6th grt.	3	4th	6th grt.	8ve
3d greater	8ve	4	3d grt.	6th leſs.	12	3d grt.	6th grt.	8ve
3d leſſer	8ve	5	3d leſs.	6th leſs.	5	3d leſs.	6th leſs.	8ve
6th leſſer	8ve	5	4th	6th leſs.	15	4th	6th leſ.	8ve

Compound HARMONY is that which to the *harmony* of an octave adds that of another.

HARMONY again may be divided into that of *concords*, and that of *diſcords.*—The firſt is that which we have hitherto conſidered, wherein nothing but concords are admitted.——The ſecond is that wherein diſcords are uſed, and mixed with concords.

The firſt is alſo called *ſimple counterpoint*, and the ſecond *figurative counterpoint.*

Simple counterpoint conſiſts of the imperfect, as well as perfect concords, and may be therefore denominated perfect or imperfect, according as the concords are whereof it is compoſed

The *figurative counterpoint* is of two kinds; in one diſcords are introduced occaſionally as paſſing notes, ſerving only as tranſitions from concord to concord; in the others, the diſcord bears a chief part in the harmony.

The TABLE *of* Concords.

Ratio's of Vibrations.	*Grave* *Terms.*	*Acute*	*Coincidences.*
Uniſon,	1	1	0
Octave, 8ve,	2	1	16
Fifth, 5th,	3	2	30
Fourth, 4th,	4	3	20
Sixth greater, 6th grt.	5	3	20
Third, greater, 3d grt.	5	4	15
Third leſſer, 3d leſſer,	6	5	12
Sixth leſs, 6th leſſer,	8	5	12
	Grave *Lengths.*	*Acute*	

Concords are divided into *ſimple*, or *original* and *compound.*

A *ſimple* or *original* CONCORD, is that whoſe extremes are at a diſtance leſs than the ſum of any two other *concords.*

On the contrary, a compound *concord* is equal to two or more ſimple *concords.*

Other maſters of *muſick* ſtate the diviſion thus, an octave 1 : 2, and all the other inferior *concords* above expreſſed, are ſimple or original *concords*; and all greater than an octave, are called *compound concords*, as being compoſed of, and all equal to the ſum of one or more octaves, and ſome *ſimple concord* leſs than an octave, and uſually in practice denominated from that *ſimple concord.*

As to the compoſition and relations of the original *concords*, by applying to them the rules of the addition, and ſubſtraction of intervals, they will be divided into ſimple and compound, according to the firſt and more general notion, as in the following table:

Simple Concords.	*Compound Concords.*		*Octave compoſed.*
5 : 6 a 3d leſs	5th	3d gr. & 3d leſs.	of 5th & 4th.
4 : 5 a 3d gr.	6th leſs.	4th and 3d leſs.	6 gr. 3d leſs
			or 3d gr.
3 : 4 a 4th.	6th gr.	4th and 3d gr.	3d leſs 4th.

Diſcords are in *muſick*, what ſtrong ſhades are in *painting.*

Moſt pieces of *muſick* are compoſed in parts, the four principal thereof are the *treble*, *tenor*, *countertenor*, and *baſs.*

TREBLE is the higheſt, or acuteſt part of the four parts in ſymphony; or that which is heard cleareſt in a concert. In this ſenſe we ſay, a *treble* violin, *treble* hautboy, &c.

The *treble* is divided into firſt or higheſt *treble*, and ſecond or loweſt *treble*; half *treble* is the ſame with the *counter-tenor.*

The TENOR is the firſt mean or middle part, or that which is the ordinary pitch of the voice, when neither raiſed to a *treble*, or lowered to a *baſs.*

The *tenor* is commonly marked in thorough baſs with the letter T.

The BASS is that part of a concert, which is moſt heard, which conſiſts of the graveſt and deepeſt ſounds.

Muſicians hold the *baſs* to be the principal part of the concert, and the foundation of compoſition; though ſome will have the *treble* the chief part, which others only make an ornament.

A *ſecond*, or *double baſs*, is called *counter-baſs*, where there are ſeveral in the ſame concert.

The

The *thorough-bass* is the harmony made by the *bass-viols*, continuing to play both while the voices sing, and the other instruments perform their parts, and also filling up the intervals, when any of the other parts stop.

M. *Bressard* observes the *thorough-bass* to be part of the modern musick, first invented in the year 1600, by an *Italian* called *Ludovicus Viadana*, it is played by cyphers marked over the notes on the organ, spinet, harpsichord, theorbo, harp, *&c.* and frequently, and simply, and without cyphers on the bass-viol, bassoon, *&c.*

Besides these four principal parts, there is, in a concert, what we call *chorus*, which is, when at certain periods of a song, the whole company are to join the singer, in repeating certain couplets or verses.

The Vocal Musick is musick set to words, especially verses, to be performed with the voice, in contradistinction to instrumental musick, composed for, and to be executed by instruments without singing.

In the *vocal musick*, there are pieces composed for one, two, three, or more *voices*.

A song or composition, to be performed with two *voices*, or in two parts only, one sung, the other played on an instrument, is called a *duo*; and likewise when two *voices* sing different parts, accompanied with a third which is a thorough-bass. Unisons and octaves are rarely used in *duo's* except at the beginning and the end.

A piece of musick to be performed by three *voices*, or more properly a composition consisting of three parts only, is called *trio*, which is the finest kind of composition, and ought to be the most regular of all.

Next to *vocal musick* is that called *instrumental*, played on instruments; which are machines invented and disposed by art in such a manner, as to imitate the human voice, or supply its place.

There are many kinds of instruments, which are ordinarily reduced into three classes or orders.

The first class was called by the Greeks *enchorda* or *entata*; which are instruments with chords, and to be play'd on with the fingers, as the *lute*, *harp*, *theorbo*, *guitar*, and others; or by a bow, as *violins*, *bass-viols*, *trumpets marine*, &c. or by means of jacks armed with quills-ends, as *spinnets*, *harpsichords*, &c.

The second kind, *emphysomena*, *pneumatica*, or *empneousta*, made to sound by the wind, and that either natural from the mouth, as *flutes*, *trumpets*, *French-horns*, *hautboys*, *bassoons*, *serpents*, *sackbuts*, *horns*, &c. or artificial by means of bellows, as the *bagpipe*, and that which by way of excellence was called the *organ*, by the *Italians* called *stromenai da fitto*.

The last the *Greeks* called *krouvusta*, the *Latins* *pulsatilia*, and we *Instruments of Percussion*, because made to sound by beating them either with the hand, as *drums*, *tabors*, *tymbals*, &c. or with a little stick, or small iron rod, as *psaltery* and *symbal*; or by a feather, as the *cystrum* and *dulcimer*; or by striking them with hammers, as *bells*, &c.

From this general description of instruments, I'll enter into a more particular one, and examine apart every one of the *instruments* contained in each class; beginning by the first class, and in that class by the *lute*.

The Lute, from the *Arabick allaud*, is a musical instrument of the string-kind, which had antiently but five rows of strings; though in course of time, four, five, or six more have been added. It consists of four principal parts; the table, the body or belly, which has nine or ten sides; the neck which has nine or ten stops or divisions marked with strings; and the head or cross, wherein are screws, for raising or lowering the strings to the proper tune. In the middle of the table is a rose or passage for the sound: there is also a bridge that the strings are fastened to, and a piece of ivory between the head and the neck, to which the other extremities of the strings are fitted. In playing the strings are struck with the right hand, and with the left the stops are pressed.

The *lutes* of *Bologna* are esteemed the best.

The Theorbo, from the French *teorbe* or *theorbe*, is a musical instrument made in form of a large lute, except that it has two necks, the second and longer whereof sustains the four last rows of chords, which are to give the deepest sound. It has succeeded to the lute, in the playing of thorough basses.

The *theorbo* is also much out of use; the *bassoon* supplying well its place, and with much more agreement.

The Guitar has five double rows of strings, of which those that are bass are in the middle, unless it be one for the burthen, an octave lower than the fourth.

This instrument was first used in *Spain*.

The Harp is a musical instrument, of a triangular figure, and placed an end between the legs, to be played on.

There is some diversity in the structure of *harps*, that called the *triple harp* has seventy-eight strings or chords which make four octaves; the first row

is

is for ſemitones, and the third is uniſon with the firſt. There are two rows of pins or ſcrews on the right ſide, ſerving to keep the ſtrings tight in their holes, which are faſtened at the other end to three rows of pins on the upper ſide.

This inſtrument is ſtruck with the fingers and thumbs of both hands, its muſick is like that of the ſpinet; all its ſtrings go from ſemitone to ſemitone; whence ſome call it the inverted ſpinet.

The *Arpi*, a people in *Italy*, were the firſt that invented it.

The VIOLIN, VIOLINO, *fiddle*, is a muſical inſtrument, mounted with four ſtrings or guts; and ſtruck or played with a bow. The *violin* conſiſts, like moſt other inſtruments, of three parts, the *neck*, the *table*, and the *ſound board*.

At the ſides are two apertures, and ſometimes a third towards the top, ſhaped like a heart.

Its bridge, which is below the apertures, bears up the ſtrings, which are faſtened to the two extremes of the inſtrument; at one of them by a ſcrew, which ſtretches or looſens them at pleaſure.

The ſtyle and ſound of the *violin*, is the gayeſt and moſt ſprightly of all other inſtruments; and hence it is of all others, the fitteſt for dancing.

It generally makes the *treble*, or higheſt parts in concerts. Its harmony is from fifth to fifth. Its play is compoſed of baſs, counter-tenor, tenor, and treble; to which may be added, a fifth part: each part has four fifths, which riſe to a greater ſeventeenth.

In compoſitions of *muſick*, violin is expreſſed by V, V V denote two *violins*.

The word *violin* alone, ſtands for *treble violin*; when the *Italians* prefix *alto*, *tenore*, or *baſſo*, it then expreſſes the *counter-tenor*, *tenor*, or *baſs violin*.

In compoſitions where are two, three, or more different *violins*, they make uſe of *primo*, *ſecundo*, *terzo*, or of the characters I. II. III. or 1. 2. 3, *&c.* to denote the difference.

The *violin* has only four ſtrings, each of a different thickneſs, the ſmalleſt whereof makes the E *la mi* of the higheſt octave of the organ; the ſecond a fifth below the firſt, makes the A *mi la*; the third a fifth below the ſecond, is D *la re*: laſtly, the fourth a fifth below the third, is G *re ſol*.

The *largeſt* or *fourth ſtring*, has four notes belonging to it, *viz.* G *re ſol*, or G, which is to be played open; A *la mi re*, or A muſt be ſtopped with the fore-finger of the left hand, almoſt at the diſtance of an inch from the nut; B *fa be mi*, or B, with the ſecond finger about half an inch from the firſt, and C *ſol fa ut*, with the third finger cloſe to the ſecond.

The *third* has alſo four notes, D *la ſol re* is ſtruck open; E *la mi* muſt be ſtopped with the fore-finger about an inch from the nut; F *ut fa*, with the ſecond finger cloſe to the firſt; and G *re ſol ut* (on which note the cleff is commonly marked) with the third finger about three quarters of an inch from the ſecond.

The *ſecond ſtring* has four notes, A *la mi re*, or A is the open ſtring; B *fa be mi*, or B, is with the fore-finger, about an inch from the nut; C *ſol fa ut*, is the ſecond finger cloſe to the firſt; and D *la ſol re*, or D, is the third finger about three quarters of an inch from the ſecond.

The *leaſt* or *treble ſtring*, has uſually ſix notes, E *la mi*, open; F *fa ut*, or F, the fore-finger very near the nut; G *ſol re ut*, or G, the ſecond about three quarters of an inch from the firſt; A *la mi re* or A, with the third finger at the ſame diſtance from the ſecond; B *fa be mi*, with the little finger half an inch from the third; and laſtly, C *ſol fa ut*, you muſt ſtretch the little finger about a quarter of an inch further, than for B *fa be mi*. But here it muſt be obſerved, that all the notes on the *treble ſtring*, except E *la* or E, are term'd *in alt* for diſtinction's ſake.

Moſt nations ordinarily uſe the cleff G *re ſol*, on the ſecond line, to note the *muſick* for the *violin*, only in *France* they uſe the ſame cleff at the firſt line at bottom: the firſt method is beſt, where the ſong goes very low, and the ſecond where it goes very high.

The VIOLONCELLO of the *Italians*, is properly our fifth *violin*, which is a little baſs *violin*, half the ſize of the common baſs *violin*, and the ſtrings bigger and longer, in proportion; and conſequently its ſound an octave lower than that of our baſs *violin*, which has a noble effect in great concerto's.

The VIOL, *viola*, is a muſical inſtrument of the ſame form with the *violin*: and ſtruck like that with a bow.

There are *viols* of divers kinds (1.) The firſt and principal among us, is the *baſs-viol*, called by the *Italians*, *viola de gamba*, or the *leg-viol*, becauſe held between the legs. It is the largeſt of all, and is mounted with ſix ſtrings. Its neck is divided in half notes, by ſeven frets fixed thereon. Its ſound is very deep, ſoft and agreeable. The tablature or *muſick* for the *baſs-viol* is laid down on ſix lines or rules,

2. The *love-viol*, *viola d'amore*, which is a kind of *triple-viol*, or violin; having ſix braſs or ſteel ſtrings, like thoſe of the harpſichord. It yields a kind of ſilver ſound, which has ſomething in it very agreeable.

3. Their *viola prima*, or *firſt viol*, is really our *counter-tenor* violin; at leaſt they commonly uſe the

the cleff of C *ſol ut* on the firſt line, to denote the piece intended for this inſtrument.

4. *Viola ſecunda*, is much the ſame with our tenor violin; having the cleff of C *ſol ut*, on the ſecond line.

5. *Viola terza*, is nearly our fifth violin; the cleff C *ſol ut*, on the third line.

6. *Viola quarta*, or *fourth viol*, is not known in *France*, or *England*: though we frequently find it mentioned in the *Italian* compoſitions; the cleff on the fourth line.

7. Laſtly, their *violetta*, or little *viol*, is in reality our *triple viol*; though ſtrangers frequently confound the term, with what we have ſaid of the *viola prima*, *ſecunda*, *terza*, &c.

The Trumpet marine is a muſical inſtrument, conſiſting of three tables, which form its triangular body. It has a very long neck with one ſingle ſtring, very thick, mounted on a bridge, which is firm on one ſide, but tremulous on the other. It is ſtruck by a bow with one hand, and with the other the ſtring is preſſed or ſtopped on the neck by the thumb.

It is the trembling of the bridge, when ſtruck, that makes it imitate the ſound of a trumpet; which it does to that perfection, that it is ſcarce poſſible to diſtinguiſh the one from the other. And this is what has given it the denomination of *trumpet marine*, tho' in propriety it be a kind of monochord.

The third kind of *inſtruments* of the firſt claſs, are thoſe made to ſound by means of jacks, armed with quills ends, as *harpſichords*, *ſpinnet*, &c.

The Harpsichord is a muſical inſtrument of the ſtring kind, played on after the manner of the organ.

The *harpſichord* is furniſhed with a ſet, and ſometimes two ſets of keys. The touching or ſtriking theſe keys, move a kind of little jacks, which move a double row of chords, or ſtrings of braſs or iron ſtretched on the table of the inſtrument over four bridges.

To underſtand well all the notes of the *harpſichord*, and what keys to touch in order to ſound them, it muſt be obſerved, that the four notes above the treble ſtave, are called *in alt*; and thoſe below the baſs ſtave are called *double*; theſe notes are helped by additional lines, which are alſo called *ledger lines*.

Ledger-line is that, which when the aſcending and deſcending notes run very high, or very low, is added to the ſtave of five lines; there are ſometimes many of theſe lines both above and below the ſtave, to the number of four or five.

Beſides the two cleffs abovementioned, there is alſo another, called the *tenor-cleff*, which is uſed when the baſs goes high, to avoid *ledger-lines*: this cleff is generally placed on any of the four lower lines, and ſometimes on the fifth, and is always the middle C *fa ut*, of the inſtrument.

It muſt alſo be obſerved, that in the gamut there are 29 white keys (which is the number contained in many harpſichords, except thoſe made here of late years; to which they add, both above and below, ſometimes to the number of 37) there are alſo 20 black keys, ſomewhat ſhorter than the white ones, which are placed between them, and ſerve for flats and ſharps, ♭ ♭, and ♯ ♯.

If any note therefore has a ſharp before it, the inward or ſhort key above it, muſt be touched; and if there be a flat before it, the inward key below it, and ſo on with all the inward keys, which are flats to the plain keys above them, and ſharps to thoſe below them. Between B and C, and between E and F, there are no inward keys as there are between the others, by reaſon they have an interval but of a ſemi-tone between them.

As to the notes and characters in *muſick*, there are firſt the notes called the *ſemi-breve*, *minim*, *crotchet*, *quaver*, *ſemi-quaver*, and *demi-ſemi-quaver*. Next are the characters which are of ſharp, flat, and natural.

Next are the reſts or pauſes, being thoſe uſed to denote ſilence, and are of different lengths; as the *ſemi-breve-reſt*, *minim-reſt*, *crotchet-reſt*, *quaver-reſt*, *ſemi-quaver-reſt*, and *demi-ſemi-quaver*.

There are yet other characters uſed in *muſick*, ſuch as direct, which are uſually ſet at the end of a ſtave, to direct to the place of the next ſtave; as W W W.

There are alſo two ſorts of bars, *viz.* ſingle and double; the firſt ſerves to divide the time according to its meaſure, whether common, or triple; the double bars are ſet to divide the ſtrains of ſongs or tunes; thus 

A repeat which is thus *:S:* is uſed to ſignify that ſuch a part of a tune muſt be played over again; from the note it is placed over. It is alſo marked thus :||:

Common chords are to be played on any note, wherein no figure is put, except when you play in a ſharp key; the 3d and 7th above the key, then naturally require a 6th; but if you play in a flat key, then a 6th is required to the 2d and 7th above the key, unleſs otherwiſe marked.

All keys are either flat or ſharp, not by what flats or ſharps are ſet at the beginning of the tune, but by the third above the key. A ♭ ſet over any note, ſhews that it is to have a flat third; and a ♯ ſharp one, if there be no figure with it.

The

The SPINET is a musical instrument, and is played by two ranges of continued keys; the foremost range being the order of the diatonick scale, and that behind, the order of the artificial notes or semi-tones.

The keys are so many long flat pieces of wood, which touched and pressed down at the end, make the other raise jacks, which strike the wire, and cause the sounds, by means of the end of a crow's quill, wherewith 'tis armed.

The figure of the *spinet* is a long square, or parallelogram; some call it the harp couched; and the harp an inverted *spinet*: and the same rules serve to play on one, as on the other.

In the *second class* of instruments, are those which are made to sound by the wind, and that either natural from the mouth, as *flutes*, *trumpets*, *hautboys*, *bassoons*, *sackbuts*, *horns*, &c. or artificial by means of bellows, as the *bagpipe*, and that which by way of excellence is called the *organ*.

The FLUTE is an instrument of musick, the simplest of all those of the wind kind. It is played on by blowing in it with the mouth, and the tones or notes are changed by stopping and opening the holes, disposed for that purpose along its side.

There are two sorts of *flutes*, viz. the *common flute*, and the *German flute*.

The *common flute* is long like a *lamprey*, and has holes along it, like that fish.

The GERMAN FLUTE is an instrument entirely different from the *common flute*; it is not like that put into the mouth to be played, but the end is stopp'd with a tampion or plug, and the lower lip is applied to a hole about two inches and a half, or three inches distant from the end, and about half an inch distant from the hole. It is usually a foot and a half long, rather bigger at the upper end than at the lower, and perforated with holes, besides that for the mouth, the lowest of which is stopp'd, and opened by the little finger's pressing on a brass, or sometimes a silver key, like those on *hautboys*, *bassoons*, &c. Its sound is exceeding sweet and agreeable, and it serves as a treble in a concert.

The TRUMPET, from the *Italian tromba*, or *trombetta*, is a musical instrument, the loudest of all portable ones of the wind-kind, used chiefly in war among the cavalry, to direct them in the service. It is usually made of brass, often of silver, sometimes of iron or tin. Its extent is not strictly determinable, since it reaches as high as the strength of the breath can force it. A good breath will carry it beyond four octaves, which is the usual limit of the keys of the spinet and organ.

There are people, who blow the *trumpet* so softly, and draw so delicate a sound from it, that it is used not only in church musick, but even in chamber musick.

The HAUTBOY is shaped much like the flute, only that it spreads or widens towards the bottom. The treble is two feet long, the tenor goes a fifth lower when blown open; it has only eight holes; the bass is five feet long, and has eleven holes.

This instrument is thus held: place the left-hand uppermost next your mouth, and the right-hand below; and the contrary with left-handed people; and there are eight holes on this instrument, two of which are under brass keys, nevertheless seven fingers will be sufficient to supply them; as for example.

Let the fore finger of the left-hand cover the first hole, the second on the second hole, and the third on the next hole, which is a double one. In like manner the fore-finger of the right-hand must stop the next hole, which is also a double one, then place the second of the same hand on the next hole, then the third finger on the lowest hole in view, and the little-finger will command the two brass keys to open one hole, or shut the other, which is always open; the double holes serve for semitones.

Thus all the holes of the pipe being stopped, blow somewhat strong, and it will sound distinctly the note *C fa ut*, which is the lowest note on the *hautboy*.

The BASSOON is a musical instrument of the wind kind, serving as a bass in concerts of wind musick, as of *flutes*, *hautboys*, &c. to make it portable. It is divided into two parts; its diameter at bottom was formerly nine inches, at present 'tis but four at most, and its holes are stopped with keys, &c. like large flutes.

The SACKBUT is a musical instrument of the wind kind, being a kind of a trumpet, though different from the common trumpet, both in form and size.

It takes asunder into four pieces, or branches, and has frequently a wreath in the middle; which is the same tube, only twisted twice, or making two circles in the middle of the instrument; by which means it is brought down one fourth lower than its natural tone. It has also two pieces or branches on the inside, which do not appear, except when drawn out by means of an iron bar, and which lengthens it to the degree requisite to hit the tone required.

The *sackbut* is usually eight feet long, without being drawn out, or without reckoning the circles:

when extended to its full length, it is uſually 15 feet, the wreath is two feet nine inches in circumference: it ſerves as baſs in all concerts of wind Muſick.

The HORN is a ſort of muſical inſtrument of the wind kind, chiefly uſed in hunting, to animate the hunters and the dogs, and to call the latter together. The *horn* may have all the extent of the trumpet.

The term was antiently *to wind a horn*, all horns being in thoſe times compaſſed; but ſince ſtrait *horns* are come into faſhion, they ſay *blow a horn*, or *ſound a horn*.

The FRENCH HORN, called in *France*, *corne de chaſſe*, is bent into a circle, and goes two or three times round, growing gradually bigger and wider towards the end, which in ſome *horns* is nine or ten inches over.

To play on it, the firſt thing is to conſider the thickneſs or thinneſs of the lips, and provide a mouth piece accordingly; if they are thick, a pretty broad mouth-piece is required, but if thin, the piece muſt be ſomething ſmaller. Some *Muſicians* have brought the *French horn* to that perfection, and ſound it ſo ſweetly, that of late years it has been introduced into the orcheſtra, among the other inſtruments.

The laſt kind of inſtruments of the ſecond claſs, which are thoſe made to ſound by means of bellows, are the *bagpipe* and the *organ*.

The BAGPIPE is a muſical inſtrument of the wind kind, chiefly uſed in country places. It conſiſts of two parts; the firſt is a leather bag, which is blown like a foot-ball by means of a provent, or little tube fixed to it, and ſtopped by a valve. The other part conſiſts of three pipes or flutes, the firſt is called the great pipe or drone, the ſecond the little one, which paſſes the wind out only at bottom, and the third as a tongue, and is played by compreſſing the bag when full, under the arm, and opening and ſtopping the holes, which are eight, with the fingers. The little pipe is ordinarily a foot long, that played on, thirteen inches, and the provent ſix. This inſtrument takes in the compaſs of three octaves.

The ORGAN is the largeſt and moſt harmonious of all wind inſtruments, chiefly uſed for playing a thorough baſs, with all its accompaniments.

The *organ* is an aſſembiage of ſeveral rows of pipes; its ſize is uſually expreſſed by the length of its largeſt pipe: thus we ſay an *organ* of 32 feet, of 16 feet, of 8 feet, and of 2 feet.

The *organ* has at leaſt one ſet of keys, when it has only one body, and two or three when it has a *poſitive*. The large *organs* have four, ſometimes five ſets; beſides, the pedals or largeſt pipes have their keys, the ſtops or touches whereof are played by the feet.

The keys of an *organ* are uſually divided into four octaves, *viz.* the ſecond ſub-octave, firſt ſub-octave, middle octave, and firſt octave. Each octave is divided into twelve ſtops or frets, whereof the ſeven black mark the natural ſounds, and the five white the artificial ſounds, *i. e* the flats and ſharps; ſo that the keys uſually contain 48 ſtops or touches. Some organiſts add to this number one or more ſtops in the third ſub octave, as well as in the ſecond. The pedals extend to two or three octaves, at the pleaſure of the organiſt, ſo that the number or ſtops is undeterminate.

Each key or ſtop preſſed down opens a valve or plug, which correſponds lengthwiſe to as many holes as there are rows of pipes in the ſound-boards. The holes of each row are opened, and ſhut by a regiſter or ruler pierced with 48 holes: by drawing the regiſter, the holes of one row are opened, becauſe the holes of the regiſter correſpond to thoſe of the ſound-board: ſo that by opening a valve, the wind brought into the ſound-board by a large pair of bellows, finds a paſſage into the pipe, which correſponds to the open holes of the ſound-board; but by puſhing the regiſter, the 48 holes of the regiſter not anſwering to any of thoſe of the ſound-board, that row of pipes anſwering to the puſhed regiſter, are ſhut. Whence it follows, that by drawing ſeveral regiſters, ſeveral rows of pipes are opened; and the ſame thing happens, if the ſame regiſter correſponds to ſeveral rows. Hence the rows of pipes become either ſimple or compound; *ſimple*, when only one row anſwers to one regiſter; *compound*, where ſeveral. The organiſts ſay, a row is compound, when ſeveral pipes play upon the preſſing one ſtop.

The pipes of the *organ* are of two kinds, the one with mouths like our flutes, and the other with reeds: the firſt called pipes of mutation, conſiſts,

1. Of a foot, AAB B (*Fig.* 15. in the *miſcellaneous Plate*) which is a hollow cone, and which receives the wind that is to ſound the pipe.

2. To this foot is faſtened the body of the pipe, B B D, between the foot and the body of the pipe is a diaphragm or partition E E F, which has a little, long, narrow aperture to let out the wind. Over this aperture is the mouth B B C C, whoſe upper lip C C, being level, cuts the wind as it comes out at the aperture.

The pipes are of pewter, lead mixed with a twelfth part of tin, and of wood; thoſe of tin are always open at their extremities; their diameter is very

very fmall, their found is very clear and fhrill. Thofe of lead mixed are larger; the fhorteft open, the longeft quite ftopped, the mean ones partly ftopped, and having befides a little ear on each fide of the mouth, to be drawn clofer, or fet further afunder, in order to raife or lower the found. The wooden pipes are made fquare, and their extremities ftopped with a valve or tampion of leather. The found of the wooden and leaden pipes are very foft; the large ones ftopped are ufually of wood, the fmall ones of lead, the longeft pipes give the graveft found, and the fhorteft the moft acute; their length and width are made in the reciprocal ratio's of their founds, and the divifions regulated by their rule, which they call the diapafon: but the pipes that are fhut have the length of thofe that are open, and which yield the fame found: ufually the longeft pipe is fixteen feet, though in extraordinary *organs* 'tis thirty-two; the pedal tubes are always open, though made of wood and of lead.

A reed-pipe confifts of a foot, A A B B, (*tab. mifcell. Fig.* 16) which carries the wind into the fhalot, or reed C D, which is a hollow demi-cylinder, fitted at its extremity D, into a kind of mould I I, by a wooden tampion F G. The fhalot is covered with a plate of copper E E F F, fitted at its extremity F F, into the mould by the fame wooden tampion; its other extremity E E is at liberty; fo that the air entring the fhalot, makes it tremble or fhake againft the reed; and the longer that part of the tongue which is at liberty F L, is made, the deeper is the found. The mould I I which ferves to fix the fhalot or reed the tongue, tampion, *&c.* ferves alfo to ftop the foot of the pipe, and to oblige the wind to go out wholly at the reed. Laftly, in the mould is foldered the part H H K K, called the tube, whofe inward opening is a continuation of that of the reed. The form of this tube is different in the different ranks of pipes.

The degree of acutenefs and gravity in the found of a reed-pipe, depends on the length of the tongue, and the tube; and alfo on the thicknefs of the tongue, the figure of the tube, and the quantity of wind.

To diverfify the founds of the pipes, they add a valve to the port-vent, which lets the wind go in fits or fhakes.

The *laft clafs* of inftruments, we call *inftruments of percuffion*, becaufe made to found either with the hand, as *drums*, *tabors*, *tymbals*, &c. or with little fticks, or fmall iron rods, as *pfaltery* and *cymbal*; or with a feather, as the *fyftrum* and *dulcimer*; or by ftriking them with hammers, as bells, *&c.*

The DRUM is a military mufical inftrument, of the pulfatile kind, ufed principally among foldiers, to direct their march, attack, retreat, *&c.*

The body of the *drum* is of very thin oak, bent into a cylinder, and covered with parchment, which is ftrained or braced more or lefs, according to the height or depth of the tone required, by ftrings, and ftruck with fticks.

There are divers beats of the *drum*, as the *march*, *double march*, *affemblee*, *charge*, *retreat*, *chamade*, &c.

The TYMBAL, which among the antients confifted of a thin piece of leather or fkin, ftretched on a circle of wood or iron, and beat with the hand.

This may by our kettle-drum, as it appears to be from the *Italians* ufing the word *tympani* for a pair of *tymbals*.

The KETTLE-DRUMS have their body of brafs, and are ufed among the horfe to be play'd on, with two little iron bars with balls at the end; their found is fofter, and more agreeable than that of the common drum; and they are often ufed in opera's, oratorio's, tragedies, and concerts.

PSALTERION, *pfaltery*, is a mufical inftrument, much in ufe among the antient *Hebrews*, who called it *nebel*. We know little or nothing of the precife form of the antient *pfaltery*.

That now in ufe is a flat inftrument in form of a *trapezium*, or triangle truncated a-top.

The DULCIMER is a mufical inftrument, with wire ftrings, in a triangular form, ftrung with about fifty ftrings, caft over a bridge at each end, and the acuter gradually the fhorter, the fhorteft about eighteen inches, and the longeft about thirty-fix. ftuck with little iron rods: the bafs ftrings are doubled, and its found is not difagreable: to be plaid on, 'tis laid on a table before the performer, who with a little iron rod in each hand, ftrikes the ftrings. This inftrument is not much ufed except among puppet fhews.

The mufick of the inftruments is moft commonly called *fymphony*.

The *fymphony*, or *inftrumental Mufick*, makes alfo one of the moft effential parts in a concert, opera, oratorio, cantata, *&c.*

A CONCERT, popularly called *confort*, is a number or company of muficians playing or finging, the fame piece or fong at the fame time.

A *concert* for any inftrument, as organ, harpfichord, violin, *&c.* is a piece of Mufick wherein either of thefe inftruments has the greateft part, or in which the performance is partly alone, and partly accompanied by the other parts.

A CAN-

A CANTATA is a song, or composition, intermixed with recitatives, little airs, and different motions, and merrily intended for a single voice, with a thorough bass, though sometimes for two violins, and other instruments. When the words or subjects are intended for the church, it is called *cantata morali ô spirituali:* but when on love, *cantata amoroso*, &c.

OPERA is a dramatick composition, set to Musick and sung on a stage, accompanied with musical instruments, and enriched with magnificent dressings, machines, and other decorations.

ORATORIO is a sort of spiritual opera, full of dialogues, recitativo's, duetto's, trio's, rittornello's, chorus's, *&c.* the subject whereof is usually taken from the Scripture, or is the life and actions of some saint, *&c.*

A piece of *Musick* or composition, wholly to be executed by instruments, is called SONATA, by the *Italian*, *suonata*, from *suono*, sound. This is with regard to instruments of several kinds, what *cantata* is with regard to the voice.

MYTHOLOGY.

MYTHOLOGY, ΜΥΘΟΛΟΓΙΑ, (from μυθος, *fabula*; and λογος, *sermo*, *discourse*) is the history of the fabulous gods, and heroes of antiquity; with the explication of the mysteries, or allegories, couched therein.

The first false divinity adored when men began to abandon the worship of the true God, was the sun: nature seeming to depend entirely for its preservation, on its periodical course and influenence, prompted them to believe that the world was created by it.

But as the true ideas of a Creator were effaced men at last crowded heaven and earth with as many divinities as they could imagine. The earth itself was deified for furnishing fruits necessary for the subsistence of men and animals; then fire and water became objects of divine worship for their usefulness to human life.

When things were thus got in the train, gods by degrees became multiplied to infinity, and scarce any thing but what the weakness or caprice of some devotee or other, elevated into that rank, things useless, or destructive not excepted.

To authorize their own crimes, and justify their vices and debaucheries, men constituted criminal, vitious, and licentious *gods*, unjust, rapacious, and tyrannical *gods*, covetous and thievish *gods*, drunken *gods*, impudent *gods*, cruel and bloody *gods*.

The principal of the antient gods, were *Jupiter*, *Juno*, *Vesta*, *Minerva*, *Ceres*, *Diana*, *Venus*, *Mars*, *Mercury*, *Neptune*, *Vulcan*, *Apollo*.

Jupiter was considered as god of heaven; *Neptune*, as god of the sea; *Mars*, as god of the war; *Apollo*, of eloquence, poetry, and physick; *Mercury*, of thieves; *Bacchus*, of wine, *Cupid*, of love *Juno* was the goddess of the air; *Diana*, the goddess of woods and chastity; *Proserpine*, the goddess of hell; *Venus*, of beauty; *Thetis*, of the sea, *&c.*

A second sort of *gods*, called *semi-gods*, *indigetes*, or *gods adopted*, were men canonized and deified. As the greater gods had possession of heaven by their own right, these secondary deities had it by right of donation, being translated into heaven, for that they had lived as *gods* upon earth Somewhat of this kind is retained in the *Romish canonization of saints*.

The heathen *gods* may all be reduced to the following classes, 1. Created spirits, angels, or dæmons; whence good and evil gods *genii*, *lares*, *lemures*, *guardian gods*, *infernal gods*, &c.

The *genius* was supposed by the heathens a good or evil spirit or dæmon, set over each person to direct his birth, accompany him in life, and to be his guardian angel.

The antients had their *genii* of nations, of cities, of provinces, *&c.* Nothing is more common than this following inscription on medals, GENIUS POPULI ROMANI. *The Genius of the* Roman *People*; or, GENIO POP. ROM. *To the Genius of the* Roman *People*.

In this sense *genius* and *lar* were the same thing.

The *Platonists* and eastern Philosophers, supposed the *genii* to inhabit the vast region or extent of air between earth and heaven. They were a sort of intermediate powers, who did the office of mediators between the gods and men. They were the interpreters and agents of the gods; communicated the wills of the deities to men; and the prayers and vows of men to the gods. Most of the Philosophers held, that the *genii* of particular men were born with them, and died: *Plutarch* attributes the ceasing of the oracles to the death of the *genii*.

There were also evil *genii*, who took a pleasure in persecuting men, and bringing them evil tidings; such was that in *Paterculus*, &c. which appeared to to *Brutus* the night before the battle of *Philippi*. These were also called *Larvæ* and *Lemures*.

Lares were a kind of domestick *genii*, or divinities, worshiped in houses, and esteemed the guardians and protectors of families; supposed to reside more immediately in the chimney-corner.

Plutarch distinguished good and evil *lares*, as he had before done good and evil *genii*.

There were also some publick, others private *lares*.

The *publick lares* were also called *compitales*, from *Compitum*, a cross-way; and *viales*, from *Via*, a way, or publick road; as being placed at the meeting of roads, and in the highways, and esteemed the patrons and protectors of travellers.

Their private *lares* took care of particular houses and families: these they also called *præstites*, from *Præsto*.

They gave the name *Urbani*, i. e. *lares* of cities, to those who had cities under their care, and *Hostilii* to those who were to keep their enemies off. There were also *lares* of the country, called *rurales*, as appears by several antique inscriptions.

Tertullian tells us, the custom of worshipping the *lares* arose from this, that they antiently interred their dead in their houses; whence the credulous people took occasion to imagine, their souls continued there also and proceeded to pay them divine honours.

The victim offered to the *lares* in the publick sacrifices was a hog: in private they offered them wine, incense, a crown of wool, and a little of what was left at the table. They also crowned them with flowers, particularly the violet, myrtle, and rosemary. Their symbol was a dog, which which was usually represented by their side, on account of its fidelity, and the service he does to man in watching his house. They were also represented as cloathed in a dog's skin.

The term Penates, being applied to the domestick gods, whom the antients adored in their houses, was the occasion that the *penates* were ordinarily confounded with the *lares*.

Authors are not at all agreed about the origin of the *dii penates*, who were properly the tutelary gods of the *Trojans*, and were only adopted by the *Romans*, who gave them the title of *Penates*.

The *Penates* were also called sometimes *Denates*.

Dionysius Halicarnassus, *lib.* 1. speaking of the *dii penates*, tells us, that the historian *Timæus* has wrote, that the statue, figure, or effigy of the *Denates* or *Penates*, was nothing but a crooked iron, or copper rod, and a *Trojan* vessel of potters ware: and that this was all *Æneas* brought from *Troy*.

Lemures were spirits or hobgoblins; restless ghosts of departed persons, who were supposed to terrify and torment the living.

These are the same with *larvæ*, which the antients imagined to wander round the world to frighten good people, and plague the bad. For which reason at *Rome* they had *lemuria*, or feasts, instituted to appease the *manes* of the deceased.

Of these *lemures*, those that were kind to their families, were called *lares familiares*; but those, who for their crimes were condemned to wander continually, without meeting with any place of rest, and terrified good men, and hurt the bad, were vulgarly called *larvæ*.

The antients used, also, to call the gods abovementioned *indigetes*.—— The gods, to whom the *Romans* gave the name *indigetes*, were *Faunus*, *Vesta*, *Æneas*, *Romulus*, all the gods of *Italy*; and at *Athens*, *Minerva*, says *Servius*; at *Carthage*, *Dido*.

The antients called their demi gods *heroes*, who were illustrious persons of mortal nature; tho' by the populous supposed to partake of immortality; and, after their death, placed by them in the number of the *gods*.

The word *hero* was formed from the *Latin heros*, and that of the *Greek* Ἥρως, *semi-deus*, *demi-god*.

The heroes were translated into heaven, by a ceremony called *apotheosis*, from ἀπὸ and Θεὸς, *Deus*, *God*.

After the *apotheosis*, which they also called *deification*, and *consecration*, temples, altars, and images, were erected to the new deity; sacrifices, &c. were offered, and colleges of priests instituted; and even the senate decreed that oaths should be taken in their names.

Herodian. lib. 4. in speaking of the *apotheosis* of *Severus*, gives us a very curious description of the ceremonies used in the *apotheosis* of the *Roman* Emperors. After the body of the deceased Emperor, says he, had been burnt with the usual solemnities, they placed an image of wax, perfectly like him, but of a sickly aspect, on a large bed of ivory, covered with a cloth of gold in the vestibule of the palace. The greatest part of the day the senate sat ranged on the left side of the bed, dressed in robes of mourning; the ladies of the first rank sitting on the right side in plain and white robes, without any ornaments. This lasted for seven days successively, during which, the physicians came from time to time to visit the sick, always making their report that he grew worse, till at length they published that he was dead.

This done, the young senators and *Roman* knights took the bed of state upon their shoulders, carrying it through the *Via Sacra*, to the old forum, where

where the magiſtrates uſed to diveſt themſelves of their offices; there they ſate it down between two kinds of amphitheatres, in the one whereof were the youths, and in the other the maidens of the firſt families of *Rome*, ſinging hymns ſet to ſolemn airs, in praiſe of the deceaſed. Theſe hymns ended, the bed was carried out of the city into the *Campus Martius*, in the middle of which was erected a kind of ſquare pavilion, the inſide whereof was full of combuſtible matters, and the outſide hung with cloth of gold, and adorned with figures of ivory, and various paintings.

Over this edifice were ſeveral others, like the firſt in form and decoration, always diminiſhing and growing ſlenderer towards the top. On the ſecond of theſe was placed the bed of ſtate, and a great quantity of aromates, and odoriferous fruits and herbs were thrown all around; after which the knights made a proceſſion or cavalcade in a ſolemn manner around the pile, ſeveral chariots alſo run round it, thoſe who conducted them being clad in purple robes, and bearing the images of the greateſt *Roman* emperors and generals

This ceremony ended, the new emperor come to the catafalca, or pile, with a torch in his hand; and at the ſame time fire was ſet to it. on all ſides, the ſpices and other combuſtibles, kindling all at once.

While this was doing, they let fly from the top of the building an *eagle*, which mounting into the air with a firebrand, carried the ſoul of the deceaſed emperor along with it into heaven, as the *Romans* believed; and thenceforward he was ranked among the gods.—It is for this reaſon, that the medals, wherein *apotheoſes* are repreſented, have uſually an altar with fire upon it; or an eagle taking its flight into the air, and ſometimes two eagles.

Dæmons are alſo of their firſt claſs of *gods*. By *dæmons Plato* underſtood ſpirits inferior to gods, and yet ſuperior to men; which inhabiting the middle region of the air, kept up the communication between gods and men, carrying the offerings and prayers of men to the gods, and bringing the wills of the gods to men. But he allowed of none but good and beneficent ones; though his diſciples afterwards finding themſelves unable to account for the origin of evil, adopted another ſort of *dæmons* who were enemies to men.

In the *ſecond claſs* of *gods* were the heavenly bodies, as the *ſun moon*, and other planets; the *fixed ſtars*, *conſtellations*, &c.

The Sun was the god of the *Phœnicians*.

The *third claſs* was compoſed of the *elements*, as *air*, *earth*, *ocean*, *Ops*, *Veſta*, the *rivers*, *fountains*, &c.

The antients called the divinities, which they ſuppoſed to inhabit the ſea, *Nereides*, who were fifty in number, all the daughters of *Nereus*, by the nymph *Doris*: and thoſe, who inhabited rivers, fountains, *&c.* *Naiades*.

The *fourth claſs* contained *meteors*: thus the *Perſians* adored the wind: thunder and lightning were honoured under the name of *Geryon*: *Caſtor*, *Pollux*, *Helena*, and *Iris*, have alſo been preferred from meteors to be *gods*.

In the *fifth claſs* they erected *minerals*, or *foſſils* into deities; ſuch was the *Bætylus*; the *Finlanders* adored ſtones; the *Scythians* iron; and many nations ſilver and gold.

The *ſixth claſs* conſiſted of *plants*: thus *leeks* and *onions* were deities in *Egypt*. The *Sclavi*, *Lithuanians*, *Celtæ*, *Vandals*, and *Peruvians*, adored trees and foreſts: the antient *Gauls*, *Britons*, *Druids*, bore a particular devotion to the oak, and it was no other than wheat, corn, ſeed, *&c.* that the antients adored under the names of *Ceres* and *Proſerpina*.

The deities who inhabited the foreſts and trees, were called *Dryades* and *Hamadryades*.

The Dryades were imagined to hide themſelves under the bark of the oak, called by the *Greeks* Δρυς.

The Hamadryades were attached to ſome particular trees with which they were born, and with which they died; whereas the *Dryades* were the Goddeſſes of the trees and woods, and lived at large in the middle thereof.

There was alſo a kind of ſemi-god, called Satyrs, who, with the *fawns* and *ſylvans*, preſided over groves and foreſts, under the direction of *Pan*.

The *ſatyrs* are painted half men, and half goats, the upper part was human, excepting for horns on the head; the lower brutal, with the tail and legs of a goat: the whole covered with hairs.

The poets uſually confound the ſatyrs, ſylvans, ſileni, fawns, and panes.

The Fawns were alſo a ſpecies of demi-gods, inhabiting the foreſts.

The *fauns* are reputed pure *Roman* deities; unknown to the *Greeks*.—They were repreſented, like the *ſatyrs*, half men, half goats, a very flat noſe, and the reſt human.

The *Roman Faunus* was the ſame with the *Greek Pan*.

The *ſeventh claſs* of Gods was taken from among the waters: the *Syrians* and *Egyptians* adored fiſhes; the *Oxyrinchites*, *Latopolitani*, *Siennitæ*, and

and inhabitants of *Eliphantis* had each a fiſh for their god; and the *Tritons*, *Nereides*, *Syrens*, &c. what were they but fiſhes? ſeveral nations have adored ſerpents, particularly the *Egyptians*, *Pruſſians*, *Lithuanians*, *Samogitians*, &c.

The TRITON was a *ſea ſemi-god*, held by the antients to be an officer, or trumpeter of *Neptune*, attending on him, and carrying his commands from ſea to ſea.

The poets and painters, repreſent him as a half man, and half fiſh, terminating in a dolphin's tail, and bearing in one hand a ſea ſhell, which ſerved as a trumpet.

But though *Heſiod*, and the *mythologiſts*, only ſpeak of one *Triton*, the poets have imagined ſeveral; giving ſome of them for trumpeters to all the ſea-gods, particularly to *Neptune* and *Venus*.

The *Tritons* not only officiated as trumpeters in *Neptune*'s retinue, but were alſo ſuppoſed to draw his chariot.

The poets ordinarily attribute to *Triton* the office of calming the waves, and of making tempeſts ceaſe. Thus in the firſt of the *Metamorphoſes* we read, that *Neptune* deſiring to recal the waters of the deluge, commanded *Triton* to ſound his trumpet, at the noiſe whereof the waters all retired.

The SIRENS or *mermaids*, are repreſented by *Ovid* a kind of ſea-monſter, with women's faces and fiſhes tails; and by others are decked with a plumage of various colours.

They are ſuppoſed to have been the three daughters of the river *Archelous*, and called *Parthenope*, *Ligea*, and *Leucoſia*. *Homer* only makes mention of two *Syrens*, but others reckon five. *Claudian* ſays, they inhabit harmonious rocks, that they were charming monſters; and that ſailors were wrecked on their rocks without regret, and even expired in raptures; *dulce malum pelago ſyren.*

In the *eighth claſs*, *flies* and *ants* had their prieſts and votaries; theſe among the *Theſſalians*, and thoſe in *Arcania*; where bullocks were offered to them.

In the *ninth claſs* among *birds*, the ſtork, raven, ſparhawk, ibis, eagle, griffon, and lapwing, have had divine honours; the laſt in *Mexico*, the reſt in *Egypt* and at *Thebes*.

In the *tenth claſs four footed beaſts* have had their altars; as the bull, dog, cat, wolf, baboon, lion, and crocodile, in *Egypt*, and elſewhere; the hog in the iſland of *Crete*, rats and mice in the *Troas*, and at *Tenedos*; weazels at *Thebes*, and the porcupine throughout all *Zoroaſter*'s ſchool.

In the *eleventh claſs men* were placed among the number of deities, and from *Belus*, or *Baal*, to the *Roman* emperors before *Conſtantine*, the inſtances of this kind are innumerable.

In the *twelfth claſs* not men only, but every thing that relates to men has been alſo deified; as labour, reſt, ſleep, youth, age, death, virtues, vices, occaſion, time, place, numbers, and among the *Pythagoreans*, the generative power, under the name of *Priapus*. Infancy alone had a cloud of deities, as *Vegetanus*, *Levanc*, *Rumina*, *Eduſa*, *Potina*, *Cuba*, *Cumina*, *Carna*, *Oſſilago*, *Statulinus*, *Fabulinus*, &c.

They alſo adored the *gods*, health, fever, fear, love, pain, indignation, ſhame, impudence, opinion, renown, prudence, ſcience, art, fidelity, felicity, calumny, liberty, money, war, peace, victory, triumph, &c.

Laſtly, nature, the univerſe, or το παν, was reputed a great God.

Heſiod has a poem under the title of Θεογονια, *i. e.* the generation of the gods, wherein he explains their genealogy and deſcent, ſets forth who was the firſt and principal; who next deſcended from him, and what iſſue each had; the whole making a ſort of ſyſten of heathen theology.

Beſides this *popular theology*, each philoſopher had his ſeparate ſyſtem, as may be ſeen from the *Timæus* of *Plato*, and *Cicero de nat. Deor.*

The heathen divinities had a particular ſort of *prieſts* or miniſters of their ſacrifices, called *flamens:* and at *Rome* there were as many kinds of *flamens*, as there were gods who had ſacrifices offered them: as for *Jupiter*, *Flamen Dialis*; for *Mars*, *Flamen Martialis*; for *Romulus*, or *Quirinus*, *Flamen Quirinalis*, &c. In after times twelve more were added, which made the number of *flamens* fifteen.

They had alſo their *Flaminæ* or *Flaminicæ*, who were wives of the *Flamens*, or the prieſteſſes of the deities.

The *Flamina* had the ſame ſurname with her huſband, *Flamina Dialis Martialis*, &c.

NATURAL HISTORY.

NATUAL HISTORY, is a deſcription of the natural products of the earth, water, or air, *v. gr.* beaſts, birds, fiſhes, metals, minerals, and foſſils, together with ſuch extraordinary phænomena, as at any time appear in the material world, as meteors, monſters, &c.

Moſt of theſe things have already been treated of under the heads *botany*, *metals*, *minerals*, &c.

ſo that I ſhall confine this treatiſe to monſtrous, ſcarce and extraordinary animals, plants, &c.

But firſt of *animals* in general.

ANIMAL, in natural hiſtory, is an organized and living body, and endowed with ſenſation, and divided into *rational* and *irrational*.

Man is the *only rational* animal; who is an organical body, informed and directed in all its motions, by a ſpiritual, immortal, impaſſible, undefinite, and unalterable ſubſtance, called *ſoul*.

Philoſophers are not all agreed as to the manner wherein the ſoul reſides in the body. Some will have it *tota in toto*, and *tota in quâlibet parte*, *i. e.* diffuſed throughout all the parts of the organical body, which it influences alike, without any particular part, being appropriated to its chief reſidence; others will have it fixed in its center, like the *ſun*, from whence it influences all the inferior parts, like as that planet does all the ſublunary things.

Tho' the *ſoul* is indiviſible, it has ſeveral faculties, the principal whereof are the *underſtanding* and the *will*.

The UNDERSTANDING, according to the *Peripateticks*, is a faculty of a reaſonable ſoul, converſant about intelligible things, conſidered as intelligible.

Nihil eſt in intellectu quod prius non fuerit in ſenſu, nothing is in the *underſtanding*, which has not been firſt the object of our ſenſes, is the favourite axiom of our modern philoſophers; who thereby attribute two offices to the *underſtanding*, *viz.* perception and judgment.

WILL is uſually defined a faculty of the mind, whereby it embraces or rejects any thing repreſented to it, as good or evil, by the judgment.

Mr. *Locke* defines the *will*, a faculty which the ſoul has of beginning or forbearing, continuing or ending ſeveral actions of the mind, and motions of the body, barely by a thought or preference of the mind, ordering, or as it were, commanding the doing, or not doing, ſuch a particular action.

Memory, *imagination*, *liberty* and *ſenſation*, are alſo faculties of the *ſoul*.

MEMORY is a faculty whereby the *mind* retains, or recollects the ſimple ideas or images of things we have ſeen, imagined, underſtood, &c.

IMAGINATION is a faculty of the *ſoul*, by which it conceives or forms ideas of things by means of impreſſions made on the *animal ſpirits*, aſſigned to that faculty.

SENSATION is the act of perceiving external objects by means of the organs of ſenſe.

From the firſt *perception* of the objects, from the ſtrength of our *imagination*, which forms to itſelf *ideas* of thoſe objects, and from the juſt œconomy of our *underſtanding*, which directs thoſe *ideas*, proceeds the reducing them into practice, ſo as to form a judgment of them, which is effected by another faculty of the *ſoul*, in which all the operations of the other faculties come to centre themſelves, which faculty we call REASON.

Chauvin has defined *reaſon*, an innate notion, or *idea*: further diffuſed, and ariſing from a continued attention.

Reaſon is the *maſter-faculty*, (if I may uſe that expreſſion) which gives the finiſhing ſtroke to all the other operations, in order to make them a perfect, and accompliſhed work. From thoſe noble operations reſults that excellent quality which exalts the *ſoul* above all other created beings, and that eſſential difference which diſtinguiſhes *man* from all other *animals*.

RATIONALITY; beſides a reaſonable *ſoul*, which raiſes *man* above all other created beings, he has a ſenſitive one, in common with the other *animals*, which both have a vegetative one in common with the *plants*, not that thoſe *ſouls* are eſſentially and ſubſtantially divided from each other, ſo as the one to be capable of ſubſiſting without the other, for they are indiviſible in the ſame ſubject; but becauſe that very ſame *ſoul*, which is capable of rationality in *man*, is alſo capable of ſenſation and vegetation, though the ſenſitive ſoul in the brutes is not *rational*, nor the vegetative in the plants *ſenſitive*.

The *irrational animals* are ſubdivided into terreſtrial, aquatic, volatile, and amphibious, which are endowed with vegetative and ſenſitive ſoul, by virtue whereof they are enabled to provide for themſelves, know what is good for them, and are determined to preſerve and propagate their ſpecies.

Brutes, beſides their ſenſitive and vegetative *ſoul*, conſiſt alſo, like *men*, of ſolid and firm parts, as fleſh, bones, membranes, &c. of fluids, as blood, juices, &c. and of fat, which may be reckoned an intermediate kind.

The ſolid parts are mere earth, bound together by ſome oily humour, and accordingly are reducible by fire into ſuch earth again.

Terreſtrial animals, are either *quadrupedes* or *reptiles*.

QUADRUPEDES are divided by Mr. *Ray*, into thoſe which are *hoofed*, and clawed, or *digitate*.

Hoofed QUADRUPEDES, are either whole hoofed, as the horſe, aſs, the *onager* or wild aſs; the

mule,

mule, and the *zebra* of *Africa*, or the fine *ſtriped Indian* or *African* aſs, almoſt like a mule in form and ſtature; or *cloven footed*, and theſe again ſubdivided into,

Ruminant, that is ſuch as chew the cud; and theſe either have hollow and perpetual horns, as the bull, ſheep and goat-kind; or deciduous horns, as the hart and deer kind, which uſually ſhed their horns annually.

Of the bull-kind are the common bullock, of which the male is bull; the female cow; the *biſon*; the *bonaſus*, &c.

Of the *ſheep-kind*, the *Arabian* ſheep, whoſe tail is ſometimes of forty or fifty pounds weight; the *Cretic*, and the *African*, with ſhort hairs inſtead of wool; beſides the common ſort.

Of the *goat-kind*, the *German* found in the tops of the *Alps*; the *rupi capra*, or *German goms*.

Of the *hart* or deer-kind, the *cervus* or red deer; the elk; the fallow deer; the rain deer, &c.

Of the *cloven footed*, into two parts only, and which does not chew the cud, there's none but a *hog* and *ſwine-kind*.

There are ſome *quadrupedes*, whoſe hoof is cloven into four diviſions; and theſe ſeem to be not *ruminant*; as the *rhinoceros*, the *hippopotamus*; the *tapijerete* of *Braſil*, the *capa bara* of *Braſil*, and the animal *moſchiferum*.

Of the *clawed* or *digitated quadrupedes*, there are firſt, a ſort whoſe claws are not divided or ſeparated, but adhering to one another, covered with one common ſkin, but with obtuſe nails, ſticking out round the margin of the foot; as the *elephant*, which is anomulous, and not clearly referable to this kind, or to that of *cloven-footed quodrupeds*.

The *camel* has only two claws, has no horns, though they have four ſtomachs, and ruminate like thoſe of the horned ruminant-kind, and are nevertheleſs, a ſecond ſpecies of the *digitated-kind*.——There are two ſorts of *camels* or *dromedaries*, one having but one bunch on the back, and the other two.

All the *animals* whoſe foot is divided into many claws, with broad nails on them, as the *ape* and monkey-kind, is a third ſpecies of the ungulated.—Of theſe, ſome have no tails, and are called *ſimiæ*, or apes: others have tails, and are called monkeys; and ſuch as have either long or ſhort tails, if they are of a larger ſize, are called baboons.

Thoſe which have many claws covered at the end, crooked and ſharp-pointed like the talons of hawks, and not with broad flat nails, like monkeys or apes, are a fourth ſpecies of the *ungulated-kind*.——Of theſe there are two ſorts, a greater, which either have a ſhort, round head, as the cat-kind; or a leſſer ſort, having a long, ſlender body, with very ſhort legs, as the *weaſel*, or vermin-kind.——The hare-kind is a ſpecies of *quadrupedes*, which have only two large remarkable teeth in each jaw, and live upon herbs.

The *lion*, the *tiger*, the *pardus*, the *panther*, the *leopard*, the *lynx*, the *cat a-mountain*, the common *cat*, and the *bear*, are *quadrupedes*, of the cat-kind.

Beſides the common *dog*, of which kind are the *maſtiff*, the *greyhound*, the *Iriſh greyhound*, the *ſpaniel* for land or water, the *tumbler*, the *lap-dog*, the *ſhock*, the *houſe-dog*, &c. &c. The *wolf*, and the *jackall*, are alſo of the *dog-kind*; as well as the *fox*; the *civet cat*, the *badger*, grey or pate, the *otter*, the *ſea calf* or *ſeal*, the *morſe* or *ſea horſe*, the *ſea cow*, &c.

The common *weaſel*, in *Yorkſhire* called *foumart* or *fitcher*, the *quel*, or *quirple*; the *muſtela ermin* or *ſtoat*, if white; the *ferret*, the *pole cat*, the *marten* or *martlet*, the *ſable*, &c. are of the *vermin-kind* of *quadrupedes*.

The common *hare*, the *rabit* or *coney*, the *porcupine*, the *caſtor*, *fiber*, or the *beaver*, the *ſquirrel*, the *Virginian*, *Zelandic*, *Barbary*, and *American flying ſquirrel*, the common *rat* and *mouſe*, the *water rat*, the *muſk rat*, the *dormouſe*, or *ſleeper*, the *guinea pig*, &c. are *quadrupedes* of the *hare kind*.

There are ſix ſorts of anamolous *quadrupedes*, or of *quadrupedes* that deviate from the common form of *animals* of the ſame kind.

1. *Animals* with their feet divided into many claws and toes, have a longiſh ſnout, and teeth; as the *hedge-hog*, the *mole*, the *warp*, or *mole-warp*, *ſhrew*, *hardyſhrew*, *ſhrew-mouſe*, &c.

2. Thoſe with their feet divided, alſo, into many claws and toes, have a longiſh ſnout, but no teeth; as the great *ant-bear*, the leſſer *ant-bear* of *Marcgrave*, the *tamandua-guacu* of *Braſil*, &c.

3. The *bat-kind*, or *flitter-mice*, of which there are ſeveral ſizes and different forms, and which are *anomalous flying quadrupedes*, with a ſhorter ſnout, and their feet divided.

4. The *ſloath* or *ſluggard* is an anomalous *animal*, which has but three claws on each foot.

5. The *frog* or *froſh*, the *ſmall tree* or *green frog*, the *toad*, the *tortoiſe* of land or water, are *viviparous* and *ſanguinous quadrupedes*, breathing with lungs; but have but one ventricle in the heart.

6. The *crocodile*, the common *eft*, *ſwift* or *newt*; the *green lizard*, the *Neopolitan tarantula*, the *ſwift* or *ſpotted lizard*, the *water eft*, and the *cameleon* or *camilion*, are *oviparous quadrupedes*, with a long tail, ſtretched out horizontally.

Reptiles (from the Latin *repo*, I creep) are another ſpecies of *terreſtrial animals*, which inſtead of feet reſt on one part of the body, while they advance forwards with the reſt, as *vipers*, *ſnakes*, *earth worms*, &c.

The Aquatic *animals* are all thoſe that live in water; as fiſhes of all kind.

Fishes are diſtinguiſhed into ſalt water fiſh, *piſces marini*, as the *whale*, *herring*, *mackarel*, *ſole*, *ſkate*, *turbot*, &c. &c. and freſh water fiſh, *piſces fluviatiles*, as the *pike*, *trout*, *carp*, *tench*, &c. to which may be added, *ſalmons*, *ſhad-fiſh*, which abide indifferently in freſh water or ſalt.

M. *Willoughby* diſtinguiſhes fiſhes into *cetaceous*, *cartilaginous* and *ſpinous*.

The Cetaceous (from the Latin *cetus*, *whale*,) have lungs, and breath like *quadrupedes*, copulate like them, conceive and bring forth their young alive, which they afterwards ſuckle with their milk, as the *whale*, the *dolphin*, *phocæna*, the *porpus*, &c.

The *cartilaginons* ſorts (thus called for their having their bones of a cartilaginous ſubſtance) are produced from large eggs, like birds, which are alſo excluded the womb, like thoſe of birds; and theſe are divided into long cartilaginous and plain cartilaginous.

The *long cartilaginous* are the *white ſhark*, the *blue ſhark*, the *tape*, the *prickled-dog*, or *hound-fiſh*, the *ſmooth* or *unprickled hound-fiſh*, the *rough-hound*, or *bounce*, the leſſer *hound-fiſh*, or *morgay*, &c.

The *plain cartilaginous* are the *ſkate* or *flare*, the *thorn-back*, the *white horſe*, the *angel*, or *monk-fiſh*, the *toad-fiſh*, or *ſea-devil*, &c.

Spinous Fishes (from their having *ſpinæ* up and down in their fleſh to ſtrengthen it) are alſo *oviparous*, but their eggs are ſmaller; and theſe are alſo divided into *long ſpinous* and *plain ſpinous*.

The *long ſpinous* are the *eel-kind*, viz. the *lamprey*, or *lamprey-eel*; the *lampern*; the *common-eel*; the *conger*, or *ſea-eel*; the *ſand-eel*, or *launce*; the *butter-fiſh*; the *ſea-loach*, or *whiſtle-fiſh*: the *eel-pout*, or *turbou*; the *wolf fiſh*, or *ſea-wolf*; *the ſea-lark*, called in *Cornwal*, *mulgranock* and *bulkard*; the creſted *ſea-lark*; the *bull's-head*, or *miller's-thumb*; the *Dutch pot's-hog*; the *Corniſh* boys call it *Father Laſher*.

The *plain ſpinous* are the *turbot* or *brett*; the *lug aleſe*, the *plaiſe*; the *flounder*, *fluke*, or *butt*; the *holy-butt*; the *ſole*, &c.

There are three different ſorts of the *none-ſpinous* kind of fiſhes; ſome with only one ſoft and prickly fin on their back; ſome with two, and others with three.

Thoſe with only one fin on their back, are the *herring*, the *pilchard*, the *anchovy*, the *ſhad*, the *ſprat* or *ſparling*, which is nothing elſe but the *fœtus* of a *herring*; the *garniſh*, or *horn-fiſh*, the *ſturgeon*, the *pike*, or *pikrel*, the *carp*, the *bream* or *bruma*, the *tench*, the *rudd*, *ocrve*, or *nexſling*, the *chubb* or *chevin*, the *barbel*, the *dace* or *dare*, the *roach*, *bleak* or *bley*, the *gudgeon*, the *loch*, the *pink*, or *minnow*, &c.

Thoſe with two fins on their back, are the *hake*, the *ling*, the *tunny*, or *Spaniſh mackrel*, the *mackrel*, the *gragling* or *umber*, the *guinniad*, the *ſhelly*, the *ſalmon*, the *ſamlet* or *branlin*, the *gray*, the *ſalmon-trout*, the *ſcurf* or *bull-trout*, the *red-chart*, or *Welch torgoch*, the *guilt*, or *guilt charr*, the *ſmelt*, the *rock-fiſh*, or *ſea-gudgeon*, the *lump*, or *ſea-owl*, &c.

Thoſe with three unprickly ſoft fins on their back, are the *cod-fiſh*, or *caling*, the *whiting pollack*, the *coal-fiſh*, or *rawligg pollack*, the *bib*, or *blinds*, the *haddock*, the *whiting*, &c.

There are fiſhes called of the *aculate kind*, with only one fin on their back. whoſe *radii* are ſome prickly and ſome ſoft; ſuch are the *guilt-head*, or *guilt-poll*, the *bream*, the *old-wife*, or *wrap*, the *ruff*, the common *prickle-back*, or *ſharpling*, or *banſtickle*, the leſſer *prickle-back*, &c.

Others with two fins on their back, whoſe *radii* are all prickly, as the *mullet*, the *grey-gurnard*, the *tub-fiſh*, the *red gurnard*, or *rotchet*, the *piper*, the *ſur-mullet*, the *ſpider*, the *ſcad*, the *perch*, the *dory*, or *doree*, &c.

There are alſo *cruſtaceous* and *teſtaceous fiſhes*.

The Crustaceous are thoſe covered with ſhells of ſeveral pieces, or ſcales, as *crabs*, *lobſters*, *craw-fiſhes*, *ſhrimps*, &c.

The Testaceous are thoſe covered with a ſtrong, thick ſhell, as *tortoiſes*, *oyſters*, *pearl fiſh*, &c.

Amphibious (from the *Greek*, ἀμφι, *utrumque*, bothways, and βιος, *vita*, life) are a ſort of animals, which live both on land and in the water; *i. e.* which breathe the air, but paſs part of their time in the water, as affording them their chief food.——Such are the *frog*, *caſtor*, *otter*, *tortoiſe*, *ſea-calf*, *crocodile*, &c.

Volatiles are two-footed *animals*, covered with feathers, and furniſhed with wings, whereby they can ſuſtain themſelves in the air, and fly from place to place.

They are divided into terreſtrial, and aquatick *volatiles*.

Terreſtrial volatiles are ſubdivided into thoſe which have *crooked beaks*, and *talons*; and thoſe whoſe *beaks* and *claws* are ſtraiter.

Of thofe with *crooked beaks* and *talons*, fome are *carnivorus* and *rapacious*, called *birds of prey*; others *frugivorous*, called by the general name of *parrots*.

Of *birds of prey*, fome prey in the day-time, called *diurnal*; others in the night, called *nocturnal birds*.

Diurnal birds, are either of a greater, or a leffer fize.——The greater are either of a more bold, and generous nature, as the *eagle-kind*; or of a more cowardly and fluggifh, as the *vulture*, and *cuntor*.

The leffer *diurnal birds of prey*, are either of a generous and docible, or cowardly, fluggifh, and untractable nature.

The generous and docible are the *hawk-kind*, which are wont to be reclaimed, and managed for fowling.

The *nocturnal birds of prey*, with *crooked beaks*, and *talons*, are the *owl-kind*, and thefe are either horned or eared, as the *eagle-owl*, *horn-owl*, &c. or without horns or ears, as the *brown owl*, *white-owl*, *grey owl*, *howlet*, *fern-owl*, or *goat-fucker*, &c.

There are three fizes of the *land birds*, or *terreftrial volatiles*, with crooked beaks and talons, the greateft of which are called *maccaws*, and *cockatoes*; the middle-fized, and moft common *parrots* and *poppinjays*; and the leaft fort, *parakeets*: thofe all make ufe of their beak in climbing, and move the upper jaw.

There are alfo three forts of *land birds*, which have their bills and claws more ftrait; the greateft thereof are fuch as by reafon of the bulk of their bodies, and fmalnefs of their wings cannot fly at all; fuch are the *oftrich*, the *caffowary*, and the *dodo*.

The middle-fized are divided into fuch as have either large and long, or fmaller and fhorter bills.

Of thofe with large, thick, ftrong and long bills, fome feed promifcuoufly on flefh, infects and fruits, as the *crow kind*, which are wholly black; and the *pye-kind*, which are party-coloured, as the *magpye*, *jay*, *roller*, &c. others feed on fifh only, as the *King's fifher*; and others on infects only, as the *wood-pecker*.

For thofe which have a fmaller and fhorter bill, their flefh is either white, as the poultry-kind, or blackifh, as the *pidgeon*, and *thrufh-kind*.

The leaft fized kind of *land birds*, with ftrait bills, and claws, are called fmall birds.——Thefe are of two kinds; foft-beaked, which have flender, ftraight, and pretty longifh bills, moft of them, and feed chiefly upon infects; and hard-beaked, which have thick and hard bills, and feed moftly on feed.

AQUATICK VOLATILES or *water fowls*, are diftinguifhed into fuch as walk in the waters, and fuch as fwim in them,

Aquaticks, which walk in the water, are all *cloven footed*, and generally have long legs; and thofe naked, or bare of feathers, a good way above the knee, that they may the more conveniently wade in waters. Of thefe they reckon two kinds; a *greater*, and a *leffer*.——To the greater belong the *crane*, *jabiru*, &c.——The leffer are either *pifcovorous*, as the *heron*, *fpoon-bill*, *ftork*, &c. or *mudfuckers* and *infectivorous*, or *infect-eaters*.

Of *infectivorous* water-fowl, fome have very long bills, either crooked, as the *curlieu* and *wimbrel*, or ftraight, as the *woodcock* and *godwith*; others middle-fiz'd ones, as the *fea-pye* and *redfhank*; others fhort bills, as the *lapwing* and *plover*.

Thofe are reckond fhort bills, which exceed not an inch and half; middle fized bills to two inches and a half; and long bills, above two inches and a half.

Of *aquaticks*, which fwim in the water, fome are *cloven footed*, as the *moor-hen* and *coot*, &c. but moft are whole-footed or web-footed.——Of thefe, fome few have very long legs, but the generality are fhort legged.

Of the *fhort legged*, *whole footed aquaticks*, fome have but three toes on each foot, as the *pinguin*, *razor-bill*, &c. but generally they have four toes on each foot, and thefe either all connected together by intervening membranes, as in the *pelican*, *foland goofe*, &c. or more ufually with the back toe loofe.

This laft kind are either *narrow billed* or *broad-billed*; thofe with narrow bills, have them either blunt and hooked at the tip, or fharp pointed and ftraighter.

Of the former fort, fome are ferrate, as in the *diver-kind*; and fome not toothed, as in the *puffing*.

Of thofe with fharp pointed and ftraighter bills, fome have long wings, as the *gull-kind*, and fome fhorter, as thofe *diving birds*, called *daukers*.

Thofe with broad bills may be divided into the *goofe-kind*, which are larger; and the *duck-kind*, which are fmaller; and thefe latter into *fea ducks* or river and *plafh-ducks*.

Moft water fowls have a fhort tail, and none of thefe have more than one back toe.

There is alfo another kind of *volatiles*, called *birds of paffage*; fuch as the *fwallow*, *quail*, *ftork*, *crane*, *fieldfare*, *woodcock*, *nightingale*, &c. Thofe do not appear in our climates, but at certain feafons, and then difappear again; but which way they fteer their courfe, and whither they go, is what puzzles our *Naturalifts*.

INSECTS

Insects are alſo a ſpecies of terreſtrial animals, but ſmaller than thoſe heretofore mentioned, commonly ſuppoſed to be *exſanguinous*, and diſtinguiſhed by certain inciſures, cuttings, or indentings in their bodies.

They are divided by Mr. *Ray* into thoſe that change their form, and thoſe that do not change their form.

Inſects which do not change their form, are either with feet, or without feet, and of theſe ſome caſt their ſkin, and others do not.

Thoſe without feet are either *land inſects*, or *aquatick land inſects*, are either produced on the land, or in the bowels of animals.——Thoſe produced on the land, are either of the larger ſize, as the *dew worms*, or of a ſmaller ſort, of which ſome are green, and others red with yellow tails, called *gilt tails*.

Thoſe found in the bowels of animals, particularly in the inteſtines of men, are the *lumbrici teretes*, and *lumbrici lati*, alſo called *taniæ*; and *aſcarides*, chiefly found in the *rectum*.

The *vermiculi ſetiformes*, of the thickneſs of a horſe hair, and the *boeves*, and *craſſiores* or *botts*, are the two ſorts found in the inteſtines of beaſts, the latter being oftner diſcovered in horſes than in any of the others.

Aquatick inſects, without feet, not changing their form, are either of the greater, or of the leſſer ſort.—Of thoſe of the greateſt ſort, ſome are *tiretes*, round and ſmooth, of which there are three ſorts, the medicinal *hirundines*, or *leaches*, the *common black horſe leaches*, and the *aſh-colour'd ſea-leaches*.

Thoſe of the *leſſer ſort*, are alſo either round, or flat: — Of the round ſort, one is black with two ſmall horns on its head, found ſticking to wet ſtones in the watry tops of hills; and another red, about a finger's length, with a *forceps* at the tail, found at the bottom of fiſh-ponds, and ſtagnant waters —The flat ſort, called *flukes*, are very ſmall and thin, and found ſometimes in water, and ſometimes in the branches of the *porus bilerius* in ſheep. — Theſe have a different way of moving or crawling, from the greater ſort.

Inſects which do not change form, and have feet are either with ſix, eight, fourteen, or many feet.

Thoſe with but ſix feet, are either *terreſtrial*, or *aquatick*. —— Of the *terreſtrial* there are two ſorts, a larger, and a ſmaller ſort ——Of the larger ſort are, the *yellowiſh inſect*, found in rotten decaying oaks; the *black one*, on the ground, called by *Mouffet Vermivorus*, *worms-devourer*; the black one living under ground with a *forceps* at the tail; a *white ſort*, with ſquare black ſpots on its back; the *farinarium*, bred in meal, of a whitiſh colour.

Of the ſmaller ſort, ſome are found about the bodies of animals, as the *bug*, or *wall-louſe*, of a ſtinking ſmell; the *tick*, the *common louſe*, the *flea*, the *crab louſe*; and others are not found on the bodies of animals; as one found in books and rotten wood, which reſembles a louſe, both in figure and bigneſs, though a great deal nimbler and ſwifter; another with a longer body and a forcipal tail, the *black inſect*, found often in the flowers of *chelidonium*, a ſubterraneous ſort, a little whitiſh, and one that ſkips like a *graſhopper*, but is much leſs.

The *aquatic* are the *pediculus marinus grandis*, which adheres to fiſhes; and the *ſquilla fluviatilis*, with a pyramidal tail, and two hairs or briſtles at the end.

Inſects not changing form, and with eight feet, are either with a tail, as the *ſcorpion*, or without; as firſt, the *ſpider*; of which ſome ſpin no web, have but two eyes, and very long legs, as the *opilio* or *ſhepherd*: others ſpin a web, and of theſe they count three ſorts, 1. The *aranea coluſtrenſis abdomine timido ſubrotundo, & clato*. 2. The *ſpider* with the *thorax*, or middle part of its body, as big as the *abdomen*. 3. The *ſpider* with the long *abdomen*, found among reeds, ruſhes, graſs, *&c.* Secondly, the *ricinioćto pedes*, which are ſome more flat and compreſſed; as the *rambling ticks*, that run over the bodies of animals, but do not faſten; and ſome more round and thick, which do adhere to the ſkin. Thirdly, the *ſyrones*, or *mites*.

There are three ſorts of *aſelli*, or of *inſects*, not changing form, and with fourteen feet; as the *ſea-aſellus*, living among the rocks, which is the longeſt and largeſt ſort; the *aſellus lividus*, which rolls itſelf up into a ball, the common *wood-lice*, *ſows*, or *cheſt-bugs*; and the *aſellus aſininus*, with a forked tail, not rolling itſelf up.——To which may be added, the *aſellus marinus*, rolling itſelf up; the *aſellus aquarum dulcium*, with long legs, and two briſtles on its tail; *pulex aquaticus*, both in freſh and ſalt water; and the *pediculus aquaticus*, which faſtens upon fiſh.

The Naturaliſts have obſerved two kinds of *inſects*, not changing form, with four and twenty feet, the eight four-feet leſſer, and the ſixteen hinder ones larger, and both with long bodies; the larger ſort is of an obſcure colour, which live among the rocks by the ſea ſide; and the leſſer of a ſilver colour found in houſes.

There is alſo a kind with thirty feet, of an oblong ſhape, cheſnut colour, and full flattiſh body, uſually ufually lying under logs and trunks of trees; it is very agile and fwift.

Infects, not changing form with many feet, called πολυποδα, are fome on land, and either roundifh in body, with all their legs rifing out of the middle of their belly, as the *julus*; or more flat and compreffed, with their legs not rifing as before, from a point in the middle of their body, but growing along on the fide, as the *fcolopendra*.

Swammerdam fhews there is no real transformation in *infects*, fuppofed to undergo a change in their form, but only on explication of the parts of the *animal*, latent before in miniature, like the plant in the feed, and an increafe of the parts by proper degrees.

The *firft fpecies* of tranfmutation, or change, is inftantaneous, *i. e.* there is no fenfible reft or ftop, between the old and the new form.——The *infects* of this order do not lofe their motion at the time they fhift the *pellicula*, at leaft not to appearance.—This is when the *vermiculus*, leaving the former fhape of the *nympha*, with which it appeared in the egg, and fubfifted without food, now begins to feed, has its members or parts vifibly increafed, or ftretched out, and takes the form of a new *nympha*, which is not without motion; and from thence becomes a flying infect.

There are twelve forts of thefe *infects*. 1. The *libellæ*, or *porlæ*, produced from an infect of fix feet, which *Mouffet* takes for the *pulex marinus*, through whofe cruftaceous fkin the *libella* breaks by a fiffure, which begins between the eyes, and is continued to the roots of the wings, and is there joined to the lateral fiffures. 2. The *cimices fylveftres*, whofe characteriftick marks (according to *Willoughby*) are, *firft*, a long *probofcis*, not fpiral, but ftrait; *fecondly*, their upper wings to the middle are thick and like leather; thence to the end thin, and membranous; *thirdly*, there is the figure of St. *Andrew*'s crofs on their back. 3. The *locufta*. 4. The *gryllii campeftres*. 5. The *gryllii domeftici*, or *crickets*. 6. The *mole cricket*. 7. The *grafhopper*. 8. The *blatta*. 9. The *tipulæ aquaticæ*, which run very fwiftly on the furface of the water, and have a fting in their mouth like the *cimices* or *ticks*. 10. The *fcorpius aquaticus*, with a fting alfo in its mouth. 11. The *mufcæ aquaticæ*, called by *Aldrovandus*, *apes amphibiæ*. 12. The *emerobius*, or *ephemera*, or *diaria* of *Swammerdam*, the *forficula*, or *auricularia*.

The fecond fpecies of tranfmutation includes fuch *infects* as undergo a double *metamorphofis*, or change of fhape. 1 Into a *chryfalis*, or fomething analogous to it. 2. Into a flying *infect*. Thefe kinds of *infects* a-while before they change, lie quite ftill, without feeding or changing place; and in refpect of their wings are, *firft*, *vaginipennia*, as *fcarabæi*. beetles. *Secondly*, *Anelytra*, whofe wings are open, and expanded; and the wings of thefe are either farinaceous, as the *papiliones*, &c. or membranous, as the *apes*, *mufcæ*, &c. and thefe are either with two, or with four wings.

The *fcarabæi* may be divided; 1. With refpect to their horns into the *nafícornis*, *bucerota*, and *cervus volans*, or *taurus*. 2. In refpect of their *antennæ*, which are of many kinds; whereof the moft eminent are thofe called *capricorni*. 3. With regard to their motion, as the *faltatrices*, or dancers. 4. With regard to their colour, as the *cantharides*, or *Spanifh* flies.

To the *beetle*-kind may alfo be referred the *cicindela*, or *glow-worm*, the *ftaphylinus*, the *profcarabæus*, or *oil-beetle*, fo called, from its emitting from its joints a kind of oil, on its being preffed or fqueezed. The *anelytra*, with farinaceous or mealy wings, are called *papiliones*, butterflies; and thefe are either diurnal or nocturnal

The fpecifick diftinction of the diurnal *butterflies*, or *papiliones* is, that they always fettle with their wings erect, are produced from an *angulous aurelia*, and have their *antennæ* ftudded; of thefe there are above fifty forts obferved in *England*.

The *nocturnal butterflies*, though very numerous, may neverthelefs be divided into,

1. The *geometrigenæ*, (thus called, from the manner of its walking with its back curled up like the handle of a cup) which come from an *erucæ*, and has eight or ten feet. 2. Such as come from *erucæ* with fourteen feet; of this kind which is very numerous, there has been diftinguifhed the *phalæna fafciata*, whofe wings are in patches, or *area*'s of different colours; *phalæna lineata*, whofe wings are marked with one or more points; and thefe, except all the others, are diftinguifhed into greater, leffer, and of a middle fize between both.—One of the larger kind may be diftinguifhed alfo, by their inner wings; and a third by their long tails, and narrow fharp wings; which by fome are called *phalænæ prædatrices*.

The *anelytra* with membranous wings are *bees*, *flies*, *wafps*, *bombylii*, *crabrones*, &c. and to this kind the *culex vulgaris*, or *gnat*, according to *Swammerdam*, is referred, as alfo the *formica*, or *ant*.

Willoughby refers alfo to this kind, fuch water *infects* as are covered with a *theca*.

The *third fpecies* of tranfmutation, is a fimple change from a *vermiculous* to a *flying infect*; but with a fenfible reft or ftop between one form and the other. This exchange is defcribed by *Swammerdam* in the following manner.

" The vermicle excluded from the egg (fays he) gets nourifhment by little and little from without, and

and under that firſt ſkin or covering, has its members increaſed by degrees; not ſtripping it or putting it off, as other *vermiculi* do, when they change into *nymphæ*, but aſſuming the figure of a *nympha* in it. For a time it is quite motionleſs, 'till the ſuperfluous moiſture is evaporated, and then, in a few days recovers its motion again, and caſting off this ſkin, which is, as it were, double, it becomes a fly."—Of this kind are our *fleſh-flies*, and all the *nymphæ vermiformes*, the *veſpæ ichneumones*, &c.

The Silk-worm is an inſect, not more remarkable for the precious matter it furniſhes for divers ſtuffs, than for the many forms it aſſumes, before, and after its being invelloped in the rich cod, or ball it weaves itſelf. From a ſmall egg, about the ſize of a pin's head, which is its firſt ſtate, it becomes a pretty big worm or maggot, of a whitiſh colour, inclining to yellow.—In this ſtate it feeds on mulberry-leaves, till being come to maturity, it winds itſelf up into a ſilken bag or caſe, about the ſize and ſhape of a pigeon's egg; and becomes metamorphoſed into an *aurelia*: in this ſtate it remains without any ſign of life or motion; tho' it caſts a life, by which it prepares itſelf for a new life, and then dies, which egg wants no other incubation, than the warmth of the ſummer-weather, or of ſome other gradual heat.

As ſoon as the *ſilk-worm* is arrived at the ſize and ſtrength, neceſſary for beginning its cod, he makes his web; for thus they call that ſlight tiſſue, which is the beginning and ground of that admirble work.—This is his firſt day's employment. On the ſecond, he forms his *folliculus*, or ball, and covers himſelf almoſt over with ſilk. The third day he is quite hid; and the following days employs himſelf in thickening and ſtrengthening his ball, always working from one ſingle end, which he never breaks by his own fault, and which is ſo fine and ſo long, that thoſe who have examined it attentively, think they ſpeak within compaſs, when they affirm that each ball contains ſilk enough to reach the length of ſix *Engliſh* miles.

In ten days time the ball is in its perfection; and is now to be taken down from the branches of the mulberry-tree, where the worms have hung it.

The Tarantula is about the ſize of an acorn, and has eight feet, and as many eyes; its colour various, but it is ſtill hairy: from its mouth ariſes two horns, or trunks, made a little crooked, with tips exceedingly ſharp, through which it conveys its poiſon.

The Cochineal *worm* is an inſect ingendered in a fruit reſembling a pear, the ſhrub which bears it is five or ſix foot high. A-top of the fruit grows a red flower, which, when mature, falls off the fruit; and that opening diſcovers a cleft two or three inches in diameter. The fruit then appears full of little red *inſects*, having wings of a ſurpriſing ſmallneſs, and which would continue and die, and rot there if not taken out.

The *Indians* therefore ſpreading a cloth under the tree, ſhake it with poles, 'till the *inſects* are forced to quit their lodging and fly about the tree, which they cannot do long, but tumble down dead in the cloth; where they are left 'till they be entirely dry: when the *inſect* flies it is red, when it is fallen, black, and when dry, white; though it afterwards changes colour.

Some of the *inſects* are rather more perfect than the greateſt part of the other *animals*, as it plainly appears by the government of Bees, who, in their perfect union, the beauty and juſt œconomy of their government, their reſpect for their prince, and the ſubordination ſubſiſting among them, ſeem to rival the beſt eſtabliſhed commonwealth. — They all work in common, and all in common reap the fruits of their induſtry and daily labour, which they divide among them, ſome keeping within the precinct of their walls or hives, to lay up the ſtores, which the others deſigned for the queſt, bring to the common ſtock.— Theſe lay down the foundations of new manſions, and thoſe adorn them when built with that precious and rich furniture, which the maroders, who take the fields have gathered from the purple of the violets, the ſcarlet of roſes, and other inimitable and beautiful ſhades, which the inimitable artiſt, *nature*, has painted on the flowers, wherewith our fields are enamelled during the moſt favourable ſeaſons of the year.—Some are placed at the gates of the metropolis, or as advanced guards, to give the alarm at the approaches of their common enemy, the *waſp*, and hinder him from inſulting their walls; or, as aſtronomers, to obſerve the changes of the heavens, and foretel the approaches of rain and tempeſts, or to eaſe thoſe, who return home over-burthened with their booty; who all ſet out in the morning on their different occupations, leaving the care of the *hive* to thoſe, who are paſt labour, and return as well to have the pleaſure to take a meal in common, as to reſt themſelves from their fatigues; to which they are called by thoſe left within, ſounding the retreat, at which they all retire within their walls, with ſuch unanimous conſent, and quick obedience, that it is impoſſible to find, after the time fixed for that retreat, any ſtrollers upon the road.—At night they are all wrapped up in ſo profound a ſleep, that there is not the leaſt noiſe, or diſturbance heard in their little garriſons.

Though

Though the life of the *bee* is but of a ſhort duration, and ſeldom exceeding ſeven years, they nevertheleſs have very numerous families, and have the pleaſure to have been bleſſed before they die with a long poſterity, which they have the ſatisfaction to leave behind them in a flouriſhing condition, ſeldom departing before they have ſeen ſeveral generations.

No nation has ever been, or will ever be more dutiful to a ſovereign than the *bees* are to theirs; for they have really a king, who is abſolute maſter, not of their deſtiny only, but alſo of all their faculties, whom they obey, without the leaſt reluctancy, in all he is pleaſed to command them.--He is the guardian of their work; they admire none but him, and all tremble at his ſingle aſpect.——They are all his *body-guard*; and often carry him upon their ſhoulders, ſeldom being ambitious of any other glory, but that of loſing their lives in his ſight, and in his defence; for the *bees* do not live always in the ſame profound peace, as there are ſeveral nations of them, each governed by its own king; there often ariſe diſputes, jarrs, and differences between them, which ſometimes are not to be otherwiſe terminated but upon the field of battle, and then the king, who never entruſts a general with the command of his army, but alway heads them in perſon, has the ſatisfaction to ſee his ſoldiers endeavour to outvie each other in courage, valour, and intrepidity; for as ſoon as the onſet is given, they all gather round him, as if they would make him a rampart of their bodies, and fight with that diſcipline and order, which would be admired among men; the conqueror keeping the field of battle, after he has defeated his enemy, in ſign of his victory, and both parties taking care of their dead, wounded, *&c.*

MONSTER is a birth, or production of a living thing, degenerating from the proper and uſeful diſpoſition of parts, in the ſpecies it belongs to.

Monſters do not propagate their kind, for which reaſon ſome rank *mules* among the number of *monſters*, as alſo *hermaphrodites*.

A *mule* is uſually generated between an aſs and a mare, ſometimes alſo between a horſe and a ſhe aſs.

An *hermaphrodite* is a perſon, who has both ſexes, or the genital parts, both of male and female.

The word is formed of the *Greek* Ἑρμαφρόδιτος, a compound of Ἑρμῆς, *Mercury*, and Ἀφροδίτη, *Venus*, a mixture of *Mercury* and *Venus*, i. e. of male and female.

Naturaliſts diſtinguiſh four kinds of *hermaphrodites*, whereof the laſt are the perfect *hermaphrodites*, or thoſe, who have the *pudenda* of both kinds; but theſe are rarely, if ever, found.

Hermaphrodite is alſo applied metaphorically to divers other things beſides the human ſpecies.

Such are the earth-worms, the round-tail worms found in the inteſtines of men and horſes, land-ſnails, and thoſe of freſh waters, and all the ſorts of leaches.

The moſt monſtrous productions in the vegetable world are called *mules*, which are monſters produced by putting the farina fæcundans of one ſpecies of plant into the piſtil, or utricle of another.

The carnation and ſweet-william being ſomewhat alike in their parts, particularly their flowers; the farina of the one will impregnate the other; and the ſeed ſo enlivened will produce a plant differing from either.

This gives us a hint for altering the property and taſte of any fruit, by impregnating one tree with the farina of another of the ſame claſs, *e. gr.* a codlin with a pearmain, which will occaſion the codling ſo impregnated to laſt a longer time than uſual, and be of a ſharper taſte; or if the winter-fruits be fecundated with the duſt of the ſummer-ſeeds, they will decay before their uſual time.

Among the monſtrous productions of the ſea, the *mermaid* is that, which ſurpriſes and puzzles us moſt.

However naturaliſts may doubt of the reality of *mermen* or *mermaids*, we have teſtimony enough to eſtabliſh it.

In the year 1430, after a huge tempeſt, which broke down the dykes in *Holland*, and made way for the ſea into the meadows, ſome girls of the town of *Edam* in *Weſt Frieſland*, going in a boat to milk their cows, perceived a *mermaid* embarraſſed in the mud, with a very little water. They took it into their boat, and brought it with them to *Edam*, dreſſed it in woman's apparel, and taught it to ſpin. It fed like one of them, but could never be brought to offer at ſpeech. Some time afterwards it was brought to *Haerlem*, where it lived for ſome years, though ſtill ſhewing an inclination to the water. *Purival* relates, that they had given it ſome notion of a deity.

From the deſcription of *monſters*, I'll paſs to what appears the moſt capable to flatter our curioſity, in the *animal world*.

The UNICORN is an animal famous among the *Greek* authors under the name of μονόκερως; having *one horn* only, which is repreſented as five palms long, growing in the middle of the forehead.

The popular account is, that it is about the ſize of a horſe, its hair ſhort, and of a dark-brown colour very timorous, and therefore keeping mostly in the woods; and that its true place is the province of *Agaus*, in the kingdom of *Damotes* in *Ethiopia*.

The first author who wrote of the *unicorn*, was one *Ctesias*, whom *Aristotle* mentions as a very suspicious author. And the more knowing among the moderns unanimously hold it a fabulous animal.

What ordinarily passes among us for *unicorn's horn*, and is shewn for such in the collections of curiosities, and used for such by several physicians, we are assured by *Pereyra*, in his account of *Greenland*, is the tooth of a large fish of the whale-kind, called by the islanders *narval*; and in others places *walrus* and *robart*, frequent enough in the icy sea. This tooth or horn, turned, channelled, and terminated in a point, as it is, springs out of the middle of the fore-part of the upper jaw, and serves it as a weapon of defence, wherewith it dares to attack the largest whale. It can strike it with such violence, as even to pierce the side of a strong built ship.

Among the feathered tribe, the PHOENIX was a bird famous among the antients; but generally look'd upon by the moderns as fabulous.

The naturalists speak of it as single, or the only one of its kind: they describe it as of the size of an eagle; its head finely crested with a beautiful plumage. Its neck covered with feathers of a gold colour, and the rest of its body purple, only the tail white, intermixed with carnation; and its eyes sparkling like stars. They hold that it lives five or six hundred years in the wilderness: that when thus advanced in age, it builds itself a funeral pile of wood and aromatick gums; then it lights it with the wafting of its wings, and thus burns itself; and from its ashes arises a worm, which in time grows up to be a *phœnix*.

Hence the *Phœnicians* gave the name *phœnix* to the palm-tree, by reason when burnt down to the very root, it rises again fairer than ever.

In the sea we find the TORPEDO, which is a flat fish, much of the figure of the thorn-back, found about the coasts of *Provence*, *Gascony*, &c. where the people eat it without any danger.

Upon touching the *torpedo* with the finger, it frequently, though not always happens, that the person feels an unusual painful numbness, which suddenly seizes the arm up to the elbow, and sometimes to the very shoulder and head; resembling that painful sensation felt in the arm, upon striking the elbow violently against a hard body.

Bellonius assures us, that *torpedo*'s applied to the soals of the feet, have prov'd successful against fevers.

From the *animal* I'll pass to the *vegetable* world, and there take a particular notice of the *ginseng*.

The GIN-SENG, or GIN-SEM, or GINZENG, is a very extraordinary and wonderful plant, hitherto found in *Tartary* and *North America*.

The *gin seng* is one of the principal curiosities of the *Chinese* and *Tartars*; their most eminent physicians have wrote many a volume of its virtues.

It is known among them by divers other names, as the *only spirituous*, the *pure spirit of the earth*, the *plant that gives immortality*, &c.

The *gin-seng* has a white root somewhat knotty, about thrice the thickness of the stem and which goes tapering to the end: at a few inches from the head it frequently parts into two branches, which gives it some resemblance of a man, whose thighs the branches represent; and is hence it takes the denomination *gin-seng*.

From the root rises a perfectly smooth and tolerable round stem; its colour is a pretty deep red, except towards the foot, where, by the neighbourhood of the earth, it is turned somewhat whiter. At the top of the stem is a sort of joint or knot, formed by the shooting of four branches, which spread as from a centre: the underside of each branch is green mixed with white, and the upper part much like the stalk, of a deep red; the two colours gradually decrease, and at length unite on the sides.

Each branch has five leaves; and it is observable, that the branches divide equally from each other, both in respect of themselves, and of the horizon; and with the leaves make a circular figure nearly parallel to the surface of the ground.

The fibres of the leaves are very distinguishable, and on the upper side are beset with small whitish hairs; the membranes or pellicles between the fibres rise a little in the middle, above the level of the fibres.

The colour of the leaf is a dark green above, and a shining whitish green underneath, and all the leaves are finely jagged or indented.

On the edges, from the center of the branches, arises a second stalk, very strait, smooth, and whitish, from bottom to top, bearing a bunch of round fruit, of a beautiful red colour. This bunch, in the plant viewed by F. *Jartoux*, a jesuit, was composed of twenty-four berries.

The red skin that covers the berries is very thin and smooth, and contains within it a white pulp: as these berries were double (for they are sometimes single) each had two rough stones, of the size and figure

figure of our lentils. The pedicles whereon the berries were fupported, all arofe from the fame center, and fpreading exactly like the radii of a fphere, made the bunch of berries of a circular form. The fruit is not good to eat, and the ftone includes a kernel; it has alfo a fmall beard at the top, diametrically oppofite to the pedicle.

The plant dies away every year, the number of its years may be known by the number of ftalks it has fhot forth, of which there always remains fome mark.

Though the plant here defcribed had four branches, yet there are fome which have but two, others three, and others five, fix, or feven; but each branch has always five leaves.

The height of the plant is proportionable to its bignefs; and the number of branches that the root has, the larger and more uniform it is; and the fewer fmall ftrings or fibres it has, the better it is accounted.

Thofe who gather the *gin-feng*, preferve only the root, and all they can get of it in ten or fifteen days time, they bury together in fome place under ground. Then they take care to wafh it well, and fcour it with a brufh; then dip it in fcalding water, and prepare it in the fumes of yellow millet, which gives it part of its colour.

The millet is put in a veffel with a little water, and boiled over a gentle fire; the roots are laid over the veffel upon fmall tranfverfe pieces of wood, being firft covered with a linen cloth, or fome other veffel, placed over them.

They may alfo be dried in the fun, or by the fire; but then, though they retain their virtue well enough. they have not that yellow colour, which the *Chinefe* fo much admire. When the roots are dried, they muft be kept clofe in fome very dry place, otherwife they are in danger of corruption, or being eaten by worms.

The *gin feng* is an ingredient in moft of the medicines, which the *Chinefe* phyficians prefcribe to the better fort of patients: they affirm, that it is a fovereign remedy for all weakneffes occafioned by exceffive fatigues, either of body or mind: that it attenuates and carries off pituitous humours; cures weaknefs of the lungs, and the pleurify; ftops vomiting; ftrengthens the ftomach; and helps the appetite; difperfes fumes or vapours; fortifies the breaft; is a remedy for fhort and weak breathing; ftrengthens the vital fpirits; and is good againft dizzinefs of the head, and dimnefs of fight; and that it prolongs life to extreme old age. Thofe that are in health, often make ufe of it to render themfelves more vgorous and ftrong.

It fubtilizes, increafes the motion of, and warms he blood; it helps digeftion, and invigorates in a ery fenfible manner.

It is neceffary to boil it a little more than tea; as is practifed by the *Chinefe*, when they give it to fick perfons. On which occafion they feldom ufe more than the fifth part of an ounce of the dried root.

To prepare the root for exhibition, cut it into thin flices, and put it into an earthen pot well glazed, with about half a pint of water; the pot to be well covered, and fet to boil over a gentle fire; and when the water is confumed to the quantity of a cup-full, a little fugar to be mixed with it, and to be drank: immediately after this, as much more water to be put on the remainder, and to be boiled as before, to extract all the juice, and what remains of the fpirituous part of the root. Thefe two dofes to be taken, the one in the morning, and the other in the evening.

A tree grows, likewife, in *China*, *Lao*, and *Cochin-china*, called the *aloe-tree*, which is much about the fize and figure of olive-trees. The trunk confifts of three forts of wood, very different in colour and properties. Immediately under the bark, it is black, compact and heavy, called by the *Portuguefe*, *pao d'aquila*, q. d. eagle wood. The next under this is of a tan-colour, light and veiny, refembling rotten wood; and called *calambo*.

The heart or innermoft part is called *tambac*; and more valuèd by the *Indians* than gold itfelf. It affords a very ftrong, but agreeable fmell; and is ufed as a perfume; and is withal held a fovereign remedy againft the palfy, deliquium, weaknefs, *&c.*

It is the *calambo* alone which is known among us. It is brought in fmall bits of a very fragrant fcent; efpecially when caft on the fire, where it melts like wax. The beft is of a blackifh purple colour, and fo light as to fwim on water: it is hot and drying; and efteemed a great ftrengthener of the nerves.

In the *Weft Indies*, particularly in the provinces of *Guanimala*, and *Nicaragua*, and the *Caribbee* iflands, grows a tree, refembling our cherry-tree, which produces a kind of nut about the fize of an almond, called *cacao*, or *cocoa*.

The native *Mexicans* called the *cacao-tree*, *cucubaa*, *guabuets*: it is fo very delicate, and the foil it grows in fo hot, that to guard it from the fun, they always plant it in the fhade of another tree, called *mother of cacao*.

The fruit is enclofed in a kind of pod, of the fize and figure of a cucumber; except that it begins, and ends in a point. Within the pod, which is half a finger thick, is formed a tiffue of white fibres, very fucculent, a little acid, and proper to appeafe thirft. In the middle of thefe fibres are contained 10, fometimes 12, and fometimes more, as far as 40 grains or ſeeds, of a violet colour, and dry as acorns. Each grain, which is covered with a little bark or rind, when ſtripped thereof, ſeparates into five or ſix unequal pieces, in the middle whereof is a kernel or pippin, having a tender bud, very difficult to preſerve.

Of this ſeed, with the addition of *vanilla*, and ſome other ingredients, the *Spaniards*, and after their example, the reſt of *Europe*, prepare a kind of conſerve or cake, which diluted in hot water, makes that delicious wholeſome drink, called *chocolate*.

The *Cacao* nuts are eſteemed by the *Mexicans* as anodyne; and uſed, eaten raw, to aſſwage pains of the bowels. They alſo procure a kind of butter or oil from them, as ſweet as that of almonds, and drawn in the ſame manner, excellent for burns.

From this I'll paſs to *foſſils*, &c. and examine firſt the GLOSSOPETRA, which is a kind of ſtone, in form of a ſerpent's tongue, commonly found in the iſland of *Malta*, and divers other parts.

Naturaliſts are divided as to the nature and origin of theſe ſtones.

The vulgar opinion is, that they are the tongues of ſerpents petrified; and hence their name, which is a compound of γλωσσα, tongue, and πέτρα, ſtone. Hence alſo their pretended extraordinary virtue in curing the bites of ſerpents.

The common opinion of Naturaliſts is, that they are the teeth of fiſhes, left at land by the waters of the deluge; and ſince petrified.

SHELLS are alſo one of the chief objects of *natural hiſtory*. The *ſhells* of garden ſnails are formed of a matter, which perſpires from their bodies, and hardens and condenſes in the air.

SHELLS, *conchæ*, or *cochleæ*, make a conſiderable article in the cabinet of the curious: the fineſt and rareſt are theſe that follow, *viz.* the *papal crown*, *tiaraa pontificia*, which takes its name from its form, and which is all ſtreaked with red on a white ground. The *feather*, *pluma*, whoſe whiteneſs, with its carnation ſtains, have an admirable effect. The *hebraica*, which on a ground as white as ſnow, has ſpots as black as jet, much reſembling *Hebrew* characters. The *Chineſe ſnail*, *limax ſinicus*, which has a green and black embroidery, on a dark brown ground. The *cloth of gold*, *textile aureum*, remarkable for an admirable tiſſue of yellow, brown, and black. The *cloth of ſilver*, *textile argenteum*, which does not come behind that of gold in beauty. The *leopard*, *pardus*, which is all ſpeckled. The *tyger*, *tigris*, *ſeu concha cirenicea*, whoſe ſpots exceed thoſe of the leopard. The *hart's horn*, *cornu cervinum*, which has black ſtains on a white ground. The *purſe*, *crumena*, thus called from its figure; it is embroidered with three or four colours. The *ſun-dial*, *ſolarium manuarium*. The *caterpillar*, *eruca*, both denominated from their forms. Add the *nerites*, *nautilus*, *lepas*, *lepaſia*, *apperays*, *tuba*, *galea*, &c.

In *Aldrovandus*, *Geſner*, and *Fabius Columna*, we have all that the antients have ſaid on the ſubject of *ſhells*. In 1692, Dr. *Liſter* publiſhed a *natural hiſtory* of *ſhells* in folio, full of cuts, repreſenting the various kinds of ſhells. Under the firſt claſs he ranges the terreſtrial or land *ſhells*; in the ſecond, the freſh water *ſhells*, both thoſe called *turbinata*, and thoſe *bivalvia* and *multivalvia*: and in the fourth he divides into ſeveral claſſes, the ſea *ſhells*, called *turbinata*. The *turbinated* are thoſe which are ſpiral, or wreathed, conically, from a larger baſis to a kind of *apex*. *Bivalve* is a term uſed for ſuch ſhell-fiſh, as have two ſhells, *e. gr.* cockles, muſcles, oyſters, &c. which are ſaid to be of the *bivalvular* kind.

Shells are frequently found under ground in places far remote from the ſea, in mines, and even on the tops of mountains.

Dr. *Liſter* judges, that the *ſhells* found in ſome quarries were never any part of an animal; and gives this reaſon for it, that quarries of different ſtones, yield quite different ſpecies of *ſhells*; different not only from one another, but from any thing in nature beſides, which either ſea or land does yield.

The ſea *ſhells*, which are always found near the ſhores, and never far off in the deep, are called *litoral ſhells*.

Thoſe which are found in the bottom of the ſea, remote from the ſhore, are called *pelagiæ*.

The SPAR has alſo its place in *natural hiſtory*, and is a ſhining, ſtony, mix'd ſubſtance, compounded of cryſtal, incorporated with *lac lunæ*, or other mineral, earthy, ſtony, or metallick matter; frequently found in caves and grotto's, and in the clefts of rocks, lead-mines, &c.

Mr. *Beaumont* in the *Philoſophical Tranſactions*, endeavours to account for the origin and growth of *ſpar*; which he makes to be a kind of rock-plant.

Spar, he obſerves, may be formed three ways; either from ſtreams alone; or from ſteams coagulating dew, as it falls on the ground, or waters iſſuing from the joints of rocks: or it may grow from earth and clay.

The STALACTITES, or STALAGNITES, or STANONITES, is a ſtarry, ſparry ſort of icicles, which hang down from the tops or arches of grotto's, to's, and ſubterranean caverns; and from the roofs of buildings, and capitals of pillars of ſuch places as are built over hot ſprings, *&c.*

Of this kind are the *ſal alumen*, and *vitriolum ſtalacticum*; the *minera ferri ſtalactica*, the *vitriolum capillare*, &c.

The *ſtalactites*, which incruſtate or line the tops and ſides of caves, *&c.* are manifeſtly formed of exſudations or extillations of petrifying juices out of the neighbouring rocky grounds.

There is, alſo, in natural hiſtory, a kind of figured foſſil ſtones, reſembling plants, called TROCHITÆ, or TROCHITES, vulgarly *St. Cuthbert's beads.*

They are uſually of an opake, dark colour, break like flint, gloſſy and ſhining, and are eaſily diſſolved in vinegar.—Their figure is generally cylindrical, ſometimes a little tapering; the circumference ſmooth, and both the flat ſides covered with a fine radii, drawn from a certain hole in the middle to the circumference.—Two or three, or more of theſe *trochitæ* joined together, conſtitute what the naturaliſts call an *entrochos.*

The *trochitæ*, or ſimple joints, are ſo ſet together, that the rays of one enter into furrowsi n the other, as in the ſutures of the ſkull.—They are found in great plenty in the bodies of the rocks at *Broughton* and *Stock*, two villages at *Craven*, at all depths under ground; and in *Mendip* hills, *&c.* ſometimes only ſprinkled here and there, and ſometimes in large ſtrata, or beds of all magnitudes, from the ſize of the ſmalleſt pin, to two inches about.

They are generally found ramous and branchy, larger branches ariſing from the ſtem, or cylinder, and ſmaller from them: the branches being deeply inſerted into the ſtem, the tearing them off leaves great holes therein.

In the clay where trochites are found, the ſtone called *cornu ammonis* is frequent.

The CORNU AMMONIS is an extraordinary kind of ſtone, which in vinegar, juice of lemons, *&c* has a motion like that of an animal.

It is rough, knotty, of an aſh-colour, and crooked in manner of a ram's horn, ſuch as thoſe, wherewith the antients repreſented *Jupiter Ammon*; whence its name.

The *cornua ammonis* are of different thickneſſes and lengths; ſome of them weigh about three pounds: they are found in ſeveral places in *Germany.* From ſome experiments that have been made therewith, they are found to contain a little quantity of gold, which ſinks to the bottom upon pounding them ſmall, and ſtirring them in a running water, till all the earthy parts are carried off.

I'll conclude this treatiſe by a diſſertation on *ſeeds*, and on the bodies ſecundated thereby, viz. *eggs.*

SEED, taken in the general ſignification of the word, is a matter prepared by nature, for the reproduction and conſervation of the ſpecies, both in men, animals, and plants.

Some Naturaliſts add, that even ſtones, minerals, and metals themſelves, have each their proper ſeed in their mines, and are produced and perpetuated thereby.

Seed, in the animal œconomy, is a white liquid matter, or humour, 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 *ſeed*, or humour formed in the teſticles, being, when new, diluted with a little warm water, and viewed with a good microſcope, ſeems to conſiſt of innumerable, little, oblong, living, eel-like *animalcula*, floating in the other part of this humour. This is ſaid to be always obſerved in the *ſeed* of all men, quadrupedes, birds, fiſhes, amphibious animals, and inſects.

Seed, in *Botany*, is the laſt product of a plant, whereby the ſpecies is propagated. The *ſeed* is frequently the fruit of the plant, as is the caſe of moſt herbs. Sometimes it is only a part incloſed in the fruit, and that in form either of grain, kernel, or berry.

The *ſeed* is the natural offspring of the flower, and that for whoſe production all the parts of the flower are intended; ſo that when this is once well formed, the ſeveral parts of the flower dwindle and diſappear.

It is ſuppoſed to be produced by the farina of the apices, let fall on the head of the piſtil, and thence forwarded to an uterus at the bottom thereof, divided into ſeveral cells; where, coming to receive the nutritious juice of the plant, it is firſt ſoftened, then ſwelled, increaſed both in matter and bulk, and at length comes to its ſtate of maturity.

That the whole plant is contained in the ſeed, is an opinion as old as *Empedocles*, and is ſtill the prevailing doctrine among the generality of Naturaliſts. Experience, the microſcope, and the modern philoſophy, give it great countenance. In effect, by the uſe of good microſcopes, we diſcover in the *ſeed* ſeveral of the parts of the future tree, only in miniature; particularly a little root called the *radicle*, and the ſtem called the *plumule.*

The fecundity of plants in the production of *ſeed*, is very ſurprizing. M. *Dodart*, in the Memoirs of the *French* academy of ſciences, computes, that an elm, living 100 years, ordinarily produces of itſelf 33000000 grains.

The Mushroom is a plant of a form and ſtructure very different from that of all other plants. It has neither ſeeds, nor flowers.

M. *Tournefort* gives a very curious account of their culture, in the Memoirs of the Royal Academy, with the ſubſtance of which we ſhall here preſent the reader. All the ſecret of bringing up *muſhrooms* ſpeedily, and in abundance, conſiſts in ranging balls of horſe-dung, about the bigneſs of the fiſt, in lines, at the diſtance of about three feet from each other, and at the depth of one foot under ground, and covering theſe over with mould, and that again with horſe-dung

If this be done in *April*, in the beginning of *Auguſt* the pieces of dung will begin to whiteh, and grow mouldy, being cover'd all over with little hairs, or fine white threads, branched and woven about the ſtraws whereof the dung is compoſed. The dung now looſes its former excrementitious ſmell, and ſpreads an admirable odour of *muſhrooms*.

According to all appearance, theſe white threads are no other than the open'd *ſeeds* or buds of *muſhrooms*, which *ſeeds* were before incloſed in the dung, but in ſo ſmall a compaſs, that they could not be perceived till after they had ſhot themſelves into little hairs. By degrees the extremity of theſe hairs grows round, into a kind of button, which ſwelling by little and little, at length opens itſelf into a *muſhroom*, whereof the lower part is a kind of pedicle bearded in the place where it enters the ground, and at the other end loaded with a roundiſh capital or head, in the manner of a ſhalot, which expands itſelf, without producing either *ſeeds* or flowers that are ſenſible; the bottom is ſpread with laminæ, which proceeding from the center to the circumference, may be called the leaves of the *muſhrooms*.

At the foot of each *muſhroom*, are found an infinite number of little ones, not bigger than the head of a pin, when the others are at their growth. The buds of the *muſhrooms*, or the white hairs of the dung, preſerve themſelves a long time without rotting, if kept dry; and if laid again on the ground will produce new *muſhrooms*.

Muſhrooms, then, are nothing elſe but the produce of what we call the *mouldineſs* of *horſe-dung*: but what analogy is there between theſe two things? or how ſhould ſo artful and delicate a ſtructure as this of a plant, reſult frrm the mere fortuitous concourſe of a few juices differently agitated?

It ſeems paſt doubt, then, that *muſhrooms*, like all other plants, have their origin in *ſeeds*.

There are various kinds of *muſhrooms*; and the vulgar call by this name all that come under the general name of fungus's; by the *Greeks* called μυκητες.

Mr. *Bradley* mentions a hundred kinds of *muſhrooms*, which he has ſeen in *England*; beſides thoſe very numerous ſmall ones, which conſtitute the mouldineſs of liquors, fruits, &c. which laſt are ſuch quick growers, that they arrive at perfection in leſs than twelve hours.

The *fungoides* only differs from a *muſhroom* in its external form; the *coralloides* are of the ſame ſpecies, though of a different name, as being branched like coral, and truffles come under the ſame kind.

Mathiolus mentions *muſhrooms*, which weighed thirty pounds each, and were as yellow as gold. *Fer. Imperatus* tells us, he ſaw ſome which weighed above a hundred pounds; and to add no more, the *Journal des Scavans* furniſhes us with an account of ſome growing on the frontiers of *Hungary*, which made a full cart-load.

Truffles, *tubera terræ*, is a kind of ſubterraneous vegetable production, not unlike *muſhrooms*.

The antient Phyſicians and Naturaliſts, rank *truffles* in the number of roots, bulls, or cloves; and define them to be a ſpecies of vegetables, without ſtalks, leaves. fibres, &c. *Bradley* calls them *under ground edible muſhrooms*, or *Spaniſh trubbes*.

They are produced moſt in dry chapped grounds, and that, as *Pliny*, ſays, chiefly after rains and thunder, in *autumn*. Their duration he limits to a year. Their colour is uncertain; ſome being white, others black, &c.

In *Italy*, *France*, &c. they eat them as a great dainty, either fryed in ſlices with oil, ſalt, or pepper, or boiled over again in their own broth. The hogs are exceedingly fond of them, and are frequently the means of diſcovering the places where they are; whence the common people call them *ſwine-bread*. The modern Botaniſts rank *truffles* in the number of plants, though they want moſt of the uſual parts thereof. All we know of their growth is, that they are firſt no bigger than a pea, reddiſh without, and within whitiſh, and that as they ripen, the white parts grow more duſky and black; only there are ſtill left a number of white ſtreaks, which all terminate at places where the outer coat is cracked, or open: and which, in all probability, are the veſſels that convey the nouriſhment into the *truffles*.

In theſe veſſels is found a whitiſh matter, which, when viewed with a microſcope, appears to be a tranſparent parenchyma, conſiſting of veſiculæ: in the middle whereof are perceived little round black grains, ſeparate from each other, ſuppoſed to be the *ſeed* of the *truffles*.

They

They are tenderest and best in the spring, tho' easiest found in autumn; the wet swelling them, and the thunder and lightning disposing them to send forth their scent, so alluring to the swine. Hence some of the antients call them *ceraunia*, q. d. *thunder-stones*.

The antients are exceedingly divided as to the use of *truffles*; some affirming them to be wholesome food; and others pernicious. I am of opinion, they have both good and evil effects; they restore and strengthen the stomach, promote the semen, &c. But when used too freely, they attenuate and divide the juices immoderately, and by some volatile and exalted principles, occasion great fermentations, &c. though the pepper and salt they are ordinarily eaten withal, do doubtless contribute greatly to those effects.

We must inform ourselves next what *eggs* are.

Egg is a part formed in the female of certain animals; which, under a shell or cortex, includes an embrio or fœtus, of the same species; the parts whereof are afterwards displayed and dilated, either by incubation, or by the accession of a nutritious juice.

The species of animals that produce *eggs*, are particularly denominated *oviparous*; and the part wherein the *egg* is formed the *ovary*.

An *egg*, improperly so called, is that of the whole whereof the animal is formed: such are the *eggs* of flies, butterflies, &c. which *Aristotle* calls *vermiculi*.

The two have this further difference, that whereof the former, after they are excluded from the female, need no external nutriment, nor any thing but warmth and incubation, to bring the fœtus to perfection: the latter, after they are fallen out of the *ovary* into the *uterus*, require the nutritious juices of the *uterus* to distend and enlarge them; whence they remain much longer in the *uterus* than the other.

It was antiently thought, that none but birds and fishes, with some other animals, were produced *ab ovo*, *eggs*; but the generality of the moderns incline to think, that all animals, even man himself, is generated the same way. *Harvey*, *De Graaf*, *Kerckringius*, and several other great *Anatomists*, have so strenuously asserted this opinion, that it now generally obtains.

In the testes of women, are found little vesicles, about the size of green peas, which are accounted as *eggs*; for which reason, these parts, which the antients called *testicles*, the moderns call *ovaries*. These *eggs* fecundified by the most volatile and spirituous parts of the seed of the male, are detached from the *ovary*, and fall down the fallopian tubes into the *uterus*, where they grow and increase.

This system is countenanced and confirmed by abundance of observations and experiments. M. *de St. Maurice*, upon opening a woman at *Paris*, in 1682, found a fœtus perfectly formed in the testicle.

There is not so much as a plant, whose generation, according to the sentiment of *Empedocles*, and since him of *Malpighi*, *Rallius*, *Fabric. de Aquapendente*, *Grew*, and others, is not effected by the way of *eggs*.

On the other hand we have many instances of *viviparous* animals producing their young absolutely alive, and without *eggs*. Such instances we have of a crow, a hen, serpents, fishes, eels, &c.

Animalcule, is a diminutive of animal, and expresses such a minute creature, as is scarce, or not at all discernable by the naked eye.

Such are those numerous insects which crowd the waters in the summer-months, changing it sometimes of a deep or pale red colour, sometimes a yellow, &c. they seem to be of the shrimp kind, called by *Swammerdam*, *pulex aquaticus arborescens*. The cause of their concourse at this time, Mr. *Derham* observes, is to perform their coit. He adds, that they afford a comfortable food to many water-animals. The green scum on the top of stagnant waters is nothing else but prodigious numbers of another smaller order of *animalcules*; which in all probability serve for food to the *pulices aquatici*.

The microscope discovers legions of *animalcules* in most liquors, as water, wine, brandy, vinegar, beer, spittle, urine, dew, &c. In the *Philosophical transactions*, we have observations of the *animalcules* in rain-water, in several chalybeat waters, infusions of pepper, ivy-berries, oats, barley, wheat, &c.

The human seed has been observed by divers authors to contain huge numbers of *animalcules*, which gave occasion to the system of generation *ab animalculo*.

Leaves may also claim a place in this treatise; therefore,

Leaf, is a part of a plant, ordinarily very thin and flat, growing in the spring, and falling off in autumn.

As to the structure of *leaves*, Dr. *Green* observes, that their fibres never stand on the stalk on an even line, but always in an angular or circular posture, and their vascular fibres or threads are 3, 5, or 7. The reason of which position is for their more erect growth, and the greater strength of the *leaf*.

The skin or coat of the leaves, is no more than that of the branches extended, as gold, by beating, is reduced into *leaves*. In the gem the leaves are

are folded, ſometimes in two, and ſometimes in ſeveral plaits, ſomewhat after the manner of a fan. If the leaves be too thick to plait commodiouſly in two, and to be ranged againſt each other; or if they be in too ſmall a number, and their fibres too delicate, inſtead of being plaited they are rolled up, and form either a ſingle roll, as the *leaves* of the mountain-cowſlip, which are thick; or two rolls, which begin at each extremity of the *leaf*, and meet in the middle. There are alſo ſome plants whoſe *leaves* form three rolls, as fern; ſeveral *leaves* are covered with hair of ſeveral figures; thoſe of lavender and olive-tree, have hairs reſembling ſtars.

Botaniſts conſider the *leaves* of plants, with regard to their ſtructure, ſurface, figure, conſiſtence, edges, ſituation and ſize.—With regard to their ſtructure, *leaves* are either *ſingle*, as thoſe of the apple-tree, pear-tree, &c. or *double*, as thoſe of angelica, parſley, &c.—With regard to their ſurface, *leaves* are either *flat*, as the nummularia, aſarum, origany, androſæum, brionia canadenſis, &c. or *hollow*, as thoſe of the onion and aſphodel; or in *bunches*, as ſeveral kinds of kali, and houſe-leeks.—With regard to their conſiſtence, *leaves* are either thin and fine, as thoſe of St. John's-wort, and dog's graſs; or thick and groſs, as thoſe of portulaca; or fleſhy, as thoſe of ſeveral kinds of houſe-leeks; or woolly, as thoſe of the wool-blade.—With regard to the verge or edges, *leaves* are either cut ſlightly, as ſome ſpecies of gum, and cannabis lutea; or deep, as trefoil, &c.—With regard to their ſituation, *leaves* are either alternate, that is, ranged alternately, as the philyca; or oppoſite to each other, as the philerya, and ſome ſpecies of the rubia.—With regard to their ſize, *leaves* are either very big, as thoſe of the colonſia, and ſphondylium; moderate, as thoſe of the biſtorte, the fig-tree; ſmall, as thoſe of the apple-tree, pear-tree; peach-tree, or very ſmall, as thoſe of millepertuis, or St. John's-wort.

There are likewiſe, annual, crenated, diſſimilar, procumbent, ſegment, ſeminal, and vernal *leaves*.

Annual leaves, are ſuch *leaves* as come up afreſh in the ſpring, and periſh in the winter.

Crenated leaves, are ſuch *leaves* as are jagged or notched.

Diſſimilar leaves, denote the two firſt *leaves* of any plant, at its firſt ſhooting out of the ground. They are thus called, becauſe they uſually are of a different form from the common *leaves* of the grown plant.

Procumbent leaves, are ſuch leaves as lie flat, and trailing on the ground.

Segment leaves, is a Denomination given to thoſe *leaves* that are cut and divided into many ſhreds, or ſlices, as fennel, &c.

Vernal leaves, are thoſe *leaves* which come up in the ſpring.

NAVAL ARCHITECTURE.

NAVAL ARCHITECTURE, or *ſhip-building*, is that which teaches the conſtruction of ſhips, galleys, and other floating veſſels for the water; with ports, moles, docks, &c. on the ſhore.

A *ſhip*, is defined by the Sieur *Aubin*, a timber-building, conſiſting of various parts, or pieces, nailed and pinned together with iron and wood, in ſuch form as to be fit to float, and to be conducted by wind and ſails from ſea to ſea.

Ships, are uſually divided into three claſſes; *ſhips of war*, *merchant-ſhips*, and an intermediate kind, half war, half merchant; being ſuch, as though built for merchandize, yet take commiſſions for war.

Ships of war, are again divided into ſeveral orders, called *rates*; which are ordinarily ſix, *viz.* *firſt*, *ſecond*, *third*, *fourth*, *fifth*, and *ſixth rate*; the *rate* being uſually accounted by the length and breadth of the gun-deck; the number of tons, and the number of men and guns the veſſel carries.

A *firſt* Rate *Engliſh* man of war, has its gun-deck from 159 to 174 feet in length; and from 40 to 50 feet broad, containing from 1313 to 1882 tons; has from 800 to 1000 men; and carries from 96 to 110 guns.—A *French* man of war of that rate, has from 1000 to 1200 men.

Second Rate ſhips have their great deck from 153 to 165 foot long; and from 41 to 46 broad; they contain from 1086 to 1482 tons; and carry from 524 to 640 men; and from 84 to 90 guns.—A *French* ſhip of the ſame rate, carries from 900 to 1000 men.

Third Rates, have their gun-deck from 142 to 158 feet in length; from 37 to 42 feet broad; they contain from 871 to 1262 tons; carry from 389 to 476 men; and from 64 to 80 guns.

Fourth Rates are in length, in the gun-deck, from 118 to 146 feet; and from 29 to 38 broad; they contain from 448 to 915 tons; carry from 226 to 346 men; and from 48 to 60 guns.

Fifth Rates, have their gun-deck from 100 to to 120 feet long; and from 24 to 31 broad; they contain from 259 to 542 tons; carry from 145 to 190 men; and from 26 to 44 guns.

Sixth Rates, have their gun-deck from 87 to 95 feet long; and from 22 to 25 feet broad; they contain from 152 to 256 tons; carry from 50 to 110 men; and from 16 to 24 guns.

Merchant-ſhips are eſteemed by their burden, that is, by the number of tons they bear; each ton reckon'd at 2000 pounds weight. The eſtimate is made by guaging the hold, which is the proper place of loading.

The different parts of a *man of war* (and in fact almoſt all other ſhips with three maſts) are as follows.

The *keel*, the *ſtern-poſt*, the *rudder*, the *buttock of the ſhip*, the *gallery*, the *freeze*, the *enſign ſtaff*, and its *block*, the *dunette*, or higheſt part of the ſtem of the ſhip, the *half-deck*, or *corps de guard*, which is commonly that part under the *hind-caſtle*, the *fore caſtle* or *prow*, the *belt hooks*, the *cut-water*, the *cannon*, the *port holes*, the *laver*, and *upper check*, the *trail board*, the *figure*, the *grating*, the *brackets*, the *main ſtem*, the *falſe ſtem*, the *hawſe hole*, out of which runs the cable, the *cable*, the *buoy*, and its *orin*; the *mizzen maſt*, the *main-maſt*, the *fore-maſt*, the *bowſprit*, the *mizzen top*, the *main top-maſt*.

A Mast is a large upright pole, or long piece of round wood, raiſed in veſſels, for the rigging to be faſtened to.

In large veſſels the number of *maſts* are three; or four, if we reckon the *bowſprit*, viz. the *main-maſt*, the *fore-maſt*, the *mizen-maſt*, and the *bowſprit*. To which ſome add a fifth, *viz.* a *counter-mizen*, which is very ſeldom uſed.

The *fore-maſt* is between the *main-maſt* and the head.

The *mizen-maſt* is between the *main-maſt* and ſtern.

The *bowſprit* lies upon the beak, in the prow or head of the ſhip.

The *counter-mizen*, in large veſſels and galleons is in the ſtern.

We alſo uſe the word *maſt* to ſignify thoſe diviſions, or additional pieces in the maſts placed over one another.

The *main-maſt*, and *fore-maſt*, have each of them two, *viz.* the *main-maſt*, has the *main top-maſt*, and the *main-top-gallant-maſt*. The *fore-maſt*, has the *fore-top-maſt*, and the *fore-top-gallant-maſt*.

The *mizen-maſt*, has but one, *viz.* the *mizen-top-maſt*.

The *rigging* of the *main-maſt*, are the *runners* and *tackles*; the *tackle*, the *ſhrouds* and *laniards*, the *ſtay* and *ſail*, the *ſtay ſail halliards*, the *yard* and *ſail*, the *jeers*, the *ſheets*, the *tacks*, the *luntlines*, the *bowlines*, the *braces*, the *leach-lines*, the *puttock ſhrowds*, the *crowfoot*, the *lifts*, the *top*, the *top armour*, the *top rope*, the *cap*, the *main-yard tackles*.

The *rigging* of the *main-top maſt*, are the *tackles*, *ſhrouds*, *back-ſtays*, *halliards*, *ſtay* and *ſail*, *ſtay ſail halliards*, *yard* and *ſail*, *braces*, *bowlines*, *ſheets*, *clewlines*, *lifts*, *runners*, *buntlines*, *croſs-trees*, *cap*, *ſtump*, *ſtay*, *truck*, *pendant*.

The *rigging* of the *fore maſt*, are the *runner* and *tackles*, the *tackle*, *ſhrouds* and *laniards*, *ſtay*, *yard* and *ſail*, *ſheets*, *tacks*, *braces*, *bowline*, *buntlines*, *leach-lines*, *yard tackle*, *jeers*, *puttock ſhrouds*, *crow-foot*, *top*, *top armour*, *top rope*, *lifts*, *cap*.

The *rigging* of the *fore-top maſt*, are the *tackles*, the *ſhrouds*, the *back ſtays*, *halliards*, *ſtay* and *ſail halliards*, *yard* and *ſail*, *runner*, *lifts*, *braces*, *bowlines*, *ſheets*, *clewlines*, *buntlines*, *croſs-trees*, *cap*, *ſtum*, *ſtay*, *truck*, *ſpindle*, *vane*.

The *rigging* of the *mizen maſt*, are the *yard* and *ſail*, the *ſheet*, *ſhrouds* and *laniards*, *bowlines*, *brayles*, *jeer*, *peak halliards*, *croſs jack yard*, *lifts*, *braces*, *puttock ſhrouds*, *mizen-top*, *top armour*, *cap*, *crow-foot*, *ſtay* and *ſail halliards*.

The *rigging* of the *top maſt*, are the *yard* and *ſail*, *braces*, *lifts*, *ſhrouds*, *halliards*, *back ſtays*, *bowlines*, *ſheets*, *clewlines*, *ſtay*, *croſs-trees*, *cap*, *ſtump*, *ſtay*, *truck*, *ſpindle*, *vane*, *ſlings of the croſs jack yards*.

The *rigging* of the *bowſprit*, are the *horſe*, *yard* and *ſail*, *lifts*, *ſheets*, *clewlines*, *braces*, *bobſtay*, *top*, *top armour*.

The *ſprit-ſail*, *top-ſail*, and the *rigging* of the *top-maſt*, are the *ſhrowds*, *halliards*, *crane line*, *yard* and *ſail*, *braces*, *lifts*, *ſheets*, *croſs-trees*, *cap*, *jack-ſtaff*, *truck*, *jack*, *beſt bower buoy*, and the *cable*.

Weight of Cables *of a hundred fathoms.*

Inches		*Inches*	
A cable of 4	weighs 325	A cable of 11	weighs 2150
$4\frac{1}{2}$	— 400	$11\frac{1}{2}$	— 2325
5	— 490	12	— 2580
$5\frac{1}{2}$	— 558	$12\frac{1}{2}$	— 2750
6	— 680	13	— 3000
$6\frac{1}{2}$	— 800	$13\frac{1}{2}$	— 3250
7	— 930	14	— 3500
$7\frac{1}{2}$	— 1060	$14\frac{1}{2}$	— 3800
8	— 1200	15	— 3900
$8\frac{1}{2}$	— 1340	16	— 5332
9	— 1490	17	— 5900
$9\frac{1}{2}$	— 1640	18	— 6600
10	— 1800	19	— 7000
$10\frac{1}{2}$	— 1970	20	— 8000
		21	— 9000

A liſt of the *length* and *breadth* of ſome ſhips, and of the *length* and *thickneſs* of the maſts, and of their *tacklings*.

Ships of 142 *feet in length, and* 37 *broad.*

	Feet.		Inch.
The length of the main-maſt	88	Diam.	20
of the fore-maſt	78		19
of the bowſprit	52		20
of the mizen-maſt	69		14
of the main-top-maſt	56		$13\frac{1}{2}$
of the fore-top-maſt	46		$10\frac{1}{2}$
of the mizen-yard	74		10
The length of mizen top gallant,	28		6
of the main-top gallant,	25		6
of the fore-top gallant,	21		5
of the top gallant of the bowſprit,	18		6
Yards.			
The main-yard, feet long,	28		15
— of the fore-maſt,	24		13
— of the bowſprit,	17		$8\frac{1}{2}$
— of the main-top maſt,	15		$8\frac{1}{4}$
— of the fore-top maſt,	13		8
— of the top-gallant of the bowſprit,	10		$4\frac{3}{4}$
— of the main-top gallant,	9		4
— of the fore-top gallant,	$7\frac{1}{2}$		$3\frac{3}{4}$

Riggings or cordages of the main-maſt.		Inches	Fath.
Stay,	15		18
Shrowds,	$7\frac{1}{2}$		18
Lanniards,	$7\frac{1}{2}$		10
Halyard,	8		29
Tacks,	$7\frac{1}{2}$		22
Sheets,	$4\frac{1}{2}$		39
Lifts,	9		29
Runners and tackles,	9		37
Leach lines,	26	Threads	50
Bowlines,	16		14
Braces,	8		35
Buntlines,	8		28
Foremaſt.		Inches	
Stay,	12		13
Shrowds,	7		
Lanniards,	7		9
Tacks,	7		20
Sheets,	4		37
Runners and tackles,	9		37
Lifts,	8		27
Halyard,	$7\frac{1}{2}$		27
Leach-lines,	24	Threads	40
Bowlines,	14		20
Braces,	7		25
Buntlines,	7		27
Mizen-maſt.			
Stay,	6	Inches	12
Shrowds,	4		12
Brayles of the top gallant,	11		36
Sheet,	10		25
Runner of armour,	21	Threads	9
Lifts,	21		12
Bowſprit.		Inches	
Halyard,	$4\frac{1}{2}$		7
Clew line of the top gallant	6		14
Sheets,	7		18
Braces,	5		19
Halyards,	6		22
Buntlines,	5		11
Main-top-maſt.			
Shrowds,	$4\frac{1}{2}$	Inches	
Tackles,	$4\frac{1}{2}$		
Halyard,	$5\frac{1}{2}$		9
Stay,	26		22
Sheets,	6		32
Clew-line,	9		57
Bowlines,	10	Threads	23
Buntlines,	7		40
Fore-top-maſt.		Inches	
Shrowds,	4		
Tackles,	4		
Halyard,	5		7
Stay,	16		14
Lifts,	5		28
Sheets,	33		24
Clew-line,	7		38
Buntlines,	6		37
Braces,	21	Threads	27
Bowlines,	21		30

Another manner of rigging a ſhip of 123 feet in length, and 28 in breadth.

Rigging of the top-gallant of the bowſprit.	Fath.	*Tackles of the main-top gallant.*	Fath.
The halyard muſt have in length.	3	The ſtay,	20
The lifts,	8	The lifts,	10
The braces,	18	The halyard,	4
The clew-line,	16	The clew-line,	30
The buntlines,	18	The braces,	32
The ſheet,	18	The buntlines,	23
		The bowlines,	30

The tackles of the ſprit-ſail.	Fath.	*Tackles of the main-top maſt.*	Fath.
The buntlines,	18	The ſtay,	21
The braces,	18	The lifts,	29
The lifts of the middle of the yard,	3	The braces,	30

The

The ſheet,	16
The halyard,	6
The ſafeguard of the bowſprit,	6
The crane-line,	18

Tackles of the fore-top gallant.

	Fath.
The ſtay,	18
The braces,	30
The lifts,	10
The buntlines,	22
The bowlines,	24
The clew-line,	28
The halyard,	3
The ſheets,	24

The tackles of the fore-top maſt.

	Fath.
The ſtay,	15
The runner & tackles,	8
The lifts,	28
The halyard,	7
The braces,	30
The bowlines,	30
The buntlines,	32
The clew-line,	30

Tackles of the fore-maſt.

	Fath.
The ſtay,	12
The runner & tackles	12
The lifts,	28
The braces,	20
The buntlines,	24
The tacks,	14
The bowlines,	15
The ſheets,	36
The halyard,	14
The clew-line,	35
The lanniard,	5

The buntlines,	33
The bowlines,	34
The halyard,	8
The clew-line,	34
The ſtay runner,	18

The tackling of the main-maſt.

	Fath.
The ſtay,	16
The ſtay runner,	16
The lifts,	29
The braces,	30
The ſheets,	30
The tacks,	16
The great bowline,	24
The halyard,	24
The clew-line,	38
The buntline,	26
The lanniard,	6

The tackling of the mizzen top gallant.

	Fath.
The running ſtay,	10
The halyard.	4
The lifts,	10
The ſheets	12
The buntlines	15
The bowlines,	16
The braces,	11

The tackling of the mizzen maſt.

	Fath.
The ſtay,	10
The halyard,	8
The clew-line,	28
The ſheet,	16
The buntlines,	20
The bowlines	18
The lifts,	5

Another manner of cutting the tackling, and of regulating their proportions.

TABLE *of the thickneſs of the threads, and of the weight of cables.*

Thickneſs Inches	*Threads.*	*Weight. Pounds.*	*Thickneſs Inches.*	*Threads.*	*Weight. Pounds.*
3	48	192	13	821	3284
4	77	308	14	952	3808
5	121	484	15	1093	4372
6	174	696	16	1244	4976
7	238	952	17	1404	5616
8	311	1244	18	1574	6296
9	393	1572	19	1754	7016
10	485	1940	20	1943	7772
11	598	2392	21	2144	8576
12	699	2796	22	2352	9408

In the firſt column of this table is ſeen the thickneſs of the *cables*; in the ſecond column the number of threads; and in the third, the weight of the *cables*.

The meaſure of the *anchors*, and of the *cables* by the bigneſs of the ſhips, to which they muſt ſerve.

Bigneſs of the Ships by Feet.	*Length of the Anchor by Feet*	*Weight of the Anchor by Pds*	*Thickneſs of the Cables by Inches*
8	$3\frac{1}{5}$	33	4
9	$3\frac{2}{5}$	47	$4\frac{1}{2}$
10	4	64	5
11	$4\frac{2}{5}$	84	5
12	$4\frac{4}{5}$	110	$6\frac{1}{2}$
13	$5\frac{1}{5}$	140	$6\frac{1}{2}$
14	6	175	7
15	$6\frac{2}{5}$	216	$7\frac{1}{2}$
16	$6\frac{4}{5}$	262	8
17	$7\frac{1}{5}$	314	$8\frac{1}{2}$
18	$7\frac{3}{5}$	373	9
19	8	439	$9\frac{1}{2}$
20	$8\frac{2}{5}$	512	10
21	$8\frac{4}{5}$	592	$10\frac{1}{2}$
22	$9\frac{1}{5}$	681	11
23	$9\frac{3}{5}$	779	$11\frac{1}{2}$
24	10	884	12
25	$10\frac{2}{5}$	1000	$12\frac{1}{2}$
26	$10\frac{4}{5}$	1124	13
27	$11\frac{1}{5}$	1259	$13\frac{1}{2}$
28	$11\frac{3}{5}$	1405	14
29	12	1562	$14\frac{1}{2}$
30	12	1662	15
31	$12\frac{2}{5}$	1728	$15\frac{1}{2}$
32	$12\frac{4}{5}$	1996	16
33	$13\frac{4}{5}$	2297	$16\frac{1}{2}$
34	$13\frac{3}{5}$	2300	17
35	14	2515	$17\frac{1}{2}$
36	$14\frac{2}{5}$	2742	18
37	$14\frac{4}{5}$	2986	$18\frac{1}{2}$
38	$15\frac{1}{5}$	3242	19
39	$15\frac{3}{5}$	3512	$19\frac{1}{2}$
40	$15\frac{1}{5}$	3796	20
41	$15\frac{3}{5}$	4096	$20\frac{1}{2}$
42	16	4426	21
43	$16\frac{2}{5}$	4742	$21\frac{1}{2}$
44	$17\frac{1}{5}$	5088	22
45	18	5451	22

A SAIL, is an aſſemblage of ſeveral breadths of canvaſs, or ſtrong hempen cloth, ſewed together by the liſts, and edged round with a cord, faſtened to the yards and cords of a veſſel, to make it drive before the wind.

For the *meaſures* and *proportions* of the *anchors* and *cables*, we muſt take with a compaſs twice the thickneſs of the yard of the *anchor* to find its breadth; then we'll double the inches which the thickneſs gives, and give to the length as many feet

feet, as there are inches in that thickneſs doubled, and an inch beſides above every foot. For inſtance, the meaſure of the thickneſs being 6 inches by the compaſs, that makes 12 feet for the yard, and by adding 13 inches to it, the whole together make 13 feet 1 inch. Under 1000 pounds, one muſt, *i. e.* for the length of the yard, add 2 inches for each foot, inſtead of 1, which has been marked above; and under 5000 pounds take three times the thickneſs to give the length. Thus when there are two inches and a half of thickneſs, the length muſt be $7\frac{1}{2}$ feet, half whereof, which is $3\frac{3}{4}$, 1 being taken for 100 pounds, the weight of the *anchor* will be 3.

For the thickneſs of the cables in proportion to the weight of the anchors. We muſt obſerve in the two following tables, each whereof conſiſts of 12 articles, that each article of the firſt muſt anſwer to the ſame article in the ſecond. For inſtance, in taking in the firſt article of the firſt table, a cable of 20 inches, you'll find in the ſecond table, at the firſt article, the ſecond line, a common *anchor* of 56 hundred and one fourth weight; which is the proportion of the *anchor* for a *cable* of 20 inches, of the firſt article of the firſt table; and thus of all the reſt.

Firſt TABLE.

Article		Inch.
1.	Cables	of 21
		of 20
		of $14\frac{1}{2}$
		of 10
		of 9
2.	Cables	of 20
		of 19
		of 13
		of 9
		of 8
3.	Cables	of 17
		of 16
		of 12
		of 8
4	Cables	of 12
		of 16
		of 11
5.	Cables	of 15
		of 14
		of 9
6.	Cables	of 13
		of 12
7.	Cables	of 10
		of 9
8.	Cables	of 16
		of 15
		of 10
9.	Cables	of 14
		of 13
		of $12\frac{1}{2}$
		of 12
		of 8
10	Cables	of 12
		of 12
11.	Cables	of 8
		of $7\frac{1}{2}$
		of 6
12.	Cables	of 8
		of 7
		of 6

Article	Anchor	104 *lb.*		
1.	Sheet anchor	60	0	3
	Common anch.	56	0	1
	Stream anch.	55	0	0
	Kedge anch.	25	0	[illegible]
	Grapler	7	0	2
2.	Sheet anchor	43	0	0
	Common anch.	40	0	5
	Stream anch.	39	0	3
	Grapler	7	2	0
3.	Sheet anchor	35	3	3
	Common anch.	34	0	2
	Stream anch.	31	2	7
	Kedger	11	3	5
4.	Sheet anchor	32	0	0
	Common anch.	30	2	2
	Stream anch.	27	0	0
5.	Sheet anchor	29	0	0
	Common anch.	25	0	0
	Stream anch.	23	3	2
	Kedger.	9	0	0
	Grapler	2	2	7
6.	Sheet anchor.	28	0	0
	Common anch.	27	0	0
7.	Sheet anchor	22	0	2
	Common anch.	11	0	0
8.	Sheet anchor	27	0	0
	Common anch	23	3	5
	Stream anch.	23	0	0
9.	Sheet anchor	18	0	0
	Common anch.	17	0	0
	Stream anch.	16	0	2
	Kedger	4	2	0
	Grappler	2	2	0
10.	Sheet anchor	11	0	0
	Common anch.	10	0	0
11.	Sheet anchor	7	0	0
	Common anch.	6	0	0
	Stream anch.	5	2	0
12.	Sheet anchor	5	0	2
	Common anch.	4	0	0
	Stream anch.	3	2	3

The *Sheet anchor* is uſed in a ſtorm; the *ſtream anchor* daily; and the *kedger* to tow a ſhip.

Ships are *caulked* and done over with *pitch* and *tar*, as well to preſerve them and make them laſt, as to hinder the water from running through the cracks and ſeams; this operation is made by means of tow, which, after it has been boiled and dried, either in the ſun or in an oven, is ſpun very looſe as big as the arm, and thruſt afterwards by the caulker into the ſeams of the ſhip.

The *graving* a ſhip is to be done over with, from underneath to the line of water, is a compoſition made of roſin, tallow, brimſtone, train oil, and pounded glaſs, to preſerve her from worms. When a ſhip is to make a long voyage ſhe is ſheathed, and the boards thereof are garniſhed with an almoſt infinite number of ſmall nails.

We'll now put a *ſhip* on the *ſtocks*.

1. MODEL, or *gabarit*.

When a ſhip-builder makes the *draught* or *model* of the conſtruction of a ſhip, he gives the name of firſt *model* or *chief rib*, to that *rib* which is to be placed under the main beam, and which anſwers to it; and even to the whole *model* raiſed perpendicularly over it.

The ſecond, third, and fourth *model*, fore or aft, are the other *models* raiſed on the other beams, fore or aft. Thoſe *models* are made with pieces of thin boards, to repreſent the length, breadth, and caliber of the members, and parts of a ſhip, when to be built and put on the ſtocks.

Expla-

Explanation of the first model.

FIGURE I.

1. *Ribs* of the firſt deck, which muſt have two thirds of the main ſtem.

2. *Futtocks*, of the upper deck; they muſt have the ſame thickneſs with the ribs of the firſt deck.

3. The *ſcupper holes bindings*, of the lower deck, are pieces of wood which running round the ſhip inſide, ſerve to join it, and muſt be 19 inches broad, and 5 or ſix inches thick; thoſe of the upper deck 17 inches broad, and $3\frac{1}{2}$ to 4 inches thick. Which is the deciſion of maſter ſhip-builders who have regulated the proportions of a ſhip of 137 feet in length.

4. *Scupper-holes*, are apertures made ſhelving, in the length of a piece of wood, placed on the ſide of the ſhip, for the running out of rain and ſea-water. The *ſcupper-holes* of the upper-deck, *i. e.* the pieces of wood where the holes are made, muſt be four inches broad, and 4 thick; and the holes have 2 inches diameter, if the aperture be round, but it is moſt commonly made ſquare-wiſe, and of ſeveral pieces. The *ſcupper-holes* of the lower deck muſt be 6 inches broad, and $5\frac{1}{2}$ inches thick; and the holes have 3 inches diameter.

5. The *the burdens of the deck*, which muſt be 17 inches broad, and $4\frac{1}{2}$ thick: we'll have occaſion afterwards to regulate better their proportions.

6. The *ſide-planks*, which ſerve to cover the firſt gun-deck, are $2\frac{1}{2}$ inches thick.

7. The *bolſter* of the carriage.

8. The *floor-timber* of the lower deck, which is a girder placed with ſeveral others, throughout the breadth of a ſhip, and reſts on two ribs, by its two ends. Moſt carpenters give them $1\frac{1}{2}$ inch for every 10 feet of the length of the ſhip, taken from the ſtem to the ſtern-poſt; every 10 feet in length given them, likewiſe an inch of roundneſs archwiſe.

9. The *wheel* of the carriage.

10 The *alonge* of the *migrinier*, which is the firſt, or that joined with the *rib* and *knee* of the bottom.

11. The *knee of the bottom*, which is joined with the firſt *alonges* and *ribs*, they muſt have in their angle half the thickneſs of the ſtem.

2 MODEL, or *gabarit*.

FIGURE II.

1. The *keel*.

2. The *platform*, which begins at number 2, and ends at 2.

3. The *floor-timber*, which croſſes over the keel, and over all the bottom.

4. The *lengthening* or *alonge*, which forms the breadth and depth of the ſhip.

5. The *ſerre-bauquierre*, in which the beams are joined, in the ſhape of a ſwallow's tail. The *ſerre-bauquierres* run all round the ſhip They have ſometimes half the thickneſs of the ſtem, taken inſide; others give them two fifths of that ſame thickneſs.

6. The *vaigre* above the *ſcupper-holes binding*.

7. The *rib* of the firſt deck.

8. The *lowermoſt deck* between the flowers and the lower precinct.

9. The *flowers*: for the beauty of a *model*, the *flowers* muſt aſcend and riſe with a roundneſs agreeable to the ſight, and well proportioned. The flowers are formed by the junction of the floor-timbers with the knees of the bottom.

10 The *ſide-planks* between the girts.

11. The *girts* with their jutting out.

12. The *tranſom* of the *viboard*, which makes the laſt and higher *girt* of the ſhip, and which is moſt like the other *girts*.

13. *Beams* of the upper deck.

14. A *ſtrop* commonly placed on the binding, as the *alonges* are under it, to ſtrengthen the ſhip which carry many cannon.

15. The *vaigres* of *empature* of the knees and floor-timbers.

16. The *vaigres* of the bottom, and placed under the firſt girts.

17. The *carline*, which is the biggeſt piece of wood employed in the hold of a ſhip; ſeveral of them are put end to end, and placed on all the ribs, and as they ſerve to tie them with the keel, they are often called *keelſon*, or *falſe keel*.

18. The *carriage* of a ſhip gun.

19 *Planks* which ſerve to cover certain notches made in the floor-timbers, of which the bottom of the ſhip is compoſed; and thoſe notches ſerve for the evacuation of the water, which is in the ſhip from the prow to the pumps.

20. The *jarlot* of the keel, where the *gaboard* enters; it is a kind of notch made in the keel, in the ſtem, and in the ſtern-poſt of the ſhip, to introduce into it a ſmall part of the ſide-planks, which cover the members of the ſhip.

21. The *line*, which hanging to the level of the biggeſt part of the ſhip, is found a foot diſtant from the lowermoſt deck, at the place where it ends, and where the flowers begin in deſcending, and that's the breadth of the biggeſt part of the ſhip.

FIGURE III.

Which repreſents in another manner the ſame pieces of the two preceding MODELS, *and ſhew better the roundneſs thereof.*

1. The *futtocks* under the *falſe beams*, placed at every

every 6 feet distance, under the first deck, to strengthen the bottom of the ship. These *false beams* are pieces of wood like to those over which often a false deck is made; and where it has its greater height, a retrenchment is contrived, where the soldiers retire to repose themselves and sleep.

2. The *bindings* of the *scupper-holes*.
3. The *weight* or *burden* of the deck.
4. The *carline*.
5. The *futtocks* of the upper deck.
6. The *reverse lengthenings*.
7. The *binding* of the *bauquierre*.
8. A *scaffold* on which the workmen place themselves.
9. The *main stem* inside

FIGURE IV.

Which shews distinctly and successively the parts or members of a ship, which give it the length and depth it must have forwards.

1. The *carline*.
2. The *keel*.
3. The *gabords*, or first boards downwards which form the outward sides of the ship. The row of boards which are placed above the *gabord* are called *ribord*.
4. The *vaigres* and *lengthenings*.
5. The *lowermost deck*.
6. The *floor timbers*.
7. The *knees* of the bottom.
8. The *ribs* which support the deck.
9. The *beams* of the first deck.
10. The *girts* with their jutting out.
11. The *bindings* of the *bauquierres*.

FIGURE V.

Represents,

1. The *floor* or *cieling*.
2. The *weight* of the deck, which is thick and narrow boards notched, to put over the beams in the length of the ships, on each side. from fore to aft, at very near one third of the length of the ship.
3. The *flat ribs*.
4. The *lengthenings*.
5. The *futtocks*.
6. The *port holes*, placed bandwise on both sides of the ship.
7. The *beams* of the second deck.

FIGURE VI.

Shews distinctly and successively the parts or members of a ship, which give it the breadth and depth it must have backwards.

1. The *carline*.
2. A *rib* placed backward and round inside.
3. *Flat ribs*,
4. A *rib* half backward, it has less cavity than those quite backwards.

Note, That we see in this *figure*, that the *flat ribs* are in the middle; that those placed backward follow them; and those quite backwards are placed at the extremities of the ship.

FIGURE VII.

Represents,

1. The *port-holes*, bandwise, on both sides of the ship.
2. Two *port-holes* at the stern.
3. *Bands*, pieces of timber-work. There are several sorts of them, and are placed in different parts of the ship, as well to join the members thereof, as to strengthen and keep up the whole structure.
4. The *futtocks*, which support the deck.
5. The bindings of the *scupper-holes* of the lower deck, we have already observed, that they must be 19 inches broad, and 5 or 6 thick at the first deck.

Here follows a rule for the thickness of the *side planks*, mentioned in the above described *figures*.

	Feet.	*Thickness.*
The side planks of the bottom of a ship, from		*Feet in length, from the stem to the stern-post, must be*
	40 to 60	2 *Inches thick.*
	60 to 80	$2\frac{1}{2}$
	80 to 100	3
	100 to 120	$3\frac{1}{2}$
	120 to 140	4
	140 to 160	$4\frac{1}{2}$
	160 to 170	$4\frac{1}{2}$

I'll explain here the two figures of the fore part of a man of war, represented in the plate of *Naval Architecture*; those figures being cut in a manner, that the outside parts which do not appear in one, are represented very distinctly in the other, and are marked with the same cyphers or letters, *viz.*

S. The *neck-piece* of the cutwater, which must have 27 feet in length, and 5 in breadth, to be proportioned to a man of war, which has 145 feet in length from the stem to the stern-post, 36 feet broad, and 15 deep.

R. R. The *futtocks* of the neck-piece. The needles of the cutwater comprized between the neck piece and the yard-bearers, and which jut out much into the sea, are here more rounded than they were formerly.

T. The *holes* or *fastenings* of the tacks of the fore-mast.

V. V. The *ſtem.*

W. The *keel.*

X. The hole thro' which paſſes the tack of the bowſprit.

P. The *hawſe holes.*

Q. Q. The *girts.*

O. O. The *ſide planks*, which are put two and two between the girts.

N. The *threſhold* of the port-hole, or lower *threſhold.*

M. The *valves* of the port-holes of the large battery. Large men of war have commonly three batteries.

L. The ſecond *battery* is placed above the lower, or at the middle deck; and the third on the upper deck. Each port-hole muſt have its *drague* and its crane; which are big ropes, ſerving to approach, and draw back the cannon, and likewiſe to ſtop the recoil, ſo that a piece of cannon may not recoil, when it is fir'd, further than half deck.

F. K. *Embraſures* to level the cannon.

I. The *cadenes* of the ſhrowds, which are iron-chains, at the end whereof is placed a *ram's block* (g) to make the ſhrowds tight. They ſerve to ſo many other things, that for the rigging of a ſingle ſhip, we take moſt commonly 13 dozen of them.

E. E. The *yard bearers* 1, 2, 3. which are above the cutwater, the uppermoſt is 8 inches broad backwards, and $4\frac{1}{2}$ thick; 5 inches broad forwards, and $3\frac{1}{2}$ thick. The ſecond 6 inches broad, and $4\frac{1}{2}$ thick backwards; $4\frac{1}{2}$ broad, and $3\frac{1}{2}$ thick forward. The lowermoſt $6\frac{1}{2}$ broad, and 4 inches thick backward; and 5 inches broad forwards.

4. The door of the fore-caſtle.

1. 2. The ornaments of the uppermoſt part of the poop.

3. 5. Shewing the ſheathing of the boards, which make an end of covering the hind part of the ſhip, as far as the *platboard.*

Note, That here follows a more particular deſcription of ſeveral pieces or members of a ſhip, which have already been mentioned; beginning at the ſtern.

The *great block* of the *driſſe.*——It is a large ſquare piece of timber, placed upright on the *carline*, whence it riſes over the deck. At the upper end of that piece of wood, there are three or four ſpinning wheels of pullies on the ſame axle-tree, on which the great clew-lines paſs; the main block of clew lines ſerve to the main-yard.

The *main capſton*, 2. *Fig.* 17. is a wooden machine placed on the firſt gun deck, and which riſes 4 or 5 feet above the ſecond; it is called *double capſton*, becauſe it ſerves to raiſe the anchor, and for other uſes, which I'll mention, when I'll explain its figure.

The *little* or *ſimple capſton*, placed on the ſecond deck.

1. The *dogue* of *amure.* There is one on each ſide of the ſhip. It is a hole with a *taquet* inſide, and a frame outſide. One of thoſe holes is larboard of the ſhip, and the other ſtarboard, on the flat body at the head of the main-maſt, to tie the *couets* of the main-ſail. The diſtance between the etambraie of the main-maſt, and either of the *dogues* of *amure*, is equal to the length of the main beam.

3. *Chains* of the *ſhrowds.*

4. *Maſt*; it is a great tree, or a long piece of wood placed in a ſhip, to which the yards, ſails and tackles neceſſary for the ſailing of the ſhip, are faſtened.

5. *Chouquet.*

6. It is a triangular piece of wood placed on the end of the ſtays, and which join them with the ſtern.

7. *Taquet* of the key of the ſtays. It is a piece of timber, placed under the key of the ſtays, between the counter-fort, and the counter ſtern-poſt.

8. The *ladder of the poop*; which is made of cord, and hangs at the ſtern of the ſhip, for the convenience of the people of the ſhallop, and to make uſe of it in a tempeſt.

FIGURE XI.

Shews,

1. A ſimple pulley; which is a *muffle* where there is only a ſingle pulley.

2. A *crane pulley*, which is a double muffle, where there are ſometimes two pullies over one another, and ſometimes even four.

3. *Pullies of caliornes*, which are pullies with two or three wheels on the ſame axle-tree.

4. *Common pullies*; which is a round body made of wood or metal, in form of a plate, with a hollow all round it, for a rope to run round. The pulley is ſet in what's called a *ſcarf* or *muffle*; and by that word *pulley* is underſtood the whole together, *viz.* the *ſcarf*, the *pulley*, the *wheel*, and the *axle-tree.*

5. *Cut*, or *dented pulley*, is a pully which has its ſcarf ſloping on one ſide, to run the bow-line into it, when it is neceſſary to hale it.

6. *Hawſe-block*, is a large ſquare piece of timber, placed upright on the carline, whence it riſes over deck. At the upper end of that piece of timber, there are three or four wheels of pullies on the ſame axle-tree, over which the great driſſes run.

7. The *block* of the *driſſe* of the mizen maſt, the pullies whereof muſt be eight inches broad, with proportionable cordages.

8. The *ſuttle*: it is a kind of little platform, ſupported by wooden bars, and which runs, in jutting out, round the cap of the maſt: though moſt commonly

commonly the largest ships have but four *scuttles*, viz. the main-scuttle, the fore-mast-scuttle, that of the bowsprit, and that of the mizen, and there are but bars at the other masts, those bars are notwithstanding called *scuttles*. The *scuttles* serve for working the ship, wherefore the sailors go up to them. They serve likewise to fasten the stays, shrowds, and several other cordages. A sailor is kept there in centry, that he may see at a greater distance.

The *sixteenth figure* represents,—1. The *etambraie* of the main mast. The *etambraies* are round holes made in the decks of a ship, to pass the masts thro' them, or they are two large pieces of wood which embrace a round hole made in the deck, through which the mast runs, the better to strengthen the deck in that place, and keep the mast more steady.

2. The *etambraie* of the fore-mast.

3. The *etambraie* of the *capston*.

4. The *pump*.

5. The iron, or wooden *rod* of the pump.—It holds the apparatus.

6. The *girt of viboard*, is a girt a little smaller than the others, which runs all along the ship upwards.

7. The *girts* are long pieces of wood, put in divers places a-top of the ribs of a ship, as well for ornament as necessity. The chief of them are over the *acastillages* at breast-high. There are likewise some of them on the pediment of both castles.

The *twelfth figure* shews,—1, 2. The figures of the *bits*.

1. The first shews the *bits*, such as they are seen backwards; *b b*, the *pillars* or the *bits*; *c c*, the head of the pillars; *d d*, the holes which serve for the large iron pegs when the cable is on the *bits* to stop it, and hinder it from spinning; *e e*, the bowsprit; *g g*, the deck; *h h*, the head of the bolster, which is of deal.

This first figure of the *bits* has its proportions, that it should not rise above the first deck. But if it was to be carried as far as the second, the pillars should be kept longer downwards.

The second figure shews the bits on the fore part of the ship, the better to discover the futtocks which do not appear at the stern; *b b* the upper branches of the futtocks which extend over the deck, as far as the head of the bolster; *c c*, the lower branches of the futtocks, which cannot be made too long, and can be extended as far as the guerlandes, which are those large pieces of carpenter-work bent, and placed square-wise on the stem, above, and under the hawse-holes, to form the joining of the fore part of the ship, and keep up the side-planks; *d d d d*, bolts with rings which run through the ribs and beams, and are fastened with pins.

3. The *Pillars of the bits*.

4. *Hawse-hole*. Commonly there are two *hawse-holes*, one on each side of the stem; and sometimes four, two on each side the fore part of the ship, starboard and larboard of the stem. In men of war which have two gun-decks the *hawse holes* are pierced under the first or lower deck.

5. The *great level*.

The *fifteenth figure* shews,—1. The *architrave*, *epistyle*, which is a piece of timber placed on columns instead of arcade, and is the first and principal, which support the others.

2. *Bars* of the capston, are certain square pieces of wood, serving to turn the capston round.

3. The *carline*. I have said already, that it is the longest and biggest piece of wood, employ'd in the hold of a ship.

4. The *girts*, already mentioned, are placed parallel one to the other. The sailors find a conveniency in them when they want to get into the ship to clean it.

5. *Counter-girts* are those placed over the thillar-transum.

6. The *great carline*, or *zarline* of the main-mast.

7. The *carline* of the foot of the fore-mast.

8. The *carline* of the mizen-mast.

9. The *carline* of the capston.

10. The *straps*, which are pieces placed over the binding, as the *alonges* are under it, to strengthen large ships which carry many cannon. The larger ships which have two rows of port-holes want double straps backwards, and still more under the fore-castle, because of the anchors, which are drawn up there, and shake that part much.

The *fourteenth figure* represents,—1. The thillar-transum, already mentioned.

2, 3. *Porques* of the bottom, situated about the middle of the carline, and are less bent, and flatter than the other *porques*, because the bottom of the ship is flatter about the middle of the *carline*.

4. *Bindings* of the *scupper-holes*.

5. *Flat boards*, placed over the ends of the reverse lengthening close to the *girts*.

6. *Thresholds* of a port-hole, or lower threshold, is a board which being put over the lower part of the port-hole, covers the thickness of the sides, and prevents the water from rotting the members of the ship.

7. Some call likewise, *thresholds*, the cross piece of timber, which rests on the two upright beams, and into which enters the iron work.

8. The *vaigres* of *empature* of the floor-timbers and *knees*, are those which follow the *vaigres* of the bottom, and are risen above it, to form the roundness on both sides.

9. The *fargues* are boards risen on that part of the

the *flat board* called the *bule*, to ſerve inſtead of guard-corps, the better to defend the deck, and to ſteal from the ſight of the enemy what paſſes on deck. The *belle*, or *embelle*, is that part of the upper deck which runs between the ſhrowds, of the fore-maſt and the main-ſhrowds, and which having its ſide leſs riſen than that of the other parts of the ſhip fore and aft, leave that part of the deck almoſt quite open at its flanks. It is then to cover that place that the *fargues* are uſed. They are took off when the fight is over, as well as the guard-corps, which are mates, or textures made of ropes, and placed on the upper ſides of men of war, to ſhelter ſoldiers againſt the muſketry of the enemies.

11. The gallow of the lever which ſerves to draw the water out of the pump.

We have ſeen in the preceding figures, the application of the models made to ſhew the length, breadth, and caliber of the members and parts of a ſhip, when it is to be built, to be put on the ſtocks; and in a condition to be launched, which is done in the following manner.

To place well a keel on the ſtocks (*Fig* 7.) the *ſtocks* muſt be placed at 6 feet diſtant from one another, taking care that the middle of the *keel* ſhould reſt directly on the middle of the *ſtocks*. The bigger tins deſigned to keep the *keel* almoſt in an equilibrium when the ſhip is launched, muſt be placed at 5 feet of the length of *keel*, taking it backwards, and from the heel of the *keel*. The *tins* more backward need no wedges, becauſe as ſoon as the ſhip leans a little forward, it reſts leſs on thoſe ſtocks, and they fall of themſelves; but wedges muſt be put at all the other ſtocks, from the biggeſt forwards. Some carpenters make the fore-maſt ſtock, which is under the ſtem, of a wood very eaſy to ſplit, and to launch the ſhip, they dig up a little of the earth round the ſtock, and under it, ſo that it ſinks a little, and then breaks it in pieces.

When the *keel* is well placed on its ſtock, a line is drawn through its middle, from fore to aft, to ſee if it be not arched. Moſt carpenters make it arch by 6 or 8 inches underneath, according to its length, pretending that it ſtraitens again when it is in the water, becauſe ſhips being much narrower at their extremity than in their body, and conſequently leſs ſupported there by the water, the extremities ſeldom fail ſinking a little at firſt, and afterwards, when the ſhip grows old, they continue to ſink a little by degrees, and the *keel* bends inſide, which produces a very diſagreeable effect, and ſometimes a dangerous one. In placing the *keel* on the ſtock, care is taken to keep it higher backwards, and as high as is neceſſary to launch eaſily the ſhip to the water, and before the *tins* are put under the *keel*, it would be very proper to make a bed of good boards 10 or 12 inches broad, or more, to place the *tins* upon it, rather than on the ground. All this may be eaſily underſtood in examining *figure* 7. of the plate, where the letter A ſhews the ſhip on the *ſtocks*, with the following circumſtances.

1. A ſcaffold made ſlanting for the workmen to go in, and come out of the ſhip.

2. An aperture left for the paſſage into the ſhip, of the biggeſt pieces of timber, which muſt ſerve for its conſtruction.

3. Pieces of timber diſpoſed at a level, and ſupported by other perpendicular ones, in a dock, *Dutch* faſhion, or the ground even with the water, to facilitate the launching of the ſhip, in the manner repreſented under the letter B.

4. *Tins* placed on the ground, or on boards to ſupport the *keel*.

5. The ſtocks, or bed where the tins and ſhip reſt.

6. *Wedges* greaſed, and drove under the *keel*.

7. *Coites*, or long pieces of timber placed parallel under the ſhip, to carry it when taken off the ſtocks, in order to launch it to the water. The *French* make uſe of two indented pieces of wood, which they call *colombiers*, and which go to the water along with the ſhip; and when the ſhip begins to float, the *colombiers*, which are tied to it with ropes, floating likewiſe, are withdrawn. But among the *Dutch* the *coites* remain in their place, and the ſhip ſliding over them, goes alone to the water. The *Dutch* have this particular beſides, that they put each ſide on the coites, the wedges which ſerve to make the ſhip ſlide on the coites, and launch it.

8. The *caliome*, and rope to ſtop the ſhip and draw it forwards and backwards, as neceſſity requires it. Laſtly, it is ſeen in the figure B, how far the conſtruction of a ſhip is advanced when it is launched. It is perfected afterwards by erecting a ſcaffold, which reaches from the ſtern of the ſhip to the ſhore, where there are quays made for that uſe.

The pit, pond, or creek, where ſhips are built or repaired, is called *dock*.

To *careen* a ſhip, is to lay it on one ſide, to caulk, ſtop up leaks, refit or trim the other ſide.

This operation of *careening* is ſeen, *Fig.* 8. *Nav. Arch.* in thoſe figures A ſhews a ſhip which is careened on the ſtarboard ſide; and B, a ſhip careened on the larboard ſide.

C, Heating made with ſmall wood, while the careen is given to the ſhip. The heat muſt not be ſpared.

D, The tar wherewith the wood of the ſhip, and

and the cordages are imbibed, that they may reſiſt the water, wind, and heat of the ſun.

E, That tripod or candleſtick, which are three ſtakes driven very far into the ground, in the middle whereof is a fourth, placed like a candle in a candleſtick. It is called ſtool and tripod, becauſe of its likeneſs to the ſeats with three feet, uſed in *Holland* by moſt workmen. To this are faſtened the ropes which ſerve to ſupport the ſhips when they are put on their ſides to be careened; to which are faſtened likewiſe the *atrapes*, which are large ropes, to hinder a ſhip from lying too much on its ſide, while ſhe is in careen.

A man of war thus entirely finiſhed, muſt be fitted with two *boats*, one called the *ſhalop*, or *long-boat*, and the other the *canoe*.

The *ſhalop*, or *long-boat*, ſerves to carry people on board the ſhip, or on ſhore, or from one ſhip to another. It ſerves likewiſe to carry the towing-anchor, when it muſt be caſt. To carry on board the munitions and proviſions, the ballaſt, and other heavy burthens, to ſave the crew and cargo in caſe of a ſhipwreck, or any other misfortune at ſea, and to a great number of other particular uſes. In plate of *Naval Architecture*, Fig. 9. is ſeen a *ſhalop* turned upſide down, to ſhew from the top the ſituation and order of its inward parts, *viz.*

A, The *ribs.*

B, The *knees* of the bottom.

C, The *carlines.*

D, The *ſerrebanquierres*

E, The benches where the rowers ſit.

F, The *deck*, and the bench of the fore part of the *ſhalop*.

G, The benches joined round the hind part inſide, for the conveniency of thoſe who are in it.

H, The *floor*, or bottom of the *ſhalop*.

I, The *taquets* with their *echomes*, to preſerve the boards againſt the rubbing of the oar. In their ſtead is placed, in ſmaller boats, two *tolets*, which are ſmall wooden pegs to place the oar between.

K, The *freeze* and *girt* of the viboard.

M M, The *crowning* of the *ſhalop*.

N N, Small *futtocks* to keep the benches of fore and aft ſteady.

O O, A rool of defence, to defend the ſtem from ſtriking againſt large veſſels.

P. The pegs to hang the *ſoals* or *derives*.

Q, *Hole* in the *carline*, with a notch in the bench to place the maſt.

The *canoe*, is a kind of ſmall ſhalop, deſigned for the ſame uſes as the long-boat. The tenth figure of the plate ſhews a *canoe* turned upſide-down like the *ſhalop*, wherein are repreſented all the inſide parts thereof, and diſtinguiſhed by figures. The figures which are not viſible in the canoe turned upſide-down, are eaſily ſeen in the perpendicular ſection of the ſame *canoe*, viz.

1. The fore part of the *canoe*.
2. The hind part.
3. The ribs.
4. The knees of the bottom.
5. The carline.
6. The ſerrebanquierre.
7. The board.
8. The taquets with their echomes.
9. Pieces of wood placed behind the *careen*, to place the oar to row the canoe, either to the ſhip or to ſhore.
10. The deck and bench of the fore part of the canoe.
11. The *cajute*, and benches of the ſtern.
12. *Taquets* to faſten the ſoals, when the wind ſerves.
13. The hole to place the maſt.
14. The futtocks to ſtrengthen the benches fore and aft.
15. The virevaut.
16. The hatch.

17. 18. The length of the canoe, which is moſt commonly as much as the breadth of the ſhip to which it is to ſerve.

In *England* and *Holland* they have a kind of ſmall veſſel, called *yacht*. There are ſome of thoſe *yachts* which are 66 feet long, 19 broad, and 6 deep, under the ſcupper-holes.

On the *Mediterranean*, the *French*, *Italians*, *Spaniards*, &c. have *galleys*.

A GALLEY is a low built veſſel, going both with oars and ſails.

Here follows a deſcription of the principal parts of a *galley*, viz.

The *rudder*, called by the Italians *temone*, is ſuſpended to the ſtern with two hooks, like in other veſſels.

The *main maſt* is 90 palms long; big at the bottom 2 palms, and a-top $1\frac{1}{3}$. The *Italians* call it *albero maeſtro*.

The *fore-maſt*, called by the Levantines *trinquet*, and the Italians *albero de trenchetto*, is 54 palms long, big at the bottom, $1\frac{1}{4}$, a-top $\frac{2}{3}$ of a palm.

The *main yard* is 112 palms long, $\frac{5}{6}$ big at the lower end, and $\frac{7}{12}$ at the upper end. The *yard* of the fore-maſt is leſs, according to the proportion which is between both maſts, or from 90 to 54.

The *main ſail* is by the *Italians* called *antenna*.

The *gabier*, is the ſailor who ſtands centry on the ſcuttle, called *gabie* on the *Mediterranean*. There are the *great flag*, the *banniere*, the *flag of* *the trinquet*, the *weather cocks* of the *fore-mast*, the *banner* of the *fore-mast*, the *standard*, which distinguishes the nation, *&c.*

The *place* of the steerer.

The *place* of the captain in the *dunette*.

The *courser*, or *corsia*, which is the passage from the prow to the poop, thro' the rows of galley-slaves.

The *place* of the two *comites*, or officers of the galley-slaves.

The *place* of the trumpeters.

The *cutwater* of the *galley*, in *Italian* called *sperone*.

The *place* of the *courser*, which is a large piece of cannon in battery, lodg'd on the fore part of the *galley*; it is commonly a 33 or 34 pounder.

Lighter cannons, which are commonly two bastard pieces, and two others 5 or 6 pounders. But the galleys of the King of *France* carry only at present in their stead, two 25 or 26 pounders.

The holes through which the ropes run, which serve to lift up on board the cannon, and other heavy burdens.

The *anchor* or *grapler* of the *galley*.

The outside and inside parts of the *galleys*, and what they contain, are,

1. The *prow*.
2. The *poop*.
3. The *place* of the captain.
4. The *bandins*, which are places for the knight's volunteers.

The *oars* of a *galley* must be made of beech, 48 palms long, and have each 5 men to row. The palm is a measure of 9 inches.

The invention of ships is very antient, since God himself gave the first model thereof to *Noah*, for the building of his ark, to save the human race from the waters of the deluge. The first celebrated ships of antiquity, besides this ark, are that of *Ptolemy Philopater*, which was 280 cubits long, 38 broad, and 48 high; it carried 400 rowers, 400 sailors, and 3000 soldiers. That which the same prince made to sail on the *Nile*, we are told, was half a stadium long. Yet these were nothing in comparison with *Hiero*'s ship, built under the direction of *Archimedes*; on the structure whereof *Moschion*, as we are told by *Snellius*, wrote a whole volume. There was wood enough employ'd in it to make fifty galleys; it had all the variety of apartments of a palace; banquetting-rooms, galleries, gardens, fish-ponds, stables, mills, baths, a temple of *Venus*, &c. It was encompassed with an iron rampart, eight towers, with walls, and bulwarks, furnished with machines of war; particularly one, which threw a stone of 300 pounds, or a dart 12 cubits long, the space of half a mile; with many other particulars related by *Athenæus*.

NAVIGATION.

NAVIGATION is the art or act of sailing, or of conducting a vessel from one place to another, the safest, shortest, and most commodious way.

Common NAVIGATION, usually called coasting, is when the ports are on the same, and very neighbouring coasts; and where the vessel is seldom out of sight of land, or out of reach of sounding.

In this, little else is required, but an acquaintance with the land, the compass and sounding line,

Proper NAVIGATION, is where the voyage is long, and out in the main ocean.

In this, besides the requisites in the former, are likewise required the use of *Mercator's chart*, *azimuth*, and *amplitude compasses*, *log-line*, and other instruments for celestial observations, as *quadrants*, *fore-staffs*, &c.

Navigation turns principally on four things, two whereof being known, the rest are easily found from them, by the tables, scales, and charts.

These four things are, the *difference of latitude*, *difference of longitude*, the *reckoning*, or *distance run*, and the *course*, or *rhumb sailed on*.

The *latitudes* are easily found, and with sufficient accuracy.

The *course* and *distance* are had by the log-line, or dead reckoning, and the compass.

Before we set sail, we must provide ourselves with the various instruments necessary for both a *common* and *proper* NAVIGATION, as *common compasses*, *sounding-lines*, *azimuth*, and *amplitude compasses*, *log-lines*, *quadrants*, *fore-staffs*, *back-staffs*, &c. and learn the use of each of them in particular, beginning by the *common compass*.

The *common* SEA-COMPASS consists of a box which includes a *magnetical needle*, that always turns to the *north*; excepting a little declination, which is various in various places, and even at times in the same place.

The first thing pupil pilots learn on this *compass*, are the 32 winds; to which the 32 points of the compass answer. The names of those winds and points, and the distances of the points, *&c.* from *North* are as follow:

	From the North.	
1. North,	0°	0′
2. North by Eaſt	11	15
3. North-North-Eaſt	22	30
4. North-Eaſt by North	33	45
5. *North-Eaſt*	45	
6. North-Eaſt by Eaſt	56	15
7. Eaſt-North-Eaſt	67	30
8. Eaſt by North	78	45
	From the Eaſt.	
9. East,	0°	0′
10. Eaſt by South	11	15
11. Eaſt-South-Eaſt	22	30
12. South-Eaſt by Eaſt	33	45
13. *South-Eaſt*	45	
14. South-Eaſt by South	56	15
15. South-South-Eaſt	67	30
16. South by Eaſt	78	45
	From the South.	
17. South,	0°	0′
18. South by Weſt	11	15
19. South-South-Weſt	22	30
20. South-Weſt by South	33	45
21. *South-Weſt*	45	
22. South-Weſt by Weſt	56	15
23. Weſt-South-Weſt	67	30
24. Weſt by South.	78	45
	From the Weſt.	
25. West,	0°	0′
26. Weſt by North	11	15
27. Weſt-North-Weſt	22	30
28. North-Weſt by Weſt	33	45
29. *North-Weſt*	45	
30. North-Weſt by North	56	15
31. North-North-Weſt	67	30
32. North by Weſt	78	45

Next, they learn the *uſe of the compaſs*, which is *obvious*. For the courſe a ſhip is to ſail in, being known by the chart; and the *compaſs* ſo placed, as that the two parallel ſides of the ſquare bore be diſpoſed according to the length of the ſhip, *i. e.* parallel to a line drawn from the head to the ſtern, the rudder is to be directed accordingly; *v. gr.* if the courſe be found on the chart, between the ſouth-weſt and ſouth-ſouth-weſt, *i. e.* ſouth-weſt ¼ to the ſouth; turn the ſtern, ſo that a line from the ſouth-weſt, ¼ ſouth, exactly anſwers the mark on the middle of the ſide of the bore. This is all that is required.

The *magnet* or *loadſtone* as it is commonly called, is a ſort of iron-ſtone, found in iron mines, of the colour, but harder and more ponderous than iron.

Its natural property is to attract iron; and this attractive property is conveyed by rubbing the ſtone upon ſteel or iron to the metal alſo.

But its moſt uſeful faculty is its direction always to the north point of the globe.

To account for all the phænomena of the *magnet*, according to both its *attractive* and *directive faculty*, ſeveral hypotheſes have been invented at different times, and by divers philoſophers, tho' none of them has been found ſatisfactory yet.

Cardan attributes the *directive* faculty of the *magnet* to the polar ſtar: the univerſity of *Conimbre*, to ſome part of the heavens, not very diſtant from the pole: the common ſcholaſticks to an occult quality, which God wills *ſhould be the ſubject of our ſurprize, but above our apprehenſion.* And the modern philoſophers, have recourſe to certain ſubſtantial effluvia flowing from the earth; which laſt opinion is the moſt probable; tho' in the particular explication of their ſeveral opinions, a great number of difficulties occur, which are not very eaſily reſolved.

Des Cartes explains the *magnetical* virtue, by the ſtriated or channelled matter, which he ſuppoſes circulating round the earth, and imagines this hypotheſis very eaſy, and very proper to explain the phænomena of the *magnet*. But ſeveral philoſophers cannot believe that it is poſſible, that either the necklace of the ſtriated matter, or the channels or ſmall pipes in which they are moved, can always retain their ſtriated figure, without the prominences of the channels being wore off at laſt. For how is it poſſible, ſay they, that a continual friction ſhould not wear off the channels: and how can the prominent parts of the beads be ſo aptly received into the ſtriated receptacles dug in the channels, as never to ſtop in them, nor retard the motion of the ſucceeding holes; and be moved with no leſs celerity, than if they were carried round their axis with a direct motion?

The *directive faculty* of the *magnet* muſt be taken from the ſubſtantial effluvia entring, by a perpetual circulation, one pole of the earth, and coming out at the other; ſince by thoſe ſubſtantial effluvia, entring by a perpetual circulation one pole of the earth, and coming out at the other, the direction of the *magnet* towards the poles of the earth is rightly underſtood; thoſe *effluvia* being again moved through the ſame meatus they had formed to themſelves in the mine. And this is confirmed not only by the phænomena of the *magnet* itſelf, but likewiſe by thoſe of the iron, the nature whereof is much like that of the *magnet*.

For, 1. Iron rods which have been a long time fixed on the earth in a perpendicular manner acquire a *magnetick* virtue, whereby they direct themſelves towards the poles of the world. When any iron bar ſtanding, for a conſiderable time, perpendicularly in the fire, has a *magnetick* power; and when applied to the needle of of a sea-compass, attracts it to itself, on one part, and repulses it on the other, as it happens in the *magnet*; which cannot be understood unless by the substantial effluvia, which flowing from the earth incline the small fibres of the iron on that part, towards which they are moved. For that power is easier communicated to a hot iron, and a little softened, than when it is cold and hard.

2. We can be persuaded that the *magnet* borrows its *attractive faculty* from the earth, by the *inclination of the needle of a sea compass*. For if the needle, which is placed in an equilibrium in the box of the compass, be touched by the *magnet*, presently the part thereof, directed towards the north, beyond the equinoctial circle, in the northern climates is depressed, and the opposite part raised; because the rays of the *magnetick* matter flowing from the earth, and penetrating the needle at its northern part or pole, are bowed archwise, as they are seen towards the poles *a*, *b*, fig. 3. in the *magnet* plate, whence they force that part to descend a little, therefore the mariners commonly affix wax to the other part, to keep the needle on a level.

But if the same mariners come under the equator, where the rays of the *magnetick* matter are carried in an almost direct line, as it can be seen towards the middle of the *magnet*, *a*, *b*, *Fig*, 3. *ib.* the wax must be taken off, and both parts of the needle will mutually keep one another in an equilibrium. Lastly, if they pass beyond the equator, the southern part of the same needle, which before tended upwards, will begin to incline downwards, or be depressed, and the wax shall be affixed to the other part; from which experiment it is very well inferred, that the *directive power* of the *magnet* is to be attributed to the effluvia flowing from the earth.

3. The *magnet* not only adapts itself to the situation of the earth, but must also be conceived as a certain *terella*, or small earth, having its poles, equator, and meridians, according to Dr. *Gilbert*'s sentiment. For it has its vortex or atmosphere, which the farther it goes the weaker it is; which vortex appears manifestly in iron-filings, strewed round the *magnet*; for those filings are soon seen to dispose themselves in the form of an orb, from one pole to the other, *viz.* from the pole *a*, southern, to the pole *b*, northern, *Fig*. 3. *ib.*

But as the *magnetick* substance enters through one pole of the *magnet*, and comes out at the other pole; if the northern, or pole of ingress of one *magnet*, be turn'd towards the southern or pole of egress of another *magnet*; the matter which flows from the one, will easily enter the other; whence the iron-filings between both will be directed in right lines, *v. gr.* if the pole *a*, or southern of one *magnet*, Fig. 4. *ib.* be turned towards the pole *b*, northern of another *magnet*, the iron-filings thrown between both, will be soon directed in right lines, and to form one and the same vortex, around both *magnets*.

But if the two poles, which mutually regard one another, are both poles of ingress or poles of egress, or both northern or southern, *Fig*. 5. *ib.* then the *magnetick* effluvia will form two vortices, and remove one *magnet* from the other.

When the *magnet* is armed at both poles with polished steel, as *Fig*. 2. then the magnetick effluvia flow with a greater facility towards the pole, *v. g.* the northern A, through the steel between A and *a*, than through the air. Likewise on the other part, it is easier moved between B and *b*, than in the air, and therefore form a vortex, whereby iron-rings, disposed in a semi-circle, are suspended. Whence, if in lieu of rings a piece of iron be applied to the two extremities of the steel, *viz. a* and *b*, that iron will be sustained by the force of both poles; whereas if it was not armed, it would only be sustained by one, *viz.* either the northern or southern: wherefore the magnetick virtue acquires a considerable increase by the *magnet* being armed. But if the steel wherewith the *magnet* is armed be rusty, so as to hinder the magnetick matter moving thro' it with ease, then the magnetick virtue acquires but little increase. When a piece of paper is put between the armature, and the iron which is to be attracted, the paper hinders the *magnet* from having more virtue than if it was not armed; because it does not touch the iron with more parts than if it was not armed.

The *navigator* having been well informed of the nature and properties of the loadstone, and the use of the compass, is to apply himself diligently to the study of *charts* and other instruments.

In common navigation nothing is wanted but the *compass* and *sounding-line*.

A Chart, or Sea-chart, is a hydrophical map; or a projection of some part of the sea in plans, for the use of *Navigation*.

There are three kinds of *sea-charts*, viz. *plain charts*, reduced, or *Mercator's charts*, and *globular charts*.

Plain charts are those wherein the meridians and parallels are exhibited by right lines parallel to each other

These *plain charts* are made, 1. By drawing a right-line, and dividing it into as many equal parts as there are degrees of latitude in the portion of the sea to be represented. 2 Another line is added to it, at right angles, which must be divided into as many parts, and those equal to one another, and to to the former, as there are degrees of longitude in the portion of the ſea to be repreſented. 3. The parallelogram muſt be compleated, and its area reſolved into little ſquares; then right-lines parallel to the two firſt will be meridians, and the others parallel. 4. The coaſt, iſlands, ſands, rocks, *&c.* muſt be inſerted in this *chart*, from a table of longitudes and latitudes, in the ſame manner as it is done in maps.

Hence, 1. The latitude and longitude of a ſhip being given, her place is eaſily exhibited in the *chart*. 2. The places to and from which the ſhip ſails, being given in a map, the right-line drawn from one to the other, makes, with the meridian, an angle equal to the inclination of the rhumb; and ſince the parts intercepted between equidiſtant parallels are equal, and the inclination of the right-line (drawn from one place to the other) to all the meridians or right-lines parallel to the firſt right-line, is the ſame; the right-line drawn from one place to the other truly repreſents the rhumb. After the ſame manner may be ſhewn, that this *chart* exhibits miles of longitude truly.

A Sounding-line is a line and plummet, uſed in *navigation*, to try the depth of the water, and the quality of the bottom.

There are two kinds of *lines* occaſionally uſed in *ſounding* the ſea; the *ſounding-line*, and the *deep ſea line*.

The *ſounding line* is the thickeſt and ſhorteſt, as not exceeding 20 fathoms in length; and marked at two, three, and four fathoms, with a piece of black leather between the ſtrands; and at five with a piece of white leather.

The ſounding-line may be uſed when the ſhip is under ſail, which the *deep ſea-line* cannot. The plummet is uſually in form of a nine-pin, and weighs 18 pounds; the end is frequently greaſed, to try whether the ground be ſandy or rocky; and to diſcover in what degree of latitude the ſhip is, when a pilot thinks himſelf near a coaſt, and could not take any obſervation for ſeveral days before; for ſeveral coaſts are diſcovered, either by the quality, or colour of the bottom near them.—Near banks, ſhores, *&c.* they are to be ſounding continually.

Dr. *Hook* has invented a manner of *ſounding* the depth of the deepeſt ſea without any line, only by a wooden globe, lighter than water, to which, at a little diſtance, is a piece of lead or ſtone fixed, by means of a ſpringing wire in the firſt, fitted into a ſtaple in the ſecond. The whole being let gently down with the ſtone or lead foremoſt, as ſoon as that arrives at the bottom, it will ſtop; but the ball by the impetus it has acquired in deſcending, will be carried a little lower after the weight is ſtopped; by which means the ſpringing wire will be enabled to fly back and diſtinguiſh itſelf, and reaſcend. By obſerving then the time of the ball's ſtay under water by a watch or pendulum, and the help of ſome tables, the depth of the ſea is found.

In ſome experiments made in the *Thames* with a maple globe, $5\frac{1}{5}$ inches in diameter, and weighing 4 pounds and a half, lin'd with pitch, and a conical weight 11 inches long, the ſharp end downwards; at the depth of 19 feet, there paſſed ſix ſeconds, and at the depth of 10 feet $3\frac{1}{2}$ ſeconds between the immerſion and emerſion of the ball. From theſe numbers given, the depth at any other ſtays, may be computed by the Rule of Three.

The inſtruments we muſt embark for *a proper navigation*, or what the *French* call, *un voiage du long cours*, are, as already obſerved, *Mercator's chart*, *azimuth*, and *amplitude compaſſes*, *log-lines*, and other inſtruments for celeſtial obſervations, as *quadrants*, *fore-ſtaffs*, *back-ſtaffs*, &c.

Mercator's Chart, is that wherein the meridians and parallels, are repreſented by parallel right-lines; but the degrees of the meridians are unequal, ſtill encreaſing as they approach the pole, in the ſame proportion as thoſe of the parallels decreaſe; by means whereof the ſame proportion is obſerved between them as on the globe.

This *chart* has its name from that of the author, who firſt propoſed it for uſe, and made the firſt *chart* of this projection, *N. Mercator*: but the thought was not originally his own, as having been hinted by *Ptolemy*, near 2000 years ago; and the *Engliſh* ſay, that the perfection thereof is owing to their countryman Mr. *Wright*, who firſt demonſtrated it, and ſhewed a ready way of conſtructing it, by enlarging the meridinal line by the continual addition of ſecants.

To ſail by means of *Mercator*'s *chart*, the following obſervations are to be made.

I. *The longitude and latitude of two places given, to find the departure or miles of longitude, in* Mercator'*s ſailing* (which we have already found in *plain ſailing*) the reduction whereof is much more commodiouſly performed in *Mercator's charts*; wherein the arch intercepted between the two meridians, is applied to an arch of the meridian intercepted between the two parallels; and the diſtance in their meaſures, gives the departure, or miles of longitude required.

II. *The longitude and latitude of two places, to and from which a ſhip is to ſail, being given, to find the rhumb to be ſailed on, and the diſtance to be run in* Mercator's *ſailing*,—1. The center of the mariner's ner's compaſs is applied on the place ſailed from, on *Mercator's chart*, and ſo as that the north and ſouth line thereof be parallel to ſome of the meridians. 2. The rhumb of the compaſs is marked, wherein the place ſailed to is placed; for this is the rhumb to be ſailed on. 3. The ſame rhumb is likewiſe found by drawing a right line from the place ſailed from to that ſailed to; and with a protractor, finding the angles the rhumb makes with any meridian it cuts.

III. *The rhumb and diſtance ſailed being given; to find the longitude and latitude of the place arrived at, in* Mercator's *ſailing*.—1. The mariner's compaſs is placed on the *chart*, with the center over the place ſailed from; and the meridian, and north or ſouth line, parallel to the meridian thereof. 2. From the place ſailed from, a right line is drawn for the ſhip's courſe: then the diſtance is taken by parts, in parts of the meridian, and is ſet off upon the right line, then will C be the place the ſhip is arrived at; the longitude and latitude whereof are given by the *chart*.

To find it by the loxodromick tables.——1. Under the given rhumb, ſeek the diſtance anſwering to the latitude of the place ſailed from; and either add it to, or ſubſtract it from the given diſtance, as the latitude of the place ſailed to is greater, or leſs than that ſailed from. 2. Under the ſame rhumb, aſcend or deſcend further, till you meet with the diſtance corrected. 3. The latitude anſwering thereto in the firſt column, is the latitude of the place ſailed to. 4. From the ſecond column of the table, take the longitudes correſponding to the latitudes of the places ſailed to, and from Their difference is the difference of longitude of the places ſailed to and from.

In *plain ſailing*, i. e. by *common charts*, the operation is conducted thus, 1. From the *data*, the difference of latitude of the two places is found; this difference added to the latitude of the place ſailed from, or ſubſtracted from the ſame, the ſum, or the remainder, leaves the latitude of the place ſailed to. 2. From the ſame, the departure muſt be found; and thence the latitude of the place ſailed to.

IV. *The latitudes of the places ſailed to and from, together with the rhumb ſailed in, being given; to find the diſtance and difference of latitudes, in* Mercator's *ſailing*—1. The compaſs is placed on the *chart* as in the preceding caſe; and from the place ſailed from, the rhumb line ſailed in is drawn, till it cuts the parallel of the given latitude. 2. The point of interſection will be the place arrived in. 3. Hence its longitude is eaſily found, and the diſtances.

By the tables. Take both the longitude and the diſtances, anſwering to the latitudes of the given places, out of the tables; then ſubſtract both the longitudes and the diſtances from each other. The firſt remainder is the difference of longitude, the latter the diſtance of the places.

The ſame operation in *plain ſailing*, is made by finding the diſtance from the difference of latitude and the rhumb given; and from the ſame data the departure. This converted into degrees of a great circle, exhibits the difference of longitudes ſought.

V. *The latitudes of the places ſailed from and to, with the diſtance given; to find the rhumb, and the difference of longitude, in* Mercator's *ſailing*; the parallel the ſhip arrives at, is drawn on the map; and the diſtance run reduced into parts proportional to the degrees of the map.

By the tables; ſubſtract the given latitudes from each other; and in the tables ſeek the rhumb, under which the diſtance run anſwers to the given difference of latitude. Subſtract the longitude under the rhumb, anſwering the latitude of the place ſailed to, and that under the ſame rhumb againſt the latitude of the term ſailed to, from each other; the remainder is the difference of longitude ſought.

The operation in *plain ſailing*, runs thus.—A rhumb is to be found from the difference of latitude, and the diſtance; and from the ſame data, the departure muſt be found, likewiſe; which may be alſo determined from the rhumb now found, and the difference of latitude; or from the rhumb and the diſtance run. Laſtly, from the departure the difference of longitude is to be found.

VI. *The difference of longitudes of the places ſailed to and from, with the latitude of one of the places, and the diſtance run being given; to find the rhumb and the latitude of the other, in* Mercator's *ſailing*; a right line is drawn thro' the place given in the map, parallel to the meridian, making another line equal to the difference of longitude; then another parallel is drawn which will be the meridian the ſhip is arrived at. Afterwards with the interval of the diſtance run, an arch is deſcribed interſecting the meridian, whereby the place ſought is found.

By the tables. We may take a rhumb at pleaſure, and under the ſame, in the tables, find the longitude, and the diſtance anſwering to the given latitude. Adding the given diſtance to the diſtance found in the tables, if the veſſel ſailed from the equator; or ſubſtracting it therefrom, if it ſailed towards the ſame. With the ſame ſum, or the difference, we muſt enter the tables; ſubſtracting or adding the longitude found againſt it, to that juſt found. If the remainder be found the given difference of longitudes, the rhumb is well taken. Otherwiſe it muſt be changed for a more, or leſs oblique one; till the ſame operation being repeated, the

the remainder be found the difference of longitudes; then the latitude in the firſt column, correſponding to the diſtance, will be the latitude of the other place.

The operation in *plain ſailing*, is made by converting the difference of longitudes into miles of longitude for the departure; ſeeking the rhumb from the given departure and diſtance run; and from the ſame, and the rhumb, ſeeking the difference of latitude; which, and the latitude of one place being had, the latitude of the other readily follows.

VII. *The difference of longitude, and the latitude of one of the places given, together with the rhumb, to find the differences run, and the latitude of the other place, by* Mercator's *ſailing:* the compaſs muſt be placed on the *chart* as before; and by the given rhumb the rhumb-line is drawn, and a meridian thro' the given place, and another with the interval of the difference of longitude, for that the veſſel is arrived at. Where this interſects the rhumb-line, is the place where the veſſel is arrived at. Wherefore if thro' that place be drawn a line parallel to the rhumb-line, the diſtance between both lines will be the latitude of the place. The diſtance run is eaſily reduced into miles by the ſcale.

By the tables. Under the given rhumb, ſeek the diſtance run, and the difference of longitude anſwering to the given latitude. If the veſſel has ſailed towards the pole, the difference of longitude is to be added to the given difference of longitude; if towards the equator, it is to be ſubſtracted from the ſame. In the former caſe deſcend in the table, and in the latter, aſcend; till in the firſt, the aggregate, in the latter, the difference be ſeen in the column of longitude. The latitude anſwering hereto in the firſt column, is that ſought. And from the diſtance anſwering to the latitude in the firſt caſe, the tabular diſtance is to be ſubſtracted. What remains is the diſtance run.

In *plain ſailing*, the difference of longitude muſt be reduced into miles of longitude or departure, as under the firſt caſe. From the departure and the rhumb, the diſtance run is found; and from theſe, or from the rhumb, and the diſtance run, the difference of latitude. This done, as the latitude of the one is already had, that of the other is ſo too.

Rhumb, according to *Aubin*, is a line on the terreſtrial globe, ſea-compaſs, or ſea chart, repreſenting one of the 32 winds, which ſerve to conduct a veſſel. So that the *rhumb* a veſſel purſues, is conceived as its rout or courſe.

Rhumbs are divided, and ſubdivided like points. Thus the whole *rhumb* anſwers to the cardinal point. The half *rhumb* to a collateral point, or makes an angle of 45 degrees with the former. The quarter *rhumb* makes an angle of 22° 30′ therewith. And the half quarter *rhumb* makes an angle of 11° 15′

Rhumb-line, *loxodromia*, is the line which a ſhip keeping in the ſame collateral point or *rhumb*, deſcribes throughout its whole courſe.

The great property of this *rhumb-line*, or *loxodromick*, and that from which ſome authors define it, is, that it cuts all the meridians under the ſame angle. This angle is called the *angle of the rhumb*, or the *loxodromick angle*.

The angle, which the *rhumb-line* makes with any parallel to the equator, is called the complement of the *rhumb*.

The uſe of the *rhumb-line* in *Navigation*, is as follows. 1. If ſeveral meridians be not very far apart, the *rhumb-line* is divided by the equi-diſtant parallels, into equal parts.

Hence, 1. The parts of ſeveral *rhumb-lines*, are as the ſeveral latitudes of the places the ſhip ſails from and to. 2. Since the arches form'd thereby are equal in magnitude, and therefore unequal in numbers of degrees, the ſum of the arches, called the *latus mecodinamicum*, or miles of longitude, is not equal to the difference of longitude of the two places above-mentioned.

2. The length of the *rhumb-line* is to the change or difference of latitude, in the ſame ratio as the whole ſine to the co-ſine of the angle of the *rhumb*.

Hence, 1. The *rhumb* ſailed on being given, together with the difference or change of latitude, turned into miles; the length of the *rhumb-line*, or the diſtance from one place to another upon the ſame *rhumb*. is had by the Rule of Three. 2. The *rhumb-line* being given, together with the quantity of the ſhip's way; on the ſame *rhumb*; the difference of latitude is had by the Rule of Three, in miles to be converted into degrees of a great circle. 3. The difference of latitude being given in miles; as alſo the length of the *rhumb-line*; the angle of the *rhumb*, and conſequently the *rhumb* ſailed on, is had by the Rule of Three. 4. Since the co ſine is to the whole ſine, as the whole ſine to the ſecant; the difference of latitude is to the length of the *rhumb-line*, as the whole ſine to the ſecant of the *rhumb*.

3. The length of the *rhumb-line*, or of the ſhip's way in the ſame *rhumb*, is to the *latus mecodinamicum*, or *mecodinamick ſide*, as the whole ſine to the ſine of the *loxodromick angle*.

Hence, 1. The *rhumb*, or angle of the *rhumb*, being given, as alſo the ſhip's way in the ſame *rhumb-line*; the *mecodinamick* ſide is had by the Rule of Three, in miles, *i. e.* in the ſame meaſure wherein the length of the *rhumb* is given. 2. In like

like manner, the *mecodinamick* fide being given, as alfo the *rhumb-line* or fhip's way; the *rhumb* failed in, is found by the Rule of Three.

4. The change of latitude, is to the *mecodinamick* fide, as the whole fine to the tangent of the *loxodromick angle*.

Hence the *rhumb* or *loxodromick angle*, and the change of latitude being given; the *mecodinamick* fide is found by the Rule of Three.

5. The *mecodinamick* fide is a mean proportional, between the aggregate of the *rhumb*, and the change of latitude, and their difference.

Hence the change of latitude, and the *rhumb-line*, being given in miles; the *mecodinamick* fide is found in the fame meafure.

6. The *mecodinamick* fide being given, to find the longitude.

Multiply the change or difference of latitude by fix, which reduces it into parts, of ten minutes each, divide by the product the *mecodinamick* fide; the quotient gives the miles of longitude, anfwering to the difference of latitude in ten minutes; reduce thefe miles of longitude in each parallel into differences of longitude, from a *loxodromick* table: the fum of thefe is the longitude required.

7. If a fhip fails on a north or fouth *rhumb*, it defcribes either the equinoctial, or a parallel thereto.

8. To find the *rhumb* between two places, by *calculation*, or *geometrically*, we have two canons or proportions: the firft, as the radius is to the half fum of the co-fines of both latitudes; or (rather for geometrical fchemes) as the diameter is to the fum of the co-fines of both latitudes, fo is the difference of longitude, to the departure from the meridian.

For an example of the former proportion.—Let the *rhumb* be required between Cape *Finifter*, lat. 43° long. 7°, 2 ′, and St. *Nicholas* ifle, lat. 38°, long. 352°. The middle latitude is 40°, 30′, the complement 49°, 30′, and the difference of longitude 15°, 20′; out of thefe leffer equal parts, prick down 15°, and defcribe an arch with 60° of the chords, and make it equal to 49°; then draw an arch continued to the further diftance, making the neareft diftance the leg of a right angled triangle, and the other leg the difference of latitude 5°, which muft be pricked from the equal parts. Thus the extent meafured on the faid parts, fhews the diftance to be 13°, 24′; which allowing 20 leagues to a degree, is almoft 268 leagues. Then the *rhumb* triangle muft be croffed with the radius; which extent meafured on the greater chord is almoft 22°, the complement whereof is 68°; and fo much is the *rhumb* from the meridian between the two places, amounting to 6 points, and upwards of 80 minutes.

For an inftance of the laft proportion.—Let it be required to find the *rhumb* and diftance between the *Lizard* and *Bermudas*, the latitude of the *Lizard* being 50°, and that of *Bermudas* 32°, 20′; or 32°, 4′, centefms, and their difference of longitude, 55°, two lines muft be drawn at right angles, and with 60° of the leffer chords, a quadrant muft be defcribed, and radius pricked, the fecond line drawn will be the diameter; then counting both latitudes, the neareft diftance is the co-fine of *Bermudas* latitude; and the neareft diftance to this is the co-fine of the *Lizard*'s latitude. Then drawing again another line, and pricking down 55 degrees out of the greater equal parts, and a parallel to the line laft drawn, the diftance from the firft of the 55 degrees to the right end of the parallel is the departure from the meridian in the courfe between both places. Making that, therefore, one leg of a right angled triangle, prick down 17°, 59 centefms, the difference of latitude between thofe places, and at the fame equal parts draw a line. This reprefents the courfe and diftance between the *Lizard* and *Bermudas*; and the extent meafured on the fame equal parts, fhews the diftance to be 44°, 31 centefms, which allowing 20 leagues to a degree, is 886 leagues.

The next inftrument is the *azimuth compafs*, which differs from the *common compafs* in this, that there is faftened on the round box wherein the card is, a broad circle, one half whereof is divided into 90 degrees; and thofe fubdivided diagonally into minutes. The index has a fight moving on a hinge. From the upper part of the fight, to the middle of the index, is faftened a fine hypothenufal luteftring, to give a fhadow on a line in the middle of the index. The circle is croffed at right angles with two threads, from the extremities whereof are drawn four lines on the infide of the round box: there are alfo four lines drawn at right angles to each other on the card. The round box fitted with its card, graduated circle, and index, is hung in brafs hoops, and thofe hoops faftened to a fquare box.

The ufe of the AZIMUTH COMPASS, is for finding the fcale, magnetical azimuth, or amplitude; and thence the variation of the compafs.

If the obfervation be for an amplitude at funrifing, or an *azimuth* before noon; apply the center of the index on the weft point of the card, within the box; fo that the four lines on the edge of the card, and thofe on the infide of the box may meet. If the obfervation be for the fun's amplitude fetting, or an *azimuth* in the afternoon, turn the center of the index right againft the eaft point of the card, and make the lines within the box concur with thofe on the card: the inftrument thus

thus fitted for obſervation, turn the index towards the ſun, till the ſhadow of the thread falls directly on the ſlit of the ſight, and on the line that is along the middle of the index; then will the inner edge of the index cut the degree and minute of the ſun's magnetical *azimuth* from the north or ſouth.

But note, that if, when the compaſs is thus placed, the *azimuth* is leſs than 45 degrees from the ſouth, and the index turned towards the ſun, it will paſs off the diviſions of the limb: the inſtrument, therefore, in this caſe, muſt be turned juſt a quarter of the compaſs, *i. e.* the center of the index muſt be placed on the north or ſouth point of the card, according as the ſun is from you; and then the edge will cut the degree of the magnetick *azimuth*, or ſun's *azimuth* from the north as before.

The ſun's magnetical amplitude thus found, the variation of the needle is thus determined.

Being out at ſea the 15th of *May*, 1759, in 45° north latitude, the tables give you the ſun's latitude 19° north, and its eaſt amplitute 27° 25′ north: by the *azimuth compaſs*, we find the ſun's magnetical amplitude, at its riſing and ſetting; and finds he riſes, *v. gr.* between the 62d and 63d degree, reckoning from the north towards the eaſt point of the compaſs, *i. e.* between the 27th and 28th deg. reckoning from the eaſt.

The Equinoctial Compass, which we have, likewiſe, among our inſtruments, ſerves to know at what point is the moon. That compaſs being riſen on the ſuperficies of the equinoctial line, divides it juſtly into equal parts, as the common compaſs does the horizon. We ſee the line which runs through the figure of that compaſs, repreſents the axis of the world. The round before the compaſs muſt be marked on both ſides, as well upwards and downwards, inſide with a common compaſs, and on the outſide with twice twelve hours: and on both ſides, which mark the eaſt and weſt, it muſt be ſuſpended on the tops of two pegs, as an axle-tree, ſo that it may turn upwards, and that the lower part of the arrow, which is on the quadrant, may be placed on all the altitudes of the pole.

The Nocturnal Compass, is a very common inſtrument, uſed to find at all hours of the night, how much the *northern ſtar* is higher or lower than the pole. It is alſo called a *quadrant for the ſtars*, becauſe it ſhews the hours in the night by means of the ſtars. Mariners make uſe moſt commonly for that purpoſe, of the ſtars of *Urſa major*, in this hemiſphere, becauſe they are more remarkable than the others which are nearer the northern pole; but in the other hemiſphere, or beyond the line, they chuſe the *Cruſade*, which is a conſtellation compoſed of four ſtars, which are eaſily diſtinguiſhed.

As the Sector, or *compaſs of proportion*, is a mathematical inſtrument, of great uſe in finding the proportion between quantities of the ſame kind, as between lines and lines, ſurfaces and ſurfaces, &c.

The great advantage of the *ſector* above the common ſcales, &c. is, that it is made ſo as to fit all radius's and ſcales. By the lines of chords, ſines, &c. on the *ſector*, we have lines of chords, ſines, &c. to any radius betwixt the length and breadth of the *ſector* when opened.

The *ſector* is founded on the fourth propoſition of the ſixth book of *Euclid*, where it is demonſtrated, that ſimilar triangles have their homologous ſides proportional.

This inſtrument conſiſts of two equal rules, or legs of braſs, or other matter, riveted together; but ſo as to move eaſy on the rivet. In the faces of the inſtrument are placed ſeveral lines: the principal are the line of equal parts, line of chords, line of ſines, line of tangents, line of ſecants, and line of polygons.

The *line of equal parts*, called alſo *lines of lines*, marked 6, is a line divided into 100 equal parts; and where the length of the line will allow it, each is ſubdivided into halves and quarters. It is founded on each leg, on the ſame ſide; and the diviſions numbered 1, 2, 3, 4, &c. to 10, which is near the extremity of each line. In practice 1 is taken for 10, or 100, or 1000, or 10,000, &c. as occaſion requires; in which caſes 2 repreſents 20, or 200, or 2000, &c. and ſo of the reſt.

The *line of chords*, marked C on each leg, is divided after the uſual manner, and numbered 10, 20, 30, &c. to 60.

The *line of lines*, denoted on each leg by the letter S, is a line of natural ſines, numbered 10, 20, 30, &c. to 90.

The *line of tangents*, denoted on each leg by the letter T, is a line of natural *tangents*, numbered 10, 20, 30, &c. to 45; beſides which is another little line of *tangents* on each leg, commencing at 45, and extending to 75°, denoted by the letter T.

The *line of ſecants*, denoted on each leg by the letter S, is a line of natural ſecants, numbered 10, 20, 30, &c. to 75, and commencing, not from the center of the inſtrument, but at two inches diſtance therefrom.

The *line of polygons*, denoted by the letter P, on each leg is numbered 4, 5, 6, &c. to 12, which falls 12 inches ſhort of the center of the inſtrument.

Beſides theſe lines, which are eſſential to the *ſector*, there are others placed near the outward edges

edges on both faces, and parallel, which are in all respects the same as in *Gunter's* scale, and used after the same manner. Such are the lines of artificial sines, marked S; the line of artificial tangents, a line of 12 inches, marked M, and *Gunter's* line of numbers marked N. There are sometimes other lines placed to fill up the vacant spaces, as the lines of hours, latitudes, and inclinations of meridians, which are used the same as on the common scales.

JACOB-STAFF, the same with *cross-staff*, is a mathematical instrument for taking heights and distances.

The *jacob*, *cross*, or *fore-staff* takes its denomination hence, that the observer in using it, turns his face towards the object; in contradiction to *back-staff*, where he turns his back to the object. The *fore* or *cross-staff*, represented in our table of the magnet, consists of a straight, square, graduated staff, and four crosses or vanes, which slide thereon. The first, or shortest of these vanes, is called the *ten cross*, or *vane*, and belongs to that side of the instrument, whereon the divisions begin at 3 degrees, and end at 10. The next longer vane is called the *thirty-cross*, belonging to that side of the staff, wherein the divisions begin at 10 degrees, and end at 30, called the *thirty scale*. The next vane is called the *sixty-cross*, and belongs to the side where the divisions begin at 20 degrees, and end at 60. The last, and longest, called the *ninety-cross*, belongs to the side whereon the divisions begin at 30 degrees, and end at 90.

The great use of this instrument is to take the height of the sun and stars, or the distance of two stars; and the ten, thirty, sixty, or ninety crosses, are to be used according as the altitude is greater or lesser, that is, if the altitude be less than 10 degrees, the tenth cross is to be used; if above ten, but lesser than thirty, the thirtieth cross to be used, &c.

To observe an altitude by the *fore-staff*, apply the flat end of the staff to your eye, and look at the upper end of the cross of the center of the sun or star, and at the lower end for the horizon. If you see the sky instead of the horizon, slide the cross a little nearer the eye; and if you see the sea instead of the horizon, slide the cross further from the eye: and thus continue moving, till you see exactly the sun or star's center, by the top of the cross, and the horizon by the bottom thereof.

Then the degrees and minutes cut by the inner edge of the cross upon the side of the *staff*, peculiar to the cross you use, is the altitude of the sun or star.

If it be the meridian altitude you want, continue your observation as long as you find the altitude increase, still moving the cross nearer to the eye.

By subtracting the meridian altitude thus found, from 90 degrees you will have the zenith distance.

To work accurately, an allowance must be made for the height of the eye, above the surface of the sea, *viz.* for 1 *English* foot, 1 minute, for 5 feet $2\frac{1}{4}$, for 10 feet $3\frac{1}{2}$, for 20 feet 5, for 40 feet 7, &c.

These minutes subtracted from the altitude observed, and added to the zenith distance observed, give the true altitude, and zenith distance.

To observe the distance of two stars, or the moon's distance from a star, by the *fore-staff*. Apply the instrument to the eye, and looking to both ends of the cross move it nearer, or farther from the eye, till you see the two stars; the one on one end, and the other on the other end of the cross; then the degrees and minutes cut by the cross on the side proper to the vane in use give the star's distance.

The *back-staff*, consists of three vanes, and of two arches, *viz.* the *horizon vane*, the *shade vane*, and the *sight vane*.

To use this *staff*, the *shadow vane* is set upon the arch, to an even degree of some altitude, less by 10, or 15 degrees than you judge the complement of the sun's altitude will be; and the *sight vane* on the thirtieth arch: the observer's back being then turned to the sun, (whence the name of *back-staff*, or *back-quadrant*) he lifts up the instrument, and looks through the *sight vane*, raising or falling the quadrant, till the shadow of the upper edge of the *shade-vane*, fall on the upper edge of the slit in the *horizon-vane*; and then if you can see the horizon through the said slit, the observation is well made; but if the sea appears instead of the horizon, move the *sight-vane*: if the sky appears move it upwards, and so try if it comes right; then observe how many degrees and minutes are cut by that edge of the *sight-vane*, which answers to the sight hole, and to them add the degrees cut by the upper edge of the *shade-vane*; the sum is the sun's distance from the zenith, or the complement of his altitude. To find the sun's meridian, or greatest altitude on any day, continue the observation as long as the altitude is found to increase, which you will perceive by the appearance of the sea instead of the horizon, removing the *sight-vane* lower; but when you perceive the sky appear instead of the horizon, the altitude is diminished; therefore desist from further observation at that time, and add the degrees upon the sixtieth arch to the degrees and minutes upon the thirtieth arch, and the sum is the zenith distance, or co-altitude of the sun's upper limb.

And because it is the zenith's distance, or co-altitude

titude of the upper limb of the sun, not the center that is given by the quadrant, in observing by the upper end of the *shade-vane*, add 16 minutes, the sun's semi-diameter, to that which is produced by your observation, and the sum is the true zenith distance of the sun's center. If you observe by the lower part of the shadow of the *shade-vane*, then the lower limb of the sun gives the shadow; and therefore you must substract 16 minutes from what the instrument gives; but considering the height of the observer above the surface of the sea, which is commonly between 16 and 20 feet, you may take 5 or 6 minutes from the 16 minutes, and make the allowance but of 10 or 12 minutes to be added instead of 16 minutes.

M. *Flamstead* contrived a glass lens, or double convex, to be placed in the middle of the *shade-vane*, which makes a small bright spot on the slit of the *horizon-vane*, instead of the shade; which is a great improvement, if the glass be truly made: for by this means the instrument may be used in hazy weather, and a much more accurate observation made in clear weather, than could be by the shadow.

From this I'll pass to examine the *log-line*, which is a little cord or line fastened to one end of the *log*, and wound round a reel, fixed for that purpose in the gallery of the ship.

A *log* is a small piece of wood of a triangular figure on board a ship; into one end whereof a convenient quantity of lead is cast, to make it swim upright in the water; the other end being fastened to a line.

This line from the distance of about ten fathom off the log, has certain knots or divisions, which ought to be at least 50 feet from each other; though it is the common practice at sea not to have them above 42 feet asunder.

The use of the *log* and *line*, is to keep account, and make an estimate of the ship's way, or distance run, which is done by observing the length of the line unwound in half a minute's time, told by a half-minute glass; for so many knots as run out in that time, so many miles the ship sails in an hour.

Thus, if there be four knots veered out in half a minute, the ship is computed to run four miles an hour.

To heave the log, as they call it, they throw it into the water, letting it run till it comes without the eddy of the ship's waste, then one holding a half minute glass, turns it up just as the first knot turns off the reel (though some turn the glass as soon as the log touches the water) as soon as the glass is out the reel is stopped, and the knots run off are told, and their parts estimated.

The log ought to be heaved every hour, or every two hours.

There is also the *log-board*, which is a table divided into four or five columns, whereon are marked the reckoning of every day; from whence they are entered into the *log-book*, or traverse-book, ruled and columned just as the log-board is: whence it may be transcribed into the journals, and how much the ship gains in her course be estimated daily.

In the first column of the log-board is entered the hour of the day, from one to one: in the second, the rhumb, or the direction of the vessel, with regard to the points of the compass: in the third, the number of knots run off the reel each time of heaving the log: in the fourth, the wind that blows; and in the fifth, observations made of the weather, variation of the compass, &c.

A *Journal* is a register kept by the pilot, wherein notice is taken of every thing that happens to the ship from day to day, and from hour to hour, with regard to the wind, the rhumbs, the rake, soundings, &c. in order to enable him to adjust the reckoning, and determine the place where the ship is: thus,

Journal *of* 12 *hours*.

Rhumb.	*Value of the Rhumb.*	*Wind.*	*Quality of the Wind.*	*Leagues of 3000 Paces.*
W. N. W.	W. N. W	E. S. E. back	middling	2
W. N. W.	W. N. W	E. S. E. back	good or fresh.	3
W. N. W.	W. N. W	E. S. E. back	middling.	2
W. N$\frac{1}{4}$ W	W. N. W.	S. E. sidewise.	good	4
W. N$\frac{1}{4}$ W.	W. N. W.	S. E. sidewise	middling	1$\frac{1}{2}$
N. W.	W. N. W.	S. E. sidewise	little Wind	2
N. W.	W. N. W.	S E. sidewise	midd.ng	1$\frac{1}{2}$
N. N. W.	N. W.	E. S. E Quarter.	good	8

From

From the Firſt Day of March *at Noon.*

Hour Glaſſes of half Hours.	Latit. valued. D.	M.	Lat. obſerv'd. D.	M.	Longitude. D.	M.	Declenſion of the Needle. D.	M.
2			41.		5.		2. *Eaſt*	30.
2								
2								
4								
2								
4								
2								
6 12 *at Night.*	41.	50.	41.	30.	3.	15.	1.	10.

Journal, 1759.

In this journal we ſuppoſe to have conveyed ſome merchant ſhips to *Liſbon*, whence we proceed on our voyage to *Jamaica*.

In the Name of God, *Amen.*

The 27th of *February*, at noon, the wind being north-north-eaſt, we ſailed from the gulph of *Liſbon*, to proceed, with God's aſſiſtance, on our voyage to *Jamaica*, in his Majeſty's ſhip the *N.* 400 tons burthen, carrying 36 guns; the captain *M. P.* the lieutenant *M. R.* and the firſt pilot *N.* God grant us a good voyage.

We anchored by about 12 fathoms of water, and after we had waited till the 18th, we heaved up our anchor at ſix in the morning, with a middling eaſterly wind; and after we had doubled the cape of *Rocca*, we put the cape to the north-weſt till ſix in the evening; but that rhumb was worth but weſt-north-weſt to us, becauſe of the currents, and we reckoned to have made 25 leagues.

About ſix in the evening, the wind being turned to the ſouth, we kept ſtill the cape to the north-weſt, therefore that ſame wind having laſted till twelve at noon the next day, we reckon'd to have failed 55 leagues by that rhumb. For having made our obſervation, we found ourſelves at 40 degrees of latitude, and by eſtimate at 5 of longitude.

Rhumb.	Value of the Rhumb.	Wind.
N. W.	W. N. W.	E. *Mid.*
N. W.	N. W.	S. *Good.*

Leagues.	Latitude.	Longitude.
25	38 Deg. 30 Min.	9 Deg 15 Min.
55	41 Deg. 0 Min.	5 Deg. 0 Min.

From twelve at noon, of the 1ſt day of *March*, we ſailed on the north-weſt, ¼ weſt, with a very unſettled wind, ſometimes good, ſometimes middling, which blew part from the eaſt-ſouth-eaſt, and part from the ſouth-eaſt. We reckoned to have failed 24 leagues in 12 hours and to be under the 41°, 50′, of latitude. And by that obſervation, judged that we were under the 3° 15′ of longitude, and that ſame current had made us lie by weſt-north-weſt.

The ſecond day of the ſame month, we were overtaken by a violent tempeſt, mixed with thunder and lightning, and night happening all on a ſudden, a prodigious *puchot* (which is a kind of whirlwind) ſeized our ſhip by the bowſprit with ſo much violence, that it laid her on her ſide; we then thought ourſelves loſt; but that whirlwind finding no hold on that ſide of the ſhip, was ſoon over, and our ſhip raiſed herſelf by degrees. We were forced to throw ſome pieces of cannon, and ſome merchandizes over-board; becauſe the tempeſt continued till the next day, and was followed by very foul weather, which continued till the 5th in the morning; and that day having made an obſervation at noon, we found ourſelves under the 39° 12′; and having told our hour-glaſſes, for 12 at noon of the firſt day of *March*, there were but 193, *i. e.* one more than four times 48, wanted for the four days, at that time there could be one quarter of the ſand run through. We reckoned then, that we could be diſtant from the meridian of the place, where we were the firſt of *March*, at noon, but of about 9 degrees weſtward; becauſe the ſun running thro' 7½ in a half hour, the degree and a half above was reckoned for the quarter of the ſand run at the time of the obſervation; and that, therefore, we could be under the 356 degrees of longitude.

By that reaſoning we corrected our eſtimate, and judge, in pointing our chart, that we had made 115 leagues, and that we were diſtant from the *Tercera* iſlands, of about 40 leagues.

Rhumb.	Value of the Rhumb.	Wind.
N. W. ¼ W.	W. N. W.	E. S E. *middling.*
W. N. W.	W. S. W.	N. N. E. *Tempeſt.*

Leagues.	Latitude.	Longitude.
24	41° 30′	3° 15′
115	39° 12′	356° 0′

6. We were ſcarce recovered from our fright, cauſed by the tempeſt, then the 6th of *March* about

eight

eight in the morning, we difcovered four *Spanifh* men of war, which chafed us; but as we were not capable to cope with them, we fet out all our fails, and putting the cap to the north, we bore away for the ifle of *St. Michael*, where we caft anchor about five in the evening under fhelter of the caftle, which we faluted with two pieces of cannon, and though it be not a very fafe place, the enemy did not dare to attack us there.

Rhumb.	*Val. of the Rhumb.*	*Wind.*
S. S. W.	S. S. W.	N. good.
Leagues.	*Latitude.*	*Longitude.*
22	38° 15′	355° 20′

7. The weather was fair enough during the five days we were forced to remain in the road of that ifland, to refit our fhip by the governor's leave, who gave us frefh provifions. We took our obfervation, and found that our compafs declined no longer.

12. The twelfth, at ten in the morning we hove up our anchor by a good wind of fouth-eaft, and failed towards the ifland *Tercera*, which we faluted with two pieces of cannon. The next day early in the morning we continued our voyage towards *Jamaica*.

This is the plan and order which can be followed in a grand journal: fome reduce it into a table of ten or twelve columns, like that of 24 hours, but make the fquares four times bigger, to have more room for their particular obfervations.

OPTICKS.

OPTICKS, according to Sir *Ifaac Newton*, is a mixed mathematical fcience, which explains the manner wherein vifion is performed in the eye; treats of fight in the general; gives the reafon of the feveral modifications or alterations which the rays of light undergoes in the eye; and fhews why objects appear fometimes greater, fometimes fmaller, fometimes more diftinct, fometimes more confufed, fometimes nearer, and fometimes more remote.

I'll begin this by treating of fight in general; and previoufly to it, by an exact defcription of feveral parts which compofe the eye; then I'll pafs to *catoptricks*, and from thence to *dioptricks*, leaving *perfpective* for a treatife a-part.

The organ of *fight* is the eye; the author of nature has provided for the fecurity of both eyes, by placing them under the forehead, on the fides of the nofe, in two orbits, dug in the bones of the cranium, that in thofe ofceous feats, they may be the better fhelter'd againft all foreign accidents. To thefe orbits, he was pleafed to add, for a ftill greater fecurity, two eye-lids, or veils, to cover the eye, and defend it from duft, fmoak, and all other things which could hurt it.

There occurs in the eye lids feveral fmall glands, which with the humour contained therein, water the eye; but more particularly in the great angle, called *canthus*, there is the lachrymal gland, whence tears flow.

As to the particular ftructure of the eye itfelf; it is compofed of three proper membranes, and of fo many humours.

The firft *proper membrane*, is faid to be expanded round the ball of the eye; the hind-part thereof, A F, is called *fclerotica*, or hard; and the anterior, *viz* A B, *cornea*, becaufe tranfparent like horn. *Fig.* 6.

The fecond, which is thinner, proceeds from the *pia mater*, and is commonly called in its pofterior parts C C *choroides*, and *uvea* in its anterior, Q I I Q.

The perforation of the *uvea*, II. is called the *pupil*, or *apple* of the eye; which by means of mufcular fibres, is fometimes contracted, when too much light offends the eye; and fometimes dilated, when there is but a moderate light. Thofe mufcular fibres being difpofed round the pupil, in a circular manner, are called the *iris*.

The third membrane, or tunick S S S, is the *retina*, fo called as refembling a net, and covering only the fund or bottom of the eye, oppofite to the fight. This membrane derives from the medullary fubftance, T S S S, of the *optick* nerve; and is confidered as the proper organ of the fight.

Three *humours* are confpicuous in the eye, and inclofed between thefe tunicks, *viz.* 1 The *aqueous*, a limpid tranfparent humour, fituated in the fore part of the eye, immediately under the *cornea*, and occafioning its protuberance.

The *chryftalline*, fituated immediately under the aqueous, behind the *uvea*, oppofite to the pupil.

3. The *vitreous* or *glaffy humour*, which fills all the hind-part of the cavity of the globe; and is that which gives the fpherical figure to the eye. On its back-part is the *retina* fpread.

I'll pafs to the explication of *vifion*; the act of feeing, or perceiving objects by the fight.

Vision

Vision is very well defined to be a ſenſation, whereby, from a certain motion of the *optick* nerve, made in the bottom of the eye, by the rays of light emitted or reflected from objects, and hence conveyed to the common ſenſory in the brain, the mind perceives the luminous object; its quality, quantity, figure, &c.

The better to underſtand this article, we muſt carefully examine the nature of *light* and *colours*, which is the medium, or vehicle, whereby objects are carried to the eye.

Light is that ſenſation occaſioned in the mind, by the view of luminous bodies; or that property in bodies, whereby they are fitted to excite thoſe ſenſations in us.

Light is alſo uſed to denote a certain action of the luminous body, on a medium between it and the eye; by means whereof, ſome ſuppoſe the one to act on the other.

This they call *ſecundary* or *derivative light*; to diſtinguiſh it from that of luminous bodies, which is called *primary* or *minute*.

Every ray of light has two oppoſite ſides, the one originally endued with a property, whereon its unuſual *refraction* depends, and the other not endued with that property.

Sir *Iſaac Newton* having obſerved the vivid coloured image, projected on the wall of a darkned room, by the ſun-beams tranſmitted through a priſm, to be five times as long as broad, concludes, that *light* itſelf is a heterogeneous mixture of rays differently refrangible; and hence he diſtinguiſhes *light* into two kinds, *viz.* that whoſe rays are equally refrangible, which he calls *homogeneal*, *ſimilar*, or *uniform light*; and that whoſe rays are unequally refrangible; which he calls *heterogeneal light*.

There are but three affections of *light*, wherein he obſerved its rays to differ, viz. *refrangibility*, *reflexibility*, and colour; and thoſe rays which agree in *refrangibility*, agree alſo in the other two: whence they may be well defined homogeneal, though in ſome other reſpects they may poſſibly be heterogeneal.

Again, the colours exhibited by homogeneal *light*, he calls homogeneal colours; and thoſe produced by *heterogeneal light*, *heterogeneal colours*. Theſe definitions laid down, he advances ſeveral propoſitions.

As, firſt, that the ſun's light conſiſts of rays differing by indefinite degrees of refrangibility. Secondly, that rays which differ in refrangibility, when parted from one another, do proportionably differ in the colours which they exhibit. Thirdly, that there are as many ſimple and homogeneal colours as degrees of refrangibility; for to every degree of refrangibility belongs a different colour. Fourthly, whiteneſs in all reſpects like that of the ſun's immediate *light*, and of the uſual objects of our ſenſes, cannot be compounded of ſimple colours, without an indefinite variety of them; for to ſuch a compoſition there are required rays endued with all the indefinite degrees of refrangibility, which infer as many ſimple colours. Fifthly, the rays of *light* do not act on one another, in paſſing through the ſame medium. Sixthly, the rays of *light* do not ſuffer one alteration of their qualities from *refraction*, nor from the adjacent quieſcent medium. Seventhly, there can be no homogeneal colours produced out of *light* by *refraction*, which are not commixed in it before; ſince *refraction* as was before obſerved, changes not the qualities of the rays, but only ſeparates thoſe which have divers qualities, by means of their different refrangibility. Eighthly, the ſun's light is an aggregate of homogeneal colours; whence homogeneal colours may be called *primitive* or *original*.

We have already obſerved, that the rays of light are compoſed of diſſimilar or heterogeneous parts; ſome of them being, in all probability greater, others leſs. Now the ſmaller the parts are, by ſo much the more refrangible they are, *i. e.* they are ſo much the more eaſily diverted out of their rectilinear courſe; and thoſe parts which differ in refrangibility (conſequently in bulk) we have alſo obſerved differ in colour.

Hence ariſes the whole theory of colours; thoſe parts, *v. gr.* which are the moſt refrangible, conſtitute violet colours (ſay ſome modern Philoſophers) that is, the moſt minute particles of light, when ſeparately impelled on the organ, do there excite the ſhorteſt vibrations in the retina, which are thence communicated by the ſolid part of the optick nerve in the brain, and excite in us the ſenſation of violet-colour, the dimmeſt and moſt languid of all colours; and thoſe particles on the contrary, which are the leaſt refrangible, conſtitute a ray of a red colour, *i. e.* the greateſt particles of *light* excite the longeſt vibrations in the retina, and ſo convey the ſenſation of a red colour, as being the moſt bright and vivid of all others. The other particles being diſtinguiſhed into little rays, according to their reſpective magnitudes and degrees of refrangibility, excite intermediate vibrations, and ſo occaſion ſenſations of the intermediate colours; in like manner as the vibrations of the air, according to their different magnitudes, excite ſenſations of different ſounds. The colours then of theſe little rays not being any adventitious modifications of them, but connate, primitive and neceſſary properties, reſulting in all probability from their different

ferent magnitudes, muſt be perpetual and immutable, not to be altered by any reflection, refraction, or any ſubſequent modification.

Others explain refraction in a clearer and more conciſe manner, and ſay that it happens either *by acceding to the perpendicular, or receding from it.* For when light paſſes from a rarer or thinner medium into one more denſe, *viz.* from air into water or glaſs, then it is refracted by acceding to the perpendicular; but when it paſſes from a thicker medium into a thinner, *viz.* from glaſs into water, or from water into air, the *refraction* happens by its receſs from the perpendicular.

But to give a ſtill clearer notion of the *refraction* of light, they illuſtrate it with the following experiments :—Therefore let us imagine that AHBGC, *Fig.* 8. is an earthen veſſel, in the bottom whereof there is the crown-piece B, that crown-piece will certainly be ſeen by the eye placed in E, by means of the ray B E; but not by the eye placed in D; for the ray D H is terminated in H, not in B. But if the veſſel be filled with water to the very top or ſuperficies, A C (which though it be ſeen here covered with a cloth, can notwithſtanding, be imagined uncovered) then the ray which was carried from the point B into E, will be refracted in the point I, where the ſuperficies of the air occurs, and tends towards D, in receding from the line F *i* G, which is perpendicular to the ſuperficies A *i* C: and then the crown-piece will be ſeen by him who will be placed in D; and will be referred not to the point B, but to the point H.

The experiment of this is eaſily made, by taking a pretty deep diſh, and putting in the bottom a crown or half a crown-piece, and then going backward from the diſh till the edges thereof hinder us from ſeeing the piece any longer; but if we put water in the diſh, we ſhall ſee the piece from that place; whence we could not ſee it before.

If the veſſel A H B G C, *Fig.* 8. be a glaſs veſſel, and the ſide C G oppoſed to the ſun, as well as the ſuperficies A *i* C, be covered in ſuch a manner, that there be but the very little hole *i* left for the paſſage of the light, then the ray D *i* will tend towards the point H. But if the veſſel be filled with water, through the ſmall tube M N, then the ray which was carried into H will be *refracted* by acceding to the perpendicular F *i* G, and environ the point B. The quantity of this *refraction* will be known, by adapting either a ſemi-circle or the quadrant of a circle within the veſſel, or in any other manner; for I do not pretend to relate here the different means invented, uſed, and adapted by the learned, to the menſuration of *refraction.*

But to underſtand better what follows; we muſt admit here the definitions of divers angles: therefore let's examine the 19th *Figure* of our table of *Opticks*, in which the ray A B is imagined to paſs obliquely from air into water or glaſs; this being directed towards P, will notwithſtanding deſcend refracted into the point I, becauſe meeting with a denſer body, by acceding to the perpendicular H B G, and for the ſame reaſon the ray K B, which inclined towards O, will incline towards L.

Then the angle A B C formed by the ray A B, and the ſuperficies B C, is called *angle of incidence*; likewiſe the angle K B C, is an *angle of incidence.*

The angle A B H, formed by the ray A B and the perpendicular H B, is the *angle of inclination*, and the ſame is to be ſaid of the angle K B M.

The angle G B I, formed by the refracted ray B I, and the perpendicular BG, is called a *refracted angle*, as well as the angle N B L.

Laſtly, the angle I B P, formed by the refracted ray B I, and the right ray A B, imagined to be carried into P (the ſame to be ſaid of the angle L B O) is called the *angle of refraction.*

Des Cartes has very ingeniouſly obſerved, that there is not always the ſame ratio between the *angles of inclination*, and thoſe *refracted.* For that ratio changes according to the various inclination of the rays; whence though the ratio which is between the angle of inclination A B H, and the refracted angle G B I, be very well underſtood, it cannot be carried to K B M and N B L, becauſe the angle A B is more inclined on the ſuperficy C B then K B. But the ratio of the ſines of the angles of inclination to the ſines of the *refracted* angles, is always the ſame, *v. gr.* if we know the ratio of the line AH, which is the ſine of the angle A B H to the line G I, which is the ſine of the refracted angle G B I; we'll find the ſame ratio between the angle K M, the ſine of the angle K B M, and the line N. L, the ſine of the angle N B L.

As to COLOUR, ſome define it a property inherent in light, whereby, according to the different ſizes, or magnitudes of its parts, it excites different vibrations in the fibres of the *optick* nerve; which propagated to the *ſenſorium*, affect the mind with different ſenſations.

Various are the opinions of antient and modern Authors, of the ſeveral ſects of Philoſophers, with regard to the nature and origin of the phænomenon *colour*.

But Sir *Iſaac Newton* thinks, that he has eſtabliſhed a ſolid and conſiſtent theory of *colours*; built on ſure experiments, and ſolving all the phænomena thereof: his doctrine is as follows:

That Author ſays, that it is found by experience, that rays, or beams of light, are compoſed of particles

ticles very heterogeneous, or dissimilar to each other, *i. e.* some of them, as it is highly probable, are larger, and others less. For a ray of light being received on a refracting surface, in a dark place, is not wholly refracted to a single point; but split, as it were, and diffused into several radioli, or little rays, *i. e.* those particles of the light which are the most minute, are of all others the most easily and most considerably diverted, by the action of the refracting surface, out of their rectilinear course: and the rest, as each exceeds another in magnitude, so is it with more difficulty, and less considerably turned of its right line to the intermediate points.

Now each ray of light, as it differs from another in its degree of refrangibility, so does it differ from it in *colour*; this is warranted by numerous experiments. Those particles, *v. gr.* which are more refracted, are found to constitute a ray of a violet *colour*, i. e. in all probability, the most minute particles of light, thus separately impelled, excite the shortest vibration in the retina; which are thence propagated by the solid fibres of the *optick* nerves into the brain, there to excite the sensation of violet *colour*; as being the most dusky and languid of all *colours*.

Again, those particles which are the least refracted, constitute a *radiolus*, or ray of a red *colour*, i. e. the largest particles of light excite the longest vibrations in the retina; so as to excite the sensation of red *colour*, the brightest and most vivid of all others.

The other particles being in like manner separated, according to their respective magnitudes, into little rays, excite the intermediate vibrations, and thus occasion the sensation of the intermediate *colours*; much in the same manner as the several vibrations of the air, according to their respective magnitudes, excite the sensations of different sounds.

To this it may be added, that not only the more distinct and notable colours of red, yellow, blue, *&c.* have thus their rise from the different magnitude, and refrangibility of the rays; but also the intermediate degrees or shades of the same colour, as of yellow up to green, of red down to yellow, *&c.*

Further, the *colours* of these little rays, not being any adventitious modifications thereof, but connate, primitive, and necessary properties; as consisting, in all probability, in the magnitude of their parts, must be perpetual and immutable, *i. e.* cannot be changed by any future refraction or reflection, or any modification whatsoever.

In order to *vision*, we are certain, it is required that the rays of light be thrown from the visible object to the eye: what befalls them in the eye, will be conceived from what follows.

Suppose, *e. gr.* Z the eye, and A B C the object, (*Optick Plate*, Fig. 11.) now though every point of an object be a radiant point, that though there be rays reflected from every point of the object to every point of the circumambient space, each carrying with it its respective colour, (which we falsly imagine to be those of the object) yet as only those rays, which pass thro' the pupil of the eye affect the sense, we shall here consider none else.

And again, though there be a great number of rays passing from one radiant point, as B, through the pupil, yet we shall only consider the action of a few of them; as B D, B E, B F.

Now then the ray B D falling perpendicularly on the surface, E D F, will pass out of the air into the aqueous humour, without any refraction, and proceed right to H; where, falling perpendicularly on the surface of the crystalline humour, it will go on, without any refraction, to M; where again falling perpendicularly on the surface of the vitreous humour, it will proceed strait to the point O, in the fund or bottom of the eye. Again, the ray B E passing obliquely out of the air upon the surface of the watery humour E D F, will be refracted, and approach towards the perpendicular E P: thus proceeding to the point G, in the surface of the crystalline, it will be there refracted still nearer the perpendicular. — So also E G falling obliquely out of the air into a harder body, will be refracted towards the perpendicular G R, and falling on the point L of the surface of the vitreous humour, it will still be brought nearer to M.

Lastly, G L falling obliquely out of a denser, upon the surface of a rarer body, L M N, will be refracted, and recede from the perpendicular L T; in receding from which, it is evident it approaches towards the ray B D O, and may be so refracted as to meet the other in O.—In like manner the ray B F being refracted in B will turn to I, and thence to N, and thence to the others in O. But the rays between B E and B F, being somewhat less refracted, will not meet precisely in the same point O.

Thus will the radiant point B affect the fund of the eye, in the same manner as if the pupil had had no breadth, or as if the radiant itself had only emitted one single ray, such as were equal in power to all those between B E and B F.

In like manner the rays proceeding from the point A, will be so refracted in passing through the humours of the eye, as to meet near the point X; and the rays from any intermediate point between A and B, will nearly meet in some other point in the fund of the eye between X and O.

Upon the whole it may be asserted universally, that every point of an object affects only one point in the fund of the eye; and, on the contrary, that every point in the fund of the eye only receives rays from one point of the object. Though this is not to be underſtood in the utmoſt rigour.

Now if the object recede from the eye in ſuch manner, as that the radiant point B does not decline from the line BD; the rays which ſhould proceed from B, not enough divaricated, would be ſo refracted in paſſing the three ſurfaces, as that they would meet ere they reached the point O: on the contrary, if the object ſhould brought nearer the eye, the rays paſſing from the point B in the pupil, too much divaricated, would be refracted ſo as not to meet till beyond the point O; nay the object may be ſo near, that the rays proceeding from any point may be divaricated, as that they ſhall never meet at all. In all which caſes, there would be no point of the object, but would move a pretty large portion of the fund of the eye; and thus the action of each point would be confounded with that of the contiguous one.

And this would commonly be the caſe, but that nature has provided againſt it; either by contriving the eye, ſo as its bulb may be lengthened or ſhortened, as objects may be more or leſs diſtant; or, as others will have it, ſo as that the cryſtalline may be made more convex, or more flat; or, according to others, ſo as that the diſtance between the cryſtalline and the retina, may be lengthened or ſhortened.

The firſt expedient is the moſt probable; on the footing of which, when we direct our eyes to an object ſo remote, as that it cannot be diſtinctly viewed by the eye in its accuſtom'd figure, the eye is drawn back into a flatter figure, by the contraction of four muſcles; by which means, the retina becoming nearer, the cryſtalline humour receives the rays ſooner: and when we view an object too near, the eye being compreſſed by the two oblique muſcles, is render'd more globular; by which means the retina being ſet further off from the cryſtalline, does not receive the rays of any point before they meet.

It may be here added, that this acceſs, and receſs of the cryſtalline, is ſo neceſſary to viſion, that whereas in ſome birds the coats of the eye are ſuch a bony conſiſtence, that muſcles would not have been able to contract or diſtend them; nature has taken other means, by binding the cryſtalline down to the retina, with a kind of blackiſh threads, not found in the eyes of other animals. Nor muſt it be omitted that of the three refractions above-mentioned, the firſt is wanting in fiſhes; and that to remedy this, their cryſtalline is not lenticular, as in other animals, but globular. Laſtly, ſince the eyes of old people are generally worn flatter than thoſe of young ones; ſo that the rays from any point, fall on the retina, ere they become collected into one; they muſt exhibit the object ſomewhat confuſedly: nor can ſuch eyes ſee any but remote objects diſtinctly.

Thoſe, who have the cryſtalline of the eye thus configurated, are called *preſbytæ*. This defect is helped only by convex-glaſſes or ſpectacles; which will make the rays converge ſooner, and if they are well fitted, fall exactly on the retina. If the diſtance between the retina and the cryſtalline be too ſmall, the perſon will likewiſe be a *preſbyta*. The word is formed from the *Greek* πρεσβυς, *ſenex*; becauſe old people are naturally ſubject to this defect; time, and the friction of the eye-lids, *&c.* gradually wearing the ball flat.

In others, whoſe eyes are too globular, the caſe is juſt the reverſe, and theſe are called *myopes*.

From what has been ſhewn, that every point of an object moves only one point of the bottom of the eye; and, on the contrary, that every point in the fund of the eye, only receives rays from one point of the object; it is eaſy to conceive, that the whole object moves a certain part of the retina; that in this part there is a diſtinct and vivid collection of all the rays received in at the pupil; and that as each ray carries its proper colour along with it, there are as many points pointed in the fund of the eye, as there are points viſible in the object. Thus is there a ſpecies or picture, on the retina, exactly like the object; all the difference between them is, that the body is here repreſented by a ſurface; a ſurface frequently by a line, and a line by a point: that the image is inverted, the right hand anſwering to the left of the object, *&c.* and that it is exceedingly ſmall, and ſtill the more ſo, as the object is more remote.

What we have ſhewn of the nature of light and colours, readily accounts for this painting of the object on the retina. The matter of fact is proved by an eaſy experiment firſt tried by *Des Cartes*; thus, the windows of a chamber being ſhut, and light only admitted at one little aperture; to that aperture apply the eye of ſome animal newly killed, having firſt dextrouſly pulled off the membranes that cover the bottom of the vitreous humour, *viz.* the hind part of the ſclerotica, choroides, and even part of the retina; then will the images of all the objects, without doors, be ſeen diſtinctly painted on any white body, as on an egg-ſhell, that the eye is laid upon. The ſame thing is better ſhewn by an artificial eye, or *camera obſcura*.

The laws of *viſion*, with regard to the figures of *viſible* objects, are,

1. That if the center of the pupil be exactly againſt, or in the direction of a right line, the line will appear as one point.

2. If

2. If the line be placed in the direction of a surface, so that only one line of the perimeter can radiate on it, it will appear as a line.

3. If a body be opposed directly towards the eye, so as only one plane of the surface can radiate on it, it will appear as a surface.

4. A remote arch, viewed by an eye in the same place, will appear as a right-line.

5. A sphere viewed at a distance appears a circle.

6. Angular figures at a distance appear round.

7. If the eye look obliquely on the center of a regular figure, or a circle, the true figure will not be seen; but the figure will appear oval.

The laws of vision, with regard to the motion of visibles, are, 1. That if two objects unequally distant from the eye, move from it with equal velocity, the more remote one will appear, the slower; or if their celerities be proportionable to their distances, they will appear to move equally swift.

2. If two objects, unequally distant from the eye, move with unequal velocities in the same direction, their apparent velocities are in a ratio compounded of the direct ratio's of their true velocities, and the reciprocal ones of their distances from the eye.

3. A *visible* object, moving with any velocity, appears to be at rest, if the space described in the interval of one second be imperceptible at the distance of the eye. Hence it is that a near object, moving very slowly, as the index of a clock, or a remote one very swiftly, as a planet, seem at rest.

4. An object moving with any degree of velocity will appear to rest, if the place it runs over in a second of time, be to its distance from the eye, as 1 to 1400, nay, in fact, if it be as 1 to 1300.

5. The eye proceeding strait, from one place to another, a natural object, either on the right or left, will seem to move the contrary way.

6. If the eye and the object move both the same way, only the eye much swifter than the object, that last will appear to go backwards.

7. If two or more objects move with the same velocity, and a third remains at rest, the moveables will appear fixed, and the quiescent in motion the contrary way.—Thus clouds moving very swiftly, their parts seem to preserve their situation, and the moon to move the contrary way.

If the eye be moved with a greater velocity, lateral objects at rest, appear to move the contrary way.—Thus to a person sitting in a coach, and riding briskly through a wood, the trees seem to retire the contrary way; and to people in a ship, &c. the shores seem to recede.

Having explained the first principles and rudiments of *Opticks*, with regard to the *speculative* part thereof; I'll next reduce all those rules into practice, and shew by plain demonstration, that they are true and well founded, by means of the *catoptricks* and *dioptricks*; therefore,

CATOPTRICKS is that branch of *Opticks*, which delivers the laws of light reflected from *mirrours*.

Mirrour in *catoptricks*, denotes any polished body impervious to the rays of light, and which of consequence reflects them equally.

The doctrine of *mirrours* is founded on the following general principles. 1. Light reflected from any *mirrour* or *speculum*, makes the angle of incidence equal to that of reflection. Hence a ray of light falling perpendicularly on the surface of a *speculum*, will be reflected back upon itself. Which we find by experience it actually does. From the same point of a *mirrour*, therefore, there cannot be several rays reflected to the same point; since in that case, all the angles of reflection must be equal to the same angle of incidence, and therefore to each other; which is absurd; nor can the ray be reflected to two or more points: since in that case, all the angles of reflection, would be equal to the same angle of incidence: which is likewise absurd.

2. From every point of a *mirrour*, are reflected rays thrown on it, from every point of a radiant object. Since then rays coming from different parts of the same object, and striking on the same point of the *mirrour*, cannot be reflected back to the same point; the rays which flow from different points of the same radiating object, are again separated after reflection: so that each point shews whence it came. Hence it is, that the rays reflected from *mirrours* exhibit the objects to view. Hence also it appears, that rough uneven bodies must reflect the light in such a manner, as that rays coming from different points will be blended or thrown confusedly together.

Mirrours are commonly divided into *plane*, *concave*, *convex*, *cylindrical*, *conical*, *parabolical*, and *elliptical*.

Plane MIRROURS are *looking-glasses*.

The laws or phænomena of *plane mirrours*, are as follows. 1. Every point of an object is seen in the intersection of the *cathetus* of incidence, with the reflected ray.

The *cathetus of incidence*, in *catoptricks*, is a right line drawn from a radiant point, perpendicular to the reflecting line. or the plane of the *mirrour*. The *cathetus of reflection*, or of the eye, in a right line drawn from the eye, or from any point of a reflected ray, perpendicular to the plane of reflection, or of a *mirrour*.

Hence, 1. As all the reflected rays meet with the *cathetus of incidence* in the intersection: by

 whatever

whatever reflected ray the radiant point be ſeen, it will ſtill appear in the ſame place. Conſequently any number of perſons viewing the ſame object in the ſame *mirrour*; will all ſee it in the ſame place behind the *mirrour*. And hence it is, that the ſame object has only one image, and that we do not ſee it double with both eyes.

Hence alſo the diſtance of the image from the eye, is compounded of the ray of incidence, and the reflected ray: and the object radiates reflectedly, in the ſame manner as it would do directly, were it removed into the place of the image.

2. The image of a radiant point, appears juſt ſo far behind a *plain mirrour*, as the radiant point is before it.

Hence, if the *mirrour*, A G, *Table Opticks*, Fig. 15. be placed horizontal, the point A will ſeem ſo much below the horizon as it is really elevated above it; conſequently erect objects will appear as if inverted; and therefore men ſtanding on their feet as if on their heads, or if their *mirrour* be faſtened to the cieling of a room, parallel to the horizon, objects on the floor will appear above the cieling as much as they really are below it; and that upſide-down.

3. In a *plain mirrour*, the images are perfectly ſimilar and equal to the objects. And hence they are us'd as looking-glaſſes.

4. In a *plain mirrour*, things on the right-hand appear as on the left, and *vice verſâ*.

Hence alſo we have a method of meaſuring any inacceſſible altitude by means of a *plain mirrour*.— Thus the *mirrour* being placed horizontally in C, *Fig.* 16. retire from it till ſuch time as the top of the tree be ſeen therein. Meaſure the height of the eye D E, the diſtance of the ſtation from the point of reflection E C, and the diſtance of the foot of the tree from the ſame. Then to E C, C B, and E D, find a fourth proportional A B. This is the altitude ſought.

5. If a *plain mirrour* be inclined to the horizon, in an angle of 45 degrees, an object perpendicular to it will appear parallel, and an horizontal object perpendicular.

6. If the object be parallel to the ſpeculum, and equally diſtant from it, with the eye; the reflecting line will be half the length of the object.

7. If *ſeveral mirrours*, or ſeveral fragments, or pieces of a *mirrour*, be all diſpoſed in the ſame plane, they will only exhibit an object once.

8. If two *plain mirrours*, or ſpecula, meet in any angle; the eye placed within that angle, will ſee the image of an object placed within the ſame. as often repeated as there may be catheti drawn, determining the places of the images, and terminated without the angle.

On this principle are founded various catoptrick machines, ſome of which repreſent objects infinitely multiplied and diſtorted; others infinitely magnified, as the *catoptrick cyſtula*, &c.

The *catoptrick cyſtula* is a machine or apparatus, whereby little bodies are repreſented extremely large, and near ones extremely wide, and diffuſed through a vaſt ſpace, with other agreeable phænomena.

To make a *catoptrick cyſtula to repreſent ſeveral ſcenes of objects, when looked in at different foramina or holes* Provide a polygonous *cyſtula*, or cheſt, of the multilateral priſm A B C D E F (plate *Opticks*, Fig. 17.) and divide its cavity by diagonal planes E B, F C, D A, interſecting each other in the center, into as many triangular locules or cells, as the cheſt has ſides. Line the diagonal planes with *plain mirrours*, in the lateral planes make round holes, through which the eye may peep within the locules of the cheſt. The holes are to be covered with plain glaſſes, ground within-ſide, but not poliſhed, to prevent the objects in the locules from appearing too diſtinctly In each locule are placed the different objects, whoſe images are to be exhibited; then covering up the top of the cheſt with a thin tranſparent membrane, or parchment, to admit the light, the machine is compleat.

For from the laws of reflection it follows, that the images of objects, placed within the angles of *mirrours*, are multiplied, and appear ſome more remote than others; whence the objects in one locule will be ſeen, but thoſe multiplied and diffuſed through a ſpace much larger than the whole cheſt. Thus every new hole will afford a new ſcene: according to the different angles the *mirrours* make with each other, the repreſentations will be different; if they be at an angle greater than a right one, the images will be monſtrous, *&c.*

The parchment that covers the machine, may be made pellucid, by waſhing it ſeveral times in a very clear lye, then in fair water, and bracing it tight, and expoſing it to the air to dry. If it be deſired to throw any colour on the objects, it may be done by colouring the parchment. *Zahnius* recommends verdigreaſe ground in vinegar, for green; decoction of *Braſil* wood, for red, *&c.* He adds, it ought to be varniſhed to make it ſhine.

To make a *catoptrick cyſtula*, to repreſent the objects within it *prodigiouſly multiplied*, and *diffuſed through a vaſt ſpace*. Make a *polygonous cyſtula*, or cheſt, as before, but without dividing the inner cavity, into any apartments or locules. Line the lateral planes with *plane mirrours*, and at the *foramina* or apertures, pare off the tin and quickſilver, that the eye may ſee through: place any object in the bottom, *v. gr.* a bird in a cage, *&c.* Here the

eye

eye looking through the apertures, will see each object placed at bottom, vastly multiplied, and the images removed at equal distances from one another.

Convex MIRROURS are those, whose surface is convex; meaning by convex surfaces, such as are spherically convex.

There are divers methods used by divers artists, for preparing or making *convex mirrours*, particularly as to the matter and composition. One of the best that is known is given us by *Wolfius*, thus: melt one part of tin, another of marcasite together, and to the melted mass add two parts of mercury; as soon as the mercury begins to evaporate into smoak (which it presently does) the whole compost is to be thrown into cold water, and when well cooled, the water decanted off. The mixture is then to be strained through a linen cloth in two or three folds; and what is thus secerned, poured into the cavity of a glass sphere: this sphere is to be turned gently round its axis, till the whole surface is covered; the rest being reserved for future use. If the sphere were of coloured glass, the *mirrour* will be so too. And in the same manner, may conick, elliptick, cylindrick, and other *mirrours* be made.

Concave MIRROURS are those whose surface is concave; meaning *spherically concave.*

To prepare, or make *concave mirrours*; first, a mould is to be provided for casting them: in order to this, take clay well dried, pulverize and sift it; mix it up with water, and then strain or filter it; with this work up horse-dung and hair shred very small, till the mass be sufficiently tough; to which, on occasion may be added charcoal-dust, or brick-dust well sifted. Two coarse moulds are to be prepared of a gritty stone, the one concave, the other convex, which are to be ground on one another, with wet sand between, till such time as the one perfectly fits the other. By this means a perfect spherical figure is acquired.—The mass prepared before is now to be extended on the table by means of a wooden roller, till it be of a thickness proper for the *mirrour*; and then being strewed with brick-dust, to prevent its striking, it is laid over the convex mould, and so gets the figure of the *mirrour*. When this is dry it is covered with another lay of the same mass; which once dried, both covers, or segments of the hollow sphere, made of clay, are taken off. The innermost of the two being laid aside, the stone mould is anointed with a pigment prepared of chalk and milk, and the outer cover again put over it.—Lastly, the joining being covered over with the same clay whereof the cover is formed; the whole mould is bound together with an iron wire, and two holes cut through the cover, the one for the melted matter of the *mirrour* to be poured through, the other for the air to escape at, to prevent the *mirrour* being spoiled with bubbles. The mould thus prepared, eight parts of copper, one of *English* tin, and five of marcasite, are melted together; a little of the mixture is taken out with a ladle, and if it be too red when cold, more tin is put in, if too white, more copper: the mass is then poured into the mould before prepared, and so assumes the figure of a *mirrour*.—Some with ten parts of copper mix four of *English* tin, a little antimony and sal ammoniack, stirring the mass about as long as any fumes arise from it. Others have other compositions; many of which are described by *Shutters*, and *Zahnius*. The *mirrour* being thus cast, is cemented to a wooden frame, and thus worked to and fro over the convex stone mould, first with water and sand; and lastly without sand, till it be fit for polishing. The stone mould is then cover'd with paper, and that smear'd over with tripoli-dust, and calx of tin: over which the *mirrour* is worked to and fro, till it has got a perfect polish. And in the same manner are glass *mirrours* polished, excepting that the convex surface is there worked in the concave mould. When the *mirrours* are very large, they are fixed on a table, and first ground with a gritty stone, then with pumice, then with fine sand, by means of a glass, cemented to a wooden frame; and lastly, rubbed with calx of tin, and tripoli-dust, by a wet leather.—For *concave mirrours* of glass, the mould is usually made of alabaster: the rest as in metal *mirrours*.

Amongst the laws and phænomena of *concave mirrours*, we find that, 1. If a ray falls on a concave *mirrour*, under an inclination of 60 degrees, and parallel to the axis; the reflected ray will concur with the axis in the pole of the glass. If the inclination of the incident ray be less than 60 degrees, the reflected ray will concur with the axis, at a distance less than a fourth part of the diameter. And universally, the distance of the point, wherein the ray concurs with the axis, from the center, is to half the radius, in the ratio of the whole sine, to the cosine of inclination.

Hence it is gather'd by calculation, that in a concave spherical *mirrur*, whose breadth subtends an angle of six degrees, parallel rays meet after reflection, in a part of the axis less than one thousand four hundred fifty seventh part of the radius: if the breadth of the concave *mirrour* be 6, 9, 12, 15, or 18 degrees; the part of the axis wherein the parallel rays meet, after reflection is less than $\frac{1}{363}$, [illegible], [illegible], [illegible], [illegible], of the radius.

And

And on this principle it is that *burning-glasses* are built. For since the rays diffused through the whole surface of the concave *mirrour*, after reflection are contracted into a very small compass; the light and heat of the parallel rays must be prodigiously encreased thereby, *viz.* in a duplicate ratio of the breadth of the *mirrour*, and the diameter of the circle, wherein all the rays are collected: and since the sun's rays are, as to any purposes on earth, parallel, no wonder concave *mirrours* should burn with such violence.

Among the antients the *burning mirrours* of *Archimedes* and *Proclus* are eminent; by one of which the *Roman* ships besieging *Siracuse*, under the command of *Marcellus*, according to the relations of *Zonaras*, *Tzetres*, *Galen*, *Eustathius*, &c. and by the other the navy of *Vitalian* besieging *Bizantium*, according to the same *Zonaras*, were burnt to ashes. Among the moderns the most remarkable burning *mirrours* are those of *Villette*, a *Frenchman*, *Settala*, and *Tschirnhausen*. *Settala*, canon of *Padua*, made a parabolick *mirrour*, which, according to *Shottus*, burnt pieces of wood at the distance of 15 or 16 paces. M. *Tschirnhausen*'s mirrour is at least equal to the former, both in bigness and effect. The following things are noted of it in the *Acta Eruditorum*: 1. Green wood takes fire instantaneously, so as a strong wind cannot extinguish it. 2. Water boils immediately, and eggs in it are presently edible. 3. A mixture of tin and lead three inches thick drops presently, and iron or steel plate becomes red-hot presently, and a little after burns into holes. 4. Things not capable of melting, as stones, bricks, &c. become red-hot like iron. 5. Slates become first white, then a black glass. 6. Tiles are converted into a yellow glass, and shells into a blackish yellow one. 7. A pumice-stone emitted from a volcano melts into white glass: And, 8. A piece of a crucible also vitrifies in eight minutes. 9. Bones are soon turned into an opake glass, and earth into a black one. The breadth of this mirrour is near three *Leipsick* ells, its focus two ells distant from it; it is made of copper, and its substance is not above half the thickness of the back of a knife. *Vilette*, a *French* artist of *Lyons*, made a large *mirrour*, bought by *Tavernier*, and presented by him to the king of *Persia*; a second bought by the king of *Denmark*, a third presented by the king of *France* to the Royal Academy; a fourth has been in *England*, where it was publickly exposed. The effects, whereof, as found by Dr. *Harris* and Dr. *Desaguliers*, are, that a silver six-pence is melted in 7″ and ½; a king *George*'s halfpenny in 16″, and runs with a hole in 34; tin melts in 3″, cast iron in 16″, slate in 3″, a fossil-shell calcines in 7″, a piece of *Pompey*'s pillar at *Alexandria*, vitrifies in the black part in 50″, in the white in 54, copper ore in 8″: bone calcines in 4″, vitrifies in 33″. An emerald melts into a substance like a a turquois stone; a diamond weighing 4 grains, loses $\frac{7}{8}$ of its weight: the asbestos vitrifies, as all other bodies will do, if kept long enough in the focus: but when once vitrified, the mirrour can go no further with them. This *mirrour* is 47 inches wide, and is ground to a sphere of 76 inches radius; so that its focus is about 38 inches from the vertex. — Its substance is a composition of tin, copper, and tin-glass.

Wolfius tells us, that an artist of *Dresden* made *burning mirrours* of wood, bigger than those of M. *Tschirnhausen*, or *Villette*, which had effects at least equal to any of them. *Traberus* teaches how to make *burning mirrours* of leaf-gold, *viz.* by turning a concave, laying its inside equally with pitch, and covering that with square pieces of gold, two or three fingers broad, fastening them on, if need be, by fire. He adds, that very large *mirrours* may be made, of 30, 40, or more concave pieces, artfully joined in a wooden dish or skuttle, the effects of which will not be much less than if the surface was continuous. *Zahnius* adds further, that *Newman*, an engineer, at *Vienna*, in 1699, made a mirrour of pasteboard, covered within side with straw glewed to it; by which all kinds of metal, &c. were readily melted.

Cylindrical, *conical*, *parabolical*, and *elliptical* MIRROURS, or specula, are those terminated by a surface, respectively, *cylindrical*, *conical*, *parabolical*, and *spheroidical*.

To *prepare* or *make cylindrical*, *conical*, &c. *Mirrours*, the process is as follows. — For the *cylindrical* and *conical* sort, if they are to be of glass, the method of preparing them is the same as that already laid down for convex *mirrours*. If of metal they are to be made after the manner of concave *mirrours*, only that the clay moulds there described require other wooden ones of the figure of the *mirrour*.—For *elliptical*, *parabolical*, and *hyperbolical mirrours*, the mould is to be thus prepared: on a wooden or brazen plane or table, describe the figure of an *ellipsis*, *parabola*, or an *hyperbola*; which done, cut out the figure from the plane, with all the accuracy imaginable. To the elliptick figure fit an axis, with two fulcra to sustain it, &c. and a handle to move it. Lay a quantity of the clay above-described under it, and turn about the axis with the handle, till the plane has turned or impressed the elliptical figure thereon. — The axis of the *parabolical*, or *hyperbolical* figure, is to be fixed at at the vertex in ſuch manner as that it may always remain erect. This to be turned about as above, till it has given its own figure to the clay applied about it.—The part of the mould thus formed is to be dried, and either ſmeared over with fat, or ſprinkled with brick-duſt. Then a convex mould to be made, by putting a quantity of the ſame clay into a cavity thus formed. This latter is called the *male*, as the former the *female* mould.—The *male* mould being well dried, is to be applied within the *female*, in ſuch manner as only to leave the intended thickneſs of the mirrour between them. The reſt as for concave mirrours.

Beſides the *catoptrick machines* above-mentioned, there is another called *reflecting*, or *catoptrick teleſcope*, which inſtead of lens, conſiſts chiefly of *mirrours*, and exhibits remote objects by reflection inſtead of refraction.

This inſtrument is the invention of Sir *Iſaac Newton*. The firſt hint whereof, he took from Dr. *Gregory's opticks*.

For the conſtruction of this *reflecting teleſcope*, a tube A B C D, *Fig.* 22. muſt be provided, open in A D, and cloſed in B C, well blacked within ſide, and of a length equal to the diſtance of the focus; from the concave *ſpeculum* E F, to the bottom B C, is to be fitted a concave metallick *ſpeculum*, *a b*, poliſhed to the greateſt perfection; or rather, to have the objects clearer, and more diſtinct, let it be a glaſs *ſpeculum*, concave on its fore ſide, and equally convex on the hind ſide; for unleſs it be of the ſame thickneſs every where, it will reflect the images of objects tinged with a ſpurious colour; and indiſtinct. Towards the other end of the tube, is fixed an iron piece, to which is cemented a plain metallick *ſpeculum*; or, which is better, a triangular priſm of glaſs or cryſtal, whoſe upper angle is a right angle, the two others half right. The faces or planes that meet in the upper angle to be ſquare, and the third a parallelogram. This priſm is to be diſpoſed as that a ray reflected from the *ſpeculum*, paſſing through the middle of the face G M, may cut it at right angles; but be inclined to rectangle M N, in an angle of 45°. Its diſtance from the concave *ſpeculum* E F, is to be ſuch, as that the rays *a c* and *b d*, reflected from the concave *ſpeculum*, may, after a ſecond reflection, from the baſe of the priſm, concur in the point *e*; that is, the diſtance of the focus *e*, from the reflecting ſurface of the priſm, and the diſtance of that from the concave *ſpeculum*, is to be equal to the diſtance of the focus from the concave *ſpeculum*. In I is placed a plano-convex lens, whoſe focus is in *e*, that the reflected rays may enter the eye parallel. Laſtly, this lens is covered with a thin braſs or leaden plate, having a little round perforation therein, for the eye to look through, by which means all foreign rays are excluded, which would otherwiſe occaſion confuſion.

In the firſt teleſcope of this kind, which the inventor made, the ſemi-diameter of the concave metallick *ſpeculum*, was $12\frac{2}{3}$ digits, or tenths of an inch; from which, therefore, the focus was $6\frac{1}{3}$ digits diſtant. The diameter of the eye-glaſs was $\frac{1}{6}$ of a digit; ſo that it magnified the diameter of the object in the ratio of 1 to 38; but he found that objects were found ſomewhat obſcure hereby; on which account, he afterwards recommended glaſs *ſpecula* inſtead of metallick ones; adding that there is nothing more required to the perfection of this teleſcope, but that the art of poliſhing glaſs be brought to greater perfection; for that ſome inequalities, which do not hurt lenſes, are found to affect *ſpecula*, and prevent objects being ſeen diſtinctly.

The ſame author obſerves, that if the length of the inſtrument be 6 feet, and conſequently the ſemi diameter of the concave *ſpeculum* 12, the aperture of the *ſpeculum* is to be 6 inches; by which means the object will be increaſed in the ratio of 1 to 200 or 300.

If it be longer or ſhorter, the aperture muſt be as the cube of the quadrato-quadrate root of the length, and its magnifying power as its aperture. The *ſpeculum* he orders to be an inch or two broader than the aperture.

Having ended what regards the doctrine of *catoptricks*, I'll paſs to that of *dioptricks*; which is properly the third branch of *opticks*.

DIOPTRICKS (formed of δια, *per*, *through*, and ὀπτομαι, *I ſee*) is the doctrine of refracted viſion, called alſo *anaclaſticks*: Its office being to conſider and explain the effects of light refracted by paſſing through different mediums, as air, water, glaſs, &c. and eſpecially lenſes.

To proceed with ſome order on this curious ſubject, I'll explain firſt the laws of *dioptricks*; and conclude by the application thereof, in the conſtruction of *teleſcopes*, *microſcopes*, and other *dioptrical* inſtruments.

The moſt eſſential of thoſe laws, are thoſe of *refraction*, which in *dioptricks* is in the inflection or bending of the rays of light, in paſſing the ſurfaces of glaſſes, lenſes, and other tranſparent bodies of different denſities.

The *general laws of refraction* are as follow: 1. *A ray of light in its paſſage out of a rarer, into a denſer medium*, e gr. *out of air into glaſs, is refracted towards the perpendicular*, i. e. *towards the axis of refraction*

Hence the refracted angle is leſs than the angle of inclination: and the angle of refraction less than that of incidence,

2. *The ratio of the sine of the angle of inclination, to the sine of the refracted angle, is fixed and constant*, viz. if the refraction be out of air into glass, it is found greater than as 114 to 76; but less than 115 to 76; that is, nearly as 3 to 2.

Zahnius and *Kircher* have found, that if the angle of inclination be 70°, the refracted angle will be 38°, 50′; on which principle, *Zahnius* has constructed a table of refractions out of air into glass, for the several degrees of the angle of inclination; a specimen whereof follows:

Angle of Inclination.	*Refracted Angle.*	*Angle of Refraction.*
1°	0° 40′ 5″	0 19 55″
2	1 20 6	0 39 54
3	2 0 3	0 59 56
4	2 40 5	1 19 55
5	3 10 3	1 39 57

Angle of Inclination.	*Refracted Angle,*	*Angle of Refraction.*
10°	6° 39′ 16″	3° 2′ 44″
20	13 11 35	6 48 25
30	19 29 29	10 30 31
45	28 9 19	16 50 41
90	41 51 40	48 8 20

3. *When a ray passes out of a denser into a rarer medium*, e. gr. *out of glass into air, it is refracted from the perpendicular, or from the axis of refraction.*

4. *A line falling on a curve surface, whether concave or convex, is refracted after the same manner, as it fell on a plane, which is a tangent to the curve in the point of incidence.*

5. *If a right line cuts a refracting surface at right angles, and if from any point in the denser medium, be drawn a parallel to the incident ray, this will meet the refracted ray, at the less extreme of the parallel; and will be to it as the sine of the refracted angle, to the sine of the angle of inclination.*

Hence if B C, *Fig.* 25. pass out of glass into air, it is in a subsesquialterate ratio to C D; if out of air into glass, into a sesquialterate ratio to C D.

Hence also, if light pass out of water into air; C B is in a subsesquitertian ratio to C D; if out of air into water in a sesquitertian.

Amongst the *laws of refraction in plane surfaces*, it is noted, that if the eye be placed in a rarer medium, an object seen in a denser medium, by a ray refracted in a plane surface, will appear larger than it really is. If the object be in a rarer, and the eye in a denser medium, the object will appear less than it is. And in each case the apparent magnitude, is to the real one, in a ratio compounded of the distance of the point, to which the rays tend before refraction, from the refracting surface, to the distance of the eye, from the same, and of the distance of the object, from the eye, to its distance from a point to which the rays tend before refraction.

Hence, 1. If the object A D, be very remote, F M will be physically equal to G M; and therefore the real magnitude M B, to its apparent one M H; or the distance of the eye from the refracting plane, to the distance of the point of convergence from the same plane.

Hence, 2. *Objects under water, to an eye in the air, appear larger than they are; and to fishes under water, objects in the air appear less than they are.*

And amongst the *laws of refraction in spherical surfaces, both concave and convex.* A ray of light D E (*Fig.* 19,) parallel to the axis of a denser sphere; after a single refraction in E, falls in with the axis in the point *f*, beyond the center C.

For the semi-diameter C E drawn to the point of *refraction* E, is perpendicular to the surface, and is therefore the axis of refraction: and therefore the ray D E will converge to the axis of the sphere A F; and will, therefore, at length concur with it; and that beyond the center C, in F, because the angle of refraction F E H, is less than the angle of inclination C E H.

2. If a ray H E (*Fig.* 23.) falls parallel to the axis F A, out of a rarer, on the surface of a spherically concave denser medium, the refracted ray E N will be driven from the point of the axis F; so as F E will be to F C, in the ratio of the sine of the angle of inclination, to the sine of the refracted angle.

And 3. If the ray H E (*Fig.* 22,) fall parallel to the angle A F, from a denser, upon the surface of a spherically concave rarer medium; the refracted ray will concur with the axis A F, in the point F; so as the distance of the point of concourse from the center, may be to the refracted ray in the ratio of the sine of the refracted angle, to the sine of the angle of inclination.

From this examen of the laws of refraction in *dioptricks*, in general; I'll pass to a more particular one, of those laws with respect to *lenses, telescopes, microscopes, prisms*, &c. beginning by the definition of *lens*, &c.

Lens, in *dioptricks*, properly signifies a small, oblong glass, of the figure of a *lentil*; but is extended to any *optick* glass, not very thick, which either

either collects the rays of light into a point, in their passage through it, or disperses them further apart, according to the laws of refraction.

Lenses have various figures; that is, are terminated by various surfaces, from which they acquire various names. Some are plain on one side, and convex on the other; others convex on both sides; both which are ordinarily called *convex lenses*; though when we speak accurately, the former are called *plano-concave*. Others again, are concave on both sides; others are concave on one side, and convex on the other; which are called *convexo-concave*, or *concavo-convex lenses*, according as the one or other surface is more curve, or a portion of a less sphere.

It is to be here observed, that in every *lens* terminated in any of the afore-mentioned manners, a right line perpendicular to the two surfaces, is called the axis of the *lens*. Which axis, when both surfaces are spherical, passes through both their centers; but if one of them be plane, it falls perpendicularly upon that, and goes through the center of the other.

Lenses are distinguished, with regard to their manner of preparation, into *ground*, and *blown*.

Blown lenses are little globules of glass, melted in the flame of a lamp or taper. The secret is now found of making these exquisitely small, so as some of them do not exceed in diameter, the sixth part of a line, which are found to magnify objects several millions of times.

Note, also, That as to the manner of grinding *lenses*, I have explained it in my treatise of *glass-grinding*, under the letter G.

Amongst the *laws of refraction*, with regard to *lenses*, those of *convex-lens*, and the effects depending thereon, it is observed that,—1. A ray of light near the axis and parallel thereto, (*table opticks*, *Fig.* 25,) striking on the plain surface of a *plano-convex lens*, directly opposite to the luminous body, after refraction concurs with the axis in the point F, and if C be the center of the convexity, C F will be to F L, that is, from the distance of the center from the point of concourse, or focus, will be to the distance of the center in the convex surface, in the ratio of the refraction.

For the plain surface being directly opposed to the luminous body, the ray E G is perpendicular to A B, and therefore will pass unrefracted to H: thus it strikes on A H B, still parallel to the axis; and therefore coming out of a denser medium into a rarer, will meet with the axis of the lens in *b*; and so as that C F will be to F L, in the ratio of the sine of the refracted angle, to the sine of the angle of inclination,

If the refraction be out of a glass lens into air, C F : E L :: 3 : 2, and therefore F L = 2 C L, that is, parallel rays, near the axis, will concur with it at the distance of the diameter.—Again, if the refraction were out of a water lens, *i. e.* out of a *plano-convex lens* filled with water, C F : E L :: 4 : 3, and therefore F L = 3 C L, *i. e.* parallel rays nearer the axis, will concur with it at the distance of half the diameter. So that if a lighted candle be placed in the focus of a *plano-convex lens*, that is, in the point *f*, distant from the surface of the lens A L B, by the length of the diameter; and from the surface of the water *lens*, by half the diameter, its rays, after refraction, will become parallel.

2. If the ray K L (*Fig.* 24.) near the axis of a *plano-convex lens*, and parallel thereto, strikes on its convex surface A O H B, after a double refraction, it will meet the axis in F; so as that H G will be to G C, and G F to F H, in the ratio of the refraction.

For the ray K I, parallel to the axis E G, by virtue of the first refraction in I, will tend to the point G, so as G H will be to G C in the ratio of the sine of the angle of inclination, to the sine of the refracted angles: therefore by virtue of the second refraction in L, it will concur with the axis in F; so as G D will be to F D, in the ratio of the sine of the refracted angle, to the sine of the angle of inclination.

3. If a luminous body be placed in a focus behind a lens, whether plano-convex, or convex on both sides, or, whether equally or unequally, the rays after refraction become parallel.

4. The images of objects, opposed in any manner to a convex lens, are exhibited invertedly in its focus.

5. If a concave *mirrour* be so placed, as that an inverted image, formed by refraction through a lens, be found between the center and the focus, or even beyond the center, it will again be inverted by reflection, and so appear erect in the first case beyond the center; and in the latter, between the center and the focus. On these principles is built the *camera obscura*.

Camera obscura, is a machine or apparatus, representing an artificial eye; whereon the images of external objects, received through a double convex glass, are exhibited distinctly, and in their native colours, on a white matter placed within the machine, in the focus of the glass.

6. The diameter of the image of an object delineated beyond a convex lens, is to the object itself in the ratio of the distance of the image to that of the object.

7. If the eye be placed in the focus of a convex lens, an object viewed through it appears erect, and

and enlarged in the ratio of the diſtance of the object from the eye, to that of the eye from the lens, if it be near; but infinitely, if remote.

The laws of *concave lens* are as follows. 1. If parallel rays ſtrike on a plano-concave lens K L, *Fig.* 7. and F C be to F B in the ratio of refraction, the rays will diverge from the axis, and the point of divergency, or diſperſion, called the virtual focus, will be F.

For the ray H I, parallel to the axis, is perpendicular to K L, and will therefore paſs unrefracted to E. Wherefore F C being to F B in the ratio of refraction, F will be the virtual focus.

If then, the lens be glaſs, F B = 2 B C, *i. e.* the virtual focus F will be diſtant from the lens K L, by the ſpace of the diameter 2 B C.

If the refraction be in water, F B = 3 B C, *i. e.* the virtual focus F, will be diſtant from the lens K L, a diameter and a half 3 B C.

2. If the ray A E, parallel to the axis F P, ſtrike on a lens concave on both ſides; and both F C be to F B, and I P to P H, in the ratio of refraction; and F P: P H : : F B: B G; G will be the point of diſperſion, or the virtual focus, *Fig.* 5.

If therefore the refraction be in a glaſs lens, the ſums of the ſemi diameters C B and H I, will be to the diameter of the concavity of either 2 H I, as the ſemi-diameter of the other C B, to the diſtance of the virtual focus, from the lens B G.

Focus is, in *Opticks*, a point wherein ſeveral rays concur, and are collected; either after having undergone refraction or reflection. In *dioptricks, focus* is the point wherein refracted rays, render'd convergent by refraction, do concur or meet, and croſs the axis. The ſame point is alſo called the *point of concourſe*, or *concurrence.* And in *catoptricks, focus*, is a point wherein the rays reflected from the ſurface of a mirrour or ſpeculum, and by reflection render'd convergent, do concur, or meet.

The rules for finding the *foci* of glaſſes, are theſe: to find the focus of a convex ſpherical glaſs, being of a ſmall ſphere, apply it to the end of a ſcale of inches, and decimal parts, and expoſe it before the ſun; upon the ſcale you will have the bright interſection of the rays meaſured out; or expoſe it in the hole of a dark chamber; and where a white paper receives the diſtinct repreſentation of diſtinct objects, there is the focus of the glaſs. For a glaſs of a pretty long focus, obſerve ſome diſtant object thro' it, and recede from the glaſs, till the eye perceives all in confuſion, or the object begins to appear inverted; here the eye is in the focus. For a plano-convex glaſs, make it reflect the ſun againſt the wall, you will on the wall perceive two ſorts of light; one more bright within, another more obſcure: withdraw the glaſs from the wall, till the bright image is at its ſmalleſt; the glaſs is then diſtant from the wall about the fourth part of its focal length. For a double convex; expoſe each ſide to the ſun in like manner; and obſerve both the diſtances from the wall. The firſt diſtance is about half the radius of the convexity turned from the ſun; and the ſecond, about half the radius of the other convexity. Thus we have the radii of two convexities; whence the focus is found by this rule: as the ſum of the radii of both convexities, is to the radius of either convexity, ſo is the double radius of the other convexity, to the diſtance of the focus.

A Telescope is an optical inſtrument, conſiſting of ſeveral glaſſes, or *lens*, fitted into a tube, thro' which remote objects are ſeen, as if nigh at hand.

In *teleſcopes*, the lens or glaſs turned towards the object, is called the *object-glaſs*; and that next the eye, the *eye-glaſs*; and if the *teleſcope* conſiſts of more than two lenſes, all but that next the object, are called *eye-glaſſes.*

Teleſcopes are of ſeveral kinds diſtinguiſhed by the number and form of their lenſes or glaſſes; and denominated from their particular uſes; ſuch as the *terreſtrial* or *land teleſcope*; the *celeſtial* or *aſtronomical teleſcope*; to which may be added, the *Galilean* or *Dutch teleſcope*, the *reflecting teleſcope*, and the *aerial teleſcope.*

The *Galilean* or *Dutch teleſcope*, is a *teleſcope*, conſiſting of a convex *object-glaſs*, and a concave *eye-glaſs.*

For the conſtruction of a *Dutch teleſcope*; in a tube prepared for the purpoſe, at one end is fitted a convex object lens, either a plain convex, or convex on both ſides, but a ſegment of a very large ſphere: at the other end is fitted an eye-glaſs, concave on both ſides, and the ſegment of a leſs ſphere; ſo diſpoſed, as to be the diſtance of the virtual focus, before the image of the convex lens.

In an inſtrument thus framed, all people, except *myopes*, or thoſe *ſhort ſighted*, muſt ſee objects diſtinctly in an erect ſituation, and increaſed in the ratio of the diſtance of the virtual focus of the eye-glaſs to the diſtance of the focus of the object-glaſs.

But for *myopes* to ſee objects diſtinctly through ſuch an inſtrument, the eye-glaſs muſt be ſet nearer the object-glaſs. The reaſon of theſe effects will appear from what follows: For,

1. Since it is far diſtant objects that are to be viewed with a *teleſcope*, the rays proceeding from the ſame point of the object, will fall on the object-glaſs parallel, and conſequently by their refraction through the convexity, will be thrown converging on the eye-glaſs; but by their refraction through the concavity

vity hereof, they will be again rendered parallel, and in ſuch diſpoſition will enter the eye.—But all, excepting *myopes*, ſee objects diſtinctly by parallel rays.

2. Suppoſe A (Fig. 30.) to be the focus of the object-glaſs; and ſuppoſe A C, the fartheſt rays on the right hand of the object that paſſes through the tube: after refraction it will become parallel to the axis B I, and conſequently after a ſecond refraction through the concave lens, will diverge from the virtual focus. Wherefore ſince all the rays coming from the ſame extreme, to the eye placed behind the concave lens, are parallel to L E; and thoſe from the middle of the object parallel to F G; the middle point of the object will be ſeen in the axis G A; and the right extreme, on the right ſide, *viz.* in the line L N, a parallel thereto; that is, the object will be erect: which is the ſecond point.

3. Since all right-lines, parallel to L N, cut the axis under the ſame angle, the ſemi-diameter of the object will be ſeen through the *teleſcope*, under the angle A F N, or E F I: the rays L E, and G I, entring the eye in the ſame manner, as if the pupil was placed in F. If now the naked eye were in A, it would ſee the ſemi-diameter of the object under the angle *c* A *b* or C A B. But ſince the object is ſuppoſed very remote, the diſtance A F, in reſpect hereto is nothing, and therefore the naked eye, even in F, would ſee the ſemi-diameter of the object under an angle equal to A.

The ſemi-diameter of the object therefore, ſeen with the naked eye, is to that ſeen through the *teleſcope*, as I M to I E. But it is demonſtrated, that I M : I E : : I F : R B; that is, the ſemi-diameter ſeen with the naked eye, is to that viewed through the *teleſcope*, in the ratio of the diſtance of the virtual focus of the eye-glaſs F I, to the diſtance of the focus of the object-glaſs A B; which was the third point.

Laſtly, *myopes* have their retina too far from the cryſtalline humour; and diverging rays concur at a greater diſtance than parallel ones; and thoſe that were parallel become diverging, by bringing the eye-glaſs nearer the object-glaſs; by means of ſuch approach, *myopes* will ſee objects diſtinctly through a *teleſcope*; which is the fourth point.

An *aſtronomical* TELESCOPE, is a *teleſcope* conſiſting of an object-glaſs and an eye-glaſs, both convex. It has its name from its being wholly uſed in aſtronomical obſervations.

For the conſtruction of an *aſtronomical teleſcope.* The tube being prepared, an object-glaſs, either plano-convex, or convex on both ſides, but to be a ſegment of a large ſphere, is fitted in at one end; at the other end, an eye-glaſs, convex on both ſides, which is the ſegment of a ſmall ſphere, is fitted at the common diſtance of the foci.

The theory of this *teleſcope* is as follows. An eye placed near the focus of the eye glaſs, will ſee objects diſtinctly, but inverted and magnified in the ratio of the diſtance of the focus of the eye-glaſs, to the diſtance of the focus of the object-glaſs.

For, 1. Since it is very remote objects are viewed through *teleſcopes*, the rays from one point of the object fall parallel on the object-glaſs; and conſequently after refraction, will meet in a point behind the glaſs, which point is the focus of the eye-glaſs. From this point they begin to diverge, and fall diverging on the eye-glaſs, where, being refracted, they enter the eye parallel.

Hence, as all but *myopes*, ſee diſtinctly by parallel rays, a *teleſcope* thus diſpoſed, will exhibit remote objects diſtinctly.

Suppoſe the common focus of the lens's in F, *Fig.* 32. and make A B = B F. Since one of the rays A C, proceeding from the right ſide of the object, paſſes through A; the ray C E will be parallel to the axis A I, and therefore after refraction in the eye-glaſs, will fall in with it in its focus G. Since then, the eye is placed near it, and all the other rays proceeding from the ſame point of the object with E G, are refracted parallel thereto, the point in the right ſide of the object, will be ſeen in the right line E G.

After the like manner it appears, that the middle point of the object is ſeen in the axis G B, ſo that the object appears inverted.

3. From what has been already ſhewn, it appears, that the ſemi-diameter of the object will be ſeen thro' the *teleſcope*, under the angle E G I, which to the nake eye placed in A, is ſeen under the angle *b* A *c*. Suppoſe now I F equal to the diſtance of the focus I G; ſince the right angles at I are equal, E G F = E F I. Therefore, drawing F M, parallel to A C, we ſhall have I F M = B A C.—The ſemi-diameter, therefore, viewed with the naked eye, is to that viewed through the *teleſcope*, as I M to I E; draw K E parallel to F M we ſhall have I M : I E : : I F : I K; but by reaſon of that parallelіſm of the lens, C E = B I = B F + F I = A B + F I; and by reaſon of the parallelіſm of the right lines C A and E K, C E = A K, therefore B I = A K, conſequently A B = I K. And therefore I M : I E : : I F : A B; that is, the ſemi-diameter ſeen with the naked eye, is to the ſemi-diameter viewed through the *teleſcope*, in the ratio of the diſtance of the focus of the eye-lens I F, to the diſtance of the focus of the object glaſs A B.

Land TELESCOPE, or *day teleſcope*, is a teleſcope conſiſting of more than two lenſes, commonly of a convex object-glaſs, and three convex eye-glaſſes; or, a *teleſcope* that exhibits objects erect, yet different from that of *Galileo.*—It has its name from being uſed to view objects in the day time, on or about the earth.

To conſtruct a *land* or *day teleſcope*—A tube being provided, fit in an object glaſs, which is either convex on both ſides, or plano-convex, and a ſegment of a large ſphere: to this add three eye glaſſes, all convex on both ſides, and ſegments of equal ſpheres, diſpoſing them in ſuch manner, as that the diſtance of any two may be the aggregate of the diſtances of their foci.

Then will an eye applied to the laſt lens, at the diſtance of its focus, ſee objects very diſtinctly, and magnified in the ratio of the diſtance of the focus of one eye-glaſs, to the diſtance of the focus of the object glaſs.

The *optical principles* whereon *teleſcopes* are founded, are contained in *Euclid.* From this I'll paſs to the *microſcope.*

A Microscope, is a *dioptrical* inſtrument, by means whereof very minute objects are repreſented exceedingly large, and viewed very diſtinctly, according to the laws of refraction.

Microſcopes are properly diſtinguiſhed into *ſimple,* or *ſingle*; and *compound* or *double.*

Single microſcopes are thoſe which conſiſt of a ſingle lens, or a ſingle ſpherule.

Compound microſcopes conſiſt of ſeveral lenſes duly combined.

With regard to the foundation and theory of *ſingle microſcopes*—If an object A B (*Fig.* 34.) be placed in the focus of a ſmall convex lens, or a *ſimple microſcope* D E, and the eye be applied cloſe to the other ſide of the *microſcope,* the object will be ſeen diſtinct in an erect ſituation, and magnified in the ratio of the diſtance of the focus, to the diſtance wherein objects are to be placed to be ſeen diſtinctly with the naked eye.

For the object A B, being placed in the focus of the convex lens D E, the rays iſſuing from the ſeveral points thereof after refraction, will be parallel to each other. Conſequently the eye will ſee it diſtinctly, by virtue of what we have proved in ſpeaking of *teleſcopes.*

The laws of *ſimple microſcropes,* are,—1. That *ſimple microſcopes* magnify the diameter of the object A B, in the ratio of the diſtance of the focus F C to an interval of eight digits; *v. gr.* if the ſemi-diameter of a lens convex on both ſides be half a digit, A B; $IK = \frac{1}{2}\ 8 = 1 : 16$, that is, the diameter of the object will be increaſed in a ſedecuple proportion, or as ſixteen to one.

2. Since the diſtance FH is conſtant, *viz.* eight digits by how much diſtance of the focus F C is ſmaller, ſo much the ſmaller ratio will it have to FH; conſequently the diameter of the object will be ſo much the more magnified.

3. Since in the plano-convex lens, the diſtance of the focus is equal to the diameter; and in lenſes convex on both ſides, to the ſemi-diameter; *ſimple microſcopes* will enlarge the diameter ſo much the more, as they are ſegments of ſmaller ſpheres.

4. If the diameter of the convexities of a plano-convex lens, and a lens convex on both ſides, be the ſame, *viz.* $= 1$; the diſtance of the focus of the firſt will be 1, of the ſecond $\frac{1}{2}$; conſequently the ſemi diameter of the object A B, will be to the apparent one in the firſt caſe as 1 to 8, in the latter as $\frac{1}{2}$ to 8, *i. e.* as 1 to 16. A lens therefore convex on both ſides magnifies twice as much as a plano-convex,

As the whole depends on the juſt and ſteady ſituation of objects with regard to the lens, various methods have been contrived to that end; whence we have ſeveral kinds of *microſcopes*; the moſt ſimple is as follows.

1. A B (*Fig.* 34.) is a little tube, to one of whoſe baſes B C, is fitted a plain glaſs, to which an object, *viz.* a gnat, wing of an inſect, down, or the like, is applied: to the other baſe, A D, at a proper diſtance from the object is applied a lens, convex on both ſides, whoſe ſemi-diameter is about half an inch. The plain glaſs is turned to the ſun, or the light of a candle, and the object is ſeen magnified: and if the tube be made to draw out, lenſes of different ſpheres may be uſed.

Again, a lens convex on both ſides, is incloſed in a cell A C (*Fig.* 35.) and by a ſcrew H, there faſtened a-croſs; through the pedeſtal CD paſſes a long ſcrew, by means whereof, and the female ſcrew I, a ſtyle or needle fixed perpendicularly to its extreme, is kept firm at any diſtance from the lens. In E is a little tube, on which, and on the point G, the various objects are to be diſpoſed; there may be lenſes of various ſpheres applied.

2. But the *microſcope,* which is found to anſwer the end beſt is as follows; AB, *Fig.* 39. is a round braſs tube, whoſe exterior ſurface is formed into a ſcrew of a length ſomewhat leſs than the diſtance of the focus of a glaſs convex on both ſides, uſed here for illuminating the object, and fitted to its baſe A C, by a ring with a ſcrew in it D E.

F G is another braſs tube, ſomewhat wider than the firſt, and open each way for an object to be applied to the *microſcope.* To its upper baſe GH, is faſtened a ſpring of ſteel wire, twiſted into a ſpiral I, whereby an object placed between two round plates,

plates, or slices, K and L, in the manner hereafter mentioned, is by means of the screw BC brought, to the microscopical lens (or magnifying glass, whereof there are several) and kept firm in its place, to the basis HG, which has a female screw M, are fitted cells N, with a male screw O, wherein lenses of various spheres guarded by ferrils, are included. In P is a female screw, by which an ivory handle PQ is fastened to the *microscope*.

In the ivory slice T are round holes, in which are fitted little circles of *Muscovy* talc for objects, especially small and pellucid ones, as little insects, or the wings, scales, *&c.* of larger to be fastened to.

When live insects are to be viewed, they are covered with the brass slice Y, which is put in a little square brass bed, perforated with a hole X; and the same slice, whether alone, or enclosed in the bed, being laid between the round plates K and L, is brought to the lens by means of the screw AB, till the object may be distinctly viewed.

If other pellucid oblong objects are to be viewed, as down, cuticle, *&c.* instead of the slice above, is used the instrument, mentioned above for viewing wings of flies; whose structure is manifest by inspection.

There are other instruments in the apparatus of the *microscope*, as little tongs, *&c.* for taking up small objects, a glass tube for viewing the circulation of the blood in fishes, *&c.* which need no description.

What has been said hitherto, is to be understood of *lenticular microscopes*; for spherical ones, their doctrine will be understood from what follows.

In an object AB (*Fig.* 40.) be placed in the focus of a glass spherule F, and the eye be behind it, *v. gr.* in the focus G, the object will be seen distinct in an erect situation, and magnified, as to its diameter, in a ratio of $\frac{3}{4}$ of the diameter EI, to the distance at which objects are to be placed, to be seen distinctly with the naked eye.

As to *water microscopes*.—M. *S. Gray*, and after him *Wolfius*, and others, have contrived *water microscopes*; consisting of spherules or lenses of water instead of glass, fitted up somewhat after the manner above-mentioned.

As to the theory of *compound*, or *double microscopes*.——Suppose an object glass ED, *Fig.* 43. the segment of a very small sphere, and the object AB placed without the focus F.

Suppose an eye-glass GH, convex on both sides, and the segment of a sphere greater (though not too great) then that of DE, and let it be so disposed behind the object, as that if CE : CL : : CL : CK, the focus of the eye-glass may be in K.

Lastly, suppose LK : LM : : LM : LI.

If then O be the place wherein an object is seen distinct with the naked eye; the eye in this case being placed in I, will see the object AB in an inverted situation, and magnified in a compound ratio of MK to LK and LC to CO; as is proved from the laws of dioptricks.

The most commodious *double microscope* is of the contrivance of Mr. *Marshal*, an *Englishman*. In this the eye-glasses are placed in the tube at A and B (*Fig.* 47) and the object-glass at C, the little pillar DE is turned by means of a ball E, movable in the socket F; and thus the *microscope* is accommodated to any situation. The same pillar is divided into as many parts, 1, 2, 3, 4, 5, *&c.* as there are lenses of different spheres to be used in viewing different objects; so that the distance of the object from the object-glass may be found without any trouble. But as it is scarce exactly enough determined this way, the tube may be brought nearer the object at discretion, by means of the screw GH.

The objects are either laid on the circle I, or fitted to proper instruments, having their points or stiles passing through the little tube LM.

Lastly, to illuminate the object, a lens convex on both sides, is disposed in a convenient situation.

There are reflecting *microscopes*, which magnify by *reflection*, as the above-mentioned ones do by refraction. The structure of such a *microscope* may be conceived thus; near the focus of a common speculum ABC (*Fig.* 48.) place a minute object C, that its image may be formed larger than itself in D. To the speculum join a lens convex on both sides EF, so as the image D may be in its focus. The eye will here see the image inverted, but distinct and enlarged; consequently the object will be larger if viewed through the lens alone. Sir *Isaac Newton* invented this *microscope*.

The next thing, which occur, are *spectacles*.

SPECTACLES are an optick machine, consisting of two lenses set in horn or other matter, and applied on the nose, to assist in defect of the organ of sight.

Old people, and all presbytæ, use *spectacles* of convex lenses, to make amends for the flatness of the eye.

Short-sighted people, or *myopes*, use concave lenses, to keep the rays from converging so fast, through the great roundness of the eye, as to make them meet ere they reach the retina.

Spectacles were certainly unknown to the antients; yet are they not of so late a date as the telescope. *Francisco Ridi*, in a very learned treatise on *spectacles*, will have them to have been invented in the 13th century, between the years 1280, 1280, and 1311; and adds, that *Alexander Deſpina*, a monk of the order of predicants of St. *Catherine*, at *Piſa*, firſt communicated the ſecret, which was of his own invention; upon learning that another perſon had it as well as himſelf. The hiſtory is wrote in the chronicles of that convent.

Du Conge, however, carries the invention of *ſpectacles* farther back; aſſuring us, that there is a *Greek* poem in manuſcript, in the king of *France*'s library, which ſhews, that *ſpectacles* were in uſe in the year 1150.

From this I'll paſs to the deſcription of a *priſm*, in *dioptricks*; and to the explication of the phænomena thereof.

Prism, in *dioptricks*, is a glaſs in form of a triangular priſm, much uſed in experiments about the nature of light and colours.

Priſm, in *Geometry*, whence this borrows its name, is an oblong ſolid or body, contained under more than four planes, and whoſe baſes are equal, parallel, and equally ſituated.

The phænomena and uſe of the *priſm*, ariſe from its ſeparating the rays of light in their paſſage thro' it.

The more general of theſe phænomena are as follow:

1. The ſun's rays tranſmitted thro' a *priſm* to an oppoſite wall, project an image like the rainbow, of various vivid colours; the chief whereof are red, yellow green, blue, and violet.

The reaſon is, that the various colour'd rays, which were before mixed and blended together, are now, in virtue of their different refrangibilities, ſeparated by refraction, in paſſing thro' the *priſm*, and thrown each colour by itſelf.

For the blue rays, *v. gr.* repreſented by the dotted lines, *Fig.* 50. beginning to be ſeparated from the reſt in the ſide *c a*, of the *priſm a b c*, by the firſt refraction in *d d*, are again ſeparated further in the other face of the *priſm b c*, by a ſecond refraction, the ſame way in *e e*; whereas in a plain glaſs, or even in a *priſm* in a different poſition, the blue rays ſeparated by the firſt refraction, are again mixed by the ſecond refraction, at the other ſurface, which is made a contrary way.

2. The image thus projected, is not round; but when the angle of the *priſm* is 60 or 65 deg. about five times as long as broad.

3. Thoſe rays which exhibit the yellow colour, ſwerve more from the rectilinear courſe, than thoſe which exhibit the red; and the green more than the yellow; and the violet moſt of all.

4. If the *priſm*, through which the rays are tranſmitted, be turned about its axis; ſo as the red, yellow, green, &c. rays, be received in order on another *priſm* about 12 feet diſtant from the former, through a little hole, and thence projected further, the yellow, red, &c. rays, though they fall in the ſame manner, on the ſecond *priſm*, yet will not be projected on the ſame place as the red, but will be deflected further that way towards which the refraction is.

And if, in lieu of the ſecond priſm, they be received on a lens a little convex; the yellow, green, &c. rays, will be collected each in its order, into a nearer focus than the red ones. The reaſon of which two laſt phænomena is, that the yellow rays are refracted more than the red ones; the green ones more than the yellow ones, and the violet ones moſt of all.

5. The colours of colour'd rays well ſeparated, can neither be deſtroyed, nor in any manner alter'd by repeated refractions through a number of *priſms*, nor by paſſing through an illumined ſpace, nor by their mutual decuſſations, nor by the neighbourhood of the ſhade, nor by being reflected from any natural bodies.

6. All coloured rays collected together in any manner, either by ſeveral *priſms*, or a convex lens, or concave ſpeculum, form whiteneſs; but being again ſeparated after decuſſation, each exhibits its proper colour.

7. If the ſun's rays fall very obliquely on the inner ſuperficies of a *priſm*, the rays reflected will be violet; thoſe tranſmitted, red.

8. If there be two *priſms*, the one full of a red liquor, the other of a blue one; the two joined together will be opake; though, if both be filled either with a blue or a red liquor, they will together be tranſparent: for the one tranſmitting none but blue, the other none but red rays, the two together will tranſmit none at all.

9. All natural bodies, eſpecially white ones, viewed through a *priſm* held to the eye, ſeem fringed or hammed on one ſide, with red and yellow, on the other with blue and violet.

10. If two *priſms* be ſo placed, that the red of the one, and the purple of the other, meet on a paper encompaſſed with darkneſs, the image will be pale; but viewed through a third *priſm*, held to the eye at a due diſtance, will appear double, red, and purple.

And if two kinds of powder, the one perfectly red, the other blue, be mixed, a little body being covered thick with the mixture, will exhibit a double image, the one red, the other blue, through a *priſm* applied to the eye.

11. If the rays tranſmitted through a convex lens be received on a paper before they meet in the focus, the confine of light and ſhadow will ſeem tinged with a red colour; if beyond the focus, with a blue.

12. If

12. If the rays about to be tranfmitted through one part of the pupil, be intercepted by the oppofition of fome opake body near the eye, the extremes of bodies laying beyond it, will feem tinged with colours, as is feen through a *prifm*, though lefs vivid.

Euclid has wrote on the antient *opticks*, and *catoptricks*: *dioptricks* were unknown to them. *F. Honorat. Fabri* has an abridgment of *opticks*, *catoptricks*, and *dioptricks*: Father *Efchinard* has given a century of problems in *opticks*; *Vitellio* and *Alhazen*, have performed well on the elements of *opticks*. Father *Kircher* has a large volume on the fecrets of *opticks*, of light and fhadow, and their furprizing effects, which pafs on the people for magick. We have alfo *L'optique* and *catroptrique* of father *Merfenne*, *Paris* 1651. *Dioptrique Oculaire* of father *Cherubin*, *Paris* 1671. *fol. Chriftop. Cheiveri Optica*, *London* 1658. *Jacobi Gregorii Optices. Barrovii Lectiones Opticæ*, *London* 1663. *Joh. Bapt. Porta*, *De refractione Optices*, *London* 1669. *Principes generales de l'optique*, by M. *Leibneitz*, in the *Leipfick* acts, 1642. *L'Occhiale a l'occhia*, or *dioptrica practica*, *Carol. Anton. Manimé*, *Bologna* 1660, *4to*. Sir *Ifaac Newton*'s *opticks*, *Latin* and *Englifh* *4to*. and *8vo*. &c.

PAINTING.

PAINTING is the art of reprefenting on a flat fuperficies, by the duct of draught, and the degrees of colours, all forts of vifible objects.

This definition contains three things, *viz.* the *draught*, the *colours*, and the *compofition*; and tho' this laft part does not appear expreffed in a very clear manner in my definition, it can, notwithftanding, be underftood by thefe laft words, *vifible objects*, which contains the matter of the fubjects, which the painter propofes to reprefent.

The *compofition* contains two things, *viz.* the *invention* and the *difpofition*. By the *invention*, a painter muft find and introduce into his fubject, the objects which he judges moft proper to exprefs and adorn it. And by the *difpofition*, he muft place them in a manner, the moft advantageous to draw a grand effect from them, and to pleafe the eye, in fhewing beautiful parts.

For the *draught*.—A painter muft do it correctly, with a good tafte, well diverfified, fometimes heroick, and fometimes rural, according to the character of the figures he wants to introduce.

The *attitudes* are to be natural. expreffive, varied in their actions, and contrafted in their members: they ought to be fimple or noble, animated or moderated according to the fubject of the picture, and the difcretion of the painter.

Attitude, in *Painting*, is the pofture or gefture of a figure, or the difpofition of its parts, by which we difcover the action it is engaged in, and the very fentiment fuppofed to be in the mind of the perfon reprefented.

The *expreffions* muft be juft to the fubject; the principal figures having noble and fublime ones; and keeping a medium between the exaggerated and infipid.

Expreffion, in *Painting*, denotes a natural and lively reprefentation of the fubject, or of the feveral objects intended to be fhewn. The term *expreffion* is ordinarily confounded with that of *paffion*; but they differ in this, that *expreffion* is a general term, implying a reprefentation of an object, agreeable to its nature, and character, and the ufe, or office it is to have in the work; whereas *paffion*, in *Painting*, denotes a motion of the body, accompanied with certain difpofitions, or airs of the face, which mark an agitation in the foul; fo that every *paffion* is an *expreffion*, but not every *expreffion* a *paffion*.

The extremities, I mean the head, feet, and hands, muft be worked with more precifion and exactnefs than all the reft, and muft concur together, to render the action of the figures more expreffive.

The *draperies* muft be well order'd, the folds or plaits thereof large, in fmall number, as much as poffible, and well contrafted; the ftuffs thick or light, &c. according to the quality and conveniency of the figures.

Drapery, in *Painting*, is the reprefentation of the garments, or cloathing of human figures.

Animals muft be principally characterized by an ingenious and fpecial touch.

A *landfkip* ought not to be cut by too many objects; they fhould be few, but well chofen; and in cafe a great quantity of objects be introduced in it, they muft be ingenioufly *grouped* with lights and fhadows; the fight well bound and free; the trees different in form, colour, and touch, as much as prudence, and the variety of nature require it: that touch fhould be always light; the fore-parts of the landfkip rich, either by the objects, or by a greater exactnefs of work, which render the things true and palpable: the fky is to be light, and no object on the ground ought to difpute with its æthereal character, except fmooth waters, and polifhed

lifhed bodies, which are fufceptible of all colours oppofed to them; of celeftial, as well as terreftrial ones: the clouds muft be well chofen, well touched, and well placed.

Group, in *Painting*, is an affemblage or knot of two or more figures of men, beafts, fruits, or the like, which have fome apparent relation to each other. In a good *painting*, it is neceffary that all the figures be divided into two or three *groups*, or feparate collections. Such and fuch a thing make a *group*, with fuch and fuch other of different nature and kind. The antique *Laomedon* is a fine *group* of three beautiful figures.

The *perfpective* muft be regular, and not of fimple practice, very little exact.

In the *coloris*, which includes two things, the *local colour*, and the *clair-obfcure*.

The *local colour* is nothing elfe but that, which is natural to each object, in what place foever it be found.

The *clair obfcure* is the art of diftributing advantageoufly the lights and fhadows, as well on the particular objects, and in the whole of the picture: on the particular objects, to give them a convenient *relievo* and roundnefs: and in the whole of the picture, that the objects may be feen in it with pleafure; by giving occafion to the fight to reft itfelf from fpace to fpace, by an ingenious diftribution of grand *clairs*, and large fhadows, which afford one another mutual fuccours, by their oppofitions; fo that the great *clairs* are refts for the great fhadows; as the great fhadows will be refts for the great *clairs*.

In the *defcription of colours* there muft be an accord, which may produce the fame effect for the eyes, as mufick does for the ears.

If there be feveral groups of *clair-obfcure* in a picture, one of them muft be more fenfible than the reft, fo that there may be unity of object, as in the compofition there is unity of fubject.

As to *the pencil*, it muft be bold, and light, if poffible; but whether it appears fmooth, like that of *Corregio*, or uneven and rough, like that of *Rembrant*, it fhould be always foft.

As to *licences*; if one is forced to take any, they muft be imperceptible, judicious, advantageous, and authorifed; the three firft are for the art of the painter, and the laft regards hiftory.

The *invention*, which is an effential part of the art confifts only in finding the objects which muft enter the picture, according to the imagination of the painter, falfe or true, fabulous or hiftorical.

As to the *compofition*.—Some have confounded the firft part of *Painting* with the genius, others with a fertility of thoughts; and others with the difpofition of objects; but all thofe things are different from one another. I thought that to give a clear idea of the firft part of *Painting*, I fhould call it *compofition*, and divide it into two, *viz. invention* and *difpofition*. The *invention* finds only the objects of the *painting*; and the *difpofition* places them.

The *invention* is formed by reading in the fubjects extracted from hiftory or the fable. It is a pure effect of the imagination in *metaphorical fubjects*; it contributes to the fidelity of the hiftory, as to the clearnefs of the allegories; and in what manner foever it is ufed, it muft never keep the mind of the fpectator in fufpenfe by any obfcurity.

As to the *defign*, which I confider as the fecond part of *painting*.

The qualities or conditions required in a defign are correctnefs, good tafte, elegance, character, diverfity, expreffion, and perfpective.

Correctnefs depends principally on the juftnefs of the proportions, and a knowledge of anatomy. Tafte is an idea or manner of defigning, which arifes either from the complexion and natural difpofition, or from education, one's mafter, ftudies, &c. Elegance gives the figures a kind of delicacy, which ftrikes people of judgment, and a certain agreeablenefs which pleafes every body. The character is what is peculiar to each thing; in which there muft be a diverfity; in as much as every thing has its particular character to diftinguifh it. The expreffion is, as already obferved, the reprefentation of an object according to its character, and the feveral circumftances it is fuppofed to be in. The perfpective is the reprefentation of the parts of a *painting* or figure, according to the fituation they are in with refpect to the point of fight.

The principal rules that regard the defign are; that novices accuftom themfelves to copy good originals at firft fight; not to ufe fquares in drawing; for fear of ftinting and confining their judgment; to ftay till they can defign well after the life, before they begin the practice of perfpective rules; in defigning after the life, to learn to adjuft the bignefs of their figures to the vifual angle, and the diftance of the eye from the model or object; to mark it at all the parts of their defign, before they begin to fhadow; to make their contours in great pieces, without taking notice of the little mufcles, and other breaks; to make themfelves mafters of the rules of perfpective; to obferve every ftroke as to its perpendicular, parallel, and diftance; and particularly fo to compare, and oppofe the parts that meet upon, and traverfe the perpendicular, as to form a kind of fquare in the mind; which is the great, and almoft the only rule of defigning juftly: to have a regard not only to the model, but alfo to the part already defigned; there

being

being no such a thing as designing with strict justness, but by comparing and proportioning every part to the first, &c.

As to *attitudes*.——In them the ponderation and contrast are founded in nature. It performs no action without shewing those two parts; and was it to fail in it, it would be either deprived of motion, or constrained in its action.

As to *expressions*.—They are the touch-stone of the judgment of the painter: he shews by the justness wherewith he distributes them, his penetration and discernment.

As to the *extremities*, *viz.* the *head*, *feet*, and *hands*, must be more finished than any other things.

As to *draperies*.—It is said in *Painting*, to *throw a drapery*, or *give a drapery*, instead of cloathing a figure. Draperies are not to be set in form, as our cloaths are; but the plaits must be found as by chance round the members, that they may make them appear such as they are; and by an industrious artifice, contrast them in shewing them, and caress them, as it were, by their tender sinuosities, and softness.

As to the *landskip*.——As this kind of *painting* contains an abridgement of all the others, the painter who practises it, must have an universal knowledge of the parts of his art, if not in so great a detail as those who commonly paint history, at least speculatively, and in general. And if he does not finish all the objects in particular, which compose his piece, or accompany his landskip, he is obliged at least, to express in a lively manner, the taste and character thereof; and to give the much more spirit to his works, that it is less finished.

Let a landskip be ever so well finished, if the comparison of the objects does not render them valuable, and preserve their characters, if the *sites* be not well chosen, or are not supplied by a fine intelligence of the *clair-obscure*, if the touches be not judicious, if the places be not animated by figures, animals, or other objects, which are most commonly in motion, and if the truth and variety of nature be not joined to the good taste of the colour, and to the extraordinary sensations, the *painting* will never gain a reputation among connoisseurs.

As to the *perspective*.—Some authors have imagined that perspective and *painting* were the same thing, because there was no *painting* without perspective. Tho' the proposition is false, absolutely speaking, since the body, which cannot be without shadow, is not, notwithstanding, the same thing with the shadow; but however it is true, in that sense, that a painter cannot do without perspective, and that he does not draw alike, nor give a stroke of his pencil, without perspective having some part in it, at least habitually.

The colouring, in its general sense, takes in whatever relates to the nature and union of colours; their agreement, or antipathy; how to use them to advantage in light and shadow, so as to shew a relievo in the figures, and a sinking of the ground; what relates to the aerial perspective, *i. e.* the diminution of colours by means of the interposition of air; the various accidents and circumstances of the luminary and the medium; the different lights, both of the bodies illuminating and illuminated; their reflections, shadows, different views, with regard either to the position of the eye, or the object; what produces strength, boldness, sweetness, &c. in *paintings* well coloured; the various manners of colouring both in figures, landskips, &c.

As to the *pencil*.—Here the word *pencil* signifies only the manner of using it in the application of colours; and when those same colours have not been too much agitated, and as it is said too much tormented by the motion of a heavy hand, but, on the contrary, the motion appears free, quick and light, it is said that the work is of a good pencil. But that free pencil is of but little signification, unless it be guided by the head, and shew that the painter is master of his art. In a word, a fine pencil is to *painting* what musick is to a fine voice; since both are esteemed in proportion of the grand effect, and harmony which accompany them.

The next thing our pupil painter is to provide himself with, is all sorts of colours, the principal thereof are *red*, and *white lead*, or *cerufs*, *yellow okers*, several kinds of earth, as *umber*, &c. besides *orpiment*, *black lead*, *cinnabar*, *gumbooch*, *lake*, *bice*, *verditer*, *indigo*, *vermillion*, *verdigrease*, *ivory black*, *lampblack*, *smalt*, *ultramarine*, *Prussian blue*, and *carmine*.

Cerufs makes a beautiful white colour, and is much used both in oil and water colours. The best *cerufs* is that of *Venice*; but this is rare, that chiefly used is either *English* or *Dutch*, both of which have more marl in them than white lead; the latter however is the better of the two.—*Orpiment* must be chosen of a golden yellow hue, easy to scale, and the scales very thin, small and shining like gold.—The *umber* or *umbre*, is a dry dusky coloured earth, which diluted with water, serves to make a dark brown colour, usually called with us a hair-colour. It is called *umber* from *umbra*, shadow; as serving chiefly for the shadowing of objects; or rather from *Umbria*, a province of *Italy*, whence it is used to be brought. The best *oker* is that of *Berry* in *France*.—*Verditer* is used for a blue, but most usually is mixed with yellow for a green colour.——The *vermillion* is a bright beautiful red colour. We have two kinds of it

from

from *Holland*; the one of a deep red, the other pale: but it is of the fame matter at bottom, the difference of colour only proceeding from the cinnabar's being more or lefs ground; when fine ground the vermillion is pale, and this is preferred to the coarfer and redder.—The *verdigreafe*, to be good, muft be very dry, of a deep green, and pretty clear of white fpots.—The *ultramarine* is a beautiful blue colour, prepared from *lapis lazuli*. This blue is one of the richeft and moft valuable colours ufed in *painting*.—The preparation confifts in firft calcining the *lapis* in an iron pot or crucible, then grinding it very fine on a porphyry ftone, then mixing it up with a pafte made of wax, pitch, maftick, turpentine, and oil; and at laft wafhing the pafte well in clear water, to feparate the colouring part from the reft, which precipitates to the bottom in form of a fubtile, beautiful blue powder. The water is then poured off, and the powder at bottom dried in the fun; which is the true *ultramarine*. Thofe who prepare this colour have ufually four kinds, which they procure by fo many different lotions: the firft is ftill the beft, and the reft worfe and worfe to the laft. *Ultramarine* muft be chofen of a high colour, and well ground, which is known by putting it between the teeth, where, if it feels gritty, it is a fign the triture is not fufficient. To know whether it be pure or unmixed, put a little of it in a crucible, and heating it red-hot, if the powder has not changed its colour after this trial, it is certainly pure: on the contrary, if you perceive any change, or any black fpecks in it, it is falfified. Befides this, there is another called *common* or *Dutch ultramarine*; which is only *lapis* or *fmalt* well ground and pulverized, the colour whereof when ufed by the painters is much like that of true *ultramarine*, though much lefs valued. This is alfo called *Pruffian blue*.——*Carmine* is a bright red or crimfon colour, bordering fomewhat on purple, ufed by painters in miniature, and fometimes by painters in oil, though rarely, by reafon of its exceffive price. To be good, it muft be almoft an impalpable powder. Thofe that fell it mix it with a fmall quantity of red lead, in proportion to the quantity of *carmine*, to make it weigh heavy, which is a very great piece of knavery.

Painters reduce all thefe colours above-mentioned, and the other they ufe under two claffes, *viz.* *dark* and *light colours*. Under *light colours* are comprehended white, and all thofe which approach neareft it.—And under *dark colours*, black, and all thofe which are obfcure and earthy, as umber, biftre, &c.

Simple and *mineral colours*, is another divifion among them. Under *fimple colours* they range all thofe ufed by limners, illuminers, &c. extracted from vegetables; and which will not bear the fire: as the yellow made of faffron, of *French* berries, &c. Laccor, and other tinctures extracted from flowers. The reft are *mineral*, drawn from metals, &c. and are to bear the fire.

Our next care is to find a *porphyry*, to grind and mix *colours* and *pencils*, *brufhes*, &c. to apply them.

There are *pencils* of various kinds, and more of various matters; the moft ufeful are made of badgers and fquirrels hair, thofe of fwans down, and thofe of boars briftles; which laft are bound on to a ftick, bigger or lefs, according to the ufes they are deftined for; and when large are called *brufhes*. The others are inclofed in the barrel of a quill.

Befides *pencils*, we muft have a *pallet*, which is a little oval table, or piece of wood or ivory, very thin and fmooth; on and round which the painters place the feveral colours they have occafion for, ready for the pencil. The middle ferves to mix the colours on, and to make the teints required in the work. It has no handle, but in lieu thereof, a hole at one end, to put the thumb through to hold it.

Colours are prepared in three different manners, either with fize, whites of eggs, &c. or with water, or with oil.

The working of *colours* with fize or white of eggs, is faid done in *diftemper*, which was the ufual manner of mixing *colours*, before the beautiful fecret was found of mixing them with oil.

Colours diluted with water, are called *water-colours*; which is done by melting a proper quantity of gum-arabick, in water, and diluting the *colours* in that water.——*Colours* thus prepared are moft commonly ufed in *painting* in miniature, and limning.

Oil-colours are ground on the porphyry or marble, by means of a moler or muller. In this preparation, care muft be taken, that they be ground fine; that in putting them on the pallet, thofe which will not dry of themfelves, be mixed with oil, or other dryers; and that the tinged colours be mixed in as fmall quantities as poffible.

Our *colours* thus prepared, I'll return to *painting*, which, with regard to the materials, the matter whereon they are applied, and the manner of applying them, is of various kinds, hence came *painting* in frefco; *painting* in oil; *painting* in water-colours, or limning; *painting* in miniature; *painting* in enamel; and *painting* on glafs.

Frefco is a kind of *painting* performed on a frefh plaifter, or on a wall laid with mortar, not yet dry, and with water-colours.

The colours ufed, are white made of lime flaked long ago, and white marble duft; oker, both red and yellow; violet red; verditer; lapis lazuli; ſmalt; black earth, &c. all which are only ground and worked up with water; and moſt of them grow brighter and brighter, as the *freſco* dries.

This ſort of *painting* is chiefly performed on walls and vaults, newly plaiſter'd with lime and ſand: but the plaiſter is only to be laid in proportion as the *painting* goes on, no more being to be done at once than the painter can diſpatch in a day, while it is dry.

Before he begins to paint, a cartoon or deſign is uſually made on paper, to be calked and transferred to the wall, about half an hour after the plaiſter is applied.

Painting in oil i performed on walls, on wood, canvas, ſtones, and all ſorts of metals.

To paint on a wall.—When well dry, you muſt give it two or three waſhes with boiling oil, till the plaiſter remains quite greaſy and will imbibe no more. Over this are applied deſiccative or drying colours, *viz.* white chalk, red oker, or other chalks beaten pretty ſtiff. This layer being well dryed, you'll ſketch and deſign your ſubject; and at laſt paint it over; mixing a little varniſh with your colours, to ſave the varniſhing afterwards.

Others to fortify their wall better againſt moiſture, cover it with a plaiſter of lime, marble duſt, or a cement made of beaten tiles ſoaked with linſeed-oil; and at la. prepare a compoſition of *Greek* pitch, maſtich, and thick varniſh, boiled together, which they apply hot over the former plaiſter; when dry, the colours are applied as before.

To paint on wood.—They uſually give their ground a layer of white, temper'd with ſize; or they apply the oil above-mentioned. The reſt as in *painting* on walls.

To paint on cloth or canvas.—The canvas being ſtretched on a frame, you muſt give it a layer of ſize, or paſte-water. When dry you ſhall go over with a pumice-ſtone, to ſmooth off the knots.

When the cloth is dry, a lay of oker muſt be laid on, ſometimes mixing with it a little white lead to make it dry the ſooner. When dry you'll go again over it with the pumice ſtone, to make it ſmooth.

After this, a ſecond layer, compoſed of white lead, and a little charcoal black is ſometimes added, to render the ground of an aſh-colour; obſerving in each manner to lay on as little colour as poſſible.

As little oil is to be uſed as poſſible, if it be deſired to have the colours keep freſh: for this reaſon, ſome mix them with oil of aſpick, which evaporates immediately, yet ſerves to make them manageable with the pencil.

As to oils, the beſt are thoſe of walnuts, linſeed, aſpick, and turpentine. The deſiccative or drying oils, are a nut oil boiled with litharge, and ſandarach; others with ſpirit of wine, maſtic, and gum-lacca.

The next operation is to draw the deſign on the canvas; and afterwards to prime the work, which is done by laying a lay of white all over it, except on the lines of the draught, which muſt be kept viſible. Then if the picture be a hiſtory-piece, or a portrait, the painter begins by the face or faces; which together with all the other naked parts to be pronounced in the picture, are called *carnations*. The *carnations* are made with white and carmine; and brown, blue, and yellow for the ſhadows; according to the complexion the painter deſigns to give to the figure or figures he is to repreſent.

The application of colours, in *painting*, is conſider'd either with regard to the kinds of *painting*, in works of various colours, or in thoſe of one ſingle colour.

Firſt, in the larger pieces, the colours are rather laid on full, ſo as they may be impaſted or incorporated together, which make them hold the more firmly.

Or elſe the more agreeable ones, which dry too hard and too haſtily, are mixed with a little colour, and the cleareſt of the oil. But in both caſes, the colours are to be laid on ſtrong at firſt; it being eaſy to weaken thoſe which are to be thruſt back, and to heighten the others: the touches to be bold, by the conduct of a free and ſteady pencil; that the work may appear the moſt finiſhed at a proper diſtance, and the figures animated with life and ſpirit.

For *glazed colours*, care muſt be taken, that the under-colour be painted ſtrong, and that it be a body colour, and laid ſmooth.

In finiſhed works, which are to be viewed near at hand, the proceſs is either by applying each colour in its place; preſerving their purity, without fretting or tormenting them, but ſweetly ſoftening off their extremities; or by filling up all the great parts with one ſingle colour; and laying the other colours which are to form the little things, upon it. Which is the more expeditious way, but more apt to decay.

For the ſecond; the kinds of pictures in one colour are two, *viz. Camieux*, where the degradations of colours of objects afar off, are uſually managed by lights, or with crayons, and baſs relievo, which is an imitation of ſculpture, of whatſoever matter and colour; in both theſe the colours are wrought dry.

For the *œconomy*, and diſpenſing of colours in *paintings*, regard is either had, firſt, to the qualities of of the colours, to appropriate them according to their value and agreement: or, secondly, to their effect, in the union and œconomy of the work.

For the *qualities*, it must be observed, that white represents light, and gives the briskness and heightening, black, on the contrary, like darkness, obscures and effaces the objects: again, black sets off the light parts, and by that they serve each other to loosen the objects. A proper choice to be made of colours; and the too much charged manner to be avoided; both in carnations, where red colours are not to be affected, or rather resembling the flesh when flead than the skin; and all bright glowing colours; the skin, how delicate soever, being always of a bloom colour. In the drapery, where the painter has his whole stock of colours to chuse out of to procure a good effect; and in the landskip, to dispose those colours near one another, which mutually assist and raise each other's force and briskness; as red and green, yellow and blue.

To manage them so, as that they may be accommodated to the effects of the great parts of light and colours; that the strong colours lead to the soft ones, and make them more look'd at, bringing them forwards, or keeping them back, according to the situation and the degree of force required.

For the *effects of colours*, they either regard the union, or the œconomy; with respect to the first, care must be taken that they be laid so as to be sweetly united, under the briskness of some principal one; that they participate of the prevailing light of ths piece, and that they partake of each other by the communication of light, and the help of reflection.

For the *œconomy in managing their degrees*, regard is to be had to the contrast, or the opposition intervening in the union of the colours, that by a sweet interruption the briskness which otherwise fades and palls, may be raised: to the harmony, which makes the variety of colours agree, supplying and sustaining the weakness of some by the strength of others, neglecting some places on purpose to serve as a basis or repose to the sight, and to inhance those which are to prevail through the piece: to the degradation, where the better to proportion the colours that fall behind, some of the same kind are to be preserved in their purity, as a standard, for those carried afar off to be compared by, in order to justify the diminution: regard being always had to the quality of the air, which, when loaded with vapours, weakens the colours more than when clear: to the situation of the colours, where care must be taken, that the purest and the strongest be placed before, or in the front of the piece; and that by their force, the compound ones, which are to appear at a distance, be kept back, particularly the glazed colours to be used in the first rank. Lastly, to the expression of the subject, and the nature of the matters, or stuffs, whether shining or dull, opake or transparent, polished or rough.

The different colours, which you are to employ in your picture are to be mixed as follows. For a violet colour, take indigo, white lead and lake; mix them all well together; and the more or less of each quantity will make it deeper or lighter. A lead colour is made of white and indigo, well mixed together. A scarlet of lake, red lead, and a little vermilion. Though, in fine *paintings*, I would prefer carmine, with a very small quantity of ultramine, and a still smaller one of fine *cerus*. A light green of pink and smalt. A middle and light green, of verdigrease and pink; a deep and sad green, indigo and pink. A purple colour of *Spanish* brown, indigo and white, well mixed. A murrey colour of white and lake. A flame colour, of red lead and masticot, heightened with white. But these general rules are not to captivate the imagination of a painter, no more than the following ones; for a good painter, who has a good natural genius for his art, and takes pleasure in the practice thereof, makes often new discoveries, to render his draperies more beautiful; as for carnations they are always made of the same mixture of colours; the whole secret consisting in the judicious application thereof.

After a painter has transferred his draught on his canvas, and has primed it, he begging his piece, first, by drawing the eyes (having while he works, his right hand supported with a moll-stick or stay, made of heavy wood, not subject to bend, about a yard long, having at the end, which leans against the picture, a ball of ravell'd cotton, with a leather over it, the other end held with the left-hand) making the white thereof with white lead, with a little charcoal black. This finished, he leaves from the other eye (in a face full front) the distance of an eye, then draws the proportion of the nose; afterwards makes the mouth, ears, &c, This done, he lays his carnation or flesh-colour over the face, casting in, here and there some shadows, which he works in by degrees with the flesh colour: which flesh-colour is commonly compounded of white lead, lake, and vermilion or carmine, this last being best. There is no fixed rule for heightening or deepening this colour; for it is left to the discretion and judgment of the painter; who must consult in this his own imagination, with regard to the age, country, &c. of the person, whose face he endeavours to represent. Then he shadows the face over as he sees cause, and finishes the nose, compassing the tip of it, with

with some dark, or light reddish shadow; which shadows, for the face, are commonly compounded of ivory black, white-lead, vermilion, lake, seacoal black, *&c.* The cheeks and lips are shadowed with vermilion or carmine, and lake mixed together; and the mouth stroke is made with lake only. As to the circles of the eyes; for grey eyes they are made of charcoal black and white lead, heighten'd and deepen'd at pleasure: the black circle of the eye is made of umber, seacoal black, and a little white mixed together: the round ball in the eye of lamp-black and verdigrease, since the lamp-black will hardly dry without it. The same colours used in *painting* and shadowing the face, are used in *painting* the hands, and shadowing them between the fingers. When a painter wants to make a flesh-colour of a swarthy complection, he mixes white-lead, lake, and yellow oker together, and shadows it with a mixture of umber and seacoal black.

For black hairs he uses lamp-black only, and when he will have them brighter, mixes it with a little umber, white and red-lead. For flaxen hairs he takes umber and white-lead; putting in more umber if he wants them browner, and more white-lead, if whiter; but if quite dark, he adds a little seacoal black. Yellow hairs are made of a mixture of masticot, umber, yellow oker, and a little red-lead; increasing the quantity of umber and red-lead, if they be wanted redder. For white hairs he takes an equal quantity of ivory black, and of umber, *viz.* half of each, and tempers them well upon his pallet with white lead, taking more or less of those three colours, according as the hairs are to be heighten'd or deepen'd.

The teeth are made of white-lead, and shadowed with charcoal-black.

As to the different stuffs the figures are to be cloathed with, it must be left entirely to the imagination and judgment of the painter.

The several colours used in *painting*, are also called *teints*, and *semi-teints*; considering the colours as more or less high, or bright, or deep, or thin, or weakened and diminished, *&c.* to give the proper relievo, or softness, or distance, *&c.* to the several objects; and the lessening and rendering dim and confused the appearance of different objects in a landskip, so as they shall appear there as they would do to an eye placed at that distance from them, is called, in painting, *degradation.*

As to *painting* in WATER-COLOURS, called *limning*, in contradistinction of *painting* properly so called, which is done in oil colours, the usual colours are proper enough, excepting the white, made of lime, which is only used in fresco. But the azure, or ultramarine, must always be mixed up with size, or with gum, in regard the yolks of eggs give blue colours a greenish tincture; but there are always applied two lays of hot size, ere the colours mixed even with size, are laid on: the composition made with eggs, and the juice of the fig-tree, being only used for touching up, and finishing, and to prevent the necessity of having the fire always at hand to keep the size hot; yet it is certain, that the size colours hold the best, and are accordingly always used in cartoons, *&c.*—This size is made of shreds of thin leather, or of parchment.

To limn on linen, the best is that which is old, half worn and close.—This is stamped with white lead, or a fine plaister beaten up with size; which once dry, we must go over it with a layer of the same size,

The colours are all ground in water, each by itself; and in proportion as they are required in working, are diluted with their size-water.—If the yolks of eggs are desired, they must be diluted with water made of equal quantity of common water and vinegar, with the yolk, white, and shell of an egg, and the end of the little branches of a fig-tree cut small, all well beaten together in an earthen pan.

Painting in MINIATURE is a delicate kind of *painting*, consisting of little points or dots instead of lines, usually done on vellum, with very thin simple water-colours.

The colours for *miniature* may be mixed up with water of gum-arabick, or gum tragacanth.

The operation is usually made on vellum, on which the design is drawn, with carmine, or some other colour, which may render the lines discernable. That draught is filled afterwards, with a very thin and smooth lay of white, though some chuse to paint on the naked vellum without any lay; though in my opinion it contributes much towards incorporating well the colours, that the dots may not appear so visible, and so coarse, as they do without it. When the lay is dry, the painter searches with his pencil all the lines of the draught, lest some of them should be either much weakened, or entirely obliterated by the lay of white; then he begins, as in all other paintings, by the face, dipping first the point of his pencil in water, and rubbing it afterwards, on the colour he designs to employ; when thus rubbed, he makes the point thereof with the tip of his lips, and then apply it on the vellum, repeating the same process every time he wants colours, and having different pencils for the different colours. He has also before him a shell with gum-water, in case he

wants

wants to dip his pencil in it, as it often happens.

Painting in mosaick is an assemblage of little pieces of glass, marble, shells, precious stones, woods, or the like of various colours cut square, and cemented on a ground of stucco, imitating the natural colours and degradations of *painting*.

PAPER-MAKING.

PAPER-MAKING is the art of preparing certain materials, on which mankind have, in different ages, contrived to write their sentiments.

Paper, with regard to the *manner* of making it, and the *materials* employed therein, is reducible to several kinds, as *egyptian* paper, made of the rush *papyrus*; *bark* paper, made of the inner rind of several trees; *cotton* paper; *incombustible* paper; and *European* paper, made of linen rags.

Egyptian paper was principally used among the antients; being made of the *papyrus*, or *biblus*, a species of rush, which grew on the banks of the *Nile*; in making it into paper, they began with lopping off the two extremes of the plant, the head and the root; the remaining part which was the stem, they cut lengthwise into two nearly equal parts, and from each of these they stripped the scaly pellicles of these which it consisted. The innermost of these pellicles were looked on as the best, and that nearest the rind as the worst: they were therefore kept apart, and made to constitute two different sorts of paper. As the pellicles were taken off they extended them on a table, laying them over each other transversely, so as that the fibres made right angles; in this state they were glued together by the muddy waters of the *Nile*, or, when those were not to be had, with paste made of the finest wheat flour, mixed with hot water and a sprinkling of vinegar. The pellicles were next pressed, to get out the water, then dried, and lastly, flatted and smoothed by beating them with a mallet. This was the *Egyptian* paper, which was sometimes farther polished, by rubbing it with a glass ball, or the like.

Bark-paper was only the inner whitish rind, inclosed between the bark and the wood of several trees, as the maple, plane, beech, and elm, but especially the *tilia*, or *linden tree*, which was that mostly used for this purpose. On this, stripped off, flatted, and dried, the antients wrote books.

Chinese-paper is of various kinds; some is made of the rinds or barks of trees, especially the *mulberry-tree* and *elm*, but chiefly of the *bambu* and *cotton-tree*. In fact, almost each province has its several paper. The preparations of paper made of the barks of trees, may be instanced in that of the *bambu*, which is a tree of the cane or reed-kind. The second skin of the bark, which is soft and white, is ordinarily made use of for paper: this is beat in fair water to a pulp, which they take up in large moulds, so that some sheets are above twelve feet in length: they are completed, by dipping them, sheet by sheet in alum-water, which serves instead of the size among us, and not only hinders the paper from imbibing the ink, but makes it look as if varnished over. This paper is white, soft, and close, without the least roughness: tho' it cracks more easily than *European* paper, is very subject to be eaten by the worms, and its thinness makes it liable to be soon worn out.

Cotton-paper is a sort of paper, which has been in use upwards of six hundred years. In the *French* king's library are manuscripts on this paper, which appear to be of the Xth century; and from the XIIth century, cotton manuscripts are more frequent than parchment ones. *Cotton-paper* is still made in the *East-Indies*, by beating cotton-rags to a pulp.

Linen, or *European* paper appears to have been first introduced among us towards the beginning of the XIVth century; but by whom this valuable commodity was invented is not known.

The method of making paper of linen or hempen rags, is as follows: the linen rags being carried to the mill, are first sorted; then washed very clean in puncheons, whose sides are grated with strong wires, and the bottoms bored full of holes. After this they are fermented, by laying them in heaps, close covered with sacking, till they sweat and rot; which is commonly done in four or five days. When duly fermented, they are twisted into handfuls, cut small, and thrown into oval mortars, made of well seasoned oak, about half a yard deep, with an iron-plate at bottom, an inch thick, eight inches broad, and thirty long: in the middle is a washing-block, grooved with five holes in it, and a piece of hair-sieve fastened on the inside: this keeps the hammers from touching it and prevents any thing going out except the foul water.

These mortars are continually supplied with water, by little troughs, from a cistern, fed by buckets fixed to the several floats of a great wheel, which raises the wooden hammers, for pounding the rags in the mortars.

When

When the rags are beaten to a certain degree, called the first stuff, the pulp is removed into boxes, made like corn-chandlers bins, with the bottom board aslant, and a little separation on the front, for the water to drain away.

The pulp of the rags being in, they take away as many of the front-boards as are needful, and press the mass down hard with their hands; the next day they put on another board, and add more pulp, till the box is full: and here it remains mellowing a week, more or less, according to the weather.

After this, the stuff is again put into clean mortars, and is beaten a-fresh, and removed into boxes, as before; in which state it is called the second stuff.

The mass is beat a third time, till some of it being mixed with fair water, and brewed to and fro, appears like flour and water, without any lumps in it: it is then fit for the pit-mortar, where it is perfectly dissolved, and is then carried to the vat, to be formed into sheets of paper.

But lately, instead of pounding the rags to a pulp with large hammers, as above, they make use of an engine, which performs the work in much less time. This engine consists of a round solid piece of wood, into which are fastened several long pieces of steel, ground very sharp. This is placed in a large trough with the rags, and a sufficient quantity of water. At the bottom of the trough is a plate with steel bars, ground sharp like the former; and the engine being carried round with prodigious velocity, reduces the rags to a pulp in a very short time.

It must be observed, that the motion of the engine causes the water in the trough to circulate, and by that means constantly returns the stuff to the engine. The trough is constantly fed with clean water at one end, while the dirty water from the rags is carried off at the other, thro' a hole, defended with wire gratings, in order to hinder the pulp from going off with the dirty water.

When the stuff is sufficiently prepared as above, it is carried to the vat, and mixed with a proper quantity of water, which they call priming the vat. The vat is rightly primed, when the liquor has such a proportion of the pulp, as that the mould, on being dipped into it, will just take up enough to make a sheet of paper, of the thickness required.

The mould is a kind of sieve, exactly of the size of the paper to be made, and about an inch deep, the bottom being formed of fine brass-wire, guarded underneath with sticks, to prevent its bagging down, and to keep it horizontal; and further, to strengthen the bottom, there are large wires placed in parallel lines, at equal distances, which form those lines visible in all white paper, when held up to the light: the mark of the paper is also made in this bottom, by interweaving a large wire in any particular form.

This mould the maker dips into the liquor, and gives it a shake as he takes it out, to clear the water from the pulp. He then slides it along a groove to the coucher, who turns out the sheet upon a felt, laid on a plank, and lays another felt on it; and returns the mould to the maker, who by this time has prepared a second sheet, in another mould: and thus they proceed, laying alternately a sheet and a felt, till they have made six quires of paper, which is called a post; and this they do with such swiftness, that, in many sorts of paper, two men make twenty posts, or more, in a day.

A post of paper being made, either the maker or coucher whistles; on which four or five men advance, one of whom draws it under the press, and the rest press it with great force, till all the water is squeezed from it; after which it is separated, sheet by sheet, from the felts, and laid regularly one sheet upon another; and having undergone a second pressing, it is hung up to dry.

When sufficiently dried, it is taken off the lines, rubbed smooth with the hands, and laid by till sized, which is the next operation. For this they choose a fine temperate day, and having boiled a proper quantity of clean parchment or vellum-shavings, in water, till it comes to a size; they prepare a fine cloth, on which they strew a due proportion of white vitriol and roch-alum, finely powdered, and strain the size through it, into a large tub; in which they dip as much paper at once as they can conveniently hold, and with a quick motion give every sheet its share of the size, which must be as hot as the hand can well bear it.

After this the paper is pressed, hung up sheet by sheet to dry; and being taken down, is sorted, and what is only fit for outside quires, laid by themselves: it is then told into quires which are folded and pressed. The broken sheets are commonly put together, and two of the worst quires are placed on the outside of every ream or bundle; and being tied up in wrappers, made of the settling of the vat, it is fit for sale.

Paper is of various kinds, and used for various purposes: with regard to colour, it is principally distinguished into *white*, *blue*, and *brown*; and with regard to its dimensions, into *atlas*, *elephant*, *imperial*, *super royal*, *royal*, *medium*, *demy*, *crown*, *fool's cap*, and *pot-paper*.

As English paper is, in general, as good as any we receive from abroad, a very high duty is laid on the importation of all foreign paper, which is more or lefs, according to the fize, the value, and the country from whence it is brought; thus royal atlas fine, and fine imperial paper, pay 1 *l.* 9 *s.* 8 $\frac{3}{4}$ *d.* the ream; fine *Genoa* and *Dutch* royal pay 17*s.* 8$\frac{3}{4}$*d.* the ream; *Genoa* and *German* crown and fool's cap paper pay about 2 *s.* 7 *d.* and *Genoa* pot pays 2 *s.* 2 $\frac{1}{2}$ *d.* and for every 20 *s.* value, according to the book of rates, of paper brought from *Rochelle*, 6 *s.* No drawback is allowed on foreign paper exported.

As to the *incombuftible paper*, it is made of *lapis asbeftos*, or the *linum vivum*, which will bear burning without being injured.

The manner of making this extraordinary *paper* is defcribed by Mr. *Lloyd* from an affay made by himfelf. He pounded a quantity of *asbeftos* in a ftone mortar, till it became of a downy fubftance; then fifted it thro' a fine feirce, and by this means purged it indifferently well from its terrene parts; for what earth or ftones he could not pick out of it before, or at the pounding, being reduced to a powder, came through the feirce, the linum remaining. This done, he brought it to the papermill, and putting it in water in a veffel juft big enough to make a fheet with fuch a quantity, he ftirred it pretty much, and defired the workmen to proceed with it in the ufual method, with their writing-paper mould; only to ftir it about always before they put their mould in; confidering it as a far more ponderous fubftance than what they ufed, and that frequently, if not immediately taken up after it was agitated, it would fubfide.

The *paper* made of it proved but coarfe, and too apt to tear; but this being the firft trial, there is reafon to believe it might be much improved.

Befides our *modern paper*, made of linen rags, we write likewife on fkins of fheep or goats, prepared after a particular manner, and which we call *parchment* or *velum*.

Parchment is begun by the fkinner, and ended by the *parchment-maker*.

After the fkin has been ftripped of its wool, and paffed the lime-pit, the fkinner ftretches it on a kind of frame, confifting of four pieces of wood, morticed into each other at the four angles, and perforated lengthwife from diftance to diftance, with holes, furnifhed with wooden pins, that may be turned at pleafure like thofe of a violin.

To ftretch the fkin on this frame, they make little holes all around it, and through every two holes draw a little fkewer; to this fkewer they tie a piece of fmall pack-thread, and tie that over the pins; fo that coming to turn the pins equally, the fkin is ftrained tight every way, like that of a drum.

The fkin being thus fufficiently ftretched on the frame, the flefh is pared off with a fharp inftrument for that purpofe. This done, it is moiften'd with a rag, and a kind of white ftone or chalk, reduced to a find duft, ftrewed over it; then with a large pumice-ftone, flat at bottom, much after the manner of a mullet for grinding colours, they rub over the fkin, as if about to grind the chalk; and thus fcour off the remains off the flefh. They then go over it again with the iron inftrument; again moiften it as before, and again rub it with the pumice-ftone, without any chalk underneath; this fmoothens and foftens the flefh-fide very confiderably. They drain it again, by paffing over it the iron-inftrument as before.

The flefh-fide thus drained, they pafs the iron on the wooll or hair-fide; then ftretch it tight on the frame by means of the pins, and go over the flefh-fide again with the iron; this finifhes its draining, and the more the fkin is drained, the whiter it ever becomes.

They now throw on more chalk, fweeping it over with a piece of lamb-fkin, that has the wooll on; this fmoothens it ftill farther, and gives it a white down or nap. It is now left to dry, and when dried, taken off the frame by cutting it all round.

The fkin, thus far prepared by the *fkinner*, is taken out of his hand by the *parchment-maker*, who firft fcrapes or pares it dry on the fummer, with an iron inftrument like that above-mentioned, only finer and fharper; with this, worked with the arm from top to bottom of the fkin, he takes away about one half of its thicknefs. The fkin thus equally pared on both fides, they pafs the pumice-ftone over both fides to fmooth it. This laft preparation is performed on a kind of form or bench covered with a fack ftuffed with flocks, and leaves the *parchment* in a condition for writing on.

The paring the fkin dry on the fummer, is the moft difficult operation in the procefs of *parchment-making*; for which reafon the *fkinners* feldom meddle with it, but ufually leave it to thofe more experienced in it: the fummer whereon it is perform'd is a calf-fkin well ftretched on a frame, ferving as a fupport to the fkin, which is faftened a-top of it with a wooden inftrument that has a notch cut in it. Laftly, that the iron knife may pafs the eafier between the fummer and the fkin to be pared, they put another fkin which they call the counter-fummer. The parings thus taken off the leather, are ufed in making glue, fize, &c.

What we call *vellum*, is only *parchment* made of the fkin of abortive calves, or at leaft of fucking calves, 'tis finer, whiter, and fmoother than the common *parchment*, but it is prepared in the fame

manner,

manner, as that, abating that it is not paſſed thro' the lime-pit.

The word *parchment* comes from the *Latin pergamena*, the antient name of this manufacture; which it took from the city *Pergamos*, to *Eumenes*, king whereof, its invention is uſually aſcribed. Though in reality that prince appears rather to have been the improver than the inventer of *parchment*. For the *Perſians* of old, according to *Diodorus*, wrote all their records on skins; and the antient *Ionians*, as we are told by *Herodotus*, made uſe of ſheep-skins and goat-skins in writing many ages before *Eumenes*'s time.

PERSPECTIVE.

PERSPECTIVE is the art of delineating viſible objects on a plain ſurface, ſuch as they appear at a given diſtance or height, upon a tranſparent plane, placed perpendicular to the horizon, between the eye and the object.

There are three ſorts of *perſpective*, viz. *linear*, *aerial*, and *ſpecular perſpective*.

Linear PERSPECTIVE (to which moſt properly belongs our definition, and which is a branch of the Mathematicks) regards the poſition, magnitude, form, *&c.* of the ſeveral lines or contours of objects, and expreſs their diminution.

Aerial PERSPECTIVE (which makes part of the art of Painting) regards the colour, luſtre, ſtrength, boldneſs, *&c.* of diſtant objects, conſider'd as ſeen through a column of air, and expreſſes the diminutions thereof.

Specular PERSPECTIVE repreſents the objects in conical, ſpherical, or other mirrours, erect and clear; whereas on lawn, and other planes, they appear confuſed and irregular.

Theſe three ſorts of *perſpective* have each its particular doctrine; but before we proceed on the explanation of that doctrine, we muſt teach our pupils what are *planes* in *perſpective*; of which there are five ſorts, viz. *perſpective*, *geometrical*, *horizontal*, *vertical*, and *objective plane*.

Perſpective plane is a plain pellucid ſurface, ordinarily perpendicular to the horizon, and placed between the ſpectator's eye and the object he views; through which the optick rays, emitted from the ſeveral points of the objects, are ſuppoſed to paſs to the eye, and in their paſſage to leave marks that repreſent them on the ſaid plane.

A *geometrical plane* is a *plane* parallel to the horizon, whereon the object to be delineated is ſuppoſed to be placed: this *plane* is uſually at right angles with the *perſpective plane*.——A *horizontal plane* is a plane paſſing through the ſpectator's eye, parallel to the horizon, cutting the *perſpective plane*, when that is perpendicular to the geometrical one, at right angles.——A *vertical plane* is a plane paſſing through the ſpectator's eye, perpendicular to the geometrical one; and uſually parallel to the perſpective plane.——An *objective plane* is any plane ſituate in the horizontal plane, whoſe repreſentation is required in *perſpective*.

There are likewiſe ſeveral different *lines* in *perſpective*, viz. *terreſtrial line*, *geometrical line*, *line of the front*, *vertical line*, *viſual line*, *line of ſtation*, *objective line*, and *line of diſtance*.——*Geometrical line*, in *perſpective*, is a right line drawn in any manner on the geometrical plane.—A *terreſtrial line*, or *fundamental line*, is a right line, wherein the geometrical plane, and that of the picture, or draught, interſect one another. Such is the line formed by the interſection of the geometrical plane, and the perſpective plane.—A *line of the front*, is any right *line*, parallel to the terreſtrial *line*.—A *vertical line*, is the common ſection of the vertical, and of the draught.—A *viſual line*, is the *line*, or ray, imagined to paſs from the object to the eye.—An *objective line*, is any *line* drawn on the geometrical plane, whoſe repreſentation is ſought for in draughts or pictures.—A *line of ſtation*, according to ſome writers, is the common ſection of the geometrical and vertical planes. Others mean by it the perpendicular height of the eye above the geometrical plane, whoſe repreſentation is ſought for in draughts or pictures.—A *line of diſtance*, is a right line drawn from the eye to the principal point: this, as it is perpendicular to the perpendiculars of the plane, or table, can only be the *diſtance* of the eye from the table.——The *point of diſtance*, in *perſpective*, is a point in the horizontal line, at ſuch *diſtance* from the principal point, as is that of the eye from the ſame.

There are other points beſides this point of diſtance in *perſpective*, viz. the *point of ſight*, the *third point*, the *objective point*, the *accidental point*, and the *viſual point*; which term *point*, is uſed for various parts, or places, with regard to the *perſpective* plane.—The *point of ſight*, or *of the eye*, is a point on the plane, marked out by a right line drawn from the eye, perpendicular to the plane: this is alſo called the *principal point*. This *point* is in in the interſection of the *horizontal* and *vertical planes.* Some authors call it the *principal point*; and give the name *point of ſight*, or *viſion*, to the point wherein the eye is actually placed, and where all the rays terminate.—The *third point*, is a *point* taken at diſcretion in the line of diſtance, wherein all the diagonals drawn from the diviſions of the geometrical plane, concur ——An *objective point*, is a *point* on a geometrical plane, whoſe repreſentation is required on the *perſpective* plane.——An *accidental point*, is a *point* in the horizontal lines, where lines parallel to one another, though not perpendicular to the picture, or repreſentation, meet.——A *viſual point*, is a *point* in the horizontal line, wherein all the ocular rays unite. Thus a perſon ſtanding in a ſtrait long gallery, and looking forwards, the ſide, the floor, and ceiling ſeem to meet, and touch one another in a point, or common centre.

Theſe things previouſly conſidered, I'll paſs to the explanation of the different ſorts of *perſpective*; beginning by that of the *rectilinear perſpective*, which is as follows.

Suppoſe a glaſs plane H I, (*Fig.* 1.) raiſed perpendicular on an horizontal plane; and the ſpectator S, directing his eye O, to the triangle A B C: if now we conceive the rays A O, O B, O C, *&c.* in their paſſage through the plane, to have their traces, or veſtigia, in *a*, *b*, *c*; which, as it ſtrikes the eye *a* O, *b* O, *c* O, by which the ſpecies of the triangle A B C, is carried to the ſame; it will exhibit the true appearance of the triangle ABC, tho' the object ſhould be removed; the ſame diſtance and height of the eye being preſerved.

The buſineſs of *perſpective* then, is to ſhew by what certain rules the points *a*, *b*, *c*, &c. may be found geometrically: and hence alſo, we have a mechanical method of delineating any object very accurately.

Perſpective is either employed in repreſenting the *ichnographies*, and ground-plots of objects as projected on *perſpective* planes; or in *ſcenographies*, and repreſentations of the bodies themſelves.

Ichnography in *perſpective* is the view of any thing cut off by a plane parallel to the horizon, juſt as the baſe or bottom of it; ſo that *ichnography* is the ſame with what is otherwiſe called the *plan*, *geometrical plan*, or *ground-plot* of any thing.

Scenography, in *perſpective*, is a repreſentation of a body on a *perſpective* plane; or a deſcription thereof in all its dimenſions, ſuch as it appears to the eye. The *ichnography* of a building, *&c.* repreſents the plan, or ground-work of the building. The *orthography* the front, or one of the ſides: and the *ſcenography* the whole building, front, ſides, height and all, raiſed on the geometrical plan.

The following *lemma's* are to be conſidered previouſly to the general laws we are to eſtabliſh, of both *ichnographick* and *ſcenographick perſpective.*

1. That the appearance of a right line is ever a right line; whence the two extremes being given, the whole line is given.——2. That if a line be perpendicular to any right line drawn on a plane, it will be perpendicular to every other right line thro' the ſame point drawn on the ſame plane.——3. That the height of the point appearing on the plane, is to the height of the eye, as the diſtance of the objective point from the plane, to the aggregate of that diſtance and the diſtance of the eye.

Now for the *laws of the projection of plane figures*, or *ichnographick perſpective*, which are as follow.

The perſpective appearance, h, *by an objective point H*, (Fig. 2.) is exhibited, by drawing, from the given point, H I, perpendicular to the fundamental line D E; cutting from that fundamental line I K = H I: drawing through the point of ſight F, a horizontal line F P; and making F P, equal to the diſtance of the eye S L: Laſtly, drawing from the point I to the point of ſight F, the point F I; and from K to the point of diſtance P, the line P K. The interſection *h* is the appearance of the objective point. Hence,

1. Since the appearance of the extreme points or a right line being given, the appearance of the whole line is given; the *ichnographick* projection of any rectilinear figure may be had by this method.

2. Since any number of points of a curve line may by this means be projected on the *perſpective* plane; the projection of curve lines may likewiſe be effected after the ſame manner.

3. Therefore, this method will ſuffice for mentilinear figures; and is conſequently univerſal. There are indeed other methods delivered by other authors, but this is the moſt uſual; the *force* and *effect* whereof may be illuſtrated by the following examples; *viz.*

If we want to *find the perſpective appearance of a triangle*, A B C (Fig. 4.) *whoſe baſe* A B, *is parallel to the fundamental line* D E; to that fundamental line, we'll draw a parallel at an interval equal to the altitude of the eye. Taking a fundamental point V, oppoſite to this either directly or obliquely, as the caſe requires; transferring the diſtance of the eye from U to K, letting fall from the ſeveral angles of the triangles A C B, the perpendiculars A 1, C 2, B 3; and ſetting off theſe perpendiculars upon the fundamental line D E, oppoſite to the point of diſtance K, drawing from 1, 2, 3, right lines to the fundamental or principal point U 1, U 2, U 3, and from the points A, B and C of the fundamental line D E, other right lines A K, B K, C K, to the point of diſtance K.

 Since

Since *a*, *b* and *c* are the appearances of the points A B and C; the right lines *c a*, *a b* and *b c*, being drawn, *a c b* will be the appearance of the triangle A C B.

After the ſame manner is a triangle projected on a plane, where the vertex C is oppoſed to the eye: all here required is, that its ſituation on the geometrical plane be changed, and the vertex C turned towards the fundamental line D E.

When we want to *exhibit the perſpective appearance of a ſquare* A B D C (Fig. 5.) *ſeen obliquely, and having one of its ſides* A B *in the fundamental line.* The ſquare being viewed obliquely, we aſſume the principal point U in the horizontal line K R, in ſuch a manner as a perpendicular to the fundamental line falling without the ſide of the ſquare A B, at leaſt, may not biſect it; making U K the diſtance of the eye. Then we'll transfer the perpendiculars A C and B D to the fundamental line D E, drawing the right lines K B, K D, as alſo A U, U C. Then will A and B be their own appearances, and *c* and *d* the appearances of the points C and D; conſequently A *c d* B is the appearance of the ſquare A B D C.

If the ſquare A C B D ſhould be at a diſtance from the fundamental line D E; which yet rarely happens in practice; the diſtances of the angles A and B muſt likewiſe be transferred to the fundamental line; as is evident from the preceding problem. And ſince even the oblique view is not very common; in what follows we ſhall always ſuppoſe the figure to be poſited directly oppoſite to the eye, unleſs where the contrary is expreſly mentioned.

We exhibit the *appearance of a ſquare* A B C D (*Fig.* 6.) *whoſe diagonal* A C, *is perpendicular to the fundamental line*; by continuing the ſides D C and C B, till they meet the fundamental line in 1 and 2, ſetting off from the principal point U, the diſtance of the eye to K and L; drawing from K to A and 1, the right lines K A and K 1; and from L to A and 2, the right lines L A, L 2. Then the interſections of thoſe lines exhibit the appearance of the ſquare A B C D viewed angle wiſe.

Interſection is the cutting of one line or plane by another; or the point or line wherein two lines or two planes cut each other. The mutual interſection of two planes is a right line. The center of a circle is in the interſection of two diameters. The central point of a regular or irregular figure of four ſides, is the point of interſection of the two diagonals.

When we want to exhibit the *appearance of a ſquare* A B C D (Fig. 7.) *wherein another ſquare* I M G H, *is inſcribed, the ſide of the greater* A B, *being in the fundamental line*; *and the diagonal of the leſs perpendicular to the fundamental*: from the principal point U, we muſt ſet off each way, on the horizontal line H R, the diſtances U L and U K, and by drawing U A and U B, and K A and L B; A *c d* B will be the appearance of the ſquare A C D B. Then by producing the ſide of the inſcribed ſquare I H, till it meets the fundamental line in 1; and drawing the right lines K 1, and K M; *i h g* M will be the repreſentation of the inſcribed ſquare I H G M. Hence is eaſily conceived the projection of any figures inſcribed in others.

Projection in *perſpective* denotes the appearance or repreſentation of an object on the *perſpective* plane. The *projection*, e. gr. of a point, is a point through which the optick ray paſſes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optick ray. And hence is eaſily conceived what is meant by the *projection* of a line, a plane, or a ſolid.—The *projection of the ſphere in plano* is a repreſentation of ſeveral points or places of the ſurface of the ſphere, and of the circles deſcribed thereon, or of any aſſigned parts thereof, ſuch as they appear to the eye ſituate at any given diſtance, upon a tranſparent plane placed between the eye and the ſphere.—The principal uſe of the *projection of the ſphere* is in the conſtruction of planiſpheres, and particularly maps and charts, which are ſaid to be of this or that *projection*, according to the ſeveral ſituations of the eye, and the *perſpective* plane with regard to the meridians, parallels, and other points and places to be repreſented —The *projection of the ſphere* is uſually divided into *orthographick* and *ſtereographick*.

Orthographick projection is that wherein the ſuperficies of the ſphere is drawn on a plane, cutting it in the middle; the eye being placed at an infinite diſtance vertically to one of the hemiſpheres.——The *laws* of this ſort of *projection*, are theſe: 1. The rays by which the eye at an infinite diſtance perceives any object, are parallel. 2. A right line perpendicular to the plane of the *projection*, is projected into a point, where that right line cuts the plane of the *projection*. 3. A right line not perpendicular, but either parallel or oblique to the plane of the *projection*, is projected into a right line, and is always comprehended between the extreme perpendiculars. 4. The *projection* of the right line is the greateſt, when that line is parallel to the plane of the *projection*. 5. Hence it is evident, that a line parallel to the plane of the *projection*, is projected into a right line equal to itſelf; but if it be oblique to the plane of the *projection*, it is projected into one which is leſs. 6. A plane ſurface, at right angles to the plane of the *projection*, is projected into that right line, in which it cuts the plane

plane of the *projection*. Hence it is evident, that a circle ſtanding at right angles to the plane of the *projection* which paſſes through its center, is projected into that diameter, in which it cuts the plane of the *projection*. 7. A circle parallel to the plane of the *projection*, is projected into a circle equal to itſelf; and a circle oblique to the plane of the *projection*, is projected into an ellipſis.

Stereographick projection, is that wherein the ſurface and circles of the ſphere are drawn upon the plane of a great circle, the eye being in the pole of that circle. As to the *properties of this ſort of projection*. 1. In this *projection* a right circle is projected into a line of half tangents. 2. The repreſentation of a right circle perpendicularly oppoſed to the eye, will be a circle in the plane of the *projection*. 3. The repreſentation of a circle placed obliquely to the eye, will be a circle in the plane of *projection*. 4. If a great circle is to be projected on the plane of another great circle, its center will lie in the line of meaſures, diſtant from the center of the primitive by the tangent of its elevation above the plane of the primitive. 5. If a leſſer circle, whoſe poles lie in the plane of the *projection* were to be projected; the center of its repreſentation would lie in the line of meaſures, diſtant from the center of the primitive, by the ſecant of the leſſer circles diſtance from its pole, and its ſemidiameter or radius be equal to the tangent of that diſtance. 6. If a leſſer circle were to be projected, whoſe poles lie not in the plane of the *projection*, its diameter in the *projection*, if it falls on each ſide of the pole of the primitive, will be equal to the ſum of the half tangents of its greateſt and neareſt diſtance from the pole of the primitive, ſet each way from the center of the primitive in the line of meaſures. 7. If the leſſer circle to be projected, falls entirely on one ſide of the pole of *projection*, and do not encompaſs it; then will its diameter be equal to the difference of the half tangents of its greateſt and neareſt diſtance from the pole of the primitive, ſet off from the center of the primitive one, and the ſame way in the line of meaſures. 8. In the *ſtereographick projection*, the angles made by the circles of the ſurface of the ſphere, are equal to the angles made by their repreſentations in the plane of their *projection*.

To *exhibit the perſpective of a pavement*, conſiſting of ſquare *ſtones directly*. We muſt divide the ſide A B (*Fig.* 8.) transferred to the fundamental line DE into as many equal parts as there are ſquare ſtones in one row, drawing from the ſeveral points of diviſion, right lines to the principal point U; and from A to the point of diſtance K, a right line AK; and from B to the other point of diſtance L, another LB. Drawing likewiſe through the points of the interſections of the correſponding lines, right lines on each ſide to be produced to the right lines A U, and B U; then will A *f g* B be the appearance of the pavement A F G B.

For the *exhibition of the perſpective of a circle.*—If the circle be ſmall, we'll circumſcribe a circle about it; draw the diagonals and diameters *h a* and *d e* (*Fig.* 9.) interſecting each other at right angles; and the right lines *f g* and *b c* parallel to the diameter *d e* through *b* and *f*; drawing alſo through *c* and *g* right lines meeting the fundamental line DE in the points 3 and 4, to the principal point V, we'll draw the right lines V 1, V 3, V 4, V 2; and to the points of the diſtance L and K, the right lines L 2 and K 1. Laſtly, connecting the points of interſection *a*, *b*, *d*, *f*, *h*, *g*, *e*, *c*, with arches *a b*, *b d*, *d f*, &c. thus will *a*, *b*, *d*, *f*, *h*, *g*, *e*, *c*, *a*, be the appearance of the circle.

If the circle be large, on the middle of the fundamental A B (*Fig.* 10.) we'll deſcribe a ſemicircle; and from the ſeveral points of the periphery, C, F, G, H, I, &c. to the fundamental line, we'll let fall perpendiculars C 1, F 2, G 3, H 4, I 5, &c. drawing from the points A, 1, 2, 3, 4, 5, &c. right lines, to the principal point V, as alſo a right line from B, to the point of diſtance L; and another from A to the point of diſtance K, drawing alſo through the common interſections, right lines as in the preceding problem: thus ſhall we have the points *c*, *f*, *g*, *h*, *i*, which are the repreſentation of thoſe A, C, F, G, H, I, which being connected as before, give the projection of the circle.

Hence appears not only how any curvilinear figure may be projected on a plane, but alſo how any pavement conſiſting of any kind of ſtones, may be delineated in *perſpective*.

Hence alſo appears what uſe the ſquare is of in *perſpective*, for even in the ſecond we uſe a ſquare divided into certain *areolæ*, and circumſcribed about the circle; though it be not delineated on the geometrical plane in the *diagram*.

Diagram is a ſcheme for the explanation or demonſtration of any figure, or the properties thereto belonging.

If *we want to exhibit the perſpective of a regular pentagon, having a broad limb terminated by lines parallel thereto.*——1. From the ſeveral angles of the exterior pentagon A, B, C, D, E, (*Fig.* 11.) to the fundamental line T S, we'll let fall perpendiculars A o, B 1, C 2, D 3, E 4; which, as in the former, we'll transfer to the fundamental line. Connecting the points 1, 2, 3, 4, to the principal point V; and the points 1, 2, 3, 4, to the point of diſtance K. Thus will the common interſections repreſent the appearance of the exterior pentagon.

2. If

2. If now from the inner angles G H L I, the perpendiculars G o, H 5, K 6, I 7, L 8, be in the like manner let fall; and the rest be done, as in the former; we shall have the representation of the inner pentagon. The pentagon A B C D E, therefore, with its limb, is represented in *perspective*.

As to the doctrine of *scenographick perspective*, or the projection of bodies on a plane it is as follows.

1. On a *given point* C (*Fig.* 13) *to raise a perspective altitude*, answerable to the given objective altitude, P Q; we must raise on the fundamental line, a perpendicular P Q, equal to the given objective altitude: drawing right lines P T, and Q T, from P and Q to any point, as T; and from the given point C, a line C K, parallel to the fundamental line D E; and meeting the right line Q T in K, where we'll erect a perpendicular to K C, *viz.* I K; this I K is the *scenographick* altitude required.

2. If we want to exhibit the *perspective* of a solid. We must find the projection of its base in the ichnographick *perspective*, and in the several points thereof erect the *perspective* altitude: thus will the *scenography* of the solid be finished, except for what relates to the shadow. For example.

To *exhibit the scenographick perspective of a cube, viewed angle-wise.*——Since the base of a cube viewed angle-wise, and standing on a geometrical plane is a square viewed angle-wise; draw a square on the *perspective* plane, after the manner laid down above; raise the side of the square H I (*Fig.* 15.) perpendicularly in some point of the fundamental line D E; and to any point V, of the horizontal line H R, draw right lines V I, and V H, from the angles *d b* and *c*, draw *c* 1, *d* 2, parallel to the fundamental line D E, from the points 1 and 2, raise L 1 and M 2 perpendicular to the same. Lastly, since H I is the altitude to be raised in *a*, L 1 in *c*, and *b* and M 2 in *d*; in *a* raise *f a*, perpendicular to *a* E; and in *b* and *c* raise *b g*, and and *c e*, perpendicular to *b c* 1; and lastly *d h* perpendicular to *d* 2; and let *a f* be equal to H I, *b g* = *e c* = L 1, and *b d*, to M 2; if then the points *g*, *h*, *e*, *f*, be connected by right lines, the *scenography* will be finished.

This method is general, but its application is not equally obvious in every case; therefore we must enter into a more particular illustration thereof, by a few other examples, *viz.*

To *exhibit the scenography of a cube, viewed by an angle.*—1. As the basis of a cube viewed by an angle, standing on a geometrical plane, is a square viewed by an angle; draw a square viewed angular-wise, on the *perspective* table, or plane. 2. Raise the side H I (*Fig.* 14.) of the square, perpendicularly on each point of the terrestrial line D E; and to any point as V, of the horizontal line H R, draw the right line V I and V H. 3. From the angles *d*, *b*, and *c*, draw *c* 1, *d* 2, &c. parallel to the terrestrial line D E. 4. From the points 1 and 2, raise L 1, and M 2, perpendicular to the same. Lastly, since H I is the height to be raised in *a*, L I in *c* and *b*, and M 2 in *d*; in *a*, raise the line *f a* perpendicular to *a* E; in *b* and *c*, raise *b g* and *c e* perpendicular to *b c* 1; and lastly, raise *d h* perpendicular to *d* 2; if then the points *g*, *h*, *e*, *f*, be connected by right lines, the *scenography* will be compleat.

The *scenography of a hollow quinquangular prism*, is exhibited thus. 1. Since the base of a hollow quinquangular prism, standing on a geometrical plane, is a pentagon, with a limb or breadth of a certain dimension, the appearance of this pentagon must be found on a table or plane. 2. On any point, as H, of the terrestrial line D E (*Fig.* 15.) a perpendicular H I must raised equal to the objective altitude; and to any point, *a v* of the horizontal line H, the lines H V, and I V, are to be drawn. 3. From the several angles *a*, *b*, *d*, *e*, *c*, of the *perspective* inchnography, both the internal and external ones, must be drawn right lines, as *b* 2, *d* 3, &c. parallel to the terrestrial line; and from the points 1, 2, 3, perpendiculars raised to the same, as L 1, M 2, *m* 2, N 3, *n* 3. If these then be raised in the correspondent points of the ichnography, as in the preceding article, the *scenography* will be compleat.

As to the *exhibition of the scenography of a cylinder.*—1. Since the base of a cylinder, standing on a geometrical-plane, is a circle; seek the appearance of a circle. In the points *a*, *b*, *d*, *f*, *g*, *h*, *e*, *c*, the *scenography* of the circle will be compleat.

It is evident, that those lines are to be omitted, both in the plan and in the elevation, which are not exposed to the eye; though they are not to be disregarded from the beginning, as being necessary for the finding of other lines. As for example, in the *scenography* of the cube, viewed angle-wise, the lines *b d*, and *d c*, in the base, and *d h* in the elevation, are hid from the eye, and are therefore omitted in the description. But since the upper point *h* is not to be found, unless the point *d* be had in the ichnography; nor can the lines *g h* and *d c*, be drawn without the height *d h*; the appearance of the point *d* is as necessary to be determined in the operation, as the height *h d*.

To *exhibit the scenography of a pyramid standing on its base.*—Suppose, *e, gr.* it were required to delineate a quadrangular pyramid, viewed by an angle. 1. Since the base of such pyramid is a square, seen by an angle, we must draw such a square. 2. To find the vertex of the pyramid, *i. e.* a perpendicular

pendicular let fall from the vertex to the baſe, we'll draw diagonals mutually interſecting each other in *e*. 3. On any point, as H, of the terreſtrial line D E, raiſe the altitude of the pyramid H I; and drawing the right lines H V and I V, to each point of the horizontal line H R; we'll produce the diagonal *a b*, till it meets the line V H in *h*. Laſtly, from *h* we'll draw *h i* parallel to H I; this being raiſed on the point *e*, will give the vertex of the pyramid K; conſequently the lines *d k*, *k a*, and *k b*, will be determined at the ſame time. After the like manner is the *ſcenography* of a cone delineated.

If it be the *ſcenography of a truncated pyramid, it is exhibited thus.*—Suppoſe the truncated pyramid quadrangular: 1. Then, if from the ſeveral angles of the upper baſe be conceived perpendiculars let fall to the lower baſe, we ſhall have a pentagon, with another inſcribed therein, whoſe ſides are parallel to thoſe of the former. This coincides with a pentagon, furniſhed with a rim or breadth, *&c.* and may, therefore, be delineated in the ſame manner. Raiſing the altitude of the truncated pyramid I H, determines the *ſcenographick* altitudes, to be raiſed in the points *a*, *b*, *c*, *d*, *e*. If now the points higher, *f*, *g*, *h*, *i*, *k*, be connected by right lines; and the lines *l k*, *f m*, *g n*, *h o*, be drawn, the *ſcenography* will be compleat. By drawing two concentrick circles in a geometrical plane, and doing every thing elſe, as in this problem, the *ſcenography* of a truncated cone will be drawn.

To *exhibit the ſcenography of walls, columns,* &c. or *to raiſe them on the pavement.* 1. Suppoſe a pavement A F H I, repreſented in a plan, together with the baſes of the columns, *&c.* if there be any. 2. Upon the terreſtrial line ſet off the thickneſs of the wall B A and 1, 3. 3. Upon A and B, as alſo upon 3 and 1, raiſe perpendiculars A D and B C, as alſo 3, 6, and 1, 7. 4. Connect the points D and *b*, with the principal point V, by the right lines D V and *b* V. 5. Upon F and H raiſe perpendiculars H G and E F: thus will all the walls be delineated.

How to raiſe the pillars, *&c.* there needs nothing but from their ſeveral baſes (whether ſquare or circular) projected on the perſpective plane, to raiſe indefinite perpendiculars; and on the fundamental line, where interſected by the radius F A paſſing through the baſe, raiſe the true altitude A D; for D V being drawn as before, the *ſcenographical* altitudes will be determined.

To *exhibit the ſcenography of a door in a building.*—Suppoſe a door required to be delineated in a wall D E F A. 1. Upon the fundamental line ſet off its diſtance A N, from the angle A, together with the breadths of the poſts N I and L M, and the breadth of the gate itſelf L I. 2. To the point of diſtance K, from the ſeveral points N, I, L, M, draw right lines K N, K I, K L, K M, which will determine the breadth of the door *l i*, and the breadth of the poſts *i n* and *m l*. 3. From A to O ſet off the height of the gate A O, and from A to P, the height of the poſts A P. 4. Join O and P with the principal point, by the right lines P V and O V. 5. Then from *n*, *i*, *l*, *m*, raiſe perpendiculars, the middle ones whereof are cut by the line O V in *o*, and the extremes, by the right line V P in *p*. Thus will the door be delineated with its poſts. If the door were to have been exhibited in the wall E F G H, the method were nearly the ſame: For, 1. Upon the terreſtrial line, ſet off the diſtance of the door from the angle, and thence alſo the breadth of the door R T. 2. From R and T, draw right lines to the principal point V, which give the breadth *r t* in the perſpective plane. 3. From *r* and *t* raiſe indefinite perpendiculars to F H. 4. From A to O ſet off the true height A O. Laſtly, from O, to the principal point V, draw the right line O V, interſecting E F in Z, and make *r r* and *t t* equal to F Z. Thus is the door *r r*, *t t*, drawn; and the poſts are eaſily added as before.

When you know how to repreſent doors, you will find no difficulty in adding windows; all that is here farther required, being to ſet off the height of the window from the bottom of the ground. The whole operation is as follows: 1. From 1 to 2 ſet off the thickneſs of the wall at the window; and from 3 to 4 its diſtance from the angle 3; and from 4 to 5 its breadth. 2. From 4 to 5, to the point of diſtance L, draw the right lines L 5 and L 4, which will give the perſpective breadth 10, 9 of the window. 3. From 10 and 9 raiſe lines perpendicular to the pavement, *i. e.* draw indefinite parallels to *b*, 3. 4. From 3 to 11 ſet off the diſtance of the window from the pavement 3, 11; and from 11 to 12, its height 11 12. Laſtly, from 11 and 12, to the principal point V, draw lines V 11, and V 12; which interſecting the perpendiculars 10, 13, and 9, 14, in 13 and 14, as alſo in 15 and 16, will exhibit the appearance of the window.

In exhibiting the perſpective of a building. 1. Take the ichnography or ground-plot of the building; its length, breadth and depth, by actual meaſuring, and take its altitude with a quadrant.

2. Make a ſcale divided into two or three hundred equal parts, either actually, or ſo as that each diviſion ſignify ten parts: by this ſcale lay down the ground-plot.

3. This done, having a long rule, and a ſquare, which by ſliding on the rule helps you to draw your perpendiculars with more facility, reduce it into *perſpective*, in its ſcenographick appearance.

Then

Then having drawn a line towards the bottom of the paper for the front or base line, divide it into as many equal parts as you find the building has in the ichnography, or more if you pleafe. This will ferve for a fcale to determine the feveral heights, *&c.* and to thefe divifions, with a black lead pencil draw lines from the centre, when you have chofen it; which choice requires judgment on two accounts.

4. Confider how to place this center with fuch advantage, as that you may exprefs thofe things moft, which are chiefly defigned.

Place thofe things you would fee leaft of, nigheft the direct line; and fee whether the others fall according to your mind. But this muft be done after you have drawn your diagonal, which is the next thing.

5. Having pitched on your center, and having from it drawn lines to every divifion of the front line, you are to determine your diagonal A R thus: having with a pair of compaffes, meafured the length of the front line, take your compaffes, and putting one foot in the center, fee where the other will reach in the horizon, (on both fides if you pleafe) where it refts; from that point draw athwart line to the laft divifion of the front; and this will be truly drawn, or pretty nigh to the truth. That it is fo you may confider how it falls in refpect of the two laft center-lines. For if where the next line from the laft is interfected by the diagonal you draw a parallel, the front between them, you will have a rhombus; if then all the fides be pretty equal, you may be fure you are nigh the right; but if the fides that run towards the center be too long, then things will not fore-fhorten enough; if the fides be not long enough, they will fore-fhorten too much.

6. After the front line is thus divided, the center fixed, and the diagonal placed, take the breadth of the chapel, A B, which in the ichnography is fhewn to be twenty parts; becaufe this line is perpendicular, it muft run towards the center, therefore reckon twenty in the diagonal, and the rule laid parallel to the front in that point, will give you a point in the center-line, which will give the breadth of the chapel; confequently a line drawn from A to B, puts it into the ichnographick *perfpective.* The length of the chapel being feventy divifions in the front line, reckon feventy from B, parallel to the front line, and there you will have a point at C.

The depth of the building, from the chapel northward, being one hundred and fifteen from the chapel, I reckon from D; (where it cuts the diagonal at ten) onwards, in the diagonal; and at one hundred and fifteen in the diagonal, with my rule as before parallel in this place in the front, I have the point Z in the central line. Its breadth being thirty, I reckon three divifions, and there is the juft breadth there; and fo on in every particular part.

Having placed the ichnography into *perfpective*, you may then give every thing its proper height thus:

7. The height of the chapel being thirty, I reckon thirty on the front line, and with this length by a fquare clapt to the front line, I drop a perpendicular to that height; and fo where the other fide of the chapel is placed, having reckoned the height upon a fuppofed parallel, there I draw another line in that height; then joining thefe feveral heights by feveral lines, you have the *profiles* of each building.

Profile is the figure or draught of a building, fortification, or the like, wherein are expreffed the feveral heights, widths, and thickneffes, fuch as they would appear, were the building cut down perpendicularly from the roof to the foundation. Whence the *profile* is alfo called the *fection*, fometimes *orthographical fection*; and by *Virtruvius* alfo *fciagraphical.*

Having done thus, your art muft be employed for the particular expreffions of things, by drawing and fhadowing, which is the life of this half-form'd figure, which we leave to the painter.

It remains, that we fpeak of the low fight: and here we fuppofe the horizontal line juft the height of the eye, about five foot from the bafis; though its is generally placed higher, even to a third part of the height of the building, that the fide building may be expreffed more gracefully.

The diagonal is beft determined by dividing the laft divifion of the bafe-line into five parts, taking four of thefe, fometimes the whole five, becaufe we determined before, that the length of the front line was the diftance of the eye in the horizon, between the eye and the point of diftance. You may then either graduate the plan at the feveral interfections of the diagonals with the center lines, or elfe fuppofe it fo, and then raife the buildings, as you will find by *perfpectives* enough of this fort every where to be met with.

PHILOSOPHY.

PHILOSOPHY is a *Greek* derivative, ſignifying the knowledge or ſtudy of *nature* and *morality*, founded on reaſon and experience.

Philoſophy, among the antients, was uſed in various ſenſes: for, 1. It ſometimes was taken for univerſal knowledge, *viz.* of all things *human* and *divine*. 2. In a ſtricter notion, for the contemplation of *nature* only; and in this ſenſe a philoſopher was called by *Plato* φιλος της φυσεως, *i. e.* a friend and lover of nature. 3. Sometimes for *ethics*, or the doctrine of *manners*, which we call *moral philoſophy*. 4. It included alſo the *mathematical* arts and diſcipline, eſpecially *arithmetic* and *geometry*, 5. The doctrine of exiſtence, or *being* in the abſtract, called *metaphyſics*. 6. For the knowledge του πρωτου καλου, *i. e.* of the prime or chief good, *viz.* God; and this was their *prima philoſophia*, or *theology*. 7. It was ſometimes applied to *logics* or *dialectics*, which gave rules for *reaſoning* about the nature of things.

Philosophy may be divided into three parts, *intellectual*, *moral*, and *phyſical*. The *intellectual* part comprizes *logics* and *metaphyſics*; the *moral* part contains the *laws* of *nature* and *nations*; and, laſtly, the *phyſical* part comprehends the doctrine of *bodies* animate or inanimate. Theſe, with their various ſubdiviſions, will take in the whole of philoſophy.

From the firſt broachers of new opinions, and the firſt founders of ſchools, philoſophy is become divided into innumerable ſects, ſome antient, others modern; ſuch are the *Platoniſts*, *Peripatetics*, *Epicureans*, *Stoics*, *Pyrrhonians*, and *Academics*; the *Carteſians*, *Newtonians*, &c.

The riſe and doctrines of theſe ſeveral ſchools, will be beſt learned from the lives of *Socrates*, *Plato*, *Ariſtotle*, *Epicurus*, &c. In thoſe authors, who have profeſſedly employ'd their talents in conveying their memoirs and opinions to poſterity.

It may here ſuffice to obſerve in this place, that the name of a philoſopher, in itſelf compos'd of modeſty and ſimplicity, appear'd ſo fine, and ſo glorious to the learned in antient times, that they preferr'd it to the proudeſt titles, and the moſt illuſtrious characters of honour. That love of wiſdom, and that ſtudy of nature which they profeſs'd, gave them ſuch an authority over the ſpirits of men, that their example ſerv'd for a publick inſtruction, and their maxims were received as oracles in the world. Great men and governors applied to them for advice in affairs of the laſt importance: cities and provinces ſubmitted to their conduct; and princes themſelves eſteem'd it a glory to have been their diſciples. It was philoſophy which taught *Pythagoras* that integrity of morals, and that ſevere courſe of life, which drew after him ſo numerous a train of followers. It was this that gave *Empedocles* the honour of refuſing a crown, and of preferring a private and peaceable life to all the pomp of greatneſs. By this, *Democritus* rais'd himſelf to the contemplation of natural things, and renounced the pleaſures of the body, to enjoy thoſe of the mind with greater freedom and tranquillity. It was this that enabled *Socrates* to die without arrogance on the one hand, or weakneſs on the other. If there appear leſs temper and leſs modeſty in the death of *Cato*, who ſeems to have over-acted the philoſopher, yet we may obſerve in that, ſome ſtrokes of gallantry and greatneſs of ſoul, which could inſpire him with ſuch an utter contempt of life. And ſince there is ſcarce one action of bravery and reſolution recorded in *Pagan* ſtory, but what was owing to the ſpirit of philoſophy, we may affirm this to have been, in ſome ſort, the motive and principle of the brighteſt virtue that ever ſhone among the corruptions of *heathens*.

Thales and *Pythagoras* were, properly ſpeaking, the two great founders of philoſophy among the antients; the one in *Greece*, the other in *Italy*. In the ſchool of *Pythagoras*, we find ſomewhat more regular and ſolid, than in that of *Thales*, and his ſucceſſors. *Pythagoras*'s whole doctrine being conceiv'd as a myſtery, the chief character of his ſcholars was ſubmiſſion; and that religious ſilence, to which he ſo ſtrictly obliged them, was but an artifice to make himſelf heard with more entire reſpect. This philoſopher's life is at preſent a ſubject of controverſy, as well as his opinion. He muſt no doubt, have been a man of profound capacity, of a moſt penetrating judgment, and moſt indefatigable induſtry. His common method of teaching, was by geometry and numbers; by the former he explain'd material and ſenſible things, as he did intellectual things by the latter, and by muſick.

Socrates was the firſt that ever began to reduce the confuſed ideas of his predeceſſors into ſome method and order, by ranging their natural obſervations under proper heads, ſo as to render them uſeful in the forming of arts and ſciences. Beſides all that agreeableneſs of wit which ariſes from a

facility

facility of genius and felicity of parts, he had all the depth, and all the solidity imaginable; and yet this height of underſtanding, and this abundance of light, was attended with true ſimplicity, and infant meekneſs. While really engaged in every thing, he ſeem'd wholly unemploy'd; he preſerv'd an air of pleaſantry in treating of the graveſt ſubjects; and his moſt ſerious meditations never robb'd him of his good humour.

But as he was the leader of all the ſects; ſo he was in ſome ſort, the author of all their heats and diviſions. For his reaſonings were commonly level'd againſt reaſon; and while he eſtabliſh'd the ſciences, he left the means of deſtroying them, the common reſult of his inſtructions being rather doubt than aſſurance, in his hearers. But he muſt ſtill be allow'd to have contributed much to that form and character which philoſophy took ſoon after. For 'twas he that firſt traced out the plan of logick and morality, and ſupplied principles to phyſicks. Yet the peculiar bent of his genius, which carried him to ſeek for too much nicety, and to refine upon every thing, was the reaſon that he handled theſe matters with leſs ſolidity than his ſucceſſors. Not but that his authority is of very great weight, when he advances any point; but his conceptions are, for the moſt part, rather principles than deciſions; and upon the whole, his philoſophy ſeems much more proper to pull down than to build.

Plato is the fineſt ſpeaker of all antiquity, and therefore he is more deſirous to be heard, than ſollicitous to be believ'd, he is always florid, but not always ſound.

He rais'd the credit of his philoſophy more by the virtues of his life and conduct, than by his ſpeculations of doctrine. For it was he who firſt taught, that true philoſophy conſiſted more in fidelity and conſtancy, in juſtice and ſincerity, and the love of our duty, than in large attainments, or uncommon parts.

Ariſtotle is a genius ſo much above the ſtandard, as not eaſily to be comprehended. By a prodigious and unexpected reach of knowledge, he advances beyond all bounds, and conquers all oppoſitions. He was the firſt that gather'd the various parts of philoſophy, in order to the re uniting them in one body, and caſting them into a regular ſyſtem. No man ever had ſo clear, and ſo piercing a diſcernment of true and falſe.

Ariſtotle is certainly the man that has given the greateſt weight to human reaſon, and carried it to its fartheſt length. And then, his method is more ſolid than that of all others, becauſe his principles are eſtabliſh'd upon better reaſon, and his reaſon founded upon better experience. Yet he choſe to deliver himſelf with obſcurity; whether to conceal his doubts, or to increaſe his authority, is not certain. He ſeems to have written that he might not be underſtood; and his works look as if deſign'd not ſo much for the inſtruction of his own age, as for the exerciſe of all ages to come.

If we examine the motives by which the greateſt part of philoſophers are determin'd to their peculiar ſect, we ſhall find that philoſophy has the leaſt ſhare in them. 'Tis often by prevention of age, or accident, without deliberation, or choice, and ſometimes without thought, that they embrace one opinion rather than another. Men come to agree in the ſame perſuaſion, by the habit they wear, the nation to which they belong, the company they keep; by the way of life that firſt engages them, by the ſociety that firſt gains and poſſeſſes them, by the multitude that carries them along, by the ſtream that bears them down; and by any conſiderations, except thoſe of reaſon and wiſdom. Thus they ſubmit to the tyranny of prepoſſeſſion, as not having ſtrength of judgment to ſtem and reſiſt it: they abandon their own ſenſe, to follow other mens fancies: they purſue with paſſion what they have undertaken without reaſon; and defend with the utmoſt temerity what they firſt embraced by mere chance and prevention. And when they have once fix'd, they make it a point of honour to maintain their ground. Nay, it ſometimes happens, that the animoſity and contention of parties ſharpens the dulleſt wits, and vexation ſupplies the place of underſtanding. But thus raſhly and fortuitouſly to make our ſelves the properties and acceſſions of other mens conceits, has ſo very ridiculous an air, that 'tis better to be any thing than ſuch a tool of a philoſopher. Between theſe oppoſitions of ſcience, we ought to ſtand in our own defence, and not tamely to yield upon the bare ſummons of any party. For ſuch an ungrounded and precarious philoſophy is a diſtemper of mind, and a mere intellectual debauch.

Truth is ſo hardly beſet, and brought under ſuch a ſtate of perſecution, by the falſe colours of the age, that few men have ingenuity enough to ſpeak their mind, or reſolution enough to be ſincere. It requires a good degree of courage to be a philoſopher in good earneſt. Nay, it ſhews an uncommon greatneſs of ſoul, never to ſpeak but what we think, and never to think but what we dare to ſpeak.

PLUM-

P L U M B E R Y.

PLUMBERY, from the Latin *plumbum*, lead, is the art of caſting, preparing, and working lead, and of uſing it in buildings, *&c.*

The lead uſed in *plumbery* is furniſhed from the lead-works in large ingots, or blocks, called pigs of lead, ordinarily weighing about a hundred pounds a piece. As this lead melts very eaſily, it is eaſy to caſt figures thereof of any kind, by running it into moulds of braſs, clay, plaſter, *&c.*

But what makes the baſis of the plumbers work in building, are the *ſheets* and *pipes* of lead.

The lead deſigned for *caſting large ſheets*, is melted in a furnace, uſually built with free ſtone, and earth, fortified on the outſide with maſſive of ſhards and plaſter. At the bottom is a place ſunk lower than the reſt, wherein is depoſited an iron pot, or pan, to receive what may remain of the metal after the ſheet is run. The furnace is ſo raiſed above the area of the floor, as that the iron pot juſt reſts thereon.

The furnace is heated with wood laid within it, throwing afterwards into it the lead, pell-mell with the burning coal to melt.

Near the furnace is the table, or mould, whereon the lead is to be caſt. It conſiſts of large pieces of wood, well joined, and bound with bars of iron at the ends. Around it runs a frame, conſiſting of a ledge or border of wood two or three inches thick, and one or two high from the table, called the *ſharps*. The ordinary width of the tables is from three to four feet; and their length from 18 to 20 feet.

The table is covered with fine ſand, prepared, by moiſtening it with a watering pot, then working it with a ſtick; and at laſt to render it ſmooth and even, beating flat with a mallet, and planing it with a ſlip of braſs or wood.

Over the table is a ſtrike or rake of wood, which bears and plays on the edges of the frame by means of a notch cut in either end thereof; and ſo placed, as that between it and the ſand is a ſpace proportionable to the intended thickneſs of the ſheet. The uſe of this ſtick is to drive the matter, while yet liquid, to the extremity of the mould.

A top of the table is a triangular iron peel or ſhovel, bearing before, on the edge of the table itſelf, and behind on a treſtle ſomewhat lower than the table. Its uſe is to convey the metal into the mould; and the deſign of its oblique diſpoſition is, that it may by that means be able to retain the metal, and keep it from running off at the fore ſide, where it has no ledge. Some of thoſe peels are big enough to hold fifteen or ſixteen hundred weight of lead, and even more.

Things being thus diſpoſed, with a large iron ladle they take the melted lead, coals and all, out of the furnace; and with this, mixed as it is, fill the iron peel. When full, they take out the coals, and clear the lead with another iron ſpoon pierced after the manner of a ſkimmer.

This done, they hoiſt up the lower part of the peel by its handle; upon which the liquid matter running off, and ſpreading itſelf on the mould, the plumber conducts and drives it to the extremity of the table by means of the ſtrike, which the workmen paſſes along the ledges, and thus renders the ſheet of an equal thickneſs.

The ſheets thus caſt, there remains nothing but to edge them, *i. e.* to planiſh the edges on both ſides, in order to render them ſmooth and ſtrait.

To *caſt thin ſheets of lead*; the table or mould is of a length at diſcretion, only edged on one ſide. Inſtead of ſand they cover it with a piece of woollen ſtuff, nailed down at the two ends to keep it tight; and over this lay a very fine linen cloth. The feet of the table are uneven, ſo that it does not ſtand horizontal, but moderately inclined.

Gread regard is had to the lead while melting, that it has the juſt degree of heat, ſo as it may run well, and yet not burn the linen. This they judge of by a piece of paper; for if the paper takes fire in the liquid lead, it is too hot; and if it be not ſhrunk and ſcorched a little, it is not hot enough.

Being then in its juſt degree, they have a ſtrike, but different from that deſcribed in the former article; as ſerving both for peel and ſtrike, to contain and to conduct the liquid lead. It is, in effect, a wooden caſe without any bottom, only cloſed on three ſides. It is pretty high behind; but the two ſides, like two acute angles ſtill diminiſh to the tip, from the place where they are joined to the third or middle piece, where they are of the ſame height therewith, *viz.* 7 or 8 inches high. The width of the middle makes that of the ſtrike, which again makes that of the ſheet to be caſt.

The ſtrike is placed a-top of the table, which is before cover'd in that part, with a paſte-board, which ſerves as a bottom to the caſe, and prevents the linen from being burnt, while the liquid is pouring

pouring in. The ſtrike is ſo diſpoſed on the table, as that the higheſt part looks to the lower end of the table, and the two ſloping ſides to the higher end.

The ſtrike is now filled with lead, according to the quantity to be uſed: which done, two men, one at each ſide the table, let the ſtrike deſcend down the table, or elſe draw it down with a velocity greater or leſs, as the ſheet is to be more or leſs thick; the thickneſs of the ſheet ſtill depending on the promptitude wherewith the ſtrike ſlides down the inclining mould.

As to *pipes of lead*, there are ſome caſt without ſoldering; and others ſolder'd.

To *caſt pipes without ſoldering*, they have a kind of furnace, conſiſting of a large iron cauldron, ſupported on a pretty high iron ſtand. The cauldron is encompaſſed with a maſſive of bricks and loam; only leaving a mouth or paſſage for the conveyance of wood underneath, and lighting the fire, and another little aperture behind, to ſerve as a vent-hole.

In this furnace they melt the lead, after firſt heating it with a fire underneath: to forward the fuſion, they put in burning faggots along with the metal. The metal is ſkimmed and laden off with the inſtruments mentioned above.

Near the furnace is a bench, furniſhed at one end with a little mill, with arms or levers to run it withal. A ſtrong girt, armed with an iron hook at one extremity, is faſten'd by the other to the axis of the mill, around which it turns when in motion. On this bench the moulds of the pipes are placed horizontally, and the mill and the girt ſerve to draw out the iron core after the pipe is caſt.

The moulds of theſe tubes are of braſs, and conſiſt of two pieces, which open and ſhut by means of hooks and hinges; their inner calliber, or diameter, is according to the ſize of the pipe to be made; their length is uſually two foot and a half.

In the middle is placed a core, or round piece of braſs or iron, ſomewhat longer than the mould, and of the thickneſs or the inner diameter of the pipe. This core is paſſed through two copper rundles, one at each end of the mould, which they ſerve to cloſe; and to theſe is joined a little copper tube, about two inches long, and of the thickneſs the leaden pipe is intended to be of. By means of theſe tubes the core is retained in the middle of the cavity of the mould.

The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace; they take it up in a ladle, and put it into the mould, by a little aperture at one end, made in form of a funnel.

When the mould is full, and the metal cold, they paſs the hook of the girt into a hole at the end of the core; and turning the mill with the hand, draw out the core. They then open the mould, and take out the pipe.

If they deſire to have the pipe lengthen'd, they put one end thereof in the lower end of the mould, and paſs the end of the core into it; then ſhut the mould again, and apply its rundle and tube as before, the pipe juſt caſt ſerving for rundle, &c. at the other end.

Things thus replaced, they pour in freſh metal into the mould; thus repeating the operation till they have got a pipe of the length requir'd.

But if plumbers want to make *pipes of ſheet lead ſolder'd*; they have wooden cylinders, and rollers of the length and thickneſs required, and on theſe they form their pipes, by wrapping the ſheet around them; ſoldering up the edges all along, thus; after grating the lead well with a grater, they rub roſin over the part thus grated, then pour on it ſome ſolder melted in a ladle, or elſe melt it with a hot ſoldering iron, ſmearing thoſe parts where they would not have the ſolder catch, with chalk, or the ſoil of the hand.—The ſolder which the plumbers uſe, is a mixture of two pounds of lead with one of tin.

PNEUMATICKS.

PNEUMATICKS, is the doctrine of the air, or the laws wherein that fluid is condenſed, rarefied, gravitated, &c. This is alſo called by *Wolfius*, *aerometry*, or the art of meaſuring the air.

The AIR, as I conſider it in this place, is a certain ſubtile homogeneous elaſtick matter; the baſis and fundamental ingredient of the atmoſpherical air, and that, which gives it the denomination.

It is ſuppoſed a body *ſui generis*, ingenerable, incorruptible, immutable, preſent in all places, in all bodies, &c.

The moſt conſiderable of the *mechanical properties and effects* of the *air*, are its *fluidity*, *weight*, and *elaſticity*.

1. The *fluidity* of the *air* is evident from the paſſage

paſſage it affords to bodies through it; as in the propagation of ſounds, ſmells, and other effluvia.

The cauſe of this fluidity of the *air*, is attributed by ſome very modern philoſophers to the fire intermixed therewith; without which they imagine the atmoſphere would harden into a ſolid, impenetrable maſs. And hence the greater the degree of fire therein, the more fluid, moveable, and pervious the air: and thus as the degree of fire is continually varying, according to the circumſtances and poſition of the heavenly bodies; the *air* is kept by a continual reciprocation. Hence, in good meaſure, it is, that on the tops of the higher mountains, the ſenſes of ſmelling, hearing, *&c.* are found very feeble.

2. That the *air* is heavy, follows from its being a body.

We can actually weigh *air*; for a veſſel, full even of common *air*, by a very nice ballance, is found to weigh more than when the *air* is exhauſted; and this effect is proportionably more ſenſible, if the ſame veſſel be weighed full of condenſed *air*, in a receiver void of *air*.

The weight of *air* is continually varying, according to the different degree of heat and cold.—*Ricciolus* eſtimates its weight to that of water, to be as 1 to 1000; *Merſennus*, as 1 to 1300, or 1 to 1356; *Lana*, as 1 to 640; *Galileo* only makes it as 1 to 400. The ingenious Mr. *Boyle*, by a more accurate experiment, found it about *London*, as 1 to 938: and thinks, all things conſider'd, the proportion of 1 to 1000 may be taken at a medium.

By experiments made ſince before the Royal Society, the proportion of *air* to water was firſt found as 1 to 840; then, as 1 to 852; and a third time, as 1 to 860. By a very ſimple and accurate experiment of the late Mr. *Hawkſbee*, the proportion was ſettled, as 1 to 885.

The difference of the *air*'s weight at different times, is meaſured by the different height to which the mercury is raiſed in the barometer; and the greateſt variation of the height of the mercury being three inches, a column of *air* of any aſſignable baſe, equal to the weight of a cylinder of mercury of the ſame baſe, and of the altitude of three inches, will be taken off from the preſſure upon a body of an equal baſe, at ſuch time as the mercury is three inches lower in the barometer; ſo that every inch ſquare of the ſurface of our bodies, is preſſed upon at one time more than another, by a weight of *air*, equal to the weight of three cubical inches of mercury. Now a cubical foot of water being ſeventy-ſix pounds; a cubical foot of mercury is 1064 pounds = 102144 drachms; and as 102144 drachms is to a cubical foot, or, which is all one, 1728 cubical inches, ſo is 59 $\frac{192}{1728}$ drachms, to one cubical inch. So that a cubical inch of mercury being very near = 59 drachms; and there being 144 ſquare inches in a foot ſquare, therefore a maſs of mercury of a foot ſquare = 144 ſquare inches, and if three inches high, muſt contain 432 cubical inches of mercury, which + 59 (the number of drachms in a cubical inch of mercury) makes 25488 drachms. And this weight was a foot ſquare of the ſurface of our bodies, ſuſtained at one time more than at another.

Suppoſe, again, the ſuperficies of an human body = 15 feet ſquare; then would the body ſuſtain at one time more than at another, a weight = 15 + 25488 = 382230 drachms (= 47790 ounces) = $3890\frac{1}{2}$ pounds troy.

Hence it is ſo far from being a wonder, that we ſometimes ſuffer in our health, by a change of weather; that it is the greateſt wonder we do not always do ſo.—For when we conſider, that our bodies are ſometimes preſſed upon by near a ton and a half weight more than at another, and that this variation is often very ſudden; it is ſurprizing that every ſuch change does not entirely break the frame of our bodies to pieces.

To meaſure the weight of the *air* or atmoſphere, and the variations therein, in order chiefly to determine the changes of the weather, an inſtrument was invented, called *barometer*, from βαρος, weight; and μετρον, meaſure; the deſcription and phænomena thereof come very a-propos under this article of the weight of the air.

The Barometer is founded on the torricellian experiment, as it is called from its inventor *Torricelli*, which is no more than a glaſs tube filled with mercury, hermetically ſealed at one end; the other open, and immerged in a baſon of ſtagnant mercury. Now as the weight of the atmoſphere diminiſhes, the mercury in the tube will here deſcend; on the contrary, as it increaſes, the mercury will again aſcend: the column of mercury ſuſpended in the tube being always equal to the weight of the incumbent atmoſphere.

There are ſeveral kinds of *barometers*, viz. the *common*, *horizontal*, *diagonal*, *wheel*, *marine*, *ſtatical*, and *portable barometers*.

The conſtruction of a *common barometer*, is as follows.—A glaſs tube A B (*Fig.* 1. *pneumatick table*) hermetically ſealed in A, having its diameter about $\frac{1}{10}$ of an inch, and its length at leaſt thirty-one inches, is filled with mercury ſo juſtly, as not to have any air over it, nor any bubbles adhering to the ſides of the tube; which is beſt done by means of a glaſs funnel, with a capillary tube. The orifice of the tube filled after this manner, ſo as as to overflow, is closely pressed by the finger, so as to exclude any air between it and the mercury, and thus immerged in a wooden vessel of a convenient diameter; so however, as not to touch the bottom: at the distance of twenty-eight inches from the distance of the mercury, are fixed two plates, C E and D F, divided into three inches, and these again subdivided into any number of smaller parts. Lastly, the tube is enclosed in a wooden frame to prevent its being broke; and the bason, though open to the air secured from dust, and the *barometer* is compleat.

Many attempts have been made to render the changes of the barometer more sensible, and so to measure the atmosphere more accurately; which has given rise to the following *barometers* of different structure.

Des Cartes, and after him *Huygens*, used a tube A B, (*Fig* 2.) having a cylindrick vessel C D; one half of which vessel, together with the upper part of the tube, were filled with water; the other half of the vessel, and the lower part of the tube with mercury. But here, though the column suspended was longer, and consequently the variation greater, yet the air imprisoned in the water getting loose by degrees, filled the wide space in the top, and so ruined the machine.

Huygens then bethought himself of placing the mercury at top, and the water at bottom, in the manner following: A D G (*Fig.* 3.) is a bent tube hermetically sealed in A, and open in G; the cylindrick vessels B C and F E are equal, and about twenty-nine inches a-part; the diameter of the tube is about a line, that of each vessel fifteen lines, and the depth of the vessels about ten; the tube is filled with mercury (the common *barometer* standing about twenty-nine inches) which will be suspended between the middle of the vessel F E, and that of the vessel B C; the remaining space to A being void both of mercury and air. Lastly, common water, tinged with a sixth part of aqua regis, to prevent its freezing, is poured into the tube F G, till it rises a foot above the murcury in D F.

When then the mercury rising above the level of that contained in F E, through the tube A D, becomes a ballance to the weight of the atmosphere; as the atmosphere increases, the column of mercury will increase, consequently the water will descend; as the atmosphere again grows lighter, the column of mercury will descend, and the water ascend. This *barometer* therefore, which is the same with that of Dr. *Hook*, will discover much minuter alterations in the air than the common one: for, instead of two inches, the fluid will here vary two feet; and by enlarging the diameters of the cylinders, that variation may be still increased: but it has this inconvenience, that the water will evaporate, and so render the alterations precarious; though the evaporation be in some measure prevented by a drop of oil of sweet almonds swimming a-top.

On account of this defect, others have had recourse to a *horizontal* or *rectangular barometer* A B C D (*Fig.* 4.) the tube whereof is bent in form of a square B C D, a-top of its perpendicular leg it is joined to a vessel or cistern AB; and its variation accounted on the horizontal leg C D.

Now here the interval or space of variation, may be made of any extent at pleasure, and so the minutest change in the air become sensible. For the diameter of the tube CD being given, it is easy to find the diameter of the vessel AB, so as that the scale of descent in the tube D C shall have any given proportion to the scale of ascent, in the vessel A B; the rule being, that the diameter of the vessel is to that of the tube in a subduplicate reciprocal ratio of their scales.

The diameters then of CD and AB being given, together with the scale, or ascent of the mercury in the vessel, the scale of mercury in the tube is found thus: as the square of the diameter of the tube, is to the square of the diameter of the vessel, so reciprocally is the scale of mercury in the vessel, to the scale of mercury in the tube.

This last however, with its virtues, has great defects.

Some therefore prefer the *diagonal barometer*, where the space of variation is considerably larger than in the common one, and yet the rise and fall more regular than in the others. Its foundation is this, that in a *torricellian* tube B C (*Fig.* 5.) inclined at any angle to the horizon, the cylinder of mercury, equivalent to the weight of the atmosphere, is to a cylinder of mercury, equivalent to the same placed in a vertical tube, as the length of the tube B C, to the perpendicular height D C. Hence if the height D C be subtriple, subquadruple, &c. of the length of the tube, the changes in the diagonal barometer will be double, or triple, &c. of the changes in the common barometer.—This barometer will scarce allow its tube to be inclined to the horizon, at a less angle than 45 degrees, without undergoing the inconveniency of the horizontal one.

The *wheel barometer* is a contrivance of Dr. *Hook*, to make the alterations in the air more sensible; the foundation of this is the common vertical barometer, with the addition of a couple of weights A and B (*Fig* 5.) hanging in a pulley, the one playing at liberty in the air, the other resting on the surface of the mercury in the tube, and rising and falling with it. Thus is the motion of the mercury

mercury communicated, by means of the pulley, to an index which turns around a graduated circle; and thus the three inches of vertical aſcent, are here improved to five or ſix, or more, at pleaſure.—But the friction of the parts, in the pully and index, is ſo conſiderable, that unleſs the machine be made with a great deal of accuracy, it does not anſwer.

The *pendant barometer* is a machine rather pretty and curious, than uſeful. It conſiſts of a conical tube, placed vertically; its upper and ſmaller extreme hermetically ſealed: it has no veſſel or ciſtern, its conical figure ſupplying that defect: for when filled, like the reſt, there will be as much mercury ſuſtained, as is equivalent to the weight of of the atmoſphere; and as that varies, the ſame mercury takes up a different part of the tube, and ſo becomes of a different weight.

The *marine barometer* is likewiſe a contrivance of Dr. *Hook*, to be uſed at ſea, where the motion of the waves render the others impracticable. It is nothing more than a double thermometer, or a couple of tubes half filled with ſpirit of wine; the one hermetically ſealed at both ends with a quantity of common air incloſed; the other ſealed at one end, and open at the other.

This inſtrument is ſaid to be of good uſe in giving notice of all bad weather at ſea, alſo of variable winds.

The *ſtatical barometer*, or *baroſcope*, uſed by Mr. *Boyle*, *Otto de Guerick*, &c. is fallacious and liable to be acted on by a double cauſe. It conſiſts of a large glaſs bubble, ballanced by a braſs weight, in a nice pair of ſcales: for theſe two bodies being of equal gravity, but unequal bulk, if the medium in which they equiponderate be changed, there will follow a change of their weight; ſo that if the air grows heavier, the greater body being lighter in ſpecie, will loſe more of its weight than the leſſer, and more compact; but if the medium grows lighter, then the bigger body will outweigh the leſs.

The moſt accurate barometer yet invented, ſeems to be that of Mr. *Caſwell*; the ſtructure whereof he deſcribes as follows: ſuppoſe A B C D (*Fig.* 6,) a bucket of water, wherein is the barometer, *x*, *r*, *e*, *z*, *y*, *o*, *ſ*, *m*, conſiſting of a body *x r ſ m*, and a tube *e z y o*, the body and tube are both concave cylinders made of tin, or rather glaſs, and communicating with each other. The bottom of the tube *z y*, has a lead weight to ſink it ſo as the top of the body may juſt ſwim even with the ſurface of the water, by the addition of ſome grain weights a top. The water, when the inſtrument is forced with its mouth downwards gets up into the tube to the height *y o*. There is added on the top a ſmall concave cylinder, which we call the pipe, to diſtinguiſh it from the other at bottom, which we call the tube: this pipe is to ſuſtain the inſtrument from ſinking to the bottom. In *d* is a wire, in S, *d e*, two threads oblique to the ſurface of the water, performing the office of diagonals. Now, while the inſtrument ſinks more or leſs, by the alteration of the gravity of the air; there, where the ſurface of the water cuts the thread, is formed a ſmall bubble, which aſcends up the thread, as the mercury of the common barometer aſcends, and *vice verſa*.

This inſtrument, as appears from a calculation which the author gives, ſhews the alterations in the air more accurately than the common barometer, by 1200 times. He obſerves, that the bubble is ſeldom known to ſtand ſtill a minute; that a ſmall blaſt of wind that cannot be heard in a chamber, will make it ſink ſenſibly; that a cloud always makes it deſcend, *&c.*

The phænomena of the *barometer* are various; and the cauſes aſſigned for them by ſeveral authors, widely different.

Mr. *Boyle* obſerves, that it is exceedingly difficult to form any general rules about the riſe or fall thereof. Even that which ſeems to hold moſt univerſally, *viz.* that when high winds blow, the mercury is the lower, ſometimes fails.

Dr. *Halley* gives us the following obſervations: that in calm weather, when the air is inclined to rain, the mercury is commonly low; in ſerene, good ſettled weather, high.

That on good winds, though accompanied with rain, the mercury is the loweſt of all, with regard to the point of the compaſs the wind blows on. That *cæteris paribus*, the greateſt height of the mercury, are on eaſterly and north-eaſterly winds. That after great ſtorms of wind, when the mercury has been low, it riſes again very faſt.

That in calm froſty weather it ſtands high.

That the more northerly places find greater alterations than the more ſouthern; and that within the tropicks, and near them, there is little or no variation of the height of the mercury at all.

Some of the moſt modern authors ſpeak on the *cauſes of the phænomena of the barometer*, in the following manner.—Suppoſe, ſay they, any number of watery veſicles floating in any part of the atmoſphere over any determinate portion of the globe, for inſtance, over A B (*Fig.* 21.) if the upper veſicles be condenſed by the cold of the ſuperior regions, their ſpecifick gravity will be increaſed, and they will deſcend; the horizontal claſs, 1, *v. gr.* to 2, 2 to 3, *&c.* where meeting with other veſicles not yet precipitated, they will coaleſce or run into larger veſicles, by the known laws of attrac-

tion.

tion. Or if we rather chuse to have the wind act, let it drive either horizontally or obliquely; in the former case the vesicles, class 8, will be driven against 9; those against 10, &c. or the oblique class A 7, driven against 5, 8 against 4, &c. by which means likewise will the particles coalesce and form new and large vesicles, as before; so that their number, which before was supposed a million, will now be reduced, *v. gr.* to a hundred thousand.

III. *Elasticity.*—A power of yielding to an impression, by contracting its dimensions; and upon removing or diminishing the impulsive cause, returning to its former space or figure. This elastick force is accounted the distinguishing property of the air; the other properties hitherto enumerated, being common to it with other fluids.

On this property of *elasticity*, the structure, and office of the *air-pump* depends.

The invention of this noble instrument is ascribed to *Otto de Guerick*, consul of *Magdebourg*, in the year 1654.

The *air-pump*, as it is now made among us with all its advantages (*Fig.* 16.) consists of two brazen barrels or cylinders represented by *a a a a*; which communicates with each other by a canal passing between them at *d d*, and with a receiver *o o o*, by means of a hollow wire *b b*, one end whereof opens into the canal of communication, and the other into a like canal *n n*, which penetrating the plate *i i i i*, opens into the receiver.

Within the cylinder are two emboli, or suckers, made of brass, and fitted with cork and leather to the cavities of the barrels, so as exactly to fill the same; each being furnished with its valve, and terminating at top in a rack *c c*, by which it is to be worked.

At the bottom of either barrel is another valve; by which the air may pass out of the communicating canal *a d*, and consequently out of the hollow wire, and the receiver itself, into the cylinder below the piston; from whence by the valves of the piston it may proceed into the upper space of the cylinder, and thus into the open air.

For the *application* of this mechanism, the winch *b b* being turned upwards and downwards, its spindle *f* catching by its teeth into the racks, will rise and depress the two pistons alternately. Now, the consequence of depressing a piston is, that the air before inclosed between it and the bottom of the cylinder, being thus crowded into a less compass, will, by its elastick force, which now exceeds the pressure of the atmosphere, push up the valve of the piston, and thus escape, till what little remains be of the same density with the external air incumbent on the valve.

This done, and the same piston being again raised in its turn, from the bottom of the cylinder to the top; the little air before left will of necessity expand itself, so as to possess the whole space of the cylinder thus deserted by the piston: upon which its force or pressure upon the valve at the bottom of the cylinder being now inconsiderable; the other denser air of the receiver, hollow wire, and canal of communication, by their superior elastick force, will lift up the valve, and thus pass into the cylinder of rarefied air, till both be of the same degree of density.

And thus is the air in the receiver diminished at each elevation of the piston, by the quantity of a cylinder full; abating for what little remained between the depressed piston and the bottom. So that by thus repeating the operation again and again; the air in the receiver is at length rarefied to such a degree, that its density does not exceed the thin air remaining in the cylinder when the piston is raised: which done, the effect of the *air-pump* is at an end; the valve cannot now be opened, or if it could, no air would pass it; there being a just equilibrium between the air on each side.

To judge of the degree of exhaustion, there is added a gage *l l*, consisting of a tube, whose upper orifice communicates with the receiver; the lower being immerged in a bason of mercury *m m*. Hence the *air* in the tube rarefying as fast as that in the receiver; in proportion as the exhaustion advances, the mercury will be raised by the pressure of the column of external *air*, prevailing over that of the column of *air* included, till the column of *air*, and mercury together, become a ballance to that of the external *air*. When the mercury is thus risen to the same height as it stands in the barometer, which is indicated by the scale of inches added to the gage; the instrument is a just torricellian tube; and the vacuum, say those who admit such things, may be concluded to be as perfect as that in the upper end of the barometer.

To let *air* again into the exhausted receiver, the cock *n* is to be turned; which makes a communication with the external *air*; upon which the *air* rushing impetuously in, the mercury in the gage immediately subsides into the bason.

To the *air-pump* belongs a large apparatus of other vessels, accommodated to the divers kinds of experiments.

As to the effects and phænomena of the *air-pump*; it is pretended by the asserters of the *vacuum Boyleanum*, that we arrive at it by means of the *air-pump*.——Thus any thing put in a receiver so exhausted, is said to be put *in vacuo*; and some of the principal phænomena thereof to be, that the heaviest and lightest bodies as a guinea, and a feather,

ther, falls here with equal velocity.—That fruits, as grapes, cherries, apples, &c. kept for any time *in vacuo*, retain their nature, freſhneſs, colour, &c. and thoſe wither'd in the open air, recover their plumpneſs *in vacuo*.——All light, and fire becomes immediately extinct *in vacuo*.——The coalition of flint and ſteel *in vacuo*, produces no ſparks.——No ſound is heard, even from a bell rung *in vacuo*.——A ſquare viol, full of common air, well cloſed, breaks *in vacuo*; a round one does not.——A bladder half full of air will heave up forty pounds weight *in vacuo*.——Cats, and moſt other animals readily expire *in vacuo*.

The *air-pump* can never produce a preciſe vacuum, if even ſuch a thing was poſſible; as is evident from its ſtructure, and the manner of its working: in effect, every exſuction only takes a part of the air: ſo that there will ſtill be ſome left after any infinite number of exſuctions.——Add that the *air-pump* has no longer any effect, than while the ſpring of the air remaining in the receiver, is able to lift up the valves: when the rarefaction is come to that degree, you can come no nearer to a vacuum.

The weight or preſſure of the air has no dependance on its elaſticity; but would be the ſame whether the air had ſuch property or not.—But the air, in being elaſtick, is neceſſarily affected by the preſſure, which reduces it into ſuch a ſpace, as that the elaſticity, which re acts againſt the compreſſing weight, is equal to that weight.

In effect, the law of this elaſticity, is, that it increaſes as the denſity of the air increaſes; and the denſity increaſes, as the force increaſes wherewith it is preſſed. Now there muſt neceſſarily be a ballance between the action and re-action, *i. e.* the gravity of the air which tends to compreſs it, and the elaſticity of the air, which endeavours to expand it, muſt be equal.

Hence the elaſticity increaſing, or diminiſhing univerſally as the denſity increaſes or diminiſhes, *i. e.* as the diſtance between the particles diminiſhes or increaſes; it is no matter whether the air be compreſſed and retained in ſuch ſpace by the weight of the atmoſphere, or by any other means: it muſt endeavour in either caſe, to expand with the ſame force. And hence, if air near the earth be put up in a veſſel, ſo as to cut off all communication with the external air; the preſſure of the incloſed air will be equal to the weight of the atmoſphere. Accordingly we find mercury ſuſtained to the ſame height, by the elaſtick force of air, incloſed in a glaſs veſſel, as by the whole atmoſpherical preſſure.

Hence the ſtructure of the WIND-GUN, which is a machine ſerving to explode bullets, and other ſhot with great violence, by the force of the air.

There are *wind-guns* of divers contrivances; the moſt eaſy and portable one, and the moſt in uſe is repreſented (*tab. pneum.* Fig. 14.) it conſiſts of a round melted tube 3, 3, open at the end *c*, *c*, and exactly ſtopped at the other end *a*, like the barrel of other guns: 1, 1, 1, 1, is another larger metal tube, wherein the former is diſpoſed, ſo as to leave a ſpace between them 4, 4, wherein air may be incloſed.——The two tubes are joined together at the common aperture *c c*, by a circular plate exactly ſolder'd to both, ſo as to prevent the air from eſcaping out of the ſpace 4, 4, &c. At 8 is a ſpring valve, which opening inwardly, let the air paſs through from 2 into the ſpace 1, but prevents its return from 1 to 2. Near the cloſe end of the inner tube are two holes 6 and 5; by the firſt, the ſpace 1, and the inner tube communicate, ſo that the air would paſs out of that into this, but that the paſſage is ſtopped by a valve opening outwardly; by the latter there is a communication between the open air, the ſpace 4, and the inner barrel; only the air pent up in the ſpace, cannot eſcape at this hole, by reaſon of a little tube exactly ſolder'd to both barrels, which ſtops the communication: nor can air eſcape out of the inner barrel through this little tube, by reaſon of a little moveable pin, which exactly fills the cavity of the tube.

Laſtly, the part 2, 2, 2, 2, repreſents the body of a ſyringe, or ſucking pump; by which as much air as poſſible is to be intruded into the ſpace 4, 4, &c. After which a bullet being put into a cavity of the inner barrel, as high as the little tube 5, the gun is charged.

Now to diſcharge it, the little valve 6, is puſhed up by means of the pin that plays in the little tube 5. Upon this, the compreſſed air in the cavity of the outer barrel 4, ruſhing through the hole 6, into the cavity of the inner barrel, expels the bullet with a vaſt force, ſufficient to penetrate a thick board.

To give the machine a greater reſemblance of a fire-arm, the part 2, 2, 2, 2, is uſually faſhioned like the but-end of a muſket; and on the part 2, 8, 2, 8, is fitted a lock; by turning the trigger of which, the pin 5 is made to puſh back the valve, and ſo diſcharge the piece. By the lock it is contrived, that either the whole charge of air may be ſpent by exploſion, or only part of it, and the reſt reſerved for freſh bullets. By this piece of mechaniſm we can have half a dozen good effective ſhoots, with one charge of air.

The dilatation of the air by reaſon of its elaſtick force, is found to be very ſurprizing.

On this depends the ſtructure and uſe of the *manometer*, which is an inſtrument to ſhew or meaſure the alterations in the rarity or denſity of the air.

The

The MONOMETER differs from the *barometer*, in that the latter only meafures the weight of the atmofphere, or of the column of air over it; but the former the denfity of the air in which it is found: which denfity depends not only on the weight of the atmofphere, but on the action of heat and cold, &c.

M. *Montons*, and others, take the rarefaction of *air* to arife wholly from the fire contained in it; and hence, by increafing the degree of heat, the degree of rarefaction may be carried ftill further than its fpontaneous dilatation.

On this principle depends the ftructure and office of the *thermometer*, which is an inftrument fhewing, or rather meafuring the increafe and decreafe of the cold and heat of the *air*.

THRMOMETER, and *thermofcope*, are ordinarily accounted the fame thing; *Wolfius*, however, makes a difference; but fhews withal, that what we call *thermometers* are, in reality, no more than *thermofcopes*.

There are various kinds of *thermometers*, the conftructions, defects, theory, &c. whereof are as follow.

For *the conftruction of a thermometer depending on the rarefaction of the air*; in a tube BC (*Fig.* 3. n. 2.) to which is faftened a glafs ball AB, is put a quantity of common water mixed with aqua regia, to prevent its freezing; and the mixture tinged with a folution of vitriol, to give it a greenefs. In filling the tube, care is taken that there be fo much *air* left in the ball and the tube, as that when at its greateft condenfation in the middle of winter, it may juft fill the ball; and yet in its greateft rarefaction in fummer, may not drive all the liquor out of the tube. To the other extreme of the tube is faftened another glafs ball C D, open to the *air* at D: on each fide the tube is applied the fcale E F, divided into any number of equal parts.

Now, as the ambient *air* becomes warmer, the *air* in the ball and the top of the tube expanding, will drive the liquor into the lower ball; and confequently its furface will defcend: on the contrary, as the ambient air grows colder, that in the ball becoming condenfed, the liquor will afcend.

For the *conftruction of a mercurial thermometer*; in the fame manner, and with the fame caution as before, put a little quantity of mercury, not exceeding the bignefs of a pea, into a tube BC (*Fig.* 4. n. 2.) thus bent in wreaths, that taking up the lefs height, it may be the more manageable, and lefs liable to harm; divide this tube into any number of equal parts to ferve for a fcale.

Here the approaches of the mercury towards the ball A will fhew the increafes of the degrees of heat. The reafon is the fame as in the former.

The defect of both thefe inftruments confifts in this, that they are liable to be acted on by a double caufe: for, not only a decreafe of heat, but alfo an increafe of weight of the atmofphere will make the liquor rife in the one, and the mercury in the other; and on the contrary, either an increafe of heat, or decreafe of weight in the atmofphere, will make it defcend.

For the *conftruction of the florentine, or common thermometer*; the academifts *del cimento* confidering the inconveniencies of the *thermometers* juft defcribed, attempted another, that fhould meafure heat and cold by the rarefaction and condenfation of the fpirit of wine, though thofe be vaftly lefs than of *air*; and confequently the alterations in the degrees of heat like to be much fenfible.

The ftructure of their *thermometer* is this: on fome little pieces of turmerick is poured a quantity of rectified fpirit of wine, which hereby receives a red tincture; this done, the fpirit of wine is filtrated again and again through a brown paper, that the coarfe particles of the root may be feparated therefrom. With the fpirits thus tinged and prepared they fill a glafs ball A B (*Fig.* 5. n. 2) and a tube B C; and that all the fpirit may not defcend in the winter into the ball, it is convenient to put the ball into a lump of fnow, mixed with falt; or, if the inftrument be to be made in fummer, into fpring water, impregnated with faltpetre, that the condenfed fpirit may fhew how far it will retire in the extremeft cold.

If it rife to too great a height from the ball, part of it is to be taken out; and that the tube may not be made longer than need, it is convenient to immerge the ball, filled with its fpirit, in boiling water, and to mark the furtheft point, to which the fpirit then rifes.

At this point the tube is to be hermetically fealed by the flame of a lamp; and at the fides is to be added a fcale, as in the former *thermometer*.

Now, fpirit of wine rarefying and condenfing very confiderably, as the heat of the ambient *air* increafes the fpirit will dilate, and confeqently will afcend into the tube; and as the heat decreafes the fpirit will defcend: and the degree or quantity of afcent and defcent will be feen in the fcale. Yet as the ratio of yefterday's heat to to-day's is not hereby difcovered, this inftrumet is not ftrictly a *thermometer*, no more than the former.

M. *de Reamure* has contrived a new *thermometer*, wherein the inconveniencies of others are remedied.

On the *elafticity* of the air, depends alfo the *height of the atmofphere*.

Air not only acts by its common properties of *gravity*, and *elaſticity*, but there are numerous other effects ariſing from the peculiar ingredients whereof it conſiſts.

Thus, 1. It not only diſſolves and attenuates bodies by its preſſure and attrition, but as a chaos containing all kinds of menſtruums, and conſequently having wherewithal to diſſolve all kinds of bodies.

It is known, that iron and copper readily diſſolve, and become ruſty in air, unleſs well defended with oil. *Boerhaave* aſſures us, he has ſeen pillars of iron ſo reduced by air, that one might crumble them to duſt between the fingers; and for copper, it is converted by the air into a ſubſtance much like the verdigreaſe producted by vinegar.

Mr. *Boyle* relates, that in the ſouthern *Engliſh* colonies, the great guns ruſt ſo faſt, that after a few years lying in the air, large cakes of crocus martis may be eaſily beat off them. *Acoſta* adds, that in *Peru* the air diſſolves lead, and conſiderably increaſes its weight.—Yet gold is generally eſteemed indiſſoluble by air, being never found to contract ruſt, though expoſed ever ſo long. The reaſon whereof is, that ſea ſalt, which is the only menſtruum capable of acting on gold, being very difficult to volatilize; there is but a ſmall proportion of it in the atmoſphere. In the chymiſt's laboratory, where aqua regia is preparing; the air becoming impregnated with an unuſual quantity of this ſalt, gold contracts a ruſt like all other bodies.

Stones, alſo, undergo the common fate of metals.—Thus *purbeck* ſtone, whereof *Saliſbury* cathedral is built, is obſerved gradually to become ſofter, and moulder away in the air, and the like Mr. *Boyle* relates of *Blackinton* ſtone.——He adds, that air may have a notable operation on vitriol, even when a ſtrong fire could act no further on it. The ſame author has even found the fumes of a ſharp liquor to work more ſuddenly and manifeſtly on a certain metal, when ſuſtained in the air, than the menſtruum itſelf did, which emitted fumes on thoſe parts of the metal it cover'd.

2. Air volatilizes fixed bodies. Thus ſea ſalt being calcined and fuſed by the fire, and when fuſed, expoſed to the air to liquify; when liquified ſet to dry again, then fuſed again; and, the operation thus repeated, will by degrees be almoſt wholly evaporated; nothing remaining but a little earth behind.

Helmont mentions it as a mighty arcanum in chymiſtry, to render fixed ſalt of tartar volatile: but the thing is eaſily effected by air alone; for if this ſalt be expoſed to the air, in a place replete with acid vapours, the ſalt draws the acid to itſelf, and when ſaturated therewith is volatile.

3. Air alſo fixes volatile bodies. Thus, tho' nitre or aqua fortis readily evaporate by the fire; yet, if there be any putrified urine near the place, the volatile ſpirit will be fixed, and fall down in form of aqua ſecunda.

4. Add that air brings many quieſcent bodies into action, *i. e.* excites their latent powers. Thus, if an acid vapour be diffuſed through the air, all the bodies whereof, that is a proper menſtruum, being diſſolved thereby, are brought into a ſtate proper for action.

In chymiſtry, not only the preſence or abſence of the air, but even its being barely open or incloſed, is of great conſequence. Thus camphire fired in a cloſe veſſel runs wholly into ſalts; whereas, if during the proceſs the cover be removed, and a candle applied, the whole flies off in fume. So to make ſulphur inflammable, it requires a free air: in a cloſe cucurbite it may be ſublimated a thouſand times without kindling. Sulphur being put under a glaſs bell, and a fire applied, riſes into ſpirit of ſulphur *per campanam*. But if there be the leaſt chink, whereby the included air communicates with the atmoſphere, it immediately kindles. So an ounce of charcoal, incloſed in a crucible well luted, will remain without loſs for fourteen days in the intenſeſt heat of a melting furnace; though the thouſandth part of the fire in an open air, will preſently turn in into aſhes. *Helmont* adds, that the charcoal remains all that while without any alteration of its black colour; but the minute air being let in, it falls inſtantly into white aſhes. The ſame holds of the parts of all animals and vegetables, which can only be calcined in open air: in cloſe veſſels they never become any other than black coals.

The air is liable to abundance of alterations, not only in reſpect of its mechanical properties, gravity, denſity, &c. but alſo in reſpect of the ingredients it conſiſts of. Thus in places abounding with marcaſites, a fretting vitriolick ſalt is obſerved to predominate in the air, which rots the hangings, and is often ſeen lying on the ground in a whitiſh efflореſcence. At *Faſhlun* in *Sweden*, noted for copper-mines, the mineral exhalations affect the air ſo ſenſibly, that their ſilver coin is frequently diſcolour'd in their purſes, and the ſame effluvia change the colour of braſs.

The effluvia of animals alſo have their effect in varying the air; as is evident in contagious diſeaſes, plagues, murrains, and other mortalities which ſpread by the air.

The *air* is alſo liable to alterations from the ſeaſons of the year, if the ſame ſeed be ſown in the ſame ſoil, in autumn and ſpring, and the degree of heat be the ſame, a very different effect will be found.

Mr. *Boyle* ſuggeſts ſomething further on this head, *viz.* that the ſalts, &c. which in a warm ſtate of weather were kept in a fluor, and mixed together, ſo as to be in a condition to act conjunctly; upon a remiſſion of the warmth, may loſe their fluidity

fluidity and motion, shoot into crystals, and thus separate again.

The height or depth of the *air* makes a further alteration, the exhalations being few of them able to ascend above the top of high mountains, as appears from those plagues, where the inhabitants of one side of a mountain have all perished, without the least disorder on the other side.

Nor must draught and moisture be denied their share, in varying the state of the *atmosphere*. In *Guinea* the heat with the moisture conduce so much putrefaction, that the purest white sugars are often full of maggots; and their drugs soon lose their virtue, and many of them grow verminous.

On this principle depends the structure and office of the HYGROMETER, which is a machine or instrument, whereby to measure the degrees of dryness, or moisture of the air.

There are divers kinds of *hygrometers*; for whatever body either swells or shrinks by dryness or moisture, is capable of being formed into an *hygrometer*. Such are wood of most kinds, particularly ash, deal, poplar, &c. such also is catgut, the beard of a wild cat, &c.

The best and most usual contrivances for this purpose are as follows:

Stretch a hempen cord, or a fiddle-string, as A B C (*Fig*. 7.) along a wall, bringing it over a truckle, or pully B; and to the other extreme D, tie a weight E, into which fit a style or index F G. On the same wall fit a plate of metal H I, divided into any number of equal parts; and the *hygrometer* is compleat.

For it is matter of undoubted observation, that moisture sensibly shortens the length of cords and strings; and that as the moisture evaporates, they return to their former length; and the like may be said of a fiddle string. The weight therefore, in the present case, upon an increase of the moisture of the *air*, will ascend; and upon a diminution of the same descend.

Hence as the index F G will shew the spaces of ascent and descent; and those spaces are equal to the increments and decrements of the length of the cord, or gut, A B D; the instrument will discover, whether the air be more or less humid now than it was another given time.

Or thus:—If a more sensible and accurate *hygrometer* be required; strain a whipcord or fiddle-string over several truckles, or pulleys, A, B, C, D, F, and G (*Fig*. 8.) and proceed with the rest as in the former example. Nor does it matter whether the several parts of the cord, A B, B C, C D, D E, E F, and F G, be parallel to the horizon, as expressed in the present figure, or perpendicular to the same.

The advantage of this above the former *hygrometer*, is, that we have a greater length of cord in the same compass: and the longer the cord, the greater its contraction or dilatation.

Or thus:—Fasten a hempen cord or fiddle-string A B (*Fig*. 9.) to an iron hook; and let the other end B, descend upon the middle of an horizontal board or table E F; near B hang a leaden weight of a pound C, and fit an index C G; lastly, from the center B describe a circle, which divide into any number of equal parts.

Or thus:—Fasten one end of a cord, or fiddle-string H I (*Fig*. 10.) to a hook H; and to the other end fasten a ball K, of a pound weight. Draw two concentrick circles on the ball, and divide them into any number of equal parts. Fit a style or index N O, into a proper support N, so as the extremity O may almost touch the divisions of the ball.

Here the cord or gut twisting and untwisting, as in the former case, will indicate the change of moisture, &c. by the successive application of several divisions of the circle to the index.

Or thus:—Provide two wooden frames, A B, and C D (*Fig*. 11.) with grooves therein; and between those grooves fit two thin leaves of ash, A E F C, and G B D H, so as they may easily slide either way: at the extremes of the frame A, B, C, D, confine the leaves with nails, leaving between them the space E G H F, about an inch wide. On I fasten a slip of brass dented, I K; and in L a little dented wheel, upon whose axis, on the other side of the machine, an index is to be put. Lastly, from the center of the axis, on the same side, draw a circle, and divide it into any number of equal parts.

Now, it being found by experience, that ash-wood readily imbibes the moisture of the *air*, and swells therewith; and as that moisture slackens shrinks again; upon any increase of the moisture of the *air*, the two leaves A F and B H growing turgid, will approach nearer each other: and again, as the moisture abates, they will shrink, and again recede. Hence as the distance of the leaves can neither be increased nor diminished, without turning the wheel L, the Index will point out the changes in respect of humidity and siccity.

Or thus:—As all the hygrometers above described become sensibly less and less accurate; and at length undergo no sensible alteration at all from the humidity of the *air*, the following one is much more lasting.

Take a *monoscope*, and instead of the exhausted ball E (*Fig*. 12.) substitute a spunge, or other body, which easily imbibes moisture. To prepare the spunge it may be necessary, first, to wash it in water; and when dry again, in water and vin-gar, wherein ſal armoniack, or ſalt of tartar has been diſſolved, and let it dry again.

Now, if the air become moiſt, the ſpunge growing heavier will ponderate; if dry, the ſpunge will be hoiſted up; and conſequently the index will ſhew the increaſe or decreaſe of the humidity of the *air*.

In the laſt mentioned *hygrometer*, Mr. *Gould*, in the *Philoſophical tranſactions*, inſtead of a ſpunge recommends oil of vitriol, which is found to grow ſenſibly lighter or heavier, in proportion to the greater or leſſer quantity of moiſture it imbibes from the *air*; ſo that being ſatiated in the moiſteſt weather, it afterwards retains or loſes its acquired weight, as the *air* proves more or leſs moiſt. The alteration is ſo great that in the ſpace of fifty-ſeven days, it has been known to change its weight from three drachms to nine; and has ſhifted an index or tongue of a ballance, 30 degrees. A ſingle grain, after its full increaſe, has varied its æquilibrium ſo ſenſibly, that the tongue of a ballance only an inch and a half long, deſcribed an inch, one third of an inch in compaſs; which arch would have been almoſt three inches, if the tongue had been one foot, even with ſo ſmall a quantity of liquor; conſequently, if more liquor expanded over a large ſurface were uſed, a pair of ſcales might afford as nice a *hygrometer* as any yet invented. The ſame author ſuggeſts, that ſpirit of ſulphur per campanam, or oil of tartar per deliquium, or the liquor of fixed nitre, might be ſubſtituted in lieu of oil of vitriol.

This ballance may be contrived two ways, by either having the pin in the middle of the beam, with a ſlender tongue, a foot and a half long, pointing to the diviſions on an arched plate, as repreſented in *Fig.* 12.

Or, the ſcale with the liquor may be hung to the point of the beam near the pin, and the other extreme be made ſo long, as to deſcribe a large arch on a board placed for the purpoſe, as repreſented *Fig.* 13.

Wind being only air in motion, is alſo as ſuch of this province *pneumaticks*; and the force thereof is determined experimentally, by a peculiar machine, called *anemometer*.

The ANEMOMETER is variouſly contrived: in the *Philoſophical Tranſactions* we have one deſcribed, wherein the wind being ſuppoſed to blow directly againſt a flat ſide, or board that moves along the graduated limb of a quadrant; the number of degrees it advances, ſhews the comparative force of the wind.

Wolfius gives the ſtructure of another, which is moved by means of ſails A B C D (*Fig.* 17.) like thoſe of a wind mill; which raiſe a weight L, that, ſtill the higher it goes receding further from the center of motion, by ſliding along an hollow arm K M, fitted to the axis of the ſails, becomes heavier and heavier. and preſſes more and more on the arm, till being a counterpoiſe to the force of the wind on the ſails, it ſtops the motion thereof. An index, then, M N, fitted upon the ſame axis at right angles with the arm, by its riſing or falling, points out the ſtrength of wind, on a plane divided like a dial-plate into degrees.

M. *d'Onſenbray*, has invented a new *anemometer*, which of itſelf expreſſes on paper, not only the ſeveral winds that have blown during the ſpace of 24 hours, and what hour each began, and ended, but alſo the different ſtrengths or velocities of each.

WIND-MILLS being machines, which receive their motion from the impulſe of the wind, come alſo under this article.

The *wind-mill*, though a machine common enough, has yet ſomewhat in it more ingenious than it is uſually imagined.——Add, that it is commonly allowed to have a degree of perfection, which few of the popular engines have attained to, and which the makers are but little aware of. Though the new geometry has furniſhed ample matter for its improvement.

The internal ſtructure of the *wind-mill* is much the ſame with that of water-mills. The difference between them lies chiefly in an external apparatus, for the application of the power.

This apparatus conſiſts of an axis E F (*Fig.* 15.) through which paſs two arms, or yards, A B and C D, interſecting each other at right angles in E, whoſe length is uſually about 32 feet: on theſe yards are formed a kind of ſails, vanes, or flights, in the figure of the trapezeums, with parallel baſes, the greater whereof H I, is about ſix feet, and the leſs F G, determined by radii drawn from the center E, to I and H.

Theſe ſails are to be capable of being always turned to the wind, that they may receive its impreſſions: in order to which there are two different contrivances, which conſtitute the two different kinds of *wind-mills* in uſe.

In the one, the whole machine is ſuſtained upon a moveable arbor or axis, perpendicular to the horizon, on a ſtand or foot; and turn'd occaſionally this way or that by means of a lever.

In the other, only the cover or roof of the machine, with the axis and ſails, turn round. In order to which the cover is built turret-wiſe, and the turret encompaſſed with a wooden ring, wherein is a groove, at the bottom whereof are placed, at certain diſtances, a number of braſs truckles, and within the groove is another ring, upon which the whole turret ſtands. To the moveable ring are connected beams *a b* and *f c*; and to the beam *a b* in *b* is faſtened a rope, which, at the other ex-

tream

tream thereof is fitted to a windlaſs, or axis in peritochio: this rope being drawn through the iron hook G, and the windlaſs turned, the ſails will be moved round, and put in the direction requir'd.

M. *Parent* conſidering (whence an *elliptical wind-mill*) what figure the ſails of a *wind mill* ſhall have, to receive the greateſt impulſe from the wind, he determines it to be a ſector of an ellipſis, whoſe center is that of the axis or arbor of the mill, and the little ſemi-axis, the height of thirty-two feet; as for the greater, it follows neceſſarily from the rules that direct the ſail to be inclined to the axis in an angle of 55 degrees.

On this foot he aſſumes four ſuch ſails each whereof is one fourth of an ellipſis; which he ſhews, will receive all the wind, and loſe none, as the common ones do. Theſe four ſurfaces multiplied by the lever, with which the wind acts on one of them, expreſs the whole power the wind had to move the machine, or the whole power the machine has when in motion.

The ſame manner of reaſoning, applied to a common *wind-mill*, whoſe ſails are rectangular, and their length about five times their breadth; ſhews that the *elliptick wind-mill* has above ſeven times the power of the common one. A prodigious advantage! and worthy ſure, to have the common practice ſet aſide for, could ſo common a practice be eaſily changed.

A *wind-mill*, with ſix elliptick ſails, he ſhews, would ſtill have more power than one with four.--- It would only have the ſame ſurface with the four; ſince the four contain the whole ſpace of the ellipſis as well as the ſix. But the force of the ſix would be greater than that of the four, in the ratio of 245 to 231. If it were deſired to have only two ſails, each being a ſemi ellipſis, the ſurface would be ſtill the ſame, but the power would be diminiſhed, by near one third of that with ſix ſails; by reaſon the greatneſs of the ſectors would much ſhorten the levers with which the wind acts.

But as the elliptical ſails would be ſomething ſo new, that there is little room to expect they will come into common uſe; the ſame author has conſider'd which form, among the rectangular ones, will be the moſt advantageous, *i. e.* which, the product of whoſe ſurface, by the lever of the wind, will be the greateſt. And by the method *de maximis & minimis* (explained in my treatiſe of *mechanicks*, under the letter *M*) he finds it very different from the common ones.

The reſult of his enquiry is, that the width of the rectangular ſail, ſhould be nearly double its length; whereas the length is uſually made almoſt fives times the width. Add, that as we call height or length, the dimenſion which is taken from the center of the axis; the greateſt dimenſion of the new rectangular ſail will be turned towards the axis, and the ſmalleſt from it; quite contrary to the poſition of the common ſails.

The power of a *wind mill*, with four of theſe new rectangular ſails, M. *Parent* ſhews will be to the power of four elliptick ſails, nearly as 13 to 23; which leaves a conſiderable advantage on the ſide of the elliptick ones: yet will the force of the new rectangular ſails be conſiderably greater than that of the common ones.

M. *Parent*, likewiſe, conſiders what number of the new ſails will be the moſt advantageous, and finds that the fewer ſails the more ſurface there will be, but the leſs power. The ratio of the power of a *wind mill* with ſix ſails, will be to another with four, nearly as 14 to 13: and the power of another with two, will be to that with four, nearly as 13 to 9.

As to the common *wind-mill*, its power ſtill diminiſhes as the breadth of the ſails is ſmaller, in proportion to the length. The uſual proportion, therefore, of 5 to 1, is exceedingly advantageous.

The uſes of this new theory of *wind-mills* are very obvious—The more power a *wind-mill* has, the ſwifter it turns, the more it diſpatches, and the leſs wind it needs. Add, that on this theory one may have a *wind-mill*, whoſe ſails ſhall be a deal ſhorter, and yet the power greater than the common one.

POETRY.

POETRY, or *poeſy*, is an art founded on a natural genius of compoſing poems, or other pieces in *verſe*.

VERSE, (*verſus*) is a line or part of a diſcourſe, conſiſting of a certain number of long or ſhort ſyllables, which run with an agreeable cadence.

The *Greek* and *Latin* verſes (which are the only ones learned in the ſchools) conſiſt of a certain number of feet, diſpoſed in a certain order.

Verſes are of various kinds; ſome denominated from the number of feet whereof they are compoſed; as the *monometer*, *dimeter*, *trimeter*, *tetrameter*, *pentameter*, *exameter*, &c. ſome from the kinds of feet uſed in them; as the *pyrrhichian*, *proceleaſmatick*, *iambick*, *trochaick*, *dactylick*, *anapæſtick*, *ſtic'*, *ſpondaick*, *chor-iambick*, *rindi-dactylick*, and *dactylotrochaick*.——Sometimes from the names of the inventor, or the authors who have uſed them with more ſucceſs; as the *anacreontick*, *archilochian*, *hipponactick*, *pheredratian*, *glyconian*, *alcmanian*, *aſcupiadean*, *alcaick*, *ſteſichorian*, *phaliſcan*, *ariſtophanian*, *callimachian*, *galliambick*, *phalæcian*, and *ſapphick*. Sometimes from the ſubject, or the circumſtances of the compoſition; as the *heroick*, *elegiack*, *adonick*, &c.

The *verſes* moſt commonly uſed in the *Latin* poetry, are the *hexameter*, *pentameter*, *iambick*, and *ſapphick*; and almoſt the only ones learned in the ſchools.

The Hexametee is a verſe conſiſting of ſix feet, the firſt four thereof may be indifferently *dactyls*, or *ſpondees*; but the fifth muſt be always a *dactyl*, and the laſt a *ſpondee*.

This ſort of *verſe* is uſed both in the *Greek* and *Latin* poetry; ſuch is that of *Homer*, for the *Greek*.

Εις ιδωρμ εγγιψας, εχει Θεος εκδικον ομμα.

And that of *Virgil*, for the *Latin*:

Diſcite juſtitiam moniti, & non temnere divos.

Epick poems, as the *Iliad*, *Odyſſee*, *Æneid*, and all the other works of *Virgil*, conſiſt of *hexameter* verſes alone: elegies and epiſtles ordinarily conſiſt alternately of *hexameters* and *pentameters*.

A *foot*, in the *Greek* and *Latin* poetry, is a meaſure compoſed of a certain number of long and ſhort ſyllables; and conſequently depends entirely on quantity and meaſure; which quantity denotes the meaſure or magnitude of the ſyllables, or that which determines them to be called *long* or *ſhort*.

The *quantities* are uſed to be diſtinguiſhed by the characters ˘ ſhort, and - long.

Some authors confound the *quantities* with the accent; but the difference is glaring; the former being the length or ſhortneſs of a ſyllable, the latter the raiſing or falling of the voice.

There are different kinds of feet, — viz. the *ſpondee*, *iambic*, *trochee*, and *pyrrich*, which conſiſt of two ſyllables each.—The *dactyl*, *anapæſt*, *moloſſus*, *tribrach*, *bacchius*, *anti-bacchius*, *amphibrachys*, and *creticus*, conſiſting of three ſyllables each.—The *proceleuſmaticus*, *choriambus*, and *epitrite*, which are of four ſyllables each.

The Spondee, in the *Greek* and *Latin* proſody, is a foot of verſe, conſiſting of two long ſyllables.—As *vīrtūnt*.

The Iambic is a foot conſiſting of a ſhort ſyllable, followed by a long one; as in *Dĕī*, *mĕās*.

The Pyrrichius, or Pyrrich is a foot conſiſting of two ſyllables, both ſhort; — as *dĕcĕs*.—Among the antients this foot is called *periambus*; by others *hegemona*.

The Dactyl is a foot conſiſting of a long ſyllable, followed by two ſhort ones: — as *cārmĭnĕ*, &c.

The *ſpondee* has an even, ſtrong, and ſteady pace like a trot: the *dactyl* reſembles the nimbler ſtrokes of a gallop.

Anapæst is a foot, conſiſting of two ſhort, and one long ſyllable; — as *lĕgĕrent*.

The Molossus is a foot, conſiſting of three long ſyllables; — as *āūdīrī*.

The Tribrach is a foot, conſiſting of three ſyllables, and thoſe all ſhort: — as *mĕlĭūs*. Some of the antients call this foot *trochæus*.

The Bacchius is a foot, conſiſting of three ſyllables; whereof the firſt is ſhort, and the others long. — as *ĕgēſtās*.

The Antibacchius is a foot, conſiſting of three ſyllables; the two firſt whereof are long, and the third ſhort: — as *cāntūrĕ*.

The Amphibrachys is a foot, conſiſting of three ſyllables, the firſt and laſt whereof are ſhort, and that in the middle long: — as *ămārĕ*.

The Choriambus is a foot compounded of a choræus, or trochæus, and an iambus.—It conſiſts of four ſyllables; of which the firſt and laſt are long; and the two middle ones ſhort: — as *Fīlĭŏlūs*.

The Epitrite is a foot conſiſting of four ſyllables, three long, and one ſhort.

Grammarians reckon four ſpecies of *epitrites*; the firſt conſiſting of an iambus and ſpondee: — as *ſălūtāntēs*.—The ſecond of a trochee and ſpondee: as *cōncĭtātī*.—The third of a ſpondee and an iambus: as *cōmmūnĭcāns*.—And the fourth of a ſpondee and trochee: as *īncāntārĕ*.

The Proceleusmaticus is a foot conſiſting of four ſhort ſyllables: as *ărĭĕtăt*.

The Pentameter verſe, conſiſt of five feet, or metres.—The two firſt feet may be either *dactyls* or *ſpondees*; the third always a *ſpondee*; and the two laſt *anapæſt*: thus;

Carmini|bus vi|ves tem|pus in o|mne meis.

In all kinds of verſe, the poet ſhould take great care to mark well the *cæſures*, which is a certain agreeable diviſion of the words between the feet of the verſe, whereby the laſt ſyllable of a word becomes the firſt of a foot.

As in —

Arma virumque cano trojæ qui primus ab oris.

Where the ſyllables *no* and *jæ* are cæſures.

Iambick *verſes* are a kind of verſe, conſiſting in great part of *iambick* feet.

Iambick verſes may be conſider'd, either with regard to the diverſity, or the number of their feet; under each of which head, there are diſtinct kinds which have different names. — 1. Pure *iambicks*, or those which consist entirely of *iambus*'s; as the fourth piece of *Catule*, made in praise of a ship.

Phaselus ille, quem videtis hospites.

The second kind are those called simply *iambicks*.—These have no *iambus's*, but in the even feet; though there are sometimes *trybachys*'s added to them, excepting to the last, which is always an *iambus*; and in the uneven feet they have *spondees*, *anapæsts*, and even a *dactyl* in the first; such is that of *Medea* in *Ovid*:

Servare potui, perdere an possim rogas?

The third kind are the free *iambick* verses, in which it is not absolutely necessary there should be any *iambus*, excepting in the last foot; of which kind are all those of *Phædrus*:

Amittit meritò proprium, qui alienum appetit.

In comedies, the authors seldom confine themselves more, frequently less, as we may observe in *Plautus* and *Terence*; but the sixth is always indispensibly an *iambus*.

As to the varieties occasioned by the number of syllables; — *Dimeter iambick*, is that which has but four feet:

Queruntur in sylvis aves.

Those which have six are called *trimeters*: these are the most beautiful, and are used principally for the theatre; particularly in tragedy; wherein they are vastly preferable to the verses, often ten or twelve feet, used in the modern drama; in regard they come nearer to the nature of prose, and favour less of art and affectation.

Dii conjugales, tuque genialis tori
Lucina custos, &c.

Those with eight are called *tetrameters*, and are only used in comedies:

Pecuniam in loco negligere, maximum est lucrum. Terent.

Some add an *iambick monometer*, with two feet,

Virtus beat.

They are called *monometers*, *dimeters*, *trimeters*, and *tetrameters*; that is, of one, two, three, and four measures, because a measure consisted of two feet; the *Greeks* measuring their verses. two feet by two feet, or by dipodys, or epitrites, joining the *iambus* and *spondee* together.

All the *iambicks* hitherto mentioned are *perfect*; they have their just number of feet, without any thing either deficient or redundant.—The *imperfect iambicks* are of three kinds; the *catalectick*, which wants a syllable:

Musæ Jovem canebant.

The *brachycatalectick*, which wants an entire foot:

Musæ Jovis gnatæ.

The *hypercatalectick*, which have either a foot or a syllable too much:

Musæ sorores sunt Minervæ,
Musæ sorores Palladis lugent.

Many of the hymns and anthems used in the church are *dimeter iambicks*, that is, consisting of four feet.

The SAPPHICK, is a kind of verse much used by the *Greeks* and *Latins*, and consists of eleven syllables, or five feet; whereof the first, fourth, and fifth, are troches, the second a spondee, and the third a dactyl, as in,

Integer vitæ, scelerisque; purus,
Non eget mauri jaculis nec arcu. Hor.

Three verses of this kind closed with an *adonick* verse, consisting of a dactyl and spondee, usually make a strophe.

The ADONICK consists of a dactyl, and a spondee, or a trochee.—As *rara juventus*.

The chief use of the *adonick* is at the end of each strophe of sapphick verse; or among aristophanick anapæsts in the antient tragedy.

But to make a verse, there are further required certain agreeable cadences; and a certain harmony in the order, quantities, &c. of the feet and syllables; which make the piece musical to the ear, and fit for singing: and this is called *numbers* in poetry.

The *numbers* constitute the air and character of a verse; and denominate it either *smooth*, *soft*, *low*, *rough*, or *sonorous*.

But what is chiefly required in making *verses*, is an elevated, bold, figurative manner of diction: this manner is a thing so peculiar to this kind of writing, that without it, the most exact arrangement of longs and shorts, does not constitute verse so much as a sort of measured prose.

When we have made a *verse*, the next thing we must do, to know if it be a good one, is to scan it, *i. e.* measure it, to see what number of feet and syllables it contains, and whether or no the quantities, that is, the long and short syllables, be duly observed.

A POEM is a composition in verse, of a due length and measure.

There are *poems* of various kinds, some denominated from the persons who first invented, or most used them, as the *archilochia*, *sapphick*, &c.—Others from their composition, as the *monocolon*, consisting of one kind of verse; *dicolon*, of two; and *tricolon*, of three kinds.——Others from their entireness or deficiency; as *brachycatalectus*, which wants two syllables, *catalectus*, which wants one; *acatalectus*, none; and *hypercatolectus*, which has a syllable too much, which if cut off at the beginning of the next verse, the verse is said to be *hypermeter*.——Others are denominated from the subject

subject matter; as the *apobaterion*, *epilaterion*, *epinicion*, *epithalamium*, *genethliack*, *propemptick*, *elegiack*, *satyrick*, *epicedion*, *epitaph*, *threnas* or *lamentation*, *encomiastick*, *panegyrick*, *soterick*, *lyrick*, *pastoral*, &c.——Others from the manner of narration; as *exegetick*, which relates a thing under the author's own person, *dramatick* and *epick*.

The APOBATERION, among the antients, was a farewell speech, or poem, made by a person on his departure out of his own country, or some other place where he had been kindly received and entertained.

Such is that of *Æneas* to *Helenus*, and *Andromache*, *Æn. lib.* III.

The EPILATERION is a poetical composition in use among the antient *Greeks*. When any person of condition and quality returned home after a long absence or journey, into another country, he called together his friends and fellow-citizens, and made them a speech, or rehearsed them a copy of verses, wherein he returned solemn thanks to the immortal gods for his happy return, and ended with an address, by way of compliment, to his fellow-citizens.

These verses made what the *Greeks* call επιβατήριον, *epilaterium*, of επιβαίνω, *I go abroad.*

The EPINICION was a poem or composition, on occasion of a victory obtained. *Scaliger* treats expresly of the *epinicion*, in his poeticks. *lib* 1. *c.* 44.

The EPITHALAMIUM is a nuptial song, or a composition, usually in verse, on occasion of a marriage between two persons of eminence.

The topicks it chiefly consists on, are the praises of matrimony, and of the married couple; with the pomp and order of the marriage solemnity: It concludes with prayers to the gods for their prosperity, their happy offspring, *&c.*——*Catullus* exceeded all antiquity in his *epithalamiums*; and the chevalier *Marino* all the moderns.

But all these and all those which follow are not properly to be called poems, and do not all belong to the grand poetry; since of all pieces of *poetry*, the epick and dramatick deserve that name by way of eminence.

The EPICK is an heroick poem, or a poem reciting some great and signal transaction of a hero; called also *epopæia*.

Such are the *Iliad* and *Odyssee* of *Homer*, the *Æneid* of *Virgil*, the *Gierusaleme* of *Tasso*, and the *Paradise lost* of *Milton*; which are the principal poems of the *epick* kind.

The criticks lay down four qualifications, as necessary to the *epick* and tragick action. The first *unity*; the second *length*; the third *importance*; and the fourth *duration*; to which some add a fifth, *integrity*.

The *unity* of the *epick* action, M. *Dacier* observes, does not consist in the *unity* of the hero, or in the *unity* of his character and manner. Though these be circumstances necessary thereto. The *unity of action* requires that there be but one principal action, of which all the rest are to be incidents or dependencies.

F. *Bossu* assigns three things requisite thereto. The first, that no episode be used, but what is fetched from the plan and ground of the action, and which is a natural member of that body: the second, that these episodes and members be well connected with each other: the third is not to finish any episode, so as it may appear a whole action; but to let each be always seen in its quality of member of the body and an unfinished part.

As for the *unity* of time it is not very well established.

But the length of the poem *Aristotle* gives us a rule for, which is, that it be such, as it may be read over in one day.

As to the importance of the *epick* action, there are two ways of providing for it: the first by the dignity and importance of the persons. This way alone *Homer* makes use of; there being otherwise nothing great and important in his models, but what might have happen'd to ordinary persons. The second by the importance of the *action* itself, such as the establishment or downfal of a religion, or a state; which is *Virgil*'s action, and in which he has much the advantage of *Homer*.

Bossu mentions a third way of making the action important, *viz.* by giving a higher idea of the personages, than what the reader conceives of all that is great among men.—This is done by comparing the men of the poem with the men of the present time.

The action of the *epick poetry* is like that of the drama, susceptible of *oratorial narration*, which constitutes its species; the qualities thereof are, that it be agreeable, probable, moving, surprizing, and active.

Boileau gives the following rules for the *epick poem*,

1. He advises the poet to chuse a hero, deserving the attention of the reader, and capable to flatter his curiosity, and engage him to proceed further, without being tired of reading; such a hero, as his great valour, rare virtues, and even his imperfections, may deserve to be admired; and high feats worthy of being heard; such as *Alexander*, *Cæsar*, &c. And not such as *Polynice* and his perfidious brother, for one is soon tired with the deeds of a common conqueror.

2. He

2. He forewarns him against loading his subject with too many incidents; since often, says he, a too great abundance, impoverish the matter.

3. He ought to be lively and quick in his narrations; rich and pompous in his descriptions; without ever introducing into them low or mean circumstances.

4. The beginning of his poem should be simple, and without affectation; without promising more at first than he can perform in the sequel.

5. His work must be diversified with a great number of figures; mixing, as we have already observed, the agreeable with the useful; since a too tedious, and heavy sublime, is always hateful.

The Drama is a piece or poem, composed for the stage.

Our *drama's* are *tragedies* and *comedies*.

The *primary parts* of the *drama*, as divided by the antients, are the *protasis*, *epitasis*, *catastasis*, and *catastrophe*.

The *secondary parts* are the *acts* and *scenes*.

The *accessary parts* are the *argument* or *summary*, the *prologue*, *chorus*, *mimus*, *satura*, and *atellana*.

Lastly, the *epilogue*, which pointed out the use of the piece, or conveyed some other notice to the audience, in the poet's name.

Now let's explain every one of those parts in particular, beginning by the *primary parts*.

The Protasis, in the antient drama, was the first part of a comick and tragick piece; wherein the several persons of the play are shewn; their characters and manners intimated, and the action, which is to make the subject of the piece, proposed, and entered upon,

The antient *protasis* might go about as far as our two first acts.——Where the *protasis* ended, the *epitasis* commenced.

The Epitasis, was the second part or division of a dramatick poem; wherein the plot or action propos'd, and enter'd upon in the first part or *protasis*, was carried on, heighten'd, warmed, and worked upon, till it arrived at its state or height, called the *catastasis*.

The Catastasis, was the third part of the antient drama; being that wherein the intrigue or action set on foot on the *epitasis*, is supported, carried on, and heighten'd, till it be ripe for the unravelling in the *catastrophe*.

The Catastrophe made the fourth and last part in the antient drama; or that immediately succeeding the *catastasis*.

The *catastrophe* is the change or revolution of a dramatick poem; or the turn which unravels the intrigue, and terminates the piece.

The *catastrophe* is either *simple* or *implex*, whence also the fable and action are denominated.

In the first there is no change in the state of the principal persons, nor any discovery or unravelling; the plot being only a mere passage out of agitation to quiet and repose. This *catastrophe* is rather accommodated to the nature of epopœia, than of tragedy. Indeed we meet with it in some of the antients, but it is out of doors among the moderns. In the second, the principal person undergoes a change of fortune, sometimes by means of a discovery, and sometimes without.

The qualifications of this change, or peripetia are, that it be probable and necessary, in order to be probable, it is required it be the natural result or effect of the foregoing actions, *i. e.* it must spring from the subject itself, or take its rise from the incidents; and not be introduced merely to serve a turn. The discovery in the *catastrophe* must have the same qualifications as the *catastrophe* itself, whereas it is a principal part: it must be both probable and necessary. To be probable, it must spring out of the subject itself; not be effected by means of marks, or tokens, rings, bracelets, or by a mere recollection, as is frequently done both by the antients and moderns. To be necessary, it must leave the persons it concerns, in the same sentiments they had before, but still produce either love or hatred, &c. Sometimes the change consists in the discovery; sometimes it follows at a distance, and sometimes results immediately from it, which is the most beautiful kind: and thus it is in *œdipus*.

Dryden thinks a *catastrophe*, resulting from a mere change in the sentiments, and resolutions of a person, without any farther machinery, may be so managed as to become exceedingly beautiful, nay preferable to any other. It is a dispute among the criticks, whether the *catastrophe* should always fall out happily and favourably on the side of virtue, or not? *i. e.* whether virtue is always to be rewarded, and vice punished in the *catastrophe*? but the reasons on the negative side seem the strongest, *Aristotle* prefers a shocking *catastrophe* to a happy one; in regard the moving of terror and pity, which is the aim of tragedy, is better effected by the former than the latter.

Bossu divides the *catastrophe*, at least, with regard to the epopœa, into the unravelling or *denouement*; and the *achevement*, or finishing; the last of which he makes the result of the first; and to consist in the hero's passage out of a state of trouble and agitation, to rest and quiet. This period is but a point, without extent or duration; in which it differs from the first, which comprehends every thing after the knot or plot laid. He adds, that

that there are ſeveral unravellings in the piece; in regard there are ſeveral knots which beget one another: the finiſhing is the end of the laſt unravelling.

As to the ſecondary parts, *viz.* *acts* and *ſcenes.*

The Acts are certain diviſions or principal parts in a dramatick poem, contrived to give a reſpite or breathing time both to the actors and ſpectators.

In the interval between the acts, the theatre remains empty, and without any action viſible to the ſpectators; though it is ſuppoſed all the while there is one paſſing out of ſight.

It was the *Romans* who firſt introduced acts into the drama; and in *Horace*'s time the five acts were grown into a law; and all plays are held irregular, that have either more or leſs than five acts.

The *firſt* is to propoſe the matter or argument of the fable, and to ſhew the principal character. — The ſecond, to bring the affair or buſineſs upon the carpet. — The third, to furniſh obſtacles and difficulties. — The fourth, either points a remedy for thoſe difficulties, or finds new in the attempt. — The fifth puts an end to all by a diſcovery.

Some are of opinion, that, on the principles of that great maſter of the drama, *Ariſtotle*, we may have a juſt and regular play, though only divided into *three acts*.

The *acts* are ſubdivided into *ſcenes*.

A Scene is a part or diviſion of a dramatick poem, determin'd by a new actor's entering.

Whenever a new actor appears, or an old one diſappears, the action is changed into other hands, and a new *ſcene* then commences.

It is one of the laws of the ſtage, that the *ſcenes* be well connected: that is, that one ſucceed another in ſuch manner, as that the ſtage is never quite empty till the end of the act.

As to the *neceſſary* parts.—The Argument or *ſummary*, was an abridgment of the whole play; which at preſent, is almoſt out of uſe.

The Prologue is a diſcourſe addreſſed to the audience, before the drama or play begins.

The original intention of the *prologue*, was to advertiſe the audience of the ſubject of the piece, and to prepare them to enter more eaſily into the action; and ſometimes to make an apology for the poet.

The Chorus, was one, or more perſons, preſent on the ſtage during the repreſentation, and ſuppoſed to be by-ſtanders thereto, without any particular ſhare or intereſt in the action.

The *chorus* in *comedy* was at firſt no more than a ſingle perſon, who ſpoke in the antient compoſures for the ſtage; the poets by degrees added to him another; then two, afterwards three, and at laſt more; ſo that the moſt antient comedies had nothing but the chorus.

Laſtly, the Epilogue is a ſpeech addreſſed to the audience when the play is over, by one of the principal perſons or actors therein; containing uſually ſome reflections on certain incidents in the play, particularly thoſe of the parts of the perſon who ſpeaks it.

In the modern tragedy, the *epilogue* has uſually ſomewhat of pleaſantry; intended, we ſuppoſe, to compoſe the paſſions raiſed in the courſe of the repreſentation, and ſend away the audience in good humour.

We'll examine next the whole compoſition, beginning with *tragedy*.

The Tragedy is a dramatick poem, repreſenting ſome ſignal action performed by illuſtrious perſons, and which has frequently a fatal iſſue or end.

Tragedy, in its original, M. *Hedelin* obſerves, was only a hymn ſung in honour of *Bacchus* by ſeverral perſons, who, together, made a chorus of muſick with dances and inſtruments.

As this was long and might fatigue the ſingers, as well as tire the audience, they bethought themſelves to divide the ſinging of the chorus into ſeveral parts, and to have certain recitations in the intervals, as already obſerved.

Accordingly *Theſpis* firſt introduced a perſon on the ſtage with this view: *Æſchyllus* finding one perſon inſufficient, introduced a ſecond to entertain the audience more agreeably by a dialogue: he alſo cloathed his perſons more decently, and firſt put on them the buſkin.

The perſons who made theſe recitations on the ſcene, were called actors; ſo that *tragedy* at firſt was without actors. And what they thus rehearſed, being things added to the ſinging of the chorus, whereof they were no neceſſary part, were called *epiſodes*.

Sophocles found that two perſons were not enough for the variety of incidents, and therefore introduced a third. And here the *Greeks* ſeem to have ſtopped; at leaſt it is very rare that they introduce four ſpeakers in the ſame ſcene.

When *tragedy* was got into a better form, they changed the meaſure of its verſe, and endeavoured to bring the action within the compaſs of a day.

The ſeveral parts of the modern *tragedy*, are the *act*, *ſcene*, *fable*, *characters*, *manners*. We have already

already explained the *act* and the *ſcene*, therefore we'll now take notice of the *fable*, &c.

The ACTION, in the tragedy, requires *unity*, *integrity*, *importance*, and *duration*.

In the drama, there are three unities to be obſerv'd; the *unity* of *action*, that of *time*, and that of the *place*.

The *unity* of the dramatick action, conſiſts in *tragedies*, in the unity of the danger; and, in *comedies*, in that of the intrigue: and this not only in the plan of the *fable*, but alſo in the fable *extended*, and filled with *epiſodes*.

The *epiſodes* are to be worked in without corrupting the *unity*, or forming a double action; and the ſeveral members are to be ſo connected together, as to be conſiſtent with that continuity of action, ſo neceſſary to the body, and which *Horace* preſcribes, when he ſays, *Sit quodvis ſimplex duntaxat & unum.*

To the *unity of time*, it is required in the drama, that the action be included in the ſpace of a day.

The antient tragick poets ſometimes diſpenſed with this rule, and among the modern *Engliſh* ones many of them diſallow it: few of them practiſe it.

As to the *unity of place*, and *ſcene*, neither *Horace* nor *Ariſtotle* gives us any rules relating thereto. It has been agreed, that what paſſes any where in the ſame town, or city, ſhall be allowed for *unity of place*.—At leaſt, if two different places be unavoidable; yet the place is never to be changed in the ſame act.

In order to the *integrity of the action*, it is neceſſary, according to *Ariſtotle*, that it have a beginning, middle, and end. The *cauſes* and *deſigns* of a man's doing an *action*, are the *beginning*; the *effects* of theſe cauſes, and the *difficulties* met withal in the execution of thoſe deſigns, are the *middle* of it; and the *unravelling* and extricating of thoſe difficulties, the *end* of the *action*.

In the *cauſes* of an *action* one may obſerve *two* oppoſite *deſigns*; the firſt and principal is that of the hero: the ſecond comprehends all their deſigns, who oppoſe the pretenſion of the hero. Theſe oppoſite cauſes do alſo produce oppoſite effects, *viz.* the endeavours of the hero to accompliſh his deſign, and the endeavours of thoſe that are againſt it. As the cauſes and deſigns are the beginning of the *action*; ſo thoſe contrary endeavours are the middle of it; and form a difficulty, plot, or intrigue, which makes the greateſt part of the poem.

The ſolution or clearing up of this difficulty, makes the *unravelling*.

The *unravelling* of the plot, or intrigue, may happen two ways, either with a diſcovery or without.

The ſeveral effects, which the unravelling produce, and the different ſtates to which it reduces the perſons, divides the *action* into ſo many kinds. If it changes the fortune of the principal perſon, it is ſaid to be with a peripetia; and the *action* is denominated *implex*, or *mixed*: if there be no peripetia, but the unravelling be a mere paſſing from *action* to repoſe, the *action* is *ſimple*.

The FABLE is uſed for the *plot* of an *epick* or *dramatick* poem; or the *action*, which makes the ſubject of ſuch poem or romance,

The *fable*, according to *Ariſtotle*, is the principal part, and, as it were, the ſoul of a poem. It muſt be conſider'd as the firſt foundation of the compoſition; or the principle which gives life and motion to all the parts. In this ſenſe the *fable* is defined, *A diſcourſe invented with art, to form the manners by inſtructions diſguiſed under the allegory of an action.*

The characters that ſpecify the epick *fable*, are theſe: it is rational and probable; it imitates a whole, and an important action, and it is long, and related in verſe.

The *fable*, according to *Ariſtotle*, conſiſts of two eſſential parts, *viz. truth*, as its foundation; and *fiction*, which diſguiſes the truth, and gives to it the form of a *fable*. The *truth* is the point of *morality* intended to be inculcated; the *fiction* is the action, or words the *inſtruction* is covered under.

To make a plot or *fable*; the firſt thing, according to the great critick juſt mentioned, is to pitch on ſome moral inſtruction to be exemplified.

The fiction may be ſo diſguiſed with the truth of hiſtory, that there ſhall not appear any fiction at all. To effect this the poet looks back into hiſtory, for the names of ſome perſons to whom the feigned action either really or probably did happen; and relates it under thoſe known names, with circumſtances which do not change any thing of the ground of the *fable*.

The CHARACTERS, in the *epopœia* and *drama*, is the reſult of the manners, or that which each perſon has ſingular and peculiar in his manners, whereby he is diſtinguiſhed from others.

There muſt be one character reign over all the reſt; and this muſt be found in every part: juſt as the ſame hero, in ſeveral paintings, ſhould have the ſame lines and features, how different ſoever his poſtures and paſſions may be.

The firſt quality, in *Homer's Achilles*, is wrath: in *Ulyſſes*, diſſimulation; and in *Virgil's Æneas*, mildneſs: each of which may, by way of eminence, be called the *character* of theſe heroes.

Theſe are never to go alone, but always to be accompanied with others, to give them the greater lustre, either by hiding their defects, as in *Achilles*, whose anger is palliated by a world of courage: or by making them center in some solid virtue, as in *Ulysses*, whose dissimulation makes a part of his prudence; and *Æneas*, whose mildness is chiefly employed in a submission to the will of the gods.

These secondary qualities of courage, prudence, and submission, make the goodness of the *character* of those heroes, and even of the poems.

For the unity of *character*, we have *Horace*'s express command, *sit quodvis simplex, duntaxat & unum.* *Bossu* adds, that the *character* is not less the soul of the hero and the whole action, than the fable is of the poem.

The unity of *character* is not only to be kept in the hero, and the several other persons of the piece, but also in that of the poem itself: that is, all the *characters*, how opposite soever, must center and reunite in that of the hero; and be so swayed by it, as that this alone may seem to govern throughout the whole. Thus *Homer* makes wrath prevail throughout the whole *Iliad*; and artifice and dissimulation throughout the *Odyssee*: the hero's *character* is perceived every where, has its full swing, and is favoured by the similitude of the *characters*, of some of the other persons. *Virgil* has a great difficulty to grapple with to preserve this unity; in regard of the direct opposition between the humours of this hero, and those of some other of his persons, as *Turnus*, *Mezentius*, *Dido*, &c. he therefore takes care not to carry these opposite *characters* to their full length, but moderates and restrains them: and as that moderation could not flow naturally from the persons themselves, it is produced either by some passion, as in *Dido*; or some dependance, as in *Turnus* and *Mezentius*. To this artifice he adds *Episodes*, accommodated to the general *character*, by which he interrupts the particular actions, which require an opposite *character*.

The Manners denotes the inclinations, genius, and humour, which the poet gives to his persons, and whereby he distinguishes his character.

Unless the *manners* be well expressed, we shall never be acquainted with the persons at all; nor consequently shall once be either terrified with foreseeing their dangers, nor melted into pity by seeing their sufferings.

The *manners* should have four qualities; they should be *good*, *like*, *suitable*, and *equal*.

The *manners* are good when they are well marked, or expressed; that is, when the discourse of the persons makes us clearly and distinctly see their inclinations, and what good or evil resolutions they will take.

The *manners* must likewise be *suitable*; that is, they must be agreeable to the age, sex, rank, climate, and condition of the person that has them.— Again, the *manners* must be *equal*; that is, they must be constant, or consistent through the whole character; or the variety or inequality of the *manners*, as in nature, so in the *drama* must be equal. The fearful must never be brave, nor the brave timorous; the avaricious must never be liberal, nor *vice versa*. In this part *Shakespear*'s *manners* are admirable.

Besides these four qualities above-mentioned, there is a fifth essential to their beauty; which is, that they be *necessary*, that is, that no vicious quality, or inclination, be given to any poetick person, unless it appears to be absolutely necessary, or requisite to the carrying on of the action.

Boileau gives the following rules for the *tragedy*.

1. He will have the poet propose to himself, for the chief and principal end of his piece, the awaking gently the most noble of our passions, by moving gently the heart; or to speak, in a more concise manner, he must use all his best endeavours to please and move; otherwise it is in vain, that he has wrote his piece according to the best rules of the art, and in the most elegant manner.

2. The first verses of the piece should give an idea of the subject, without keeping the mind of the audience in suspence, by a long rigmarole of verses, which is much more fatiguing than entertaining; since the subject is never too soon explained.

3. The scene should be fixed and marked, *i. e.* a single fact done in one place, and in one day, fill the theatre, from the beginning to the end of the piece.

4. Nothing incredible should be offered to the spectator, since a surprizing absurdity has no charms; and the mind is never moved by what it cannot believe.

5. What is not to be seen must be told, though it would be perhaps more intelligible if it was exposed to our sight; but there are objects which the judicious art must offer to the ear, and hide from the sight.

6. The trouble increasing always from scene to scene, being arrived to its period must be easily unfolded; for the mind is never more effectually touched, than when in a subject diversified with intrigues, the truth of a secret, known all on a sudden, changes all, and gives to the whole an unforeseen face.

7. If the poet wants to represent heroes susceptible of love, he must not paint them with the same colours he would do a shepherd subject to the same passion; for *Achilles* must love in another manner than *Thyrsis* does. He must avoid, as a great imperfection,

perfection, the ridiculous love, and other low passions, of the heroes of romances; though he may sometimes allow some weakness to the most noble hearts. *Achilles* would displease, was he less hot and passionate; he pleases when he is seen shedding tears for an affront, at those small imperfections, marked in his picture, the mind discovers easily nature's weakness. Let *Agamemnon* be proud, haughty, and interested, and *Æneas* religious; preserving to each his proper character, and studying the manners of the ages and countries, never giving the air and genius of a nation to another, particularly of the moderns to the antients.

COMEDY, in its proper sense, is a dramatick piece representing some agreeable and diverting transaction: or, an allegorical representation of something in private life; for the amusement and instruction of the spectator.

Comedy, as well as *tragedy*, has its essential, and its integrant parts. Its essential parts, in the language of the antients, are the *protasis*, *epitasis*, *catastasis*, and *catastrophe*, explained above.

Comedy is distinguished from *farce*, in that the former represents nature as she is; the other distorts or overcharges her. They both paint from the life, but with different views: the one to make nature known; the other to make it ridiculous.

Boileau gives the following rules for the *comedy*.

1. He will have nature to be the whole study of an author who writes *comedies*; and says, that whoever sees very well man; and with a profound genius has penetrated the bottom of so many hidden hearts; who knows very well what a prodigal, an avaricious, an honest man, a coxcomb, a jealous man, &c. are, can bring them on the stage, and make them act and speak before us.

2. He will have the representations true, without disguise, and painted with the most lively colours.

3. He forewarns the author against making his actors speak at random, a young man like an old man, or *vice versa*.

4. He advises him to study the court, and know the town; both being always fertile in models.

5. He says that the comick being an enemy of sighs and tears; does not admit in its verses tragical pains; neither does it allow, that an actor with obscene expressions should divert the mob; but only joke in a noble manner.

6. This plot well formed, must unravel itself easily; least the action, for want of being guided by reason, should lose itself in an empty scene.

7. His discourses every where fruitful in witty sayings, must be full of passions curiously handled; and the scenes always well concerted together.

8. He must avoid all sorts of jokes, which are contrary to good sense, and never deviates from nature.

9. He concludes by saying, that he loves on the theatre an agreeable author, who, without disgracing himself to the eyes of the spectators, pleases by reason alone.

A FARCE was originally a droll, pettit-shew, or entertainment, exhibited by charletans, and their buffoons in the open street, to gather the crowd together.

At present, *farce* is of a little more dignity. It is removed from the street to the theatre; and instead of being perform'd by jack-puddings to amuse the rabble, is now acted by our comedians, and become the entertainment of the politest audiences.

The poets have reformed the wildness of the primitive *farces*; and brought them to the taste and manner of comedy. The difference between the two on our stage, is, that the latter keeps to nature and probability; and in order to that, is confined to certain laws, unities, &c. prescribed by the antient criticks.

The former disallows of all laws, or rather sets them aside on occasion. Its end is purely to please or make merry: and it sticks at nothing which may contribute thereto, however wild and extravagant. Hence the dialogue is usually low, the persons of inferior rank, the fable or action trivial or ridiculous; and nature, and truth every where heighten'd and exaggerated to afford the more palpable ridicule.

There is another kind of dramatick piece, call'd *tragi-comedy*, representing some action, passed among eminent persons, the event whereof is not unhappy or bloody, and wherein is sometimes admitted a mixture of less serious characters.

The *tragi comedy* is the only case, wherein comedy is allowed to introduce kings and heroes.

Having thus far explained all that is understood by *grand poetry*, we'll proceed to *simple poetry*, or *versification*, which consists in *elegies*, *satires*, *odes*, *songs*, *pastorals*, *epitaphs*, *sonnets*, *madrigals*, &c.

An ELEGY was originally a mournful and plaintive kind of poem.

In process of time, *elegy* degenerated from its original intention, and not only matters of grief, but also joy, wishes, prayers, expostulations, reproaches, and almost every subject, were admitted into *elegy*.

The office of *elegy* is well delivered by M. *Boileau*.

La

La plaintive elegie en longs habits de deuil,
Sait, les cheveux epars, gemir ſur un cercueil:
Elle peint des amans la joye, & la triſteſſe;
Flatte, menace, irrite, appaiſe une maitreſſe.

Translated.

In mourning weeds ſad *elegy* appears,
Her hair unhevell'd, and her eyes in tears.
Her theme; the lover's joy, but more his pains;
By turns ſhe ſings, ſooths, threatens and complains.

The diction of *elegy* ought to be clean, eaſy, perſpicuous, expreſſive of the manners, tender and pathetick; not oppreſſed with ſentences, points, *&c.* No apoſtrophes are allowed; and the ſenſe to be generally cloſed in every diſtich, or two lines; at leaſt in *Latin* compoſitions.

A Satyr is a poem wherein men's follies and vices are wittily expoſed, in order to their reformation.

Satyr bears a near affinity to raillery, ridicule, lampoon, libel, *&c.* and ſtands oppoſed to panegyrick.

A *ſatyr* ought to be lively, pleaſant, moral, and full of variety.

Satyr may be divided with regard to the meaſure, and kind of verſe, as well as the manner of the poem, and the character, into *narrative*, *dramatck*, *mixt*, &c.

Narrative is a ſimple narration, or recital of abuſes in the poet's own perſon.—Such is the firſt of *Juvenal*.

Dramatick is that wherein ſeveral perſons diſcourſe together, whether they be nameleſs, as in the firſt of *Perſius*; or have names, as of *Caſſius* and *Damaſypus*.

Mixt is compounded of both the former; as that fine one of *Horace*, *Ibam forte via ſacra.*

Grave, and animated, which inveigh with warmth and earneſtneſs, againſt corruption and vice in every ſhape.——As thoſe of *Juvenal* and *Perſius*.

Sportive, and lighter, which ſeems to play with men's folly; but in playing, omit no opportunity of making them feel the laſh.——Such are thoſe of *Horace*.

Satyr is divided into *general*, which is levelled at common abuſes, wherein numbers are equally intereſted ——And *perſonal*, which points out and expoſes particular characters.

The Ode from the *Greek* ᾠδὴ, *cantus*, a ſong, or ſinging in the antient poetry, is a ſong, or a compoſition proper to be ſung, and compoſed for that purpoſe; the ſinging uſually accompanied with ſome muſical inſtruments, chiefly the lyre.

Ode, in the modern poetry, is a lyrick poem, conſiſting of long and ſhort verſes, diſtinguiſhed into ſtanza's or ſtrophes, wherein the ſame meaſure is preſerved throughout.

It is a miſtake to imagine *Anacreon*, as the *Greeks* do, the author of lyrick poetry; ſince it appears from ſcripture to have been in uſe about a thouſand years before that poet. The characteriſtick of lyrick poetry, which diſtinguiſhes it from all others, is *ſweetneſs*. As *gravity* rules in heroick verſe; *ſimplicity* in paſtorals; *tenderneſs* and *ſoftneſs* in elegy; *ſharpneſs* and *poignancy* in *ſatyr*; *mirth* in comedy; the *pathetick* in tragedy; the *point* in epigram; ſo in the *lyrick*, the poet applies himſelf wholly to ſooth the mind of men, by the ſweetneſs and variety of the verſe, and the delicacy of the words, and thoughts; the agreeableneſs of the numbers; and the deſcription of things moſt pleaſing in their own nature.

The word *ſtrophe* is *Greek* ςροφὴ, formed from ςρέφω, I turn; becauſe at the end of the *ſtrophe*, the ſame meaſures return again; or rather as the term related principally to the muſick or dancing, becauſe at firſt coming in, the chorus, or the dancers turned to the left, and that meaſure ended, they turned back again to the right. What the couplet is in ſongs, and the ſtanza in epick poetry, *ſtrophe* is in *odes*.

In a *pindarick ode*, the plan of the whole is to be drawn firſt, and the places marked out where the elegant ſallies and wanderings may be beſt, and how the returns may be juſtly made to the ſubject.

The antient *odes* had originally but one ſtanza, or ſtrophe; but was at laſt divided into three parts, *ſtrophe*, *antiſtrophe*, and *epode*. The prieſts going round the altar, ſinging the praiſes of the gods, called their firſt entrance *ſtrophe*, i. e. turning to the left: the ſecond, turning to the right, they called *antiſtrophe*, q. d. returning. Laſtly, ſtanding ſtill before the altar, they ſung the remainder, which they called *epode*.

The Epode was not confined to any preciſe number, or kind of verſes; as the *ſtrophe* and *antiſtrophe* were. But when the *ode* contained ſeveral *epodes*, *ſtrophes*, &c. they were all alike.

As the word *epode* then properly ſignifies the end of the ſong, and as in *odes*, what they called the *epode* finiſhing the ſinging: it became cuſtomary, as M. *Dacier* ſhews, for a little verſe, which being put after another, cloſed the period, and finiſhed the ſenſe which had been ſuſpended in the firſt verſe, to be called *epode*, ἐπῳδὸς.

But

But the ſignification of the word is extended ſtill further; *epode* being become a general name for all kinds of ſhort verſes, that follow one, or more long ones, of what kind ſoever they be: and in this ſenſe a pentameter is an *epode*, after an hexameter, which in reſpect thereof is a *pro ode*.

There is another ſort of *ode*, called *alcaick*, which conſiſts of four ſtrophes, each of which contains four verſes; the two firſt are *alcaick* verſes of the firſt kind, the third an iambick diameter hypercate-lutick, *i. e.* of four feet and a long ſyllable: as,

Sors exitura, & nos in æternum.

The fourth is an *alcaick* of the ſecond kind.— The entire *alcaick* ſtrophe is as follows:

Omnes eodem cogimur, omnium.
Verſatur urna, ſerius, ocius
Sors exitura, & nos in æternum
Exilium impoſitura cymbæ.

The PASTORAL is a compoſition, the ſubject whereof is ſomething in the *paſtoral*, at leaſt rural life, and the perſon ſhepherds, at leaſt ruſticks.

The *ſcene* is always in the fields or the woods.

Every *paſtoral* ſhould have a little plot or fable, which may deſerve the title of a *paſtoral ſcene*. It muſt be ſimple, and but one; yet not ſo as to refuſe all digreſſions, provided they be but ſhort. This rule of the plot is every where obſerved by *Virgil*.

The ECLOGUE is a kind of paſtoral compoſition, wherein ſhepherds are introduced converſing together.

The *eclogue*, is properly an image of the paſtoral life.

The beauty of the *eclogue*, M. *Fontenelle* obſerves, is not attached to what is rural, but rather to what is calm and eaſy in the rural life.

The word *eclogue* is formed from the *Greek* εκλογη, *choice*. So that according to the etymology of the word, *eclogue* ſhould be no more than a ſelect or choice piece; but cuſtom has determined it to a further ſignification, *viz.* a little elegant compoſition, in a ſimple, natural ſtyle and manner.

Idyllion and *eclogue*, in their primary intention, are the ſame thing: thus the *Idyllia* of *Theocritus* are pieces wrote perfectly in the ſame vein with the *eclogæ* of *Virgil*.

But cuſtom has made a difference between them, and appropriated the name *eclogue* to pieces wherein ſhepherds are introduced ſpeaking; idyllion to thoſe wrote like the *eclogue*, in a ſimple natural ſtyle, but without any ſhepherds in them.

Boileau preſcribes the following rules for the compoſition of *idyls* and *eclogues*.

1. As a ſhepherdeſs, ſays he, in the greateſt holiday, does not load her head with precious ſtones, aud gold, but gathers in the neighbouring fields her fineſt ornaments; thus an elegant *idyllion*, amiable in its air, aud humble in its ſtyle, muſt ſhine without pomp: its turn ſimple and natural, hate the pomp and pride of a preſumptuous verſe. Its ſweetneſs muſt flatter, tickle, and awake, but never fright the ear with great words.

2. Neither ought the *idyl* to be compoſed in a mean and low ſtyle, and the author make his ſhepherds ſpeak a clowniſh dialect; but follow a road between the two extremes, imitating in it *Theocritus* and *Virgil*.

The EPIGRAM is a ſhort poem, or compoſition in verſe, treating of one only thing, and ending with ſome point or lively ingenious thought.

It is principally the point that characteriſes the *epigram*, and diſtinguiſhes it from the madrigal.

The *epigram* is the loweſt, and leaſt conſiderable of all the productions of *poetry*; and is rather an effect of good luck, than of art to ſucceed therein. The fineſſe and ſubtility of the *epigram*, M. *Boileau* obſerves, ſhovld turn on the words rather than the thought.

A MADRIGAL is a little amorous piece, containing a certain number of free unequal verſes, not tied either to the ſcrupulous regularity of the ſonnet, or the ſubtlety of an epigram, but conſiſting of ſome tender, delicate, yet ſimple thought, ſuitably expreſſed.

The *madrigal* is uſually looked on as the ſhorteſt of all the leſſer kinds of poems, and may conſiſt of fewer verſes, than either the ſonnet or rondeau. There is no other rule regarded in mingling the rhimes and verſes of different kinds, but the fancy and convenience of the author.

A SONNET is a kind of compoſition contained in fourteen verſe, *viz.* two ſtanza's or meaſures, of four verſes each, and two of three; the eight four verſes being all in two rhimes.

It is held the moſt difficult and artful of all poetical compoſitions, as requiring the laſt accuracy and exactneſs. It is to end with ſome pretty ingenious thought: the cloſe to be particularly beautiful, or the *ſonnet* is naught.

A SONG is a little compoſition, conſiſting of ſimple, eaſy, natural verſes, ſet to a tune in order to be ſung. Each ſtanza of a ſong, is called a couplet.

Its object is uſually wine, or love; whence M. *le Brun* defines a modern *ſong* to be either a ſoft and

and amorous, or a brisk and bachic thought, expressed in a few words.

Let the *song* be what it will, the verses are to be easy, natural, flowing, and to contain a certain harmony, which neither shocks the reason nor the ear; and which unite poetry and musick agreeably together.

The Fable is a tale, or feigned narration, designed either to instruct or divert; or as M. *de la Motte* defines it, an instruction disguised under the allegory of an action.

The criticks, after *Aphthonius* and *Theon*, reckon three kinds of *fables*, rational, moral, and mixed

Rational fables, called also parables, are relations of things supposed to have been said and done by men; and which might possibly have been said or done, tho' in reality they were not. Such in the sacred writings are those of the ten virgins; of *Dives* and *Lazarus*; the prodigal son, *&c.* of these rational *fables* we have likewise about a dozen in *Phædrus*.

Moral fables, called also apologues, are those wherein beasts, trees, hammers, *&c.* are supposed to speak.

Mixed fables are those composed of both sorts, rational and moral; or wherein men and brutes are introduced conversing together. Of this we have a fine instance, in *Justin*, *lib.* xxxiii. *c.* 4. made by a petty king, to alarm the antient *Gauls* against the *Massilians*, who arriving out of *Asia* in *Spain*, charmed with the place, begged leave of the inhabitants to build a city: to this effect,

A bitch big with young, begged of a shepherd a place to lay her whelps in; which when she had obtained, she begged further leave to rear them in the same. At length the whelps being now grown up; depending on the strength of her own family, she claimed the property of the place.—So the *Massilians*, who are now only strangers, will hereafter pretend to be masters of the country.

As to the laws of *fables*; the principal are, 1st, That to every *fable* there be some interpretation annexed, to shew the moral sense, or design thereof. This interpretation, if it be placed after the *fable*, is called *affabulatio*; if before it, *præfabulatio*.—2dly, That the narration be clear, probable, short and pleasant. To preserve this probability, the manners must be expressed, and closely kept to, as in *poetry*.

An Epitaph is a monumental inscription, in honour or memory of a person defunct; or an inscription engraven, or cut on a tomb, to mark the time of a person's decease, his name, family, and usually some eloge of his virtues, or good qualities.

The style of *epitaphs* is a kind of me lium between prose and verse; the jejune and the brilliant are here equally to be avoided.

Rhime is a modern invention, the product of a gothick age; *Milton* calls it the *modern bondage*.

To succeed in such kind of verses, there must be a liberty of varying the order of the words, or of changing their situation as may best suit the occasions of the poet; of making the substantive either go before, or follow after the verb, as the verse requires, *&c.*

Rhymes are either *simple* or *double*, or *triple*; tho' the two last are now disused.

Single rhymes are divided into perfect or whole *rhymes*, and imperfect or half *rhymes*.

A *whole* or *perfect rhyme* is where there is a similitude of sound, without any difference; or where a thorough identity or sound appears in the pronunciation of the two syllables, notwithstanding that there may be some difference in the orthography.

An *imperfect* or *half rhyme* is where there is a similitude with a difference, either in respect of the pronunciation, or the orthography; but chiefly the former.

There is also a jocose kind of poetry, called *burlesque*, chiefly used in the way of drollery and ridicule, to deride persons and things.

The best work we have of that taste in *French*, is the *Virgil Travesty* of *Scarron*; which was also done in *English* by *Cotton* and *Philips*; for which poor *Cotton* paid very dear, for having dressed *Dido* in the antique manner of his old aunt, and named her as an original, she resented it so much, as to carry her resentment so far as to disinherit him.

Of Romances.

As M. *Fontenelle* calls *romance* poems in prose, and *Bossu* is not averse to their being admitted as poetical pieces, I'll place them here, and say, that a *romance* is a fabulous relation of certain intrigues and adventures in the way of love or gallantry, invented to entertain and instruct the readers.

The just notion therefore of a *romance* is, that it is a discourse invented with art to please and improve the mind, and to form or mend the manners, by instructions disguised under the allegory of an action, or series of actions, related in prose, in a delightful, probable, yet surprizing manner.

A just *romance* consists of two parts, *viz.* a moral, as its foundation and end; and a fable or action, as the superstructure and means. It must also have the manners, that is, the characters must be distinguished, and the manners must be necessary, and have all the other qualities of poetical manners.

The incidents must be delightful, and to that end rightly disposed and surprizing. The sentiments fall under the same rules as the drama. But the diction is allowed to be more lofty and figurative, as being a narration; and not having terror or pity, but admiration for its end.

POTTERY.

P O T T E R Y.

POTTERY is the art of making earthen pots and veſſels; which art is as much ſubject to improvements as any other mechanical art.

The chief, and almoſt the only tools, or inſtruments uſed in *pottery*, are the *wheel* and the *lather*.

The *wheel*, conſiſts of a nut, which is a beam or axis, the foot or pivot thereof plays perpendicularly on a free-ſtone ſole or bottom. From the four corners a top of this beam, which does not exceed two feet in height, ariſe four iron bars, called the *ſpokes* of the wheel, which forming diagonal lines with the beam, deſcend, and are faſtened at bottom to the edges of a ſtrong wooden circle, four feet in diameter, perfectly like the felloes of a coach wheel, except that it has neither axis nor radii; and is only joined to the beam, which ſerves it as an axis, by the iron bars. The top of the nut is flat, of a circular figure, and a foot in diameter. On this is laid a piece of the clay or earth, to be turned and faſhioned.

The *wheel* thus diſpoſed, is encompaſſed with four ſides of four different pieces of wood, ſuſtained on a wooden frame: the hind piece, which is that whereon the workman ſits, is made a little inclining towards the wheel: on the fore piece are placed the pieces of prepared earth. Laſtly, the ſide-pieces ſerve the workman to reſt his feet againſt; and are made inclining to give him more or leſs room, according to the ſize of the veſſel to be turned. By his ſide is a trough of water, wherewith from time to time he wets his hands, to prevent the earth ſticking to them.

The potter having prepared his clay or earth, and laid a piece of it ſuitable to the work he intends, on the top of the beam, ſets down; his thighs and legs much expanded, and his feet reſted on the ſide pieces, as is moſt convenient.

In this ſituation he turns the wheel round, till it has got the proper velocity; when, wetting his hands in the water, he bores the cavity of the veſſel, continuing to widen it from the middle; and thus turns it into form, turning the wheel afreſh, and wetting his hands from time to time.

When the veſſel is too thick, they uſe a flat piece of iron with a hole in the middle, and ſomewhat ſharp on one edge, to pare off what is redundant. Laſtly, when the veſſel, is finiſhed, they take it off from the circular head by a wire paſſed underneath the veſſel.

The potter's *lathe*, is alſo a kind of wheel, but ſimpler, and ſlighter than the former. Its three chief members, are an iron beam or axis, three feet and a half high, and two inches in diameter; a little wooden wheel all of a piece, an inch thick, and ſeven or eight in diameter, placed horizontally a-top of the beam, and ſerving to form the veſſel on; and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, faſtened to the ſame beam at bottom, parallel to the horizon. The beam or axis turns, by a pivot at bottom on an iron ſtand.

The workman gives the motion to the *lathe* with his feet, by puſhing the great wheel alternately with his foot; till giving it a greater or leſſer degree of motion, as his work requires.

They work with the *lathe*, with the ſame inſtruments and after the ſame manner as with the wheel; but neither the one nor the other ſerves for any more than forming the body of the veſſel, *&c.* The feet, handle, and ornaments, if there be any, beſides the mouldings being to be made, and ſet on by hand; if there be any ſculpture in the work, it is uſually done in earthen or wooden moulds, prepared by a ſculptor, unleſs the Potter has ſkill enough to do it himſelf, which is very rare.

The piece of earthen ware being done, it is put to dry, to a certain degree: and from thence carried to the oven to be baked. As to the glazing, or varniſhing of it, it is uſually done with ſand, litharge or lead-aſhes, wood-aſhes, and ſmalt, melted into a cake,

But the moſt curious operation of this kind, is that of making *porcelain*; the proceſs thereof is as follows.

In the manufacture of *porcelain*, there are four principal things to be conſidered, *viz.* the matter it is made of, the art of forming the veſſels, and other works; the colours wherewith it is painted; and laſtly, the baking, or giving it the proper degree of fire.

There are two kinds of earths, and as many kinds of oils or varniſhes uſed in the compoſition of *porcelain*, vulgarly called *china*. The firſt earth, called *kaulin*, is beſet with glittering corpuſcles; the ſecond, called *petunſe*, is a plain white, but exceeding fine, and ſoft to the touch. They are both found in quarries twenty or thirty leagues from *Kingtecbing*; and hither theſe earths, or rather ſtones, are brought in an infinite number of little barks, inceſſantly paſſing up and down the river *Jauchen* for that purpoſe. The *petunſes* are brought in form of bricks, having been ſo cut out of the quarries, where they are naturally pieces of a very hard rock. The white of the beſt petunſe is to border a litt'e on green.

The firſt preparation of theſe bricks, is to break and pound them firſt, into a coarſe powder with iron mallets, then in mortars with peſtles, that have ſtone heads, armed with iron, and wrought either with the hand or with mills.

When the powder is rendered almoſt impalpable, they throw it in a large urn full of water, ſtirring it briſkly about with an iron inſtrument. After the water has reſted a little while, they ſkim off from the top a white ſubſtance formed there, of the thickneſs of four or five fingers, and diſpoſe this ſcum or cream in another veſſel of water. They then ſtir again the water of the firſt urn, and again ſkim it; and thus alternately, till there remain nothing but the gravel of the *petunſes* at bottom; which they lay afreſh under the mill for a new powder.

As to the ſecond urn, wherein are put the ſkimmings of the firſt; when the water is well ſettled and become quite clear, they pour it off; and with the ſediment collected at bottom in form of a paſte, fill a kind of moulds: whence, when almoſt dry, they take it out, and cut it into pieces, which are what they properly call *petunſes*; reſerving them to be mixed with the *kauling*, in the proportion hereafter aſſigned.

Theſe ſquares are ſold by the hundred, but it is very rare to meet with them unfalſified.

The *kauling*, which is the other earth uſed in *porcelain*, is much ſofter than the *petunſe* when dug out of the quarry; yet it is this, which by its mixture with the other gives the ſtrength and firmneſs to the work.

The preparation of *kauling* is the ſame with that of the *petunſes*, except that the matter being leſs hard, leſs labour is required.

The oil or varniſh, which makes the third ingredient in *porcelain*, is a whitiſh liquid ſubſtance, drawn from the hard ſtone whereof the petunſes are formed; that which is whiteſt, and whoſe ſtains are the greeneſt, being always choſen for this purpoſe.

The manner of preparing the oil is thus: the petunſes being waſhed, undergo the ſame preparations as for making the ſquares, excepting that the matter of the ſecond urn is not put in moulds, but the fineſt part of it taken to compoſe the oil. To an hundred pounds of this matter they caſt a mineral ſtone called *ſhekau*, reſembling our alum: this ſtone is firſt heated red-hot, and thus reduced in a mortar into an impalpable powder; and ſerves to give the oil a conſiſtence; which however is ſtill to be kept liquid.

The oil of lime makes the fourth ingredient; the preparation whereof is much more tedious and circumſtantial. They firſt diſſolve large pieces of quick lime, and reduce it to a powder, by ſprinkling water on it; on this powder they lay a couch of dry fern, and on the fern another of ſlacked lime, and thus alternately, till they have got a moderate pile; which done, they ſet fire to the fern: the whole being conſumed, they divide the aſhes that remain on new couches of dry fern, ſetting them on fire as before. And this they repeat five or ſix times ſucceſſively, or even more; the oil being ſtill the better, as the aſhes are oftner burnt.

In the annals of *Feuliang*, 'tis ſaid, inſtead of fern they antiently uſed the wood of a kind of medlar-tree; and that 'twas this gave the antient *porcelains* that admirable hue, which the moderns cannot come up to for want of that wood. 'Tis certain, however, the quality of the fern and lime contribute very much to the goodneſs of the oil.

A quantity of theſe aſhes of fern and lime are now thrown into an urn full of water; and to an hundred pounds of aſhes is added a pound of *ſhekau*, which diſſolves therein. The reſt being performed after the ſame manner as in preparing the earth of the petunſes; the ſediment found at the bottom of the ſecond urn, and which is to be kept liquid, is what they call the *oil of lime*; which the *Chineſe* eſteem as the ſoul of the former oil, and which gives the *porcelain* all its luſtre. This oil is eaſily ſophiſticated by adding water to increaſe the quantity; adding, at the ſame time, proportionably of the ſame *ſhekau* to maintain the conſiſtence. Ten meaſures of oil of petunſe uſually go to one of lime. To have the mixture juſt, the two oils ſhould be equally thick,

Now to form veſſels of theſe materials.—The firſt thing is, to purify the *petunſe* and *kauling*; which, for the firſt, is done after the manner already deſcrib'd in preparing the ſquares. For the ſecond, as its ſoftneſs makes it diſſolve eaſily, 'tis ſufficient, without breaking it, to plunge it in an urn full of water in an open baſket. The dregs that remain are perfectly uſeleſs, and are emptied out of the workhouſe, when a quantity is got together.

To make a juſt mixture of *petunſe* and *kauling*, regard muſt be had to the fineneſs of the *porcelain* to be made: for the finer *porcelains*, they uſe equal quantities; four parts of *kauling* to ſix of *petunſe*, for moderate ones; and never leſs than one of *kauling* to three of *petunſe* for the coarſeſt.

The hardeſt part of the work is the kneading and tewing the two earths together; which is done

done in a kind of large bafons, or pits, well paved and cemented, wherein the workmen trample continually with their feet, relieving one another, till the mafs be well mixed, growing hard, and becomes of the confiftence required to be ufed by the potter.

The earth, when taken out of the bafons, is kneaded a fecond time by piece-meal, and with the hands on large flates for that purpofe; and on this preparation, in effect, it is that the perfection of the work depends; the leaft heterogenous body remaining in the matter, the leaft vacuity that may be found in it, being enough to fpoil the whole. The fmalleft grain of fand, nay fometimes a fingle hair, fhall make the *porcelain* crack, fplinter, run, or warp.

The *porcelain*, is formed or fafhioned, either with the wheel, like earthen ware, or in moulds. Smooth pieces, as cups, urns, difhes, *&c.* are made with the wheel. The reft, *i. e.* fuch as are in relievo, as figures of men, animals, *&c.* are formed in moulds, but finifhed with the chiffel.

The large pieces are made at twice; one half of the piece is raifed on the wheel by three or four workmen, who hold it till it has acquired its figure; which done, they apply it to the other half, which has been formed in the fame manner; uniting the two with porcelain earth, made liquid by adding water to it, and polifhing the juncture with a kind of iron fpatula.

After the fame manner it is that they join the feveral pieces of *porcelain* formed in moulds, or by the hand. and after the fame manner they add handles, *&c.* to the cups, and other works formed with the wheel.

The moulds are made after the manner of thofe of our fculptors, *viz.* divers pieces, which feparately give their refpective figure to the feveral parts of the model to be reprefented; and which are afterwards united to form a mould for an entire figure.

All thefe works made in moulds are finifhed by the hand, with feveral inftruments proper to dig, fmooth, polifh, and to touch up the ftrokes that efcape the mould; fo that it is rather a work of fculpture than of *pottery*. There are fome works whereon relievo's are added, ready made, as dragons, flowers, *&c.* Others that have impreffions in creux, which laft are engraven with a kind of puncheons. In general, all *porcelain* works are to be fhelter'd from the cold; their natural humidity making them liable to break when they dry unequally.

As to the *painting of porcelain*; the painting work is diftributed among a great number of workmen: to one it belongs to form the coloured circle about the edges of the *porcelain*; another traces out flowers, which another paints: this is for waters and mountains alone; that for birds and other animals, and a third for human figures.

There are *porcelains* made of all colours, both with regard to the grounds, and to the reprefentations thereon. As to the colours of landfkips, *&c.* fome are fimple; fuch are all blues, which are thofe moft ufually feen in *Europe*; others are mixed up of feveral teints, and others again heightened with gold.

The blue is made of lapis lazuli, prepared by burning it the fpace of twenty-four hours, in a kiln, where it is buried up in the gravel, to the height of half a foot; when burnt, they reduce it into an impalpable powder in *porcelain* mortars not varnifhed, and with peftles of the fame matter.

For the red, they ufe copperas, which they call *faufan*; a pound of this they put in a covered crucible, in the lid whereof is left a little aperture, through which the matter on occafion may be feen. The crucible is heated with a reverberatory fire, till the black fmoak ceafes to afcend, and a fine red one fucceeds it. A pound of copperas yields four ounces of red liquor, which is found at the bottom of the crucible, though the fineft part is that ufually adhering to the lid and fides of the crucible.

The powder of flint is likewife an ingredient in moft of the other colours, *e. gr.* for green; to three ounces of tonghapeen, or fcoria of beaten copper, they ufe half an ounce of powder of flint, and an ounce of cerufs. Violet is made by adding a dofe of white to the green already prepared; the more green is added, the deeper is the violet. For yellow, they ufe feven drachms of white, and three of the copperas red.

Moft of thefe colours are mixed up with gum-water, for application; a little falt petre, fometimes cerufs or copperas. but more ufually copperas alone, being firft diffolved in the water. Indeed, for *porcelains* that are to be quite red, the colour is ufually applied with oil, *i. e.* with the common oil of the *porcelain*, or another made of the white flints.

There is alfo another red, called *blown red*, becaufe in reality applied by blowing with a pipe, one of whofe orifices is cover'd with a very fine gauze. The bottom of this tube is lightly applied to the colour wherewith the gauze is fmear'd; when blowing againft the *porcelain*, it becomes all fprinkled over with little points. This *porcelain* is very rare, and of great price.

Black *porcelain*, which they call *umian*, has likewife its beauty. This colour has a leaden caft, like our metal burning mirrors, and is ufually heighten'd with gold. It is made of three ounces of of apis lazuli, with ſeven of the common oil of ſtone; though that proportion is varied, as the colour is deſigned to be more or leſs deep. The back is not given the *porcelain* till it be dry, nor muſt the work be put to the fire till the colour be dry.

The gold is not applied till after the baking, and is rebaked in an oven for the purpoſe. To apply the gold, they break and diſſolve it in water at the bottom of a *porcelain*, till a thin gilded cloud ariſe on the ſurface: it is uſed with gum water, and to give it a body they add three parts of ceruſs to thirty of gold.

There is likewiſe a kind of *marbled porcelain*, which is not made by applying the marbling with the pencil, but for oil to varniſh it withal, uſing that of white flints, which hatches and cuts the work with a thouſand humourous ſtrokes, in manner of moſaick work. The colour this oil gives, is a white, ſomewhat aſhy. This *porcelain* is called *tſiwiki*.

There are ſeveral kinds of *porcelain*; but they are ſuch as are rather for curioſity than uſe.

There are two kinds of ovens uſed in baking, or knealing of *porcelain*; large ones, for works that are only to come to the fire once, which is the common way; and ſmall ones for ſuch as require a double baking. The large ones are two *Chineſe* fathoms deep, and almoſt four wide. They are formed of a mixture of three earths; one whereof yellow, and common, makes the baſis; the two others are ſcarcer, and dug out of deep mines, wherein people can only work in winter. One of them called *lautou*, is a very ſtrong, ſtiff earth; the other *yauto*, only.

The ſides and roof of the ovens are ſo thick, that one may lay the hand on them, when the fire is at its height, without danger of burning. At the top of the dome, which is in form of a tunnel, is a large aperture, to give vent to the flames and ſmoke, which mount up inceſſantly, as ſoon as fire is once ſet to the oven. Beſide the principal aperture, there are four or five ſmall ones around; which, by being open'd and ſhut, ſerve to augment or diminiſh the heat: like the holes in the Chymiſts furnaces, called *regiſters*. The earth, which takes up the whole breadth of the oven, is placed in front preciſely againſt the opening of the door, and is two or three feet deep, and two broad, people paſſing over it on a plank, to go into the furnace to range the *porcelain*.

As ſoon as the fire is lighted, the door is walled up: only leaving an aperture for the conveyance of wood. Laſtly, the bottom of the oven is cover'd with ſand, wherein part of the firſt *porcelain* caſes are buried. The oven itſelf is uſually placed at the extremity of a long, narrow veſtible, which ſerves in lieu of bellows, the cold air being thus driven directly in the face of each other.

Each piece of *porcelain*, of any note, is diſpoſed in the furnace in its ſeparate caſe or coffin. Indeed, as to the tea diſhes, *&c.* the ſame caſe ſerves for ſeveral. The caſes are all of the ſame matter with the oven: they have no lids, but ſerve each other mutually, the bottom of the ſecond caſe fitting into the aperture of the firſt; and thus ſucceſſively to the top of each column. Each coffin, which is uſually of a cylindrical form, that the fire may communicate itſelf more equally to the *porcelains* incloſed, has at bottom, a little lay of very fine ſand, cover'd over with duſt of kauling, that the ſand may not ſtick to the work, and care is taken that the *porcelain* may not touch the ſides of the caſe. In the larger caſes which hold the ſmall pieces, they leave the middle vacant, becauſe *porcelain* placed there would want the neceſſary heat. Each of theſe little pieces is mounted on a little maſſive of earth, the thickneſs of two crowns cover'd with powder of kauling.

The *porcelains* are put in caſes to prevent any diminution of luſtre from the too violent effect of a naked fire.

As faſt as the caſes are filled, a workman ranges them in the cavity of the furnace; forming them into piles or columns, whereof thoſe in the middle are at leaſt ſeven feet high: the two caſes at the bottom of each column are left empty; becauſe being partly ſunk in the ſand, the fire has the leſs effect on them; and for the ſame reaſon, the uppermoſt one is left empty. In this manner is the whole cavity of the oven filled with columns, excepting that part preciſely under the grand aperture.

In ranging the caſes, they obſerve always to place the fineſt pile of *porcelain* in the center; the coarſeſt at the bottom; and thoſe that are high-colour'd, and conſiſt of as much petunſe as kauling, and wherein the waſte oil is uſed, at the mouth.

Theſe piles are all placed very near one another, and are bound together at top, at bottom, and in the middle, by pieces of earth; in ſuch manner as that the flame may have a free paſſage among them, and inſinuate equally on all ſides: in which a great part of the workman's art lies, and on which the perfection of the *porcelain* much depends. Another thing to be obſerv'd is, that an oven muſt never be ſet all together with new coffins; but half one, half the other; the old ones at the bottoms and tops of the piles, and the new ones in the middle. Indeed it were better to have all burnt in an oven a-part, ere they come to be uſed for *porcelain*; as was antiently done.

When

When the oven is filled, they wall up the door; only leaving a little aperture for the throwing in little pieces of wood, a foot long but very slender to keep up the fire. It is then heated by degrees, for the space of a day and night; after which two men, who relieve one another, continue to throw in wood without any interruption. To know when the *porcelain* is baked enough, they open one of the lesser holes of the oven, and with a pair of tongs take off the lids of one of the piles. If the fire appears very brisk and clear, and the piles equally inflamed; and especially if the colours of the *porcelains* that are uncover'd, dart forth a noble lustre; the action is sufficient, they discontinue the fire, and wall up what remained of the door of the furnace.

If the oven be only filled with small *porcelains*, they take them out twelve or fifteen hours after the fire is extinct: if it be filled with larger, they defer opening it for two or three days. In this the modern practice differs from the antient; wherein the door was not open'd till after ten days for the large pieces, and five for the small ones.

The *Chinese* make another kind of *porcelain*, which they paint and bake twice; and for this second baking they have a kind of little ovens on purpose. When very small, they are made of iron; otherwise of a kind of bricks an inch thick, a foot high, and half a foot broad, made of the same earth with the *porcelain* cases. The biggest of these ovens does not exceed five foot in height, and three in diameter; and being made much in form of bee-hives, the bricks are arched a little to form the curvity the better. The hearth is of earth, half a foot high, formed of two or three ranges of bricks, and on this massive is the oven built. Around the oven, at the distance of about half a foot, is raised a shell of common bricks, joined to the oven itself by a kind of arcboutant of earth, which serves to strengthen it. They usually build four or five of these ovens at equal distances from each other. At the bottom of the shell are holes to give air to the fire when lighted: at top is an aperture which they cover up with a piece of the baked earth, when the *porcelains* are laid in the oven.

The *porcelains* here are not inclosed in coffins; as in the common ovens; the oven itself serving that purpose, and being so exactly closed, that they receive no other impression of the fire, but that of the heat of the charcoal disposed in the hearth, at the bottom of the oven, as well as at top of the vault, and the interval between the oven and the shell, or brick-wall.

To prepare the *porcelains* for a second baking, they must have had their varnish in the common manner, and have passed the great oven. In this state they are painted with various colours, after which, without giving them any new varnish, they are ranged in piles in the little oven, setting the little ones over the larger in form of pyramids.

This second baking is sometimes intended to preserve the lustre of the colours the better, and at the same time to give them a kind of relievo. But more usually its design is to hide defective places, by covering them over with colours: but the artifice is easily found out by passing the hand over them.

When the workman judges his *porcelains* enough baked, he takes off the piece that covers the aperture; and if the works appear glittering, and the colours glowing, he takes out the charcoal, and when the oven is cold, the *porcelain* too.

Porcelain, is made chiefly, some say wholly, at *Kingteching*, a large town in the province of *Kyangsi*. There is some indeed made in the province of *Canton* and *Fokyen*; but is of little account, being far inferior in beauty and value to the *porcelain* of *Kingteching*. That of *Fokyen* is perfectly white, without either gloss or painting. Attempts have been made to remove the manufacture from *Kingteching* to *Pekin*, and other places, but in vain; the *porcelain* made in the new manufactories never coming up to that of the old: so that *Kingteching* has the honour of supplying the greatest part of the world with this commodity. Father *Du Halde* assures us, that even the *Japanese* come to *China* for it.

Porcelain makes a very curious article in commerce, and even natural history. Its manufacture has passed, till of late years, for a mystery in *Europe*; and that in spite of all the endeavours of the Jesuit Missionaries (to whom *Europe* is indebted for so many curious and useful discoveries) to penetrate into the secret. The veil however, was at length drawn; and in a letter of Father *d'Entrecolles* to Father *Orry*, from *Jauchen*, dated *September* the 1st, 1712, and afterwards published in *French*, the whole process is described in all its circumstances; and such as it is given here word for word, from the *French*.

The *French* soon made all the use they could of this discovery of F. *d'Entrecolles*, in attempting to imitate *porcelain*. The first Essays made at *Rouen* succeeded tolerably well; and are now carried to such a point in the manufactories at *Passi* and *St. Clou*, near *Paris*, that the French *porcelains* want nothing to make them of equal value with the *Chinese*, but to be brought five or six thousand leagues. In effect, for the fineness of the grain of the matter, the beauty and turn of the vessels, the exactitude of the design, and the lustre of the

the colours, the *French* are not much behind the *Chinese*.

The like may be said of the *porcelain* manufactures at *Bow* and *Chelsea*, near *London*, and in other parts of *England*.

There is also a beautiful manufacture of *porcelain* at *Miken* the capital of *Misnia*, in *Saxony*, which the Baron *de Polnitz* assures us, produces *porcelains* painted and enamelled in such perfection, that they are more beautiful, as well as dearer, than those of *China* itself.

I am of opinion, that the best *English* chalk, and the whitest, well beaten, sifted very fine, to free it of all sandy, or other heterogeneous matter, and mixed afterwards with a sixth part of quick-lime, the whole mixture buried in a hole out of which clay has been dug, and left there to ferment, and incorporate for two or three years, would produce a matter very proper to imitate *porcelain*.

Having been desired by some friends to give them a secret to join *porcelain* when broke: I must inform them, that they must take the largest snails they can find in their shells; and take the tail of these snails, which they'll find at the bottom of the shell, white like a roll of fat; dissolve that fatty matter in the best brandy, so as to form of it a kind of thick glue, and besmearing the edges of the broken china with that glue, join the pieces, thus smear'd, together, and put them to dry from the sun. This is a secret worth notice, and *porcelain* thus joined, appears, as if it was only flawed. Flint and other glasses, may also be joined with the same matter, and in the same manner.

P R I N T I N G.

PRINTING is the art of taking impressions on paper, vellum and silk, from either seperate types, characters or figures; or from plates of metal, or blocks of wood

The *printing* with separate types is peculiar to books, &c. and is distinguished by the name of *letter-press-printing*. The art of printing from plates is called *rolling-press-printing*. And that from wood is commonly stiled *block printing*: and though the letter-printer uses wood devices for head and tail pieces, facts and extraordinary large capital letters, and chaces them up with his metal types: this sort of printing is generally confined to callicoes, linnens, &c. Therefore I shall confine this treatise to the *letter-press* only.

Who the first inventors of the *European* method of *printing books* were, in what city, and what year it was set on foot, are questions long disputed among the learned. In effect, as the Grecian cities contended for the birth of *Homer*, so do the German printers for that of printing. *Mentz*, *Haerlem*, and *Strasburg*, are the warmest on this point of honour, and these are left in possession of the question, which is not yet decided: though it must be owned that *Mentz* has always had the majority of voices.

John Guttenburg, and *John Faust* of *Mentz*; *John Mentcel* of *Strasburg*, and L. *John Koster* of *Haerlem*, are the persons to whom this honour is severally ascribed, by their respective country-men; and they have all their advocates among the learned. However, their first essays were made on *wooden blocks*, after the *Chinese* manner. The book at *Haerlem*, the *vocabulary* called *Catholicon*, and the pieces in the *Bodleian* library, and that of *Bennet-college*, are all performed in this way; and the impression appears to have been only given on one side of the leaves; after which the two blank sides were pasted together. But they soon found the inconveniencies of this method, and therefore bethought themselves of an improvement; which was by making single letters distinct from one another, and these being first done in wood, gave room for a second improvement, which was the making them of metal; and, in order to that, forming moulds, matrices, *&c.* for casting them.

From this ingenious contrivance we ought to date the origin of the present art of printing, contradistinguished from the method practised by the *Chinese*. And of this *Schæffer*, or *Schefter*, first servant, and afterwards partner and son in-law of *Faust*, at *Mentz*, above-mentioned, is pretty generally allowed to be the inventor; so that he may properly be reckoned the first printer, and the *Bible* which was printed with *moveable letters* in 1450, the first printed book; the next was *Augustine de civitate Dei*, then *Tully's Offices*, printed about the year 1461. In these books they left the places of the initial letters blank, and gave them to the illuminers to have them ornamented and painted in gold and azure, in order to render the work more beautiful, and, as some think, to make their books pass for manuscripts.

From *Mentz*, the art of printing soon spread itself throughout a good part of *Europe*; *Haerlem* and *Strasburg* had it very early; which, as the current of authors represent it, occasioned their pretending to the honour of the invention.

From

From *Haerlem* it paſſed to *Rome* in 1467; and into *England* in 1468, by means of *Tho. Bourchier*, archbiſhop of *Canterbury*, who ſent *W. Turner*, maſter of the robes and *W. Caxton*, merchant, to *Haerlem* to learn the art. Theſe privately prevailing with *Corſelles*, an under-workman, to come over, a preſs was ſet up at *Oxford*, and an edition of *Ruffinus* on the creed was printed the ſame year in *octavo*.

From *Oxford*, *Caxton* brought it to *London* about the year 1470, and the ſame year it was carried to *Paris*.

Hitherto there had been nothing printed but in *Latin*, and the vulgar tongues; and this firſt in *Roman* characters, then in *Gothic*, and at laſt in *Italic*: but in 1480, the *Italians* caſt a ſet of *Greek* types, and they have alſo the honour of the firſt *Hebrew* editions which were printed about the ſame time with the *Greek*. Towards the end of the ſixteenth century there appeared various editions of books in *Syriac*, *Arabic*, *Perſian*, *Armenian*, *Coptic* or *Egyptian* characters, ſome to gratify the curioſity of the learned, and others for the uſe of the *Chriſtians* of the Levant.

Out of *Europe*, the art of printing has been carried into the three other parts of the world: for *Aſia*, we ſee impreſſions of books at *Goa*, and in the *Philippines*; at *Morocco*, for *Africa*; at *Mexico*, *Lima*, *Philadelphia*, *New York*, *Boſton*, &c. for *America*. The Turks, indeed, rigorouſly prohibit printing throughout their empire, as imagining that the too frequent communication with books might occaſion ſome change in their religion and government; yet the *Jews* have ſeveral editions of their books printed at *Theſſalonia*, and even at *Conſtantinople*.

And Sir *Paul Rycaut* the *Engliſh* ambaſſador at the Port had the articles of peace, &c. between his country and the *Turks* printed at *Conſtantinople* alſo in the year 1660 in 4to, and in the *Engliſh* tongue.

To fit up a printing houſe, we muſt have ſeveral fonts of different characters, or types, preſſes, and caſes divided into little cells or boxes of different ſizes, to contain the types; *compoſing ſticks*, *galleys*, *chaſes*, *rules*, *ſtones* for impoſing, *head-ſticks*, *gutter-ſticks*, *ſide-ſticks*, *foot-ſticks*, *quoins*, *plainers*, *riglets*, *ciſterns*, *ink*, *paper*, &c.

Characters or *types* have different names, according to their ſizes or bodies, *viz. pearl*, *nonpareil*, *brevier*, *long primer*, *ſmall pica*, *pica*, *engliſh*, *great primer*, *double pica*, *two-lined engliſh*, and *French canon*, we ſhould have in our *printing-houſe*, together *Saxon*, and *Greek* types, &c.

We call a ſet of any of theſe ſizes a *font*, which includes current letters, capitals, numeral letters, points, quadrats, ſpaces, &c.

Beſides the ſeveral kinds of characters and letters above-mentioned, we muſt have rules for *black lines*, *borders*, and *head* and *tail pieces*, accommodated to the ſeveral kinds of letters.

The *rules* for blank lines are of braſs, and made exactly the height of the letter.

The *borders* are a kind of ornaments in form of long bars, ſerving for the diviſions of books, chapters, &c. their depth is proportioned to the letter, and their length adjuſted to the page, for being compoſed of ſeveral moveable pieces, it is eaſy lengthening or ſhortening them.

The *head* and *tail-pieces* cut either in wood or pewter, are compartments uſed at the beginnings and endings of books.

The initial letters are ſometimes cut in wood and figured; ſometimes caſt like the other characters.

Having purchaſed our *fonts* of letters, and ſent them to our intended *printing-houſe*, our next care is to have a *printing-preſs* (repreſented in the *miſcellaneous* plate) which is a very compleat machine: its two principal parts, each whereof conſiſts of ſeveral others, are the *body* of the *preſs*, which ſerves to give the pinch or ſtroke for the impreſſion; and the carriage, on which the form is laid to undergo the ſame.

The *body* conſiſts of two ſtrong cheeks, placed perpendicularly, and joined together by four croſs pieces or planks.

The firſt plank, called the *cap* of the *preſs*, is fixed, and ſerves to keep the two cheeks together at the due diſtance a-top: the ſecond called the *head* is moveable; being ſuſtained by two iron pins or *long bolts*, that paſs the *cap*: in this plank is fixed a female ſcrew, or *worm*, with a *braſs nut*, ſuſtained by two *ſhort bolts*, which keep it up: the third plank called the *ſhelves*, ſerves to keep ſteady a part called the *hoſe*, in which the ſpindle (to be ſpoken of hereafter) is incloſed: the fourth plank, called the *winter*, is moveable; it bears the carriage, and ſuſtains the effort of the *preſs* beneath, as the head does above; each giving way a little, the one upwards, the other downwards, to make the pull the eaſier.

The *ſpindle* is an upright piece of iron, pointed with ſteel, of different dimenſions, having a male ſcrew, which goes into the female of the head, about four inches. Through the eye of this ſpindle is rivetted the *bar*, by which the preſs-man works the preſs.

The lower part of the ſpindle paſſes through the ſhelves, being incloſed in a ſquare wooden frame, called the *hoſe*; and its point works into the plug, fixed in a braſs pan ſupplied with oil; which pan is fixed to an iron plate, let into the top of the platten. The press-man, then, by turning or pulling the bar fixed in the eye by an iron key, presses upon a square smooth piece of wood, called the *platten*, and enables it to compress the form cover'd with the paper, *tympans*, and its blankets, which in order thereto, are brought under the *platten*.

At each corner of the *hose* is an iron hook fastened to those at each corner of the platten, with cords or packthread, very exactly.

The *carriage*, which makes the second principal member of the press, is placed a foot below the platten, having its fore part supported by a wooden prop, called the *fore stay*, while the other rests on the winter. On this carriage, which sustains the plank, are nailed two long iron bars or *ribs*; and on the plank are nailed short pieces of iron or steel, called *cramp-irons*, equally temper'd with the ribs, and which slide upon them when the press is turned in or out.

Under the carriage is fixed a small piece of iron, called the *spit*, with a double wheel in the middle, round which leather *girts* are fastened, nailed to each end of the plank. To the outside of the *spit* is fixed a handle, or rounce, by which the pressman turns the press in or out at pleasure.

Upon the plank is a square wooden frame or coffin, wherein is inclosed a marble or polished stone, for the form to be laid on. To this coffin are fasten'd leather stay-girts, one to each side; which being again fasten'd to the cheeks of the press, prevent the plank from running too far out, when drawn from under the platten. On the fore part of the plank is a gallows, which serves to sustain the tympans, when taken from off the form.

On the front of the coffin are three frames, much alike, though serving for different purposes, *viz.* the two tympans and frisket: the *tympans* are square, made of three slips of very thin wood, and a top, of a slip of iron, still thinner, called a *head band*: that called the outward *tympan*, is fasten'd with iron joints to the coffin. They are both cover'd with parchment; and between the two are placed blankets, which serve to make the impression of the platten, upon the surface of the letters more equal; as also to prevent the letters from being bruised by the force of the press. The *frisket* is all of iron, very thin, fasten'd a-top to the great or outward tympan, and sustained by a slip of wood hanging from the cieling, when open'd to take out the printed sheets, and put in others. It is also covered with parchment or paper, cut in the necessary places, that the sheet, which is between the great tympan and frisket, may receive the ink, and that nothing may hurt the margin. On the parchment of the great or outward tympan it is, that the blank sheet is laid to be printed.

To regulate the margin, and make the lines and pages answer each other when printed on the other side, in the middle of the wood, in the sides of this tympan, are two iron points, which make two holes in the sheet, to be placed on the same pins, when the sheet is returned for an impression on the other side, called the reiteration.

Our *press* fixed, we'll range in order the *cases*, which are to contain our letters, placing two of them, one over the other; the upper one is divided into 98 boxes, to contain the *capitals*, *small capitals*, *accented letters*, &c. and the lower one divided into 54, to contain the *common running letters*, with the *points*, *commas*, *quadrats*, &c. placing each case a little slope, like a reading desk.

In the boxes of these cases, our letters must be distributed, according to the order of the alphabet; together with *spaces*, *quadrats*, *quotations*, &c.

The *printing-house* thus in order, we must seek next for a good set of workmen, *viz. compositors*, and *press-men*; *compositors* to range and dispose the letters into words, lines, pages, *&c.* according to the copy delivered them by the author: and *pressmen* to apply ink upon the same, and take off the impression.

The *compositor* most commonly works standing; and must place himself against the middle of the case; holding his *composing-stick*, (Plate *ibid.*)

The *composing-stick* consists of a plate or slip of iron, brass, wood, *&c.* more or less broad, and contrived so as to be made more or less long, according to the width of the page, and the number of lines to be composed in it. From the right of this plate arises a ledge, about half an inch high, running the whole length of the plate, and serving to sustain the letters, the sides of which are to rest against it; from the said plate likewise arise three other lesser pieces, two of which are contrived to slide along it, that so the two pieces may be either approached or withdrawn at pleasure, to adjust the length of the line to the measure intended.

Add, that where marginal notes, references, *&c.* are required in a work, the two sliding pieces are opened in the composing-stick, to a proper distance from each other.

Ere the workmen proceeds to compose, a *rule* or thin slip of brass plate, cut to the length of the line, and of the same height as the letter, is placed in the composing-stick against the ledge thereof, for the letters to bear immediately against.

Things thus prepared, the compositor having the copy (which is what the author has wrote) laying before him, and the stick in his left hand, with the right he picks up the letters, spaces, *&c.* and places them against the rule; while with the thumb of the left he places them close to the upper screw, or cheek; and thus keeps them ſteady, while the other hand is conſtantly employed in ſetting in more letters: the whole being performed with ſuch expedition and addreſs, not eaſy to be imagined.

A line being thus compoſed, if it ends with a word or ſyllable, and fills the meaſure, there needs no further care; otherwiſe more ſpaces are to be put between the ſeveral words to juſtify the lines, *i. e.* to make the meaſure quite full, ſo that every one may end even; and thus he proceeds to another line.

The *ſpaces* here uſed are a ſort of blanks of the like dimenſions with the letters, but leſs high; and whoſe faces therefore, when ſet, do not appear, nor give any impreſſion. They are of ſeveral kinds, according to the dimenſions of the whites, or intervals to be made by them, *viz.* quadrats, to fill up a break at the end of a paragraph, or the like; *m* quadrats, which are ſquare, and of the thickneſs of an *m*, ſerving to make the diſtance after a period, or between ſentence and ſentence; *n* quadrats, of the thickneſs of an *n*, to be placed after the colons, ſemi-colons, and comma's; and thick or thin ſpaces, to be uſed between the words in juſtifying, as above.

For marginal notes, in the ſpaces reſerved for them, between the two ſliding pieces of the compoſing-ſtick, are put little quadrated pieces of metal, called *quotations* (already mentioned) which are juſtified by other ſmaller pieces; a ſlip of ſcaleboard being placed from the top of the page to the bottom, to keep the note and text at a due diſtance.

The firſt line thus compleatly juſtified, the *compoſitor* advances to the next; in order to which he moves the braſs rule from behind the former, and places it before it, and thus compoſes another line againſt it, after the ſame manner as the former.

The *compoſitor* having thus ſet the proper number of lines in his ſtick, *viz.* four, five, ſix, or more, and emptied them thus out into the galley; he again fills and empties, as before, till a compleat page be formed, remembring at the bottom of every page to ſet a line of quadrats. and at the end thereof the firſt word of the page enſuing, for a catchword; and if it be the firſt page of the ſheet, one of the letters for a ſignature.

The *galley* is a flat wooden inſtrument, in form of a long ſquare; of a length and breadth proportionable to that of the page: it conſiſts of two parts, the upper called the *ſlice*, whereby the pages of large volumes, when compoſed, are ſlidden upon the ſtone; the other, called the *coffin*, which is the body of the *galley*, is ledged on three ſides, to contain the ſlice; the inner ledge not to exceed half an inch in height, that the compoſed page riſing above it by one half the height of the letter, may be tied up or bound down, and removed without danger.— This *galley* is placed at the top of the caſe, and detained by a wooden pin from ſliding down the boxes.

The page then compoſed and ranged in the galley, he ties it down therein with a cord of packthread, and ſets it by; and proceeds to the next till the number of pages in the ſheet be compoſed: which done, he carries them to the impoſing or correcting-ſtone, there to range them in order in a *chaſe*, which they call *impoſing*.

The *chaſe* is a rectangular iron frame of different dimenſions, according to the ſize of the paper to be printed on; having two croſs pieces of the ſame metal, called a *long* and *ſhort croſs*, mortiſed at each end, into the frame, ſo as to be taken out occaſionally.—By the different ſituations of theſe croſſes, the *chaſe* is fitted for different volumes; for quarto's and octavo's one traſverſes the middle lengthwiſe, ſo as to interſect in the center; which is the moſt cuſtomary ſituation: for twelves and twenty fours, the *ſhort croſs* is ſhifted nearer to one end of the *chaſe*: for folio's, the *long croſs* is left entirely out, and the ſhort one placed in the middle; and for broadſides, or ſheets printed on one ſide only, both *croſſes* are ſet aſide. To dreſs the chaſe, or range and fix the pages therein, they make uſe of a ſet of furniture, conſiſting of riglets, or ſlips of wood of different dimenſions, and of about half an inch high, that they may be lower than the letters: ſome of theſe are placed at the top of the pages, called *head-ſticks*; others between them to form the inner margin, called *gutter-ſticks*, others at the ſides called *ſide-ſticks*; and others at the bottom, called *foot-ſticks*.

The pages then placed in order on the ſtone, the *chaſe* is put over them, and the riglets applied between the letter and the chaſe, in the poſition above-mentioned; the whole is locked up by means of ſmall pieces of wood, cut in the wedge-form, called *quoins*, which are driven with a mallet and ſhooting-ſtick, to a ſufficient tightneſs.

Before the form be quite locked up, they dreſs down the ſame, by paſſing a ſmooth piece of wood, called the *plainer*, over the letters, to make their ſurfaces ſtand flat and even; and when locked up, they ſhake it to ſee that nothing ſtir.

In this condition the work is called a form, containing more or fewer pages, according to the volume.

As there are two forms required for every ſheet, when both ſides are to be printed, it is neceſſary they be exactly of the ſame length and breadth, *i. e.* the correſponding riglets, head ſticks, &c. are to be equal in both forms, that the pages may fall exactly

actly on the back one of another, which is called *register*.

The form thus finished is committed to the press-men, to pull a proof there; in order to rectify the errors which may have slipped the compositor's attention; which are in a greater or lesser number, according as the *compositor* has been more or less careful in his composition; or has a greater or lesser capacity.

The proof pull'd is carried to the *corrector* of the press, who ought to read it over with a great deal of attention, and compare it carefully with the copy, in order to rectify all the mistakes; which is seldom done as it ought to be.

The corrections are placed on the margin of each page, right against the line where the faults are found. There are different characters used to express different *corrections*, D or & *dele*, for any thing to be effaced or left out. When any thing is to be inserted, the place is marked in the line with a caret ʌ, and the insertion added in the margin. When a word, syllable, &c. is to be alter'd, it is erased out of the proof, and that to come in its room written in the margin; always observing, if there be several in the same line, that they be separated by little bars or strokes, | if a space be omitted, its place is marked with a caret, and the thing expressed in the margin ⁂: if a letter be inverted, it is expressed in the margin with ɔ: if any thing be transposed, it is marked thus; *the shortest are the | follies | best*; for, *the shortest follies are the best*: and in the margin is added *tr* in a circle. If *Roman* characters are to be changed for *Italick*, or *vice versa*, a line is drawn under them thus, and *Roman* or *Italick* added in the margin.

The *proof* or *sheet* corrected, is delivered back to the compositor, that he may rectify in the form the mistakes marked by the corrector; in order to which he goes with his composing-stick to the case, to take the letters he thinks necessary for this operation; then comes to the form, which he unlocks on the correcting-stone, by knocking out or loosening the quoins; and spreading his corrected proof so, as that the line thereof range with the respective ones of the metal; by running his eye along both, he easily spies where the corrections are to be made; according to which, he proceeds to pick out the faulty letters, points, &c. with a sharp-pointed steel bodkin, and puts others in their places.

The form corrected, and locked again by the compositor, is delivered for good to the press-man, who are to work it off; who, to be ready for this operation, has took care to prepare his ink, press, and paper for it.

The *ink* for printing is of two kinds, black and red: the last occasionally used in title pages, kalendars, &c. the first for the body of the book.

To fit the *paper* for use, it must be first wet or moistened, by dipping several sheets together in the water: these are afterwards laid in a heap over one another; and to make them take the water equally, are all pressed close down with a weight a-top. As to the degree of wetting, it must be according to the quality of the paper, and the size of the letter; small letters, and stiff paper, requiring most wetting. But the paper ought not to be wet long before it is used; otherwise it would be covered with a great number of yellow specks.

The paper, being fit for use, the ink prepared, and the form placed on the stone in the press, the press-man goes to work: and for the greater dispatch, sometimes three persons are employed in this operation, one to beat the form with the ink, another to lay the blank-sheet on the outward tympan, and work the press, and another to take off the sheet, when printed; which operator they call the *fly*; the first thing done is beating the form with ink, by means of balls, which are a kind of wooden funnels, the cavities whereof are filled with wool, covered with leather nailed to the wood. One of these the operator takes in each hand, and applying them on the ink-block, to charge them with ink, he rubs them against one another to distribute the ink equally; and at last smears over the form, by beating or dabbing them several times over the whole face thereof; taking care to do it so evenly, that no part thereof may be left unsmeared; whence would ensue fryars, as they call them, *i. e.* places in the sheet left unprinted, which is a very great detriment to it, a scandal to the operator, and his master, and a baulk to the reader: while he is beating the form, the press-man lays the white sheet on the tympan; and the form smeared, he brings the tympans and frisket down from the gallows upon it; and advancing the plank under the platten, by means of the spit-handle or rounce, gives two strokes or pulls with the bar, and with an equal strength, that the sheet may be printed every where equally; and with the same handle turned the contrary way, brings back the plank, so takes off the printed sheet, and put on a fresh one; the form being beaten with ink every time a fresh sheet is put on; and this he repeats till he has taken off the full number of sheets the edition is to consist of.

One side of the sheet being thus printed, it is remanded to the press for the other; and so disposed, as that the iron points pass through the holes already made in the sheet.

The number of sheets of the edition being compleat

pleat, and the form to be feparated, to reftore the letters into the cafes, they firft wafh it in lye to take out the remains of the ink, fcrubbing it with a brufh, and then wafh it with fair water. This done, it is carried to a board, on which it is unlocked, and the furniture, *i. e.* the fticks, *&c.* taken off to difengage it from the chafe. Then the compofitor taking up feveral lines at once upon a litttle wooden ruler, he replaces each letter in its proper box, to be again ufed in the remainder of the impreffion.

Books are printed in *China* from wooden planks or blocks, cut like thofe ufed in *printing* of callico, paper, cards. *&c.* among us.

Thefe blocks are made of a fmooth, firm, clofe wood, and of the fize of the leaf required. On the face-fide they glue a paper, upon which fome able penman draws out the feveral letters and charact[illegible] with a *Chinefe* pen, which is a kind of pencil. Th[illegible] is the principal part of the work, and that whereon the fuccefs of the reft depends.

When finifhed, the block is put in the hands of a fculptor, or cutter in wood; who following the feveral ftrokes of the writer with his gravers, and other fharp little inftruments, makes them all appear in relievo on the wood.

When the carving or cutting is finifhed, they moiften what remains of the paper, and rub it gently off.

The ink they ufe in *printing* is the fame with the common *Chinefe* ink, wherewith they alfo write; and is made of lamp-black mixed up with oil.

Their prefs refembles our rolling-prefs, much more than the letter-prefs.

PYROTECHNY.

PYROTECHNY, πυρωτεχνια, is the art of fire, or a fcience, which teaches the management and application of fire in feveral operations, either *military* or *chymical*.

Chymical pyrotechny is the art of managing, and applying fire in diftillations, calcinations, and other operations of chymiftry, of which at large in *chymiftry*.

Military pyrotechny, is the doctrine of artificial fire-works, as *rockets*, *ftars*, *ferpents*.

A ROCKET is an artificial fire-work, confifting of a cylindrical cafe of paper, filled with a compofition of certain combuftible ingredients; which being tied to a ftick, mounts in the air to a confiderable height, and there burfts.

Befides the *rocket* here defined, which is properly called the *fky-rocket*, there is another, which from the fphere it moves in, the water is denominated *water-rocket*.

The compofition wherewith *rockets* are filled, is made in the following manner.

You muft take the biggeft gun-powder, bruife it on a table, with a wooden muller, and pafs it afterwards through a very fine filk fierce, take fixteen ounces thereof, and put it by itfelf: then you'll bruife charcoal likewife, made of willow, or white wood, and pafs it afterwards through a fierce of horfe-hairs, a little coarfer than that of filk. You'll mix with your hands four ounces of this coal, with your fixteen ounces of powder, and pafs the mixture four or five times thro' a horfe-hair fieve, much coarfer than the other; and every time you'll have paffed it you'll ftir it with the hand. This compofition well mixed and incorporated together, muft be kept in a proper veffel for ufe.

You'll try one of your *rockets* charged with this compofition; if it does not afcend there is too much charcoal, and the compofition is too weak therefore it muft be ftrengthned with an ounce of gun-powder pulverized; and if it burfts in afcending into the air (as it often happens when the rockets have not been tried) the compofition is too ftrong, and an ounce of charcoal muft be added to it, or more, according to the prudence of the artificer.

Several artificers are of opinion, that *fky rockets* can be made with the following compofitions, in proportion to their bignefs; fome of them weighing, when filled and equipped, as far as twelve pounds, as it is explained in the following tables.

Dofe to make fky-rockets.

Compofition for a Mould of 2 lb.	*Compofition for a Mould of 1 lb.*	*Compofition for a Mould of ½ lb.*	*Compofition for a Mould of 4 oz.*	*Compofition for a Mould of 2 oz.*
Powder 2lb.	—— 1 lb.	—— 20 oz.	—— 5 oz.	8 o 9 oz.
Saltpetre 1 lb.	—— 12 oz.	—— 12 oz.	—— 1 oz.	$\frac{3}{3}$ of an oz.
Sulphur 5 oz.	—— 2 oz.	—— 1 oz.	—— ¼ oz.	
Charcoal 4oz.		—— 3 oz.	—— ½ oz.	¼ an ounce or 1 ounce.
Iron-filings 2oz				
The mould has 9½ Inches in Height.		The mould has 8 ½ Inches in Height.	The Mould has 7 Inches in Height.	The mould has 4½ In. in Heightt

As an additional ornament to *rockets*, it is ufual to furnifh them either with ftars, or with ferpents, or fparks, or with a fhower of rain, which take fire when the *rocket* burfts; and fometimes little rock-

ets

ets are inclosed in great ones, to take fire when the great one is at its greatest height.

To make *stars for rockets.*—Mix three pounds of salt petre, with eleven ounces of sulphur, three ounces of beaten gun-powder, and ten of antimony. Moisten the mass with gum water, and form them into little balls of the size of filberds; drying them well either in the sun or an oven. When dry, inclose a number of them in the conical cap of the *rocket.*

As to the method of making *water-rockets*; make a *rocket* after the usual manner, excepting in the number of choaks. Let its diameter be equal to that of a leaden ball of two or three inches diameter, and let it be bored to a third part of its height. Inclose the *rocket* in a hollow perpendicular cylinder, which smear over with melted pitch or wax, that it may resist the moisture.

The weight of the *rocket* is to be so proportioned to that of the water, that the whole cylinder may be immerged. Some instead of a cylinder use a truncated cone, or even a spheroid; and some hang a weight to the end where it is lighted.

To make a rain of fire for the *rockets*, take equal quantity of sulphur, salt-petre, and gunpowder, beat well each ingredient by itself; and melt, afterwards, the sulphur in a glazed earthen pot, or in a copper pot which is best; when melted, put the salt-petre by little and little into it, stirring continually the matter; and lastly the powder; this must be done over a very little fire, lest it should catch the mixture, while you stir it. Those three ingredients being well incorporated together, pour the mixture on paper, or board, where it will grow hard, and when you'll want to make a rain of fire, you must break it into small pieces, and mix it with the powder of the cracker of your *rocket*.

To make a *rocket* to run along a cord. Take two *sky-rockets*, of the bigness of those first in order in our table; but without a cap, or any other apparatus, only as they come out of the mould; join those two *rockets* together side-wise, the upper end of the one turned towards the lower end of the other, so that the stopple, which comes out of the massive of the one, enters the choak of the other; and paste paper over it, lest the violence of the effort should part them; taking care, likewise, to stop with wet and pasted paper, the end of the massive, which is to fire last.

Those two *rockets* thus disposed, an empty cylinder is fasten'd to them very tight in three places, and the cord run afterwards through it.

The *rocket*, which is lighted first, runs along the cord, from the end it departed to the other end; and when exhausted, the other takes fire, and returns back the same way.

To make a *serpent*, you must roll upon an iron rod, or round stick, two gaming-cards, one over the other, which must be cover'd with a paper, so that the paper appears always a top, and cards inside: it will be necessary to wet a little the cards to make them more tractable; but they are not to be used before they are dry; pasting paper afterwards, which cover them all its length, to fasten it. You introduce the base of the mould into the *serpent*, and choak it at that place, with a pack-thread greased with a little soap; and tie it afterwards with thread; then you put the mould over the *serpent*, which thereby is inclosed in it; charging it afterwards by means of a quill, with the same composition the *rockets* are made of; filling half the *serpent* first, and then ramming the charge with the same iron rod, the cylinder has been rolled upon; and having put a grain of vetch over the charge, you fill up the *serpent*, with whole gun-powder, leaving a place empty a-top, to thrust in a stopple of chew'd paper, which must be rammed down with the iron-rod: the paper being rammed down, and a little space left empty over it, you choak likewise the *serpent* at that place, and tie it with a thread, as you have done the other end; with this difference, that this end is quite close, and the other has preserved the aperture made to it, by the spike thrust into it at first; this empty place is primed afterwards with gun-powder, bruised and mixed with water.

For a Girandola it must be made in form of a wheel, with six faces: the spokes of the wheel to be of a light wood turned as near as one will have it: the nave of the wheel of a little stronger wood, the bands of the wheel only a line thick, and an inch or thereabout broad; those bands are nailed to their joints, and even glued that they may hold faster; that wheel thus disposed, you'll apply on each of the joints or bands, a sky-rocket of the same length with the joint, which you'll tie very tight with packthread in three places, *i. e.* in the middle, and at both ends; proceeding thus round the wheel, taking care that one end of the stopple which comes out of one rocket, may enter the massive of the next, for the communication of the fire to one another without interruption: all this being thus well prepared, the places where the rockets are joined, are covered with paper, putting two or three more papers over it, to hinder the fire from forcing through that way: and at the joints which remain between the two last rockets, care must be taken to stop well that which is to play last, with wet paper, and well rammed at the extremity which touches the end of the first rocket, to which the fire is set at the stopple which comes out of it.

To use this *girandola*, a foot must be made to it, four

four feet long, which is easily introduced through the nave, to make it turn easier; and at the extremity of the nave a pin is adapted, to hinder the wheel from falling while it turns round. Those *girandoles* are nailed at the corner of the theatre or scaffold.

Besides those fire-works, for diversion, there are others used in the defence of places besieged, to throw on the besiegers, when they come to the breach, or attack some other works.

For a FIRE-BALL, you must have a port-fire, a foot and a half, or two feet long, according to the bigness the *fire-ball* is to be, on an inch, or an inch and a half of diameter, which must be charged with a composition made of two pounds of salt-petre, a pound of sulphur, and half a pound of gunpowder, all well pounded separately, and passed through a fine sierce, mixing them all together afterwards.

In case the fire should be too slow, you'll add to it a little gunpowder pulverized; and salt-petre, if it burns too quick, to make it last longer; in the middle of the ball should be a little sack filled with this same composition; the port-fires shall be run thro' that sack; and over it, the ball shall be covered with tow, and chips of wood, dipt in a mixture made of linseed oil, and oil of turpentine, seven pounds of each, and eight pounds of pitch or tar, gently heated, and well incorporated together; the tow and chips must be left to be half dry before they are used; dipping mean while a piece of very coarse cloth, in the same mixture, to envelope the ball, throwing afterwards on the cloth tow and chips, salt-petre and sulphur coarsely pounded, that the fire may be clearer; observing to put by intervals iron ware round the matter which is put in the ball, to make it hold. without being too tight, otherwise the fire would be too slow; for when the matter is a little loose, the flame is greater: if you want to quicken the fire you must take three pounds of gunpowder pulverized, and a pound of charcoal pulverized likewise, and having mixed them well together, spread it on a table, and roll the ball, covered with the chips and tow upon it, covering it afterwards with the cloth.

For a FIRE-ROCK, you'll put three pounds of sulphur in powder, in a glazed earthen pot, place the pot over a little charcoal fire without flame; the sulphur melted, you'll add to it a pound of mutton suet, a pound of gunpowder pulverized, and passed through a sierce, and a pound of salt-petre in powder: the whole being well mixed, throw it into a bason, where it must be left to grow cold, or else, while it is hot, cover your granadoes, circles, launces, and other artifices with it.

Powder, which will be sometimes under water, and sometimes above it. Take gunpowder, three parts of colophone, a fourth of common oil, and a sixth of sulphur; mix them all together, and being dry, try if it burns more or less than it ought; if it does not burn enough add sulphur and colophone to it; wrap that mixture in a piece of cloth, then put straw round it, which must be tied with packthread, and dip it afterwards in pitch; cover it over again with other straw, which must be dipped as the first, to keep it from the water; this done, you'll make a little hole in it to set it on fire: the mixture would be better, if some petroleum was added to it.

To mak *torches*, which are never extinguished either by the wind or rain.—Take old ropes pretty big, and boil them in salt-petre water; and when very dry, cover them with sulphur pulverized, and coarse gunpowder, mixed with some brandy: take afterwards three parts of wax, three parts of pitch, one part of sulphur, half a part of camphire, and half a part of turpentine, and with all these matters mixed together, cover your ropes, putting four of them together; and as a torch in the middle, add besides, between those four ropes, quick-lime, with three parts of sulphur mixed together.—These *torches* will light in all weathers.

R E F I N I N G.

REFINING is the art of refining metals and salts.

All sorts of metals admit of *refining*, viz. *gold*, *silver*, *iron*, *tin*, and *lead*.

GOLD, can be refined in three different manners, *viz.* either with antimony, with sublimate, or with aqua fortis.

The last of these three manners, viz. *depart*, and which is the most usual, and most dangerous, is also called *departing*, or *parting*; the process thereof is as follows.

They take at the rate of one pound of impure gold, and two or three of silver; these they fuse together in a crucible, and when fused cast them into cold water, where they become divided into grains of the bigness of peas. These grains taken out and dried by the fire, are put in a departing vessel, which is a stone matrass, and to the matrass is added four pounds of aqua fortis. Then taking the vessel, they set it on the coals, and in about an hour's space the refining is done. For upon opening the vessel they find nothing therein but the aqua fortis, and the gold reduced into a calx, or sand; the silver being all dissolved and imbibed by the water.

To

To raiſe the *gold* to its due fineneſs, they uſually give it the aqua fortis again and again; uſing for the firſt time half a pound, and for the ſecond a quarter of a pound of the water to eight ounces of metal. If the third water be found good and clear, the operation is ended: and the calx of the gold being waſhed in repeated water, is melted down in a crucible, firſt by a gentle, and afterwards a vehement fire, to be caſt into ingots or wedges.

It muſt be added, that the ſilver with the impurities of the gold, are ſo thoroughly incorporated with the water, that to the eye there does not appear any thing beſides the pure liquid, yet this ſilver is not loſt. To recover it again out of the menſtruum, they divide their ſtock of aqua fortis into ſeveral ſtone veſſels, which they fill up with ſpring water, obſerving to put ſeven or eight times as much of this as that. This done, in each veſſel they put a quantity of copper, and leaving the whole for twenty-four hours, at the end thereof they find the particles of the aqua fortis have quitted the ſilver, and are with the copper, leaving the former in form of a calx, or incorporated aſhes at bottom. This calx being dried, is melted into an ingot, with a little ſaltpetre.

To huſband the aqua fortis, and make it ſerve again for a ſecond operation, they diſtil it in an earthen or glaſs alembick; and when the diſtillation is about a third over change the recipient. The water of the firſt recipient ſerves for the firſt operation of *departing*, and the reſt for the ſubſequent ones.

If the aqua fortis, having quitted the ſilver, and being united with the copper, be then filtrated, it is called *aqua ſecunda*, in which, if you ſteep an iron plate ſome hours, you will have another *departure*, for the menſtruum will let go the copper, and prey on the iron, leaving the copper in powder on the iron plate. And filtrating this diſſolution, you may get the iron out of it, by laying in it a piece of lapis calaminaris; for the iron in that caſe will depart to the bottom, and the lapis be diſſolved: and if you again filtrate this water, and pour on it the liquor of fixed nitre, you will have another *depart*, the lapis precipitating to the bottom. And laſtly, filtrating this water as before, and evaporating part of it, you'll have cryſtals of ſaltpetre.

To *refine gold with antimony*, you muſt take an ordinary crucible, of a ſize anſwerable to the quantity of gold to be refined; obſerving that the gold and antimony together do not above half fill it: put that crucible in a wind furnace, with the gold alone in it; and when the gold is melted throw into it the antimony in powder. The proportion of the mineral to the metals, is about a pound to eight ounces, if the gold be between 22 and 16 carrats fine: if it be beneath 16 carrats, they uſe about three quarters of a pound to eight ounces: the coarſer the gold is, the more antimony is required.

As ſoon as the antimony is in the crucible, it is covered up; and after charging the furnace with charcoal, they put on its head a cover, which ſtand till ſuch time as the crucible be left quite bare; then the head being taken off, and the crucible left to cool in the furnace itſelf, till ſuch time as it may be taken out by the hand, they break it to get out the bottom, or culot, which is a maſs of fine *gold* remaining at the bottom, with the ſocus of the antimony, the ſilver and copper alloy, and ſometimes little particles of gold itſelf over it.

Though the gold thus prepared be very pure, the antimony gives it ſuch a harſh brittle quality, that it ceaſes to be ductile; and muſt be ſoftened by fuſion, with ſaltpetre and borax, to bring it to itſelf.

For this operation they prepare what they call a *dry coppel*, that is, a coppel made of crucible earth, which does not imbibe like the coppel made of aſhes.

The coppel being ſufficiently heated in the refining furnace, they put the gold in it and cover it up with charcoal.

As ſoon as the *gold* is diſſolved, which is very ſoon by reaſon of the remains of the antimony, they blow it with the bellows to drive the mineral entirely away, which now goes off in ſmoak; adding to it, as ſoon as the fumes ceaſe, a little ſaltpetre and borax in powder: which collect the impurities remaining upon diſſolution, and fix the *gold* in the coppel in form of a plate.

The *gold* being taken out of the coppel, and melted afreſh in the crucible, with an addition of two ounces of ſalt-petre, and as much borax in powder, to each eight ounces of *gold*; as ſoon as it ceaſes to fume, they caſt it into an ingot; which, upon trial, is found 23 carrats, 26 thirty-ſeconds fine.

As to the particles of *gold* which may have been left behind with the alloy in the fæces of the antimony, they get them out by a dry coppel, with the ſame meltings and ingredients as are uſed in ſoftening the former. And when they are aſſured by the eſſay, of the ſhare of *gold* the matter contains, they refine it to ſeparate the copper; and afterwards make the depart.

As to the *gold* which may be left ſticking to the dry coppels, they get it out by breaking and pulveriving the crucibles, and by repeated lotions of the powder thereof in ſeveral waters; which is called waſhing.

To *refine gold by means of ſublimate.*—The proceſs is begun like that with antimony, *i. e.* in the ſame furnace, with the ſame coal, the ſame fire, and the ſame crucibles.

The *gold* being melted in the crucible, they caſt in the ſublimate, not pulverized, but only broke in pieces. As to the proportion, to eight ounces of *gold* to be refined, they put an ounce, or an ounce and a half, or even two ounces, if the *gold* be of 22 carrats;

carrats; three ounces if 20 carrats; and 406 ounces, if it only be from 18 to 20 carrats. In which last case they part the sublimate into two; putting half at a time, with the *gold*, into a new crucible; which, when the operation is over, leaves the *gold* from 18 to 23 carrats, according to its fineness before. After this, they raise it further by the fire as follows:

The broken sublimate being put into the crucible with the melted gold, the crucible is immediately covered up, to smother the mineral: which done, the furnace is filled with charcoal, and the head put on. A quarter of an hour afterwards they take off the head, lay the crucible bare, and give the *gold* air, *i. e.* blow off all the ashes, and other impurities that may be floating on the liquid gold, with a pair of bellows, the nozzle whereof is crooked.

This they repeat again and again, till the impurities of the *gold* being carried off, by virtue of the sublimate, it be found of a bright glittering colour; after which it is taken out of the crucible, and the *gold* cast into an ingot.

Gold may also be refined with lead and ashes, as observed in Chymistry; but this is a method seldom used, excepting in *essays*.

For the method of *assaying gold*.—The assayer having weighed the *gold* he intends to make the trial in, very exactly, with scales that will turn with the hundredth part of a grain, and noted down the weight, and twice as much fine silver thereto; though this shou'd be in proportion to the fineness the *gold* seems to be of, the basest *gold* requiring the least silver. The gold and silver thus weighed and mixed, are wrapped up in a piece of paper, to prevent their losing any thing of their weight, which would disturb the accuracy of the essay.

While the *assayer* is weighing his matters, a reverberatory fire is lighted in a furnace, furnished with a muffler and a coppel or test set therein to heat. This done, a little bullet of lead is put in the coppel, of a weight proportionable to the quantity and quality of the *gold* to be assayed. When the lead is well melted, and appears very clean and bright, they put in the gold and silver, and let it fuse and seethe till it appears of an opal colour, and hath fix'd itself in a little lump to the bottom of the coppel.

This done, the coppel is left to cool in the furnace itself; after which the lump is separated very exactly from the place where it stuck to the vessel, and stretched and hammered on the anvil, heating it again and again on the coals, to promote the stretching.

When sufficiently hammered, they roll it up in form of a cornet or coffin, and thus put it in a glass matrass, capable of containing four spoonfuls of water; and having added to it a quantity of aqua fortis well corrected, that is, mixed with near one third of the quantity of river water; they boil it over a wood fire, till such time as the aqua fortis yields no more red fumes.

This first water being poured off and the cornet left alone at the bottom of the matrass, they fill the matrass again, but with pure aqua fortis; which, after boiling, is poured off in its turn at such times as the fumes are become white.—This done, they fill up the matrass with river water, to wash the cornet.

When washed they put it dry in a crucible, with a cover over it, and heat it till it become of a cherry-colour.

This done, the *assay* is finished; and there remains nothing but to weigh it against the same weight of fine gold, as was used at first before the assay; for by comparing the first weight of the gold ere it was put in the fire, and the aqua fortis, with what it returned after it had thus undergone the test; they judge from the greater or less loss it has sustained, of the quantity of alloy mixed with it.

Now for *refining silver*; which is done two ways; the one with lead, the other with salt-petre. The best and cheapest is that with lead.

To *refine silver with lead*; a coppel is filled with a mixture of brick ashes, and ashes of a bullock's or other bones. It is set on the fire and heated red hot; in which state the lead is put in, and when this is melted, the *silver*, in the proportion of a pound of lead to four or five ounces of silver, and even somewhat more lead, if the *silver* be very coarse. As these two metals melt together, the copper, before mixed with the *silver*, dissipates in smoak, or goes away with the scum and litharge, and so does the lead itself; leaving the silver alone in the coppel, in its proper degree of fineness.

In this method of *refining*, wherein 6 or 7000 pounds may be refined at once; the metal is drawn out of the coppel two ways; the one by plunging in it, while still liquid, a thick bar of iron, round which the *silver* sticks in form of a shell, or crust; repeating this again and again: the other is by letting the coppel stand till it be cold; in the bottom whereof the silver fixes in form of cake.

The *refining silver with salt-petre*, is performed in a wind-furnace.—The *silver* to be refined having been reduced into grains of the size of little peas, by pouring it, when melted, into a tub of common water; it it heated over again in a boiler. After this they put it in a crucible, and along with it, to every eight ounces of metal, two of salt-petre.

The crucible is now covered up with an earthen lid, in form of a dome, exactly luted; which lid however is to have a little aperture in the middle.

The crucible being put in the furnace, and covered with charcoal, which is only to be lighted by degrees; at length they give it the full force of the fire to put the metal into a perfect fusion. This they

they repeat three times fucceffively, at an interval of a quarter of an hour.

After a third fire they uncover the furnace, and let the crucible cool; and at length break it, to get out the filver, which is found in a button or culot; the bottom whereof is very fine filver; and the top mixed with the fæces of the falt petre, and the alloy of the filver, and even fome particles of the fine filver.

The culot being feperated from the impurities, is melted in a new crucible, and into the diffolution is thrown charcoal-duft, and the whole brifkly worked together. Then the crucible being covered up again, and the furnace charged with coal, a fecond fire is given it.

This done the afhes, and other impurities are blown from the top of the metal, till it appears as clear as a looking-glafs; and then an ounce of borax broke in pieces is thrown in.

Laftly, the crucible being covered up again, they gave it the laft fire; after which it is caft into ingots; which are found eleven penny-weights, and fixteen grains fine.

To recover the filver that may be left in the fæces, or fcoria, they pound them, and give them repeated lotions in frefh waters.

But both the one and the other manners are tedious and troublefome, when performed on large quantities. This occafioned M. *Homberg* to endeavour to fhorten the operation: which he effected with good fuccefs. His method is, to calcine his filver with half its weight of common fulphur; and after melting the whole together, to caft a quantity of fteel-filings upon it at feveral times: upon this the fulphur quits the filver, and joins itfelf to the iron, and both are converted into fcoria, which fwim on the filver; and the metal itfelf is found pure at the bottom of the crucible.

The *affay of filver* is much after the fame manner of that of gold; only lefs difficult and fhorter. The filver is weighed as before; and the fame furnace, and muttler, the fame fire, the fame coppel ufed. Add, that lead is alfo put in the coppel, proportioned to the quantity and quality of the filver to be affayed.

The lead being well melted and clear, the filver is put in; and after it is brought to an opal colour, and fixed in a lump at the bottom of the coppel, which happens in about half an hour; they let it cool, and cleanfe it; and laftly, weigh it again as in gold; and from its diminution eftimate the quantity of alloy.

The *refining of* COPPER, is only performed by giving the mineral matter feveral lotions before the melting it, and then giving it feveral repeated fufions.

The *refining of* TIN, is performed much after the fame manner of that of copper, though we may diftinguifh two kinds of finenefs of this metal: the one arifing from its fufion, that *tin* taken firft out of the furnace wherein it is melted, being always purer than that towards the bottom.

The other kind of finenefs is that given the *tin*, by adding fome other metal or mineral to it, to render it more fonorous as well as brighter; fuch is *tin* of antimony, Pewter, &c.

For the *method of affaying tin.*—To find whether *tin* be foft and ductile, or harfh and brittle, there are two kind of affays:— he firft, is by putting the *tin* in a mould of caft brafs, and there melting it. If the metal be harfh, it will be taken out heavier than before; otherwife it will be lighter. The fecond, is by cafting the melted *tin* into a little mould, made of the thunder-ftone. This mould has a little canal of moderate length, which conducts the matter into a cavity, capable of containing half a billiard ball: if the *tin* be harfh, it appears whitifh towards the entry of the mould; otherwife it is tinged fuperficially with a very faint bluifh brown,

Refining of Iron, begins likewife by melting it. The greater degree of fufion the mineral has, the more the metal is purified: But this firft fufion is not fufficient. To render the iron malleable, and fit to endure the file, it muft be melted a fecond time; then forged or beaten a long time with huge heavy hammers, wrought by water; then heated in the fire, and at laft reduced on the anvil into bars of feveral thickneffes.

The more the iron is heated in the fire, and the more it is beaten, whether hot or cold, the finer it becomes.

Steel is only iron refined to a great degree by heating it with fome other ingredients, which clofe up the pores and foften the grain thereof.

Refining of Lead, is performed like that of moft other imperfect metals. by frequent meltings, ftill fcumming it before it be cold; and cafting in tallow and other kind of fat.

There is alfo an *Affay made of lead*; for the affay of gold and filver, being performed by means of lead; 'tis of the utmoft importance, the lead be free of any mixture of either of the two metals: Otherwife the *affay* will be falfe, by reafon the gold and filver mixed with the lead, will not evaporate like other kinds of alloy, but unite with the metal under *affay*.

To prevent this diforder, and affure the operation, there is no way but to affay the lead itfelf.

This *affay* is performed in the fame furnace, and with the fame coppels, as thofe of gold and filver: But the procefs is incomparably more fimple. All here required, when the coppel is heated, being to put in the piece of lead to be affayed. If this lead evaporates entirely, it is fit for the purpofe. On the contrary, if there remain a little grain of filver, &c. at the bottom, it muft be fet afide.

SCULP-

RHETORICK.

RHETORICK, is the art of cloathing our thoughts with words, ſo as they may be either inſtructive, perſuaſive, or entertaining, whether we ſpeak, or write; and it is commonly divided into four parts, viz. *invention*, *diſpoſition*, *elocution* and *pronunciation.*

INVENTION is to find out arguments, which the orator is to uſe for the proving his point, or moving his hearers paſſions.

ARGUMENTS are alſo divided, with reſpect to the place they are drawn from into *intrinſick* or artificial; and *extrinſick* or inartificial, or remote.

Artificial or *intrinſick* ARGUMENTS, are the proper invention of him who ſpeaks; or thoſe, which are taken from the ſubject treated of: of which there are ſeveral kinds, viz. *genus* and *ſpecies*, *form*, *cauſe*, and *effect*, *&c.*

To theſe ſome add two other places of *argument*, viz. the *manners*, and the *paſſions.*

Inartificial or *extrinſick* ARGUMENTS, are thoſe, which are borrowed from abroad, and only applied by the orator to the point in hand; ſuch are laws, common report, books, oaths, torture, and witneſſes.

A late author divides the places or general heads of arguments, with regard to their end, into 1. Thoſe intended to perſuade or diſſuade, which are chiefly drawn from the conſideration of profit, honour, and equity. 2. Thoſe intended to praiſe or diſpraiſe. And 3. Thoſe intended to accuſe and defend.

The DISPOSITION is defined, the art of diſtributing the things or arguments invented, or found out into a proper order; or a due placing, or ranging the ſeveral parts of a ſpeech or diſcourſe; which parts are uſually reckoned four, *viz.* the *exordium* or beginning; the *narration*, the *confirmation*, and the *peroration* or *concluſion*, though ſome make them ſix, viz. the *exordium*, *diviſion*, *narration*, *confirmation*, *confutation*, and *peroration*, as indicated in that popular verſe,

Exorſus, *narro*, *ſeco*, *firmo*, *refuto*, *peroro.*

But the *Diviſion* is more naturally referred to the *exordium*; and the *confutation* to the *confirmation.*

The EXORDIUM is the preamble or beginning of a diſcourſe or ſpeech; ſerving to prepare the audience, and introduce the matter in hand.

Exordiums are of two kinds; either juſt and formal; or vehement and abrupt. In the firſt, the audience is prepared and conducted by due and eaſy ſteps; in the ſecond, the orator, as if ſeiz'd with ſome ſudden paſſion, breaks out upon his audience at once. Such is that *exordium* of *Iſaiah*, *Hear, O heavens, and give ear, O earth:* Or that of *Cicero* againſt *Catiline*, *Quouſque tandem abutere patientia noſtra Catilina? How long*, Catilina, *wilt thou abuſe our patience?*

Abrupt *exordiums* are the moſt ſuitable on occaſions of extraordinary joy, indignation, or the like.

The requiſites in an *exordium* are, 1. *propriety*, whereby the *exordium* becomes of a piece with the whole diſcourſe, and matches it as a part does a whole; ſo that it could not be accommodated to any other, or perhaps a contrary occaſion.

2. *Care*, accuracy and magnificence, as being the part moſt minded, and moſt expoſed to ſhew.

3. *Modeſty*, or an ingenious baſhfulneſs, which recommends the orator exceedingly to the favour of his audience. *Tully* owns of himſelf, that at the beginning of his orations he trembled every limb, and his whole mind was in a flutter.

And 4. *Brevity*, not exemplified or ſwelled, with a deal of circumſtances, or a long circuit of words.

The DIVISION ſeldom finds place in any other diſcourſes, but in *ſermons* and *panegyricks*, and is invented only to eaſe the memory of the orator. The diviſion ſhould be always, as much as poſſible, contained in the text: for example, if I was to preach a ſermon on the grace of *Jeſus Chriſt*, and take for text of my diſcourſe this paſſage of St. *Paul*. *It is by the grace of God that I am what I am, and the grace of God has not been void in me*; I would divide my diſcourſe into two parts, proving in the firſt the power of grace, alluding to the firſt part of my text, *It is by the grace of God that I am what I am*; and in the ſecond, the neceſſity of our co-operating with grace, and *the grace of God has not been void in me.*

The NARRATION is a recital or rehearſal of a fact as it happened, or as it is ſuppoſed to have happened.

This is of two kinds, either *ſimple* and *hiſtorical*, as where the auditor or reader is ſuppoſed to hear or read of a tranſaction at ſecond-hand—or *artificial* and *fabulous*, as where their imaginations are raiſed, and the action, as it were re-acted before them.

Cicero requires four virtues in a *narration*, viz. *perſpicuity*, *probability*, *brevity* and *ſweetneſs.*

The *narration* is rendered *perſpicuous*, by obſerving the order of time, by uſing none but proper and known terms, and by reciting the action uninterruptedly.

It is rendered *probable*, by the credibility of the narrator, by the ſimplicity and openneſs of the *narration*, by avoiding every thing far remote from the

the common fenfe and opinion of mankind, and by a precife detail of circumftances.

It is rendered brief, by taking it up no higher than is juft neceffary, nor fetching it back, as that impertinent author in *Horace*, *qui gemino bellum Trojanum orditur ab ovo*; and by avoiding trivial circumftances.

Laftly, It is rendered fweet, by ufing fmooth, numerous and well-founding words; by aranging them, fo as to avoid any hiatus or clafhing; by the greatnefs, novelty, and unexpectednefs of the things related; and by enriching it with tropes and figures, as frequent admirations, exclamations, interrogations, expectations, fufpences, furprifing events, by grief, joy, fear, *&c.*

CONFIRMATION is that part of an oration, wherein the orator undertakes to prove, by laws, reafon, authorities, and other arguments, the truth of the propofitions advanced in his narration.

Confirmation is either *direct* or *indirect*; to the firft conforms what the orator has to urge for ftrengthening his own caufe; the fecond properly called *confutation*, refels the oppofite arguing of the adverfaries, the two parts together being fometimes placed under the head or title of *contention*.

The *confirmation* is, as it were, the life and foul of the oration; in this the main ftrefs of the argumentation lies, whence *Ariftotle* properly enough calls it *fides*.

The *peroration* is the epilogue or laft part of an oration; wherein, what the orator infifted on through his whole difcourfe is urged afrefh, with greater vehemency and paffion.

The *peroration* confifts of two parts, 1. Recapitulations, wherein the fubftance of what was diffufed throughout the whole fpeech, is collected briefly and curforily, and fummed up with new force and weight.

2. The moving the paffions, which is fo peculiar to the *peroration*, that the mafters of the art call this part *fedes affectuum*.

The paffions to be rais'd in the *perorations* are various, according to the various kinds of orations: in a panegyrick, love, admiration, emulation, joy, *&c.* in an invective, hatred, contempt, *&c.* in a deliberation, hope, confidence, or fear.

The qualities required in the *peroration* are, that it be vehement and paffionate, and that it be fhort; becaufe, as *Cicero* obferves, tears foon dry up.

The *peroration* was *Cicero*'s mafter-piece. Here that great orator not only fet his judges and auditors on fire, but even feemed to burn himfelf; efpecially when he was to raife pity and commiferation towards the accufed; where, as he himfelf tells us, he frequently filled the forum with weeping and lamentation.

The ELOCUTION is defined by *Tully*, the chafing and adapting of words and fentences to the things or fentiments to be expreffed.—To the *elocution* then properly belongs the choice of words. To exprefs a mean or low thing, in great and magnificent words, is, fays *Longinus*, as if one would put a large mafk on the face of a young child; unlefs it be in poetry.

The beauty of *elocution* confifts chiefly in the ufe of figures, and figurative dictions or expreffions, in the periods and the ftile.

A PERIOD, according to *Ariftotle*, is a difcourfe which has a beginning, a middle, and an end, all vifible at one view.

The *periods* allowed in oratory are three; a *period* of two members, called by the Greeks *dicolos*, and the Latins *bimembris*: a *period* of three members, *tricolos*, *trimembris*: and a *period* of four members, *quadrimembris*, *tetracolos*.

A ftrict *oratorial period*, does not allow of either more or fewer than thefe; it is poffible, indeed, to introduce a *period* of one member, called by *Ariftotle*, *monocolos*, or *fimple period*, but it will be reputed a flaw, and is a thing never practifed by the mafters.

The *period* may be likewife prolonged to five or fix members, but then it changes its name, and inftead of a *period*, commences a periodical difcourfe.

A *period* of two members *Cicero* fupplies us with: *Ergo & mihi meæ priftinæ vitæ confuetudinem, C. Cæfar, interclufam aperuifti*; *& his omnibus ad bene de republica fperandum quafi fignum aliquod fuftulifti.*

A *period* of three members the fame *Cicero* gives us in the exordium of his *Manilian oration*: *Nam cum antea per ætatem hujus autoritatem loci contingere non auderem*; *ftatueremque nihil huc nifi perfectum ingenio, elaboratum induftria afferri oportere*; *omne meum tempus amicorum temporibus tranfmittendum putavi.*

A *period* of four members he gives us in that admirable defcription of the punifhment of *parricides*. *Ita vivum ut ducere animum de Cœlo non queant: ita moriantur ut eorum offa terra non tangat: ita jactantur fluctibus, ut nunquam abluantur: ita poftremo ejiciuntur, ut ne ad fanor quidem mortui conquiefcant.*

In oratory, the members of *periods* are to be equal, or nearly equal; that the paufes, or refts of the voice, at the clofe of each member, may be nearly equal: but in writings no ways intended for rehearfal, this is difregarded.

Periods are faid to be either *rotundi*, round, or *quadrati*, fquare, according to their different œconomy and cadences, or numbers, which numbers are

are a sort of simple unaffected harmony, less glaring than that of verse, yet such as is perceived, and affects the mind with pleasure.

The *numbers* are that by which the stile is said to be easy, free, round, flowing, *&c.*

The *square period* is that consisting of three or four equal numbers, formerly distinguished from each other.

The *round period* is that whose members or parts are so connected, and fitted into each other, as that the junctures or commissures are scarce seen; but the whole slides equally round, without any notable stops or inequalities.

Now for the *stile*, which is another part of the *enunciation*.

Stile, in matter of language, is a peculiar manner of delivering a man's thought in writing agreeably to the rules of syntax; or, as Father *Buffier* more accurately defines it, the manner wherein the words contracted according to the laws of syntax, are arranged among themselves, suitably to the genius of the language.

From the definition, it appears, that *stile* supposes, or includes the syntax; and that syntax does not extend so far as *stile*: for the syntax may be very just where the *stile* is wretched.

Rhetoricians reduce the kinds of *stiles* to three; the *sublime*, the *low*, and the *intermediate*, or *equable stile*.

Sublime stile is that consisting in magnificent words and sentences; which by its noble boldness ravishes the hearers, and extorts admiration even from the unwilling.

Low or *simple stile* is that ordinarily used in smaller and humbler works; as epistles, dialogues, and common discourse. The chief virtues hereof are perspicuity, smoothness, easiness, and cleanness; it must be very sparing in the use of tropes and figures, especially the more violent ones, as the prosopopæia, apostrophe, *&c.*

Intermediate or *equable stile* partakes of the magnificence of the *sublime* and the simplicity of the *low*. It neither rises to the majesty of the one in words and sentences; nor yet is smartly pointed like the other; but, as *Tully* excellently expresses it, *est stilus quidam interjectus, intermedius, & quasi temperatus; nec acumine inferioris, nec fulmine utens superioris, vicinus amborum, in neutro excellens, utriusque particeps.*

The same author calls it the *florid* and *polished stile*; it being in this that all the graces and beauties of language are principally to be used.

For the choice of *stile*, in the general, the matter is to determine it. Such *stile*, says *Cicero*, is to be chosen, as expresses great things magnificently, middle things moderately, and low things subtilly: but more particularly, as there are three branches of the duty of an orator, to *teach*, to *delight*, and to *move*; the simple *stile* is used to teach; the middle to *delight*; and the sublime to *move*.

The beauty of the periods and stile consists chiefly in the *figures* which enter the composition.

Figure, in *rhetorick*, is a phrase or turn of speech or discourse, finer and nobler than what is used in common or ordinary speaking; or the enrichments of discourse, which we only use when raised, and moved with the consideration of something extraordinary.

There are two kinds of *figures*; the one of *sentences*, and contained in the sense itself, without any immediate dependance on any particular words; the others are only in the *words* themselves.

Of the *figures* of *sentences*, some are designed to *move*, others to *teach*, and others only to *delight*.

Of the *first* kind the most considerable are, *exclamation*, *imprecation*, *obsecration*, *interrogation*, *doubting*, *præterition*, *expolition*, and *epiphonema*.

Those of the *second* are the *antithesis*, *correction*, *communication*, and *suspension*.

Those of the *third*, the *apostrophe*, *hypothyposis*, *prosopopæia*, *ethopæia*, and *prosopographia*.

The *exclamation* is a *figure*, wherein, by raising the voice, and using an interjection, either expresly or understood, we testify an uncommon warmth and passion of mind; and express the magnitude of the thing, or the importance of the occasion.

Such is, *O heavens! O earth! O times! O manners!*

The *imprecation* is a kind of curse, expres'd in discourses, by *may* or *let*; for instance, *May the enemies of God be confounded! Let the wicked be punished! &c.*

The *interrogation* is a figure wherein the passion of the speaker introduces a thing by way of question, to make its truth more conspicuous.

Doubting is a figure wherein the orator appears sometimes fluctuating, and undetermined what to do, or say. What shall I do? shall I apply to those I once neglected! or implore those who now forsake me!

The *obsecration* is a figure whereby the orator implores the assistance of God or man.

This figure *Cicero* makes admirable use of, for King *Dejotarus* to *Cæsar*.—*Per dexteram te istam oro, quam Regi Dejotaro hospes, hospiti porrexisti: istam inquam dexteram non tam in bellis, & prœliis, quam in promissis, & fide firmiorem.*

The *preterition* is a figure, whereby in pretending to pass over a thing untouched, we make a summary mention thereof, for instance—*I will not say he is valiant, he is learned, he is just, &c.*—The most artful praises are those given by way of

 prete-

preterition.—This figure is alſo called *paralepſis* and *apoſiopeſis*.

Expolition is a figure whereby we explain the ſame thing in different phraſes and expreſſions, in order to ſhew it more fully. The ſcriptures are full of ſuch figures.

Epiphonema is a ſententious ſort of exclamation, frequently added after a narrative, or rehearſal of any thing remarkable; containing, uſually, a lively cloſe reflection on the ſubject there ſpoken of.

Such is that of St. *Paul*, when, after diſcourſing of the rejection of the *Jews*, and the vocation of the *Gentiles*, he cries out,

Oh the depth of the wiſdom and knowledge of God!

The *antitheſis* is a ſetting two things by way of expoſition to each other, that the different qualities of each may appear the more ſtrongly.

Such is that of *Cicero* in the ſecond *Catilinarian*: *On the one ſide ſtands modeſty, on the other impudence; on the one fidelity, on the other deceit: here piety, there ſacrilege; here continency, there luſt, &c.*

Correction is a figure, whereby a perſon in a paſſion, fearing he has not expreſſed a thing fully or ſtrongly enough, calls it back again, as it were, by a ſtronger phraſe, and corrects the error. This is alſo called *epanorthoſis*.

Such is that of *Cicero for Cœlius*: *O ſtultitia! ſtultitiam ne dicam, an impudentiam ſingularem!* Oh folly! folly did I call it, or rather intolerable impudence?

Suſpenſion is a keeping the hearer in ſuſpence, and attentive, in expectation of what the ſpeaker will conclude in, as, *O God! darkneſs is not more oppoſite to light, tempeſts to calm, pain to pleaſure, or death to life, than ſin to thee.*

The *apoſtrophe* is a figure, whereby the orator, in an extraordinary commotion, turns his diſcourſe from the audience, and directs it to ſome other perſon or thing.

Thus *Cicero* in his oration for *Milo*, addreſſes himſelf to the great patriots, who had ſhed their blood for the publick, and calls them to the defence of his client.

The *apoſtrophe* is alſo frequently addreſſed to inanimates, as tombs, monuments, defuncts, &c.

That *apoſtrophe* of *Demoſthenes*, wherein he addreſſes himſelf to the *Greeks* ſlain at the battle of *Marathon*, is famous. Cardinal *du Perron* ſays, it has procured the orator as much glory, as if he had raiſed them from the dead.

The *hypotypoſis* is a figure whereby a thing is ſo lively deſcribed or painted, that it does not ſeem to be read or heard, but actually ſeen, or preſented before the eyes.

Such is that elegant one of *Cicero*, wherein he paints the barbarity of *Verres*: *Ipſe inflammatus ſcelere, & furore, in forum venit. Ardebant oculi; toto ex ore crudelitas emanabat. Expectabant omnes quo tandem progreſſurus, aut quidnam acturus eſſet; cum repente hominem corripi, atque in fori medio nudari ac deligari, & virgas expedire jubet; clamabat ille miſer ſe civem eſſe Romanum*, &c.

The *ethopœia* or *ethopæa*, called alſo *ethology*, is a draught or deſcription, expreſſing the manners, paſſions, genius, tempers, aims, &c. of another perſon.

Such is that beautiful paſſage in *Salluſt*, in his *Bellum Catilinarium*, wherein he gives a picture of *Catiline*: *Fuit magna vi & animi & corporis ſed ingenio malo pravoque huic*, &c. *He had an uncommon ſtrength both of body and mind; but an ill-turned and wicked diſpoſition. When a mere boy, his great pleaſure was in inteſtine broils, rapine, ſlaughter, and civil diſcord. His body was formed to undergo faſting, cold, and watching, beyond all belief. His mind was daring, deceitful and various; and could imitate, or accommodate itſelf to every body: he was extremely covetous of other people's goods, and profuſe of his own withal: his luſts and deſires were very high; his ſtock of eloquence conſiderable; but his diſcretion, ſcarce any.*

The *ethopœia* is divided into *proſopographia*, and *ethopœia* properly ſo called; the former of which is a picture of the body, countenance, make, dreſs, gait, &c. and the latter of the mind.

The *proſopopœia*, is a figure whereby we make perſons that are abſent or dead, or even things which are inanimate, as cities, &c. to ſpeak.

There are two kinds of *proſopopœia's*; the one direct, the other indirect. For an inſtance of the latter; *Juſt gods, protectors of the innocent, permit the order of nature to be interrupted for one moment, and let this carcaſs reſume the uſe of ſpeech*, &c.

Inſtances of the former are found every where among the orators and poets: that which follows is a very beautiful one, found by way of epitaph on a tomb-ſtone: the dead wife addreſſes her ſurviving huſband thus:

Immatura peri: ſed tu felicitr, annos
Vive tuos, conjux optime, vive meos.

'I have been ſnatched away, before I was ar-
'rived yet to the years of my maturity; but thou,
'much happier, O the beſt of huſbands, may the
'years I ſhould have lived be added to thine.'

Of *figures of words*, ſome are tropes, i. e. tranſlations of words from their proper ſignification, to ſome more remote and extraordinary one.

The principal of theſe are, the *metaphor*, *allegory*,

gory, *metonimy*, *ſynechdoche*, *irony* and *ſarcaſm*, *metalepſis*, *antonomaſia* and *ſylepſis*.

Others are *figures of words*, properly ſo called, and not tropes, being ſo inherent in the words, that upon changing of thoſe the figure is deſtroyed; as in *amantes ſunt amentes*, where the figure would be loſt, if inſtead of *amentes* you ſhould put *ſtulti*.

Of theſe the principal are *repetition*, *converſion*, *complexion*, *gradation*, *ſynonymy*, *polyſyndeton* and *polyptoton*, *reticency*, *diſtinction*, *ſimilitude*, *paronomaſy*, and *tranſition*.

Trope is a word or expreſſion, uſed in a different ſenſe from what it properly ſignifies. Or a word changed from its proper and natural ſignification to another with ſome advantage; as when we ſay an *aſs* for a *ſtupid perſon*.

It is called *trope*, τρόπος, from the *greek* τρέπω, *verto*, *I turn*, *change*.

This change or inverſion is performed various ways, but chiefly four; whence ariſe four principal tropes, *viz.* the *metaphor*, *metonimie*, *ſynechdoche* and *irony*.

Some alſo refer the ſix kinds of ſcoffing or deriſion to the *tropes*, *viz.* the *ſarcaſm*, *diaſyrm*, *charientiſm*, *aſteiſm*, *myčteriſm*, and *mymeſis*, but without ſufficient reaſon.

Now for the explication of each of the different *figures* of words, beginning with the *metaphor*.

The *metaphor* is a figure of ſpeech, whereby a word is transferred from its proper ſignification to another; or whereby the proper denomination of one thing is applied to another; which other thing is more elegantly explained by this tranſlatitious, or foreign name, than by that which naturally belongs to it. As when we ſay the light of the underſtanding; to burn with zeal; to float between hope and deſpair, &c.

Quintilian diſtinguiſhes *metaphors* into four kinds. The *firſt*, when a word is transferred from one animal to another; as when *Livy* ſays, that *Cato* uſed to bark at *Scipio*; or, when our Saviour calls *Herod* fox. The *ſecond*, when the word is transferred from one inanimate to another; as *bridle* for *laws*. The *third* when inanimates are applied to animates; as the flower of youth. And the *laſt*, when animates are applied to inanimates; as the river *diſdained* its bounds.

A *metaphor* ſhould have nothing in it either coarſe or ſhocking, or that may raiſe it above the ſimplicity of nature: nor ſhould it appear a *metaphor* to any but thoſe who view it very cloſely. *Metaphor* ſhould never be carried too far; for in that caſe it degenerates into puerility. In all metaphorical dictions there ſhould be a kind of unity, ſo that the different words uſed may have a kind of ſuitableneſs to each other: different ideas are always abſurd.

The *allegory* is a figure whereby we make uſe of terms, which in their proper ſignification mean ſomething elſe than what they are brought to denote; or it is a figure, whereby we ſay one thing, expecting it ſhall be underſtood of another, to which it alludes.

An *allegory* is properly a ſeries of metaphors.—Such is that beautiful allegory in *Horace*, lib. 1. Od. 14.

> *O navis, referent in mare te novi*
> *Fluctus*, &c.

Where the ſhip is uſually held to ſtand for the *republick*; *waves* for *civil war*; *port* for *peace* and *concord*; *oars* for *ſoldiers*; *mariners* for *magiſtrates*, &c.

The old teſtament is ſuppoſed by many to be a perpetual *allegory*, or typical repreſentation of the myſteries of the new.

The *metonymy* is a rhetorical trope, conſiſting in a tranſmutation, or change of names; or a putting off the effect for the cauſe, or the ſubject for the adjunct; and *vice verſa*.

There are four kinds of *metonymies* in principal uſe: the *firſt*, when we put the inventor for the thing invented; as *Bacchus* for *wine*; *Ceres* for *bread*. The *ſecond*, when we put the containing for the thing contained; as a glaſs for the wine within it. The *third*, when effect is put for the cauſe; as the captain for his ſoldiers, *Greece* for the *Greeks*, the author for his works. The *fourth*, when the ſign is put for the thing ſignified; as the gown for the prieſthood, &c.

Synecdoche is a kind of figure, or rather trope, frequent among orators and poets.

There are three kinds of *ſynecdoches*: by the *firſt*, a part is taken for the whole; as the point for the ſword, the roof for the houſe, the ſails for the ſhip, &c.---By the *ſecond*, the whole is uſed for a part.—By the *third*, the matter whereof the thing is made, is uſed for the thing itſelf; as ſteel for ſword, ſilver for money, &c. to which may be added another kind, when the ſpecies is uſed for the genus, or the genus for the ſpecies.—As *he bore the ſin of many*, i. e. of all.

The *irony* is a figure in ſpeech, wherein we plainly intend ſomething very different from what our words expreſs: as when we ſeem to praiſe a perſon at a time, when we evidently rally and diſcommend him.---The irony diſcovers itſelf rather in the tone of the ſpeaker, than in the words.

Sarcaſm is a keen, bitter irony, whereby the orator ſcoffs and inſults his adverſary.---Such was that

that of the *Jews* to our Saviour: *He faved others, himfelf he cannot fave.*

Antonomafia is a figure whereby a noun appellative is ufed inftead of a proper name, or the contrary. Thus we fay, the philofopher, inftead of *Ariftotle*; the orator, for *Cicero*.

The *fyllepfis* is a figure whereby we conceive the fenfe of words otherwife than the words import; and thus make our conftruction, not according to the words, but the intention of the author.

It is a figure of confiderable ufe for the well underftanding of authors.— *Scioppius* divides it into two kinds, *fimple* and *relative*.

Simple fyllepfis is when the words of a difcourfe either difagree in gender or number, or both.

Relative fyllepfis is when the relative is referred to an antecedent, which is not expreffed; but which we conceive by the fenfe of the whole period.

As to the *figures of words* properly fo called, the firft is *repetition*, which is a figure whereby the orator rehearfes the fame word or phrafe over again.

Of this there are two kinds.— In the *firft* the words are repeated precifely in the fame fenfe: As, *Oh Jerufalem, Jerufalem, who killeth the prophets,* &c. *my God, my God, why haft thou forfaken me?*

The fecond kind of repetition called πλοκη, is a *repetition* of the fame word, in the fame phrafe; but in fuch a manner as that fome new idea or character is added to the words in the fecond, which it had not in the firft.

As *Corydon* is always *Corydon: ex illo Corydon, Corydon eft tempore nobis*; by which we fignify that *Corydon* is no ordinary perfon; and that nothing can diftinguifh him but the repetition of his own name: As if we fhould fay, *he is Corydon, that is enough.*— By the fame figure our Saviour fpeaks, when he fays, *let your language be yea, yea, and nay, nay.*

Converfion in *rhetorick*, is underftood of arguments which are returned, retorted, and fhewn on oppofite fides, by changing the fubject into the attribute, and the attribute into the fubject.

Complexion is a figure, including a repetition, and a converfion at the fame time; the fentence both beginning and ending with the fame word.

Thus *Tully, Quis legem tulit? Rullus, quis comitiis præfuit, Rullus,* &c.

Gradation is when a feries of confiderations or proofs is brought, rifing by degrees, and improving each on the other.

Such is that in *Cicero* to *Catiline. Nihil agis, nihil moliris, nihil cogitas; quod ego non audiam, quod etiam non videam, planeque fentiam.* This figure is alfo called *climax*.

Synonymy is a figure whereby fynonyms or fynonymous words, that is, various forms of the fame fignification, are made ufe of, to amplify the difcourfe.

Such is that paffage of *Cicero, abiit, evafit, effugit, erupit,* he went off, he efcaped, he run away, *&c.*

The *polyptaton* is the figure, wherein the fame word is repeated in different cafes, genders, or numbers, *i. e.* with different terminations.

Such is that of *Cicero, pro Arch. Sed pleni funt omnes libri, plenæ funt fapientum voces, plena exemplorum vetuftas.*

Reticency is a figure whereby we make oblique mention of a thing, in pretending to pafs it over unmentioned.

Thus: *To fay nothing of the nobility of his anceftors: I forbear to fpeak of his courage, and pafs over the feverity of his morals.*

The *comparifon* is a figure, or rather place in fpeech, whereby two things are confidered, with regard to fome third, which is common to them both.

Thus *Cicero Topic. Catoni licuit fequi bellum civile, igitur et Ciceroni licebit. It was allowed Cato to engage in the civil war, therefore it may be allowed Cicero:* where to engage in the civil wars is common to both.

There are three kinds of *comparifon*; the firft *a majori*, i. e. from the major to the minor, as that of Cicero againft *Antony, Quid feceris domi tuæ, cum alienæ tam fis infolens?*

The fecond *a minori*, i. e. from the minor to the major: Thus *Cicero, Majores noftri fæpe mercatoribus, ac naviculatoribus imperiofius tractatis, bella gefferunt; vos tot civium Romanorum millibus uno nuntio, atque uno tempore necatis, quo tandem animo effe debetis?*

The third *à pari*; as when we contend that what obtains in one thing, ought to obtain in another of the fame kind: thus, *it was a law, that he who killed his father fhould be fewed up in a fack and thrown into a river; therefore, he who killed his mother deferves the fame punifhment.*

The *paronomafy* is a figure, whereby words nearly alike in found, but of very different fenfes, are affectedly or defignedly ufed.

The *tranfition* is a kind of connexion in difcourfe, whereby the feveral parts and members thereof are joined, fo as to conftitute one regular whole.

Father *de Colonia* makes two kind of *tranfitions*; the one *perfect*, the other *imperfect*.

Perfect tranfition is that wherein we briefly intimate what is faid, and what remains to be faid. As, *now that we have fpoke of war, there remains fomething to be faid of peace.*

Imperfect tranfition is that wherein only one of thefe is expreffed.—As, *Let us now confider the confequences of,* &c.

Longinus

Longinus recommends alſo the images in the diſcourſe, which he defines to be, in general, any thoughts proper to produce expreſſions, and which preſent a kind of picture to the mind.

Theſe images or pictures are of vaſt uſe to give weight, magnificence and ſtrength to a diſcourſe. They warm and animate it; and when managed with art, according to *Longinus*, ſeem, as it were, to tame and ſubdue the hearer, and put him in the power of the ſpeaker.

The ſame author recommends the *periphraſe* as of great uſe in a diſcourſe; which *periphraſe* is a circuit or tour of words, much affected by orators, to avoid common and trite manners of expreſſion.

The *periphraſe* is certainly of good uſe in many occaſions; and we are frequently forced to have recourſe to it, to make things be conceived which is not proper to name.

Thus *Cicero*, unable to deny that *Clodius* was ſlain by *Milo*, owns it, with this *periphraſe* or *circumlocution*: '*Milo*'s ſervants being prevented from 'aſſiſting their maſter, who was reported to be 'killed by *Clodius*, they, in his abſence, and with- 'out his privity or conſent, did what every body 'would expect from their own ſervants on ſuch 'occaſions.'

The AMPLIFICATION is alſo of a very great uſe in *rhetorick*, and is part of a diſcourſe or ſpeech, wherein a crime is aggravated, a praiſe or commendation heightened, or a narration enlarged by an enumeration of circumſtances; ſo as to excite the proper emotions in the ſouls of the auditors.

Such is that paſſage in *Virgil*, where, inſtead of ſaying merely that *Turnus* died, he amplifies his death.

---------Aſt illi ſolvuntur frigore membra,
Vitaque cum gemitu fugit indignata ſub umbras.

There are two general kinds of *amplification*; the one of *things*, the other of *words*. The firſt is produced in divers manners; as, 1. By a multitude of definitions: Thus it is *Cicero* amplifies on hiſtory: *Hiſtoria eſt teſtis temporum, lux veritatis, vita memoriæ, magiſtra vitæ, nuntia vetuſtatis.* —2. By a multitude of adjuncts; of which we have a fine inſtance in *Virgil*'s lamentation for *Cæſar*'s death, by enumerating the many prodigies and monſters that either preceded or ſucceeded it. —*Vox quoque per lucos vulgo exaudita ſilentes, ingens, & ſimucra modis pallentia miris viſa ſub obſcurum noctis; pecudeſque locutæ, infandum, ſiſtunt amnes, terræque dehiſcunt, & mæſtum illachrymat templis ebur, æraque ſudant.*—3. By a detail of cauſes and effects.—4. By an enumeration of conſequences. —5. By compariſons, ſimilitudes, and examples, *&c.*—6. By the contraſts of antitheſes, and rational inference.

Amplification by words is effected ſix ways.— 1. By uſing metaphors.—2. By hyperboles.—3. By ſynonims.—4. By ſplendid and magnificent terms, as that of *Horace*, *Scandit æratas vitioſa navi cura nec turmas equitum relinquit, ocyor cervis, & agente nymbos ocyor Euro.*—5. By periphraſes, or circumlocutions.—6. By repetition.—To which may be added, by gradation.

The periods, numbers, figures, *&c.* are what compoſes what we call *diſcourſes*, or *orations*; ſince an oration is a ſpeech or harangue, framed according to the rules of oratory, and ſpoke in publick.

All the kinds of *orations* may be reduced to three heads, *viz.* *demonſtrative*, *deliberative*, and *judicial*.

To the *demonſtrative kind* belong, *panegyricks*, *genethliaca*, *epithalamia*, *epicedia*, *eucharistiæ*, *epinicia*, and *congratulations*.

Panegyrick is an oration in praiſe of ſome extraordinary perſon, or virtue.

The places or ſources of *panegyricks* are chiefly the family, country, auguries at his birth, his virtues, the talents of his body, mind, honours, riches, manner of his death, and the conſequences thereof.

Genethliacum is a compoſition in verſe, on the birth of ſome prince, or other illuſtrious perſon; wherein the poet promiſes him great honours, advantages, ſucceſſes, victories, *&c.* by a kind of prophecy or prediction.

The *epicedion* is a poetical compoſition on the death of a perſon.

I have explained what is underſtood by *epithalamium*, in *poetry*.

The *epicedion* was a compoſition on occaſion of a victory obtained

To the deliberative kind belongs *perſuaſion*, *diſſuaſion*, *exhortation*, and *commendation*.

And to the judicial kind belongs *accuſation*, *confirmation*, *confutation*, *&c.*

Confirmation is the third part of an oration, wherein the orator undertakes to prove by laws, reaſons, authorities, and other arguments, the truth of the propoſitions advanced in his narration.

Confirmation is either *direct* or *indirect*; the firſt confirms what the orator has to urge for ſtrengthening his own cauſe: the ſecond, properly called *confutation*, refels the oppoſite arguing of the adverſaries.

From this I'll proceed to the fourth and laſt part of our diviſion of *rhetoric*, *viz.* the *pronunciation*.

PRO-

Pronunciation.

The pronunciation, as underſtood in this place, conſiſts in regulating and varying the voice and geſture agreeably to the matter and words, ſo as more effectually to touch the hearers.

Pronunciation is the ſame with what we otherwiſe call *action*.

There are three things which come under the *pronunciation*; the *memory*, *voice*, and *geſture*.

The *memory* is a natural talent, which, though eſſential to the orator, is not, notwithſtanding, to be acquired by art.

The *voice* is alſo a very eſſential part of eloquence, ſince it contributes much towards diſcovering all the beauties of a diſcourſe or oration, without which it appears inanimate, or languid. A fine and ſonorous voice ſtrikes ſo agreeably the ear of the auditors, that it often penetrates the inmoſt receſſes of the heart, where it excites different ſorts of paſſions, according to the ſubject of the diſcourſe. The orator muſt always begin his diſcourſe with a gentle and moderate voice, raiſing it with diſcretion by degrees, as occaſion requires, in ſuch a manner that he may be always maſter thereof; expreſſing joy in a quite different manner than he would do ſorrow, avoiding above all things a tedious monottony, as well as thoſe exceſſive bawlings, more proper to ſtun the auditor, than to make him hear.

The *geſture* is a motion of the body, intended to ſignify ſome idea or paſſion of the mind; and it conſiſts principally in the action of the hand and face.

Action, in oratory, is an accommodation of the perſon of the orator to his ſubject; or a management of the voice and geſture, ſuited to the matter ſpoken or delivered. It is an addreſs to our external ſenſes; which it endeavours to move, and bring into its party, by a well concerted motion and modulation; at the ſame time that the reaſon and underſtanding are attacked by force of argument.

Quintilian gives us a ſyſtem of the rules of *action*, taken not only from the writers of antient orators, but from the beſt examples of the forum.

The force and effects of *action*, at leaſt as practiſed among the antients, appears to be very great; ſcarce any thing was able to withſtand it. *Demoſthenes* expreſly calls it, ‘ the beginning, the ‘ middle, and the end of the orator's office;’ and *Cicero* profeſſes, ‘ that it does not ſo much matter ‘ what the orator ſays, as how he ſays it.’

Every part of the body is by them liſted into the ſervice, and marſhalled in its proper place: the hand, the eye, head, neck, ſides, cheeks, noſtrils, lips, arms, ſhoulders, &c.—*Precipuum in actione caput eſt. Cum geſtu concordet, &* lateribus *obſequatur*, oculi, lachrymæ, ſupercilium, genæ, rubor.—*Non manus ſolum, ſed &* nutus.—*Dominetur autem maximè* vultus.—*Quin & in vultu* pallor.—*Nares, labia.*—Dentes, cervix, humeri, brachia.—Manus *vero, ſine quibus* trunca eſſet actio.----*Quintil.* xi. 3.

Demoſthenes and *Cicero* are the princes of antient eloquence; the one among the *Greeks*, the other among the *Romans*; becauſe they both wrote and ſpoke well. Their manner however was exceedingly different; the firſt being cloſe, ſtrong, nervous, conciſe, and ſevere, ſo that a word could not be ſpared: the latter copious, florid, and rich, ſo that a word could not be added.

It was objected to *Cicero*, that his eloquence was *Aſiatick*, that is, redundant, or ſtuffed with ſuperfluous words and thoughts.

Pericles was called *a torrent of eloquence*, *a thunderbolt of eloquence*. Pedants do not diſtinguiſh *eloquence*, from the heaping up of figures, the uſe of big words, and the rotundity of periods.

True *eloquence* depends principally on the vivacity of the imagination. In ſtrictneſs, it is not that which gives grace and ornament, but life and motion, to diſcourſe. Its mien is that of an amazon, not that of a coquette.

The authors of the *art of thinking* remark, that the rules of *eloquence* are obſerved in the converſations of people naturally *eloquent*, though they never think of them while they practiſe them. They practiſe thoſe rules becauſe they are *eloquent*, in order not to be *eloquent*.

The *eloquence* of the chair and pulpit, is much more difficult every where, but in *England*, than that of the bar. The obligation laid on the *Engliſh* clergy to read their ſermons, has entirely baniſhed *eloquence* from the pulpit; therefore much better *orators* are found at *Weſtminſter*, either in both houſes of parliament, or in the courts of judicature, than in the churches; whereas in other countries, *France* for example, the beſt orators are found in the chair or pulpit. It is true, that there are ſome perſons who read better than others, but ſtill it is but reading, for that can never be called preaching; and reading for reading, I had rather chuſe to read myſelf than to hear another read; ſince I cannot only read better pieces of *eloquence* than thoſe which are often read to me, but likewiſe enter better into the ſenſe of the author, and be thereby much more edified. If that prohibition of reciting ſermons by heart was taken off, the *Engliſh* pulpit would acquire a new luſtre, for no doubt but that there are as good orators among the *Engliſh* clergy, as among others, and we ſhould not see a kind of epidemical lethargy reigning in the churches.

But without confining ourselves to a particular country, we must say, that *eloquence* has shared every where the fate of all other arts and sciences, and has suffered a very great eclipse ever since, like them, it has met with little or no encouragement: in fact, true eloquence is so little in vogue at present, that the best orator would scarce find an audience worthy of being spoke to; ridiculous discourses, digested without art, order, or agreement, and stuffed with low thoughts, trivial expressions, and delivered in an indolence which had been capable only to excite the compassion, or perhaps the laughter of an honest *Roman* citizen, are almost the only ones we are entertained with at present, and can assemble a numerous audience. Not that I pretend that all discourses are to be composed with a scrupulous regularity, according to all the rules of *rhetorick* heretofore explained; but they should not be all neglected, since no body can claim the title of orator, without he be a rhetorician.

ROPE-MAKING.

ROPE-MAKING, is to spin twists, or strings of hemp; and when spun, to twist them together, in a greater or less number, according to the thickness of the *rope*.

This spinning is done by the rope-maker, twisting round him a certain quantity of coarse hempen flax, fastening one end thereof to the iron of a spinning-wheel made for the purpose, spinning it with his index, and thumbs of both hands, walking slowly backwards, *i. e.* his face turned towards the wheel, while another person turns it round, to twist what he spins.—This operation is done in a long alley, commonly called *rope-walk*; and there are placed in the walk, by intervals, racks to support the ropes, and keep it tight, which otherwise, being arrived at a certain length, would fall to the ground, and thereby prevents the operation going forwards.

If the twist, or string, which is spun, is used alone, without being joined with others, it must be twisted harder than if it was to enter into the composition of another rope; though there is scarce any rope which has not several twists.

When the rope is made very thick, it is called a *cable*; and when very small, a *cord*.

A CABLE, is a thick, long, three-string'd rope, ordinarily of hemp, serving to hold ships firm at anchor.

Cable is not applied to ropes of less than three inches circumference.

Every *cable*, of whatever thickness it be, is composed of three strands; each strand of three twists; each twist of a certain number of caburns, or threads of rope-yarn, more or less, as the *cable* is to be thicker or smaller.

To make a *cable*, after forming the strands, they use staves, which they first pass between the strands, that they may turn the better, and be intertwisted the more regularly together: And to prevent any entangling, a weight is hung at the end of each strand. The cable being twisted as much as needs, is untwisted again three or four turns, that the rest may the better retain its state.

The number of threads each kind of *cable* is to be composed of, is ever proportion'd to its length and thickness; and it is by this number of threads, that its weight and value are ascertained. A rope of three inches circumference, or one inch diameter, consists of 48 ordinary threads, and weighs 192 pounds; one of 10 inches circumference of 485 threads, and weighs 1940 pounds; a *cable* of 20 inches, of 1943 threads, and weighs 7772 pounds. The seamen say, the *cable is well laid*, when it is well wrought or made.

SCULPTURE.

SCULPTURE, is the art of cutting or carving various figures or representations in wood, stone, or other matter; as also of fashioning wax, earth, plaister, &c. to serve as models or moulds, for the casting of metalline figures.

Sculpture is divided into several branches, *viz.* *Statuary*; which is the art of making *statues* only, either in wood, stone, ivory, plaister, &c. *Carving*; which is that of making *bass-relievo's*, *festoons*, *cartouches*, *fret-work*, &c.

A STATUE is a piece of *sculpture* in full relievo, representing a human figure.

In strictness, the term *statue* is only applied to figures on foot, as that of king *James* II. at *White-*

ball; the word being formed from the *Latin ſtatura*, the ſize of the body; or from *ſtare*, to ſtand.

There are *allegorical*, *cyriatic*, *curule*, *equeſtrian*, *Greek*, *hydraulic*, *pedeſtrian*, *Perſian*, and *Roman ſtatues*.

Allegorical STATUE is that, which under a human figure, or other ſymbol, repreſents ſomething of another kind, as a part of the earth, a ſeaſon, age, element, temperament, hour, &c.

Cyriatick STATUE is the ſame with what we called in our treatiſe of architecture caryatides.

Curule STATUES are thoſe, which are repreſented in chariots drawn by two or four horſes; of which kind there were ſeveral in the circus's, hippodromes, &c. or in cars, as we ſee ſome with triumphal arches on antique medals.

Equeſtrian STATUE is that repreſenting ſome illuſtrious perſon on horſeback. As that famous one of *Marcus Aurelius* at *Rome*; that of King *Charles* I. at *Charing-Croſs*.

A *Greek* STATUE is a figure, that is naked and antique; it being in this manner the *Greeks* repreſented their deities, athletæ, of the olympick games, and heroes. The *ſtatues* of heroes were particularly called *Achillean ſtatues*, by reaſon of the great number of figures of that prince, in moſt of the cities of *Greece*.

Hydraulick STATUE is any figure placed as an ornament of a fountain, or grotto; or that does the office of a jet d'eau, a cock, ſpout, or the like, by any of its parts, or by any attribute it holds. The like is to be underſtood of any animal ſerving for the ſame uſe.

Pedeſtrian STATUE is a *ſtatue* ſtanding on foot. As that of King *Charles* II. and others in the *Royal Exchange*.

Perſian STATUES are taken notice of in the treatiſe of architecture, under the Letter A.

Roman STATUES is an appellation given to ſuch as are cloathed, and which receives various names from the various dreſſes. Thoſe of emperors with long gowns over their armour, were called *ſtatutæ paludatæ*; thoſe of captains and chevaliers, with coats of arms, *thoracatæ*; thoſe of ſoldiers with cuiraſſes, *loricatæ*; thoſe of ſenators and augurs, *trabeatæ*; thoſe of magiſtrates with long robes, *togatæ*; thoſe of the people with a plain tunica, *tunicatæ*; and laſtly, thoſe of women with long trains, *ſtolatæ*.

The *Romans* had another diviſion of *ſtatues*, 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 figure, or portrait of a perſon in *relievo*, ſhewing only the head, ſhoulders, and ſtomach; the arms being lopped off, ordinarily placed on a pedeſtal or conſol, is called *buſt* or *buſto*.

The *buſt* is the ſame with what the *Latins* called *herma*, from the Greek *hermes*, *Mercury*; the image of that god being frequently repreſented in this manner among the *Athenians*. *Buſt* is alſo uſed, eſpecially among the *Italians*, for the trunk of a human body, from the neck to the hips.

The ſculptor has ſeveral chiſſels, all different in bigneſs and fineneſs; which they change in proportion as they go on with their work; the largeſt are uſed to prime it, before they lay their deſign on the block, whereof the *ſtatue* is to be made.

For *Sculpture on marble or ſtone*; the firſt thing they do, is out of a great block of marble to ſaw another of the ſize required, which is performed with a ſmooth ſteel ſaw without teeth, caſting water and ſand thereon from time to time: then they faſhion it, by taking off what is ſuperfluous with a ſtubbed point, and a heavy mallet; after this, bringing it near the meaſure required, they reduce it ſtill nearer with another finer point. They now uſe a flat cutting inſtrument, having two notches in its edge, or three teeth; then a chiſſel to take off the ſcratches the former has left. This laſt inſtrument they uſe with a deal of delicacy, giving thereby a ſoftneſs and tenderneſs to their figure; till at length taking raſps of different degrees of fineneſs, by degrees they bring their work into a condition for poliſhing.

To poliſh or make the parts ſmooth and ſleek, they uſe pumice-ſtone and ſmalt, then tripoli; and when a ſtill greater luſtre is required, a ſkin of burnt ſtraw.

To proceed more regularly, on the head of the model, they place an immovable circle, divided into degrees, with a moveable ruler, or index, faſtened in the center of the circle, and divided likewiſe into equal parts; from the end of the ruler hangs a thread with a plummet; which ſerves to take all the points to be transferred thence to the block of marble, from whoſe top hangs another plummet like that of the model. All which may be ſeen in our table of miſcellany.

Indeed there are ſome excellent ſculptors, who diſapprove of this method; urging that the ſmalleſt motion of the model changes their meaſures, for which reaſon they rather chuſe to take all their meaſures with their compaſſes.

The perfection of a *ſtatue*, either in wood, marble, ſtone, iron, &c. conſiſts chiefly in a fine attitude, beautiful parts imitating nature as near as poſſible, without any exaggeration either in the features, or the pronunciation of the members.

The

The drapery, if there be any, well thrown, and with as few plaits as poſſible; ſince it is not ſo eaſy to make them imitate the natural with the chiſſel, as with the pencil: and a too great number of plaits in marble, ſtone, or plaſter, appear rather as the pipes of an organ, or the like, than plaits, never affecting to render the muſcles viſible in the naked, but in proportion as the age, ſex, or attitude of the perſon the figure is to repreſent, require it: for the muſcles are not to be ſo viſible in a woman as in a man, nor in a child, as in a man grown, nor in a figure ſuppoſed in an eaſy poſture, as in one ſuppoſed in a violent one: which is a fault ſeveral very good ſculptors are guilty of, pretending thereby to make connoiſſeurs admire the ſtrokes of their chiſſels, and the knowledge they have of anatomy.

Statues are ſaid to be figures alſo in *relievo*.

There are three kinds of *relievo*'s, viz. *alto-relievo*, *baſſo-relievo*, and *demi-relievo*. *Relievo* in general, or *relief*, *imboſſment*, being applied to a figure which projects or ſtands out, prominent from the ground or plain whereon it is formed; whether that figure be cut with the chiſſel, moulded, or caſt.

Alto-RELIEVO, *haut-relief*, or *high-relievo*, is when the figure is formed after nature, and projects as much as the life.

Baſſo-RELIEVO, *bas relief*, or *low-relievo*, is when the work is but raiſed a little from its ground; as we ſee in medals, and in the frontiſpieces of buildings, particularly hiſtories, feſtoons, foliages, and other ornaments in the frieze.

Demi-RELIEVO, is when one half the figure riſes from the plain, *i. e.* when the body of a figure ſeems cut in two, and one half is clapped on the ground. When in a *baſſo-relievo* there are ſome parts that ſtand clear out, detached from the reſt, the work is called a *demi-boſſe*.

The antiquity of ſculpture is paſt doubt; as the ſacred writings, the moſt antient and authentick monument we have of the earlieſt ages, mentions it in ſeveral places; witneſs *Laban*'s idols ſtolen away by *Rachel*, and the golden calf which the *Iſraelites* ſet up in the deſart, &c. but it is very difficult to fix the original of the art, and the firſt artiſts from prophane authors; what we read thereof being intermixed with fables, after the manner and taſte of thoſe ages.

Some make a maſter of *Sicyon*, named *Dibutades*, the firſt ſculptor; others ſay, the art had its origin in the iſle of *Samos*, where one *Ideaus* and *Theodorus* performed works of this kind long before *Dibutades*'s time. It is added that *Demaratus*, father of *Tarquin* the elder, firſt brought it into *Italy* upon his retiring thither; and that by means of *Euciparus* and *Eutygrammus*, two excellent workmen herein, who communicated it chiefly to the *Tuſcans*, among whom it was afterwards cultivated with great ſucceſs. They add that *Tarquin* ſent for *Taurianus*, one of the moſt eminent among them, to *Rome*, to make a ſtatue of *Jupiter*, &c. of baked earth; for the frontiſpiece of the temple of that deity.

About this time, there were many ſculptors, both in *Greece* and *Italy*, who wrought altogether in earth. Some of the moſt noted are *Chalcoſthenes* an *Athenian*, who made himſelf and his houſe famous, by the great number of earthen figures he adorned it withal; and *Demophilus* and *Gorſanus*, two painters, who enriched the temple of *Ceres* with great variety of painting and earthen images. In effect, all the firſt ſtatues of the heathen deities, were either of earth or wood; and it was not ſo much any frailty of the matter, or unfitneſs for the purpoſe, as the riches and luxury of the people, that firſt induced them to make images of marble, and other more precious ſtone.

Indeed how rich ſoever the matter were whereon they wrought, yet they ſtill uſed earth, to form models thereof: and to this day, whether they be for cutting marble ſtatues with the chiſſel, as already obſerved, or for caſting them in metal: they never undertake the one or the other, without firſt making a perfect model thereof in earth.

Phidias of *Athens*, who came next, ſurpaſſed all his predeceſſors, both in marble, in ivory, and metals: and about the ſame time appeared ſeveral others, who carried ſculpture to the higheſt perfection it ever arrived at, particularly *Policletus* at *Sicyon*; then *Migron*; *Lyſippus*, who alone was allowed the honour of caſting *Alexander*'s image in braſs: *Praxiteles* and *Scopas*, who made thoſe excellent figures now before the pope's palace, at *Monte Cavallo*: *Briacus*, *Timotheus*, and *Leothares*, who with *Scopas* wrought the famous tomb of *Mauſoleus* King of *Caria*; *Caphiſſodotus*, *Canachus*, *Dadalus*, *Bathicus*, *Niceratus*, *Euphranor*, *Theodorus*, *Xenarates*, *Pyromachus*, *Itratonicus*, *Antigonus*, who wrote on the ſubject of his art; the famous authors of *Laocoon*, viz. *Ageſander*, *Polydore*, and *Athenodorus*, and infinite others, the names of ſome whereof have paſſed to poſterity.

When *Marcus Scaurus* was Ædile, his office obliging him to provide what was requiſite towards the public rejoicings, he adorned the ſtately theatre which he erected with 3000 braſs ſtatues; and though *L. Mummius* and *Lucullus*, brought away a great number out of *Aſia* and *Greece*, yet there were ſtill above 3000 remaining in *Rhodes*, as many at *Athens*, and more at *Delphos*.

But what is more extraordinary was the bigneſs of the figures, which thoſe antient artiſts had the courage to undertake: among thoſe *Lucullus* brought to *Rome*, there was one of *Apollo* 30 cubits high; the *Coloſſus* of *Rhodes* made by *Cares* of *Lyndos*, the diſciple of *Lyſippus* far exceeding it; *Nero*'s ſtatue, made by *Xenodorus*, after that of *Mercury*, was 110 feet high.

Sculpture however did not continue above 150 years after *Phidias's* time, till it began inſenſibly to decline; not but that there were ſtill ſome fine pieces of workmanſhip both in *Greece* and *Italy*, though not performed with ſo good a fancy, and ſuch exquiſite beauty as thoſe of the former works. Beſides that the *Greek* ſtatues are moſt eſteemed for the workmanſhip; there is a ſpecial difference between them and thoſe of the *Romans*, in that the greateſt part of the firſt are naked, like thoſe who wreſtle, or perform ſome other bodily exerciſe, wherein the youth of thoſe times placed all their glory; whereas the others are clad or armed, and particularly have the toga on, which was the greateſt mark of honour among the *Romans*.

S H A M O I S I N G.

SHAMOISING is the art of preparing ſheep, goat, or kid-ſkin, in oil, in imitation of *ſhammy*. Which *ſhammy* is the ſkin of the *chamois* or *ſhamois*, a kind of wild goat, called *iſard*, inhabiting the mountains of *Dauphiné*, *Savoy*, and the *Pyreneans*.

Beſides the ſoftneſs and warmneſs of the leather, it has the faculty of bearing ſoap without damage, which renders it very uſeful on many accounts.

To counterfeit this ſort of leather, the ſkins of any of the other animals above-mentioned, being waſhed, drained, and ſmeared over with quick-lime on the fleſhy ſide, are folded in two, length-wiſe, the wool outwards, and laid on heaps; and ſo left to ferment eight days; or if they have been left to dry after flaying, fifteen days.

Then they are waſhed out, drained, and half dried, laid on a wooden leg or horſe, the wool ſtripped off with a round ſtaff for the purpoſe, and laid in a weak pit, the lime whereof had been uſed before, and had loſt the greateſt part of its force.

After twenty-four hours they are taken out, and left to drain twenty-four more; then put in another ſtronger pit. This done, they are taken out, drained, and put in again by turns; which begins to diſpoſe them to take oil; and this practice they continue for ſix weeks in ſummer, or three months in winter; at the end whereof they are waſhed out, laid on the wooden leg, and the ſurface of the ſkin on the wool-ſide pulled off, to render them the ſofter; then made into parcels, ſteeped a night more in the river, in winter; ſtretching ſix or ſeven over one another, on the wooden leg; and the knife paſſed ſtrongly on the fleſh-ſide, to take off any thing ſuperfluous, and render the ſkin ſmooth.

Then they are ſtretched as before in the river; and the ſame operation repeated on the wool ſide; then thrown into a tub of water with bran in it, which is brewed among the ſkins till the greateſt part ſtick to them; and then ſeparated into diſtinct tubs, till they ſwell, and riſe of themſelves above the water.

By this means the remains of the lime are cleared out: they are then wrung out, hung up to dry on ropes, and ſent to the mill, with the quantity of oil neceſſary to fever them. The beſt oil is that of ſtock-fiſh.

Here they are firſt thrown in bundles into the river, for twelve hours; then laid in the mill-trough, and fulled without oil till they be well ſoftened; then oiled with the hand, one by one, and thus formed into parcels of four ſkins each, which are milled, and dried on cords a ſecond time, then a third, then oiled again and dried.

This proceſs is repeated as often as neceſſity requires: when done, if there be any moiſture remaining, they are dried in a ſtove, and made up into parcels wrapped up in wool: after ſome time they are opened to the air, but wrapped up again as before, till ſuch a time as the oil ſeems to have loſt all its force, which it ordinarily does in twenty-four hours.

The ſkins are then returned from the mill to the *ſhamoiſer*, to be ſcoured, which is done by putting them in a lixivium of wood-aſhes, working and beating them in it with poles, and leaving them to ſteep till the lye has had its effect; then they are wrung out, ſteeped in another lixivium, wrung again, and this repeated till all the greaſe and oil be purged out. When this is done, they are half dried, and paſſed over a ſharp-edged iron inſtrument, placed perpendicular on a block, which opens, ſoftens, and makes them gentle: laſtly, they are thoroughly dried, and paſſed over the ſame inſtrument again, which finiſhes the preparation, and leaves them in form of *ſhammy*.

Kid and goat-ſkins are *ſhamoiſed* in the ſame manner as thoſe of ſheep; excepting that the hair is taken off, without the uſe of any lime; and that when brought from the mill, they undergo a particular

particular preparation, called *ramalling*; the moſt delicate and dfficult of all others.

It conſiſts in this; that as ſoon as brought from the mill, they are ſteeped in a fit lixivium; taken out, ſtretched on a round wooden leg, and the hair ſcraped off with the knife; this makes them ſmooth, and in working caſt a kind of fine nap. The difficulty is in ſcraping them even.

There is, likewiſe, an art or manner of preparing, or dreſſing ſkins in white, to fit them for uſe in divers manufactures, particularly gloves, purſes, &c. which art is called *tawing*.

All kinds of ſkins may be *tawed*; but it is chiefly thoſe of ſheep, lambs, kids, and goats, that are uſed to be dreſſed this way; as being thoſe fitteſt for gloves.

As to the *method of tawing, or drawing ſkins in white*. The wool or hair being well got off the ſkins by means of lime, &c. as above deſcribed, they are laid in a large vat of wood or ſtone ſet in the ground, full of water, wherein quick-lime has been ſlacked; wherein they continue a month or ſix weeks, as the weather is more or leſs hot; or as the ſkins are requir'd to be more or leſs ſoft and pliant.

While in the vat, the water and lime is changed twice, and they are taken out and put in again every day. When taken out for the laſt time, they are laid all night to ſoak in a running water, to get out the greateſt part of the lime; and in the morning are laid ſix together on the wooden leg, to get off the fleſh by ſcraping them ſtoutly, one after another, on the fleſh ſide, with a cutting two-handed inſtrument, called a knife; and while this is in hand, they cut off the legs, and other ſuperfluous parts about the extremes.

This done, they are laid in a vat or pit, with a little water, where being well fulled with wooden peſtles for a quarter of an hour, the vat is filled up with water, and the ſkins rinſed therein. They are next thrown on a clean pavement to drain; which done, they are caſt into a freſh pit of water, where being well rinſed, they are taken out, and laid on the wooden leg, ſix at once, with the hair ſide outermoſt, over which they rub a kind of whetſtone very briſkly, to ſoften and fit them to receive four or five more preparations given them on the leg, both on the fleſh ſide and the hair ſide, with the knife, after the manner above-mentioned.

This over, they are put in a pit with water, and wheat-bran, and ſtirred about therein, with wooden poles, till the bran is perceived to ſtick to them, and then they are left; as they raiſe of themſelves to the top of the water by a kind of fermentation, they are plunged down again to the bottom; and, at the ſame time, fire is ſet to the liquor, which takes as eaſily as if it was brandy, but goes out the moment the ſkins are all cover'd.

This operation is repeated as often as the ſkins riſe above water; and when they riſe no more, they are taken out, laid on the wooden leg, the fleſh ſide outermoſt, and the knife paſſed over it to ſcrape off the bran. The bran thus cleared, the ſkins are laid in a large baſket, where they are loaden with huge ſtones to promote their draining; and when ſufficiently drained, their feeding is given them, which is performed after the following manner.

For a hundred large ſheep-ſkins, and for ſmaller in proportion, they take eight pounds of allum, and three of ſea-ſalt, and melt the whole with water over the fire; pouring the diſſolution out, while yet lukewarm, into a kind of trough, wherein is twenty pounds of fine wheat flour, with eight dozen yolks of eggs; of all which is formed a kind of paſte, a little thicker than children's pap, which, when done, is put into another veſſel, to be uſed in manner following.

A quantity of hot water being poured into the trough, wherein the paſte was prepared, two ſpoonfuls of the paſte is mixed therewith; in order to which they uſe a wooden ſpoon, which contains juſt what is required for a dozen ſkins: and when the whole is well diluted, two dozen of the ſkins are plunged therein: care being taken, by the way, that the water be not too hot, which would ſpoil the paſte, and burn the ſkins.

Having ſtaid ſome time in the trough, they are taken out one after another with the hand, and ſtretched out, which is repeated twice: when they have all had their paſte, they are put into tubs, where they are fulled afreſh with wooden peſtles.

Then they are put in a vat, where they remain five or ſix days or more, and are at laſt taken out in fair weather, and hung out to dry on cords or racks: the quicker they dry, the better; for if they be too long a drying, the ſalt and allum within them are apt to make them riſe into a grain, which is an eſſential fault in this kind of dreſſing.

When the ſkins are dry, they are put up in bundles, and juſt dipp'd in fair water; from which being taken out and drained, they are thrown into an empty tub; and after ſome time, are taken out, and trampled under foot.

They are then drawn over a flat iron inſtrument, the top whereof is round like a battledore, and the botom fixed into a wooden block, to ſtretch and open them: when open, they are hung in the air upon cords to dry; and when dry, are open a ſecond

second time by repassing them over the same instrument.

Lastly, they are laid on a table, pulled out, and laid smooth; and are thus in a condition for sale and use. After the same manner are dressed horses, cows, calves skins, *&c.* for sadlers, harness-makers, *&c.* as also dogs, wolves, bears skins, *&c.* excepting that in those the use of the paste is omitted; salt and allum-water being sufficient.

It will not be improper to add here the manner of preparing *shagreen*, which is a kind of grain-leather, chiefly used on the cover of cases, books, *&c.* it is very close and solid, and cover'd over with little roundish grains or papillæ.

As to the preparation thereof. The skin being just flayed off, is stretched out, cover'd over with mustard-seed, and the seed bruised on it, and thus exposed to the weather for some days, then tanned.

The best is that brought from *Constantinople*, of a brownish colour; the white is the worst. It is extremely hard, yet when steeped in water becomes very soft and pliable; whence it becomes of great use among case-makers. It takes any colour that is given it; red, green, yellow, or black. It is frequently counterfeited by *maroquin*, formed like *shagreen*; but this last is distinguished by its peeling off, which the first does not.

There is also a kind of *shagreen* made of the skin of the *squatina*; in *English*, the monk or angel fish.

There is a dispute among authors, what the animal is whence the *shagreen* is prepared. *Rauwolf* assures us, it is the *onager*, which, according to him and *Bellonius*, is a kind of *wild ass*.

It is added, that it is only the hard part of the skin is used for this purpose. *Beul* says it is a *sea-calf*; others, a kind of fish, called by the *Turks shagreen*, whose skin is cover'd with grains, and those so hard, that they will rasp and polish wood.

Shagreen is brought from *Constantinople*, *Tauris*, *Tripoli*, *Algiers*, and some parts of *Poland*.

SMITHERY.

SMITH is an appellation given to artists who forge and prepare some metal on the anvil, particularly gold, silver, iron, copper, *&c.* therefore there are *goldsmiths*, *silversmiths*, *blacksmiths*, *coppersmiths*, &c.

There is no other difference between a goldsmith and a silversmith, but in the appellation, for commonly the same artist works both metals.

The workshop of a gold or silversmith, must be fitted with a forge, crucibles of different sizes, anvils, hammers, moulds, vices, files, polishers, burnishers, *&c.*

Gold and silver are never worked pure, but are always mixed with their proper alloy, which for gold, is silver and copper; and for silver, copper alone; but in mixing those metals, they must be kept to the standard.

The standard of gold in *England*, *France* and *Flanders*, is 22 carats of fine gold, and a carat of alloy in the pound weight troy. And the standard of silver is 11 ounces and two penny weights of silver, and 18 penny weights of alloy of copper.

Gold and silver, before they are forged, are reduced into ingots; and the ingenious artist, having took enough of it for the piece of work he intends to make, he heats it red-hot in his forge, as a blacksmith does his iron, to render it more ductile, compact and more proper for farther preparations. This first operation is the foundation, of the whole beauty of the work. For if the metal be not well forged, at first, it remains brittle and fragile, *i. e.* that it breaks easily under the hands of the artist, when he is giving the form it must have; or of those who have bought it; whereas when well forged it bends all manner of ways, without breaking. But there is a great art in forging it; for the metal must neither be heated too much, nor too little, nor too often, nor hammered too hard; for if it be heated too hot, it scales by too great abundance of the igneous particles, which crowd into the parts of the metal with too much impetuosity lacerating their texture; and if not heated enough, it resists to the hammer for want of a sufficient quantity of igneous particles, to help, by their rotation, accellerated by the motion of the hammer, towards the dilatation of the pores: therefore the metal must never be left in the fire till it emits a kind of stars when taken out; neither is it to be taken out while it appears cloudy.

The artist must likewise take a particular care to hammer it evenly, *i. e.* without leaving part of its metal very prominent while he is flattening the other. In forging, the hammer must not be let fall too heavy on the metal; for dilating thereby its pores with too much violence, it makes them burst, whereby they run into one another, and prevents the concatenation necessary, to render it pliable and manageable.

If

If it be a piece of work, which muſt be planed cold, after it has been forged; that planing muſt be done with a ſteady and even hand, with very little violence, taking the ridges ſucceſſively, one after another: and if it be a round piece of work, planing round-wiſe; beginning next the edges, and going on progreſſively towards the middle.

When a piece-work, after it has been forged, is to be filed, if it be a large piece, the filing muſt be done with bold and long ſtrokes, which contributes much to the beauty of the work, and helps towards its being poliſhed with much more eaſe.

The pieces of works, which are to be caſt, are caſt either in ſand, if they be large pieces, or in the bones of the ſcuttle-fiſh, if they be ſmall ones; which they do by preſſing the pattern between two bones; and leaving a jet or hole to convey the ſilver through after the pattern has been taken out.

If the work conſiſts of ſeveral pieces, they are ſoldered together.

Goldſmiths uſually make four kinds of ſolder, *viz.* ſolder of eight, where to ſeven parts of ſilver there is one of braſs or copper. Solder of ſix, where only a ſixth part is copper. Solder of four, and ſolder of three. It is the mixture of copper in the ſolder that makes raiſed plate always come cheaper than flat.

To ſolder the pieces they faſten them tight together with a piece of iron wire, and they cover with pieces of ſolder and ſome borax, that part where the pieces are to be joined: then if it be a ſmall piece of work, they put it on a piece of charcoal, and having lighted a lamp or a big candle, and holding their work in the left-hand, and as near the flame as poſſible, they with the right holding their pipe, blow through it into the flame, which makes it ſpread over the work, and melt the ſolder, whereby the pieces are ſolder'd together. When the artiſt ſees the ſolder fuſing, he takes his work from the lamp, and the operation is done; taking off afterwards with a file the ſuperfluidity of the ſolder; ſo dexterouſly, that the ſoldered part may be as little diſcernable as poſſible; in which conſiſts the great ſecret of the art of ſoldering.

The work in this condition is fit for poliſhing; which is done with a piece of white wood and tripoli. When poliſhed it is burniſhed with a round poliſhed piece of ſteel; which laſt operation gives a luſtre to the metal. If it be gold it is coloured in the ſame manner we have explained in our treatiſe of *gilding*, under the letter G.

As there is nothing to be thrown away of what comes out of gold or ſilver, all the aſhes of the furnaces and ſweepings of the work-ſhop, are carefully ſaved, in order to recover by waſhing the particles of gold and ſilver out of them; which is performed by ſimply waſhing them again and again, or by putting them in the waſhing-mill.

To make one of thoſe waſhes, they not only gather together the aſhes of the furnaces, and the ſweepings of the work-houſes; but they alſo pound and break the old earthen crucibles, and the very bricks whereof the furnaces are built; little particles of gold, &c. being found to ſtick to them, by the crackling nature of thoſe metals when in their vaſt degree of heat.

Theſe matters being all well ground and mixed together, are put in large wooden baſons, where they are waſhed ſeveral times, and in ſeveral waters, which run off by inclination into troughs underneath; carrying with them the earth, and the inſenſible particles of the metals; and only leaving behind them the larger and more conſiderable ones, which are viſible to the eye, and taken out with the hand, without any more trouble.

To get out the finer parts gone off with the earth, they uſe quickſilver, and a waſhing mill. This mill conſiſts of a large wooden trough, at the bottom of which are two metalline parts, ſerving like mill-ſtones; the lower being convex, and the upper, which is in form of a croſs, concave.

A-top is a winch, placed horizontally, which turns the upper piece round; and at the bottom a bung, to let out the water and earth when ſufficiently ground.

To have a waſh then, the trough is filled with common water, into which they caſt thirty or forty pounds of quickſilver; and two or three gallons of the matter remaining after the firſt lotion. Then turning the winch, they give motion to the upper mill-ſtone; which grinding the matter and the quickſilver violently together, the particles of gold and ſilver become more eaſily amalgamated therewith: This work they continue for two hours; when opening the bung, the water and earth run out, and a freſh quantity is put in.

The earths are uſually paſſed thus through the mill three times; and the ſame quantity of mercury uſually ſerves all the three times. When there is nothing left in the mill but the mercury, united with the gold and ſilver which it has amalgamated, they take it out, and waſhing it in divers waters, they put it in a thick bag, and lay in a preſs to ſqueeze out the water and the looſe quickſilver: the remaining quickſilver they evaporate by fire in a retort, or an alembick. The metal

metal which remains they refine with lead, or part it with aqua fortis, as described in my treatise of *refining*, under the letter R.

As for *black-smiths*, their workshop must likewise be fitted with a forge, anvils, and hammers, of different sizes, files, vices, &c.

The forge of a blacksmith, as likewise of the several other operators in iron, is very simple.

The hearth, or fire-place, is a mass of bricks about two feet six inches high: the back of the forge is built upright to the cieling, and is inclosed over the fire-place with a hovel, which leads into a chimney to carry away the smoak. In the back of the forge, against the fire-place, is a thick iron plate, with a taper fixed therein, about five inches long, called the *tewel*, into which the nose or pipe of the bellows is received: the use of this plate and tewel is, to preserve the pipe of the bellows, and the back of the hearth from being burnt. Right before the back, at about two feet distance, is the trough filled with water, to wet the coals in, and thereby increase their force; as also to punch the iron in. Behind the back of the forge is placed the bellows, one of whose boards is fixed so that it moves not either upwards or downwards; and to the other is fitted a rope, chain, or even rod; which rising perpendicularly, is fixed to a cross piece, called the *rocker*, which moving on a kind of fulcrum near the middle, serves as a handle.

By drawing down this handle, the moveable board of the bellows rises; and by a considerable weight atop of its upper board, sinks it down again; and by this alternate agitation performs the office of a pair of bellows.

Braziers and copper-smiths forge differs but little from that already described, unless that it is much less, and that nothing is burnt in it but charcoal; the metals used by these operators not being able to sustain the violence of pit-coal.

Iron is hammered and forged two ways, either by the force of the hand, in which there are usually several persons employed, one of them turning the iron, and hammering likewise, and the rest only hammering.

Or by the force of a water-mill; which rises, and works several huge hammers beyond the force of man, under the strokes whereof the workmen present lumps, or pieces of iron, which are sustained at one end by the anvils, and at the other by iron chains fastened to the cieling of the forge.

This last way of forging is only used in the largest works, as anchors for ships, &c. which usually weigh several thousand pounds. For lighter works, a single man suffices to hold, heat, and turn with one hand, while he strikes with the other. Each purpose the work is designed for requires its proper heat. If it be too cold, it will not feel the weight of the hammer, as the *smiths* call it (*i. e.* will not stretch or give way) and if it be too hot, it will red-sear, *i. e.* break, or crackle under the hammer.

The several heats the *smiths* give their iron, are, 1. A blood-red heat. 2. A white flame-heat. 3. A sparkling or welding heat.

SOAP-MAKING.

SOAP-MAKING is the art of preparing a kind of paste, sometimes hard and dry, and sometimes soft and liquid; much used in washing and whitening linen; and for various other purposes by the dyers, perfumers, hatters, fullers, &c.

There are three principal sorts of *soap* manufactured in *England*, viz. the *soft*, the *hard*, and the *ball-soap*. The soft soap again is either white or green.

The chief ingredients used in making the green soft soap, are lyes drawn from pot-ash and lime, boiled up with Tallow and oil. First, the lye and tallow are put into the copper together; and when melted, the oil is put to it, and the copper made to boil; then the fire is dampt or stopt up, while the ingredients lie in the copper to knit or incorporate; which done, the copper is set on boiling, being fed or filled with lyes, as it boils, till their be a sufficient quantity put therein: then it is boiled off with all convenient speed, and put into casks.

There are two sorts of *white soap*; one sort thereof is made after the same manner as *green soft soap* is, oil excepted, which is not used in white. The other sort is made from lyes of ashes of lime boiled up at twice with tallow.

First, a quantity of lye and tallow are put into the copper together, and kept boiling; being fed with lye as it boils, until it grains, or is boiled enough; then the lyes are separated or discharged from the tallowish part, which part is removed into a tub, and the lyes thrown away: this is called the first half boiled. Then the copper is charged again with fresh tallow and lyes, and the first half boil'd put out of the tub into the copper

per a second time; where it is kept boiling with fresh lyes and tallow till it comes to perfection. It is then put out of the copper into the same sort of casks, as are used in green soft soap.

As to *hard soap*.---It is made with lyes from ashes and tallow, and most commonly boiled at twice: the first called a half boiling, has the same operation as the first half-boil'd of soft white soap. Then the copper is charged with fresh lyes again, and the first half-boil'd put into it, where it is kept boiling, and fed with lyes as it boils, till it grains, or is boiled enough; then the lye is discharged from it, and the *soap* put into a frame to cool and harden. There is no certain time for bringing off a boiling of any of these sorts of *soap*; it frequently takes up part of two days.

The *ball soap* is made with lyes from ashes and tallow. The lyes are put into the copper, and boiled till the watery part is quite gone, and there remains nothing in the copper but a sort of nitrous matter (the very strength or essence of the lye;) to this the tallow is put, and the copper kept boiling, and stirring for about half an hour, in which time the *soap* is made; and then it is put out of the copper into tubs or baskets with sheets in them; and immediately (while soft) made into balls. It requires near twenty-four hours to boil away the watery part of the lye.

The *soft soap* is the most common in *England*, and the best.

Soft soap is an excellent remedy to kill crab lice, by rubbing the part with it.

STARCH-MAKING.

STARCH-MAKING is the art of procuring a sediment from wheat which had been steeped in water; of which sediment, after separating the bran from it, by passing it through sieves, are formed a kind of loaves, which being dried in the sun, or an oven, is afterwards broke into little pieces, and so sold. The process is as follows:

The grain being well cleaned, is put to ferment in vessels full of water, which they expose to the sun, when in its greatest heat; changing the water twice a day for the space of eight or twelve days, according to the season. When the grain bursts easily under the finger, they judge it sufficiently fermented. The fermentation perfected, and the grain thus softened; it is put, handful by handful, in a canvas bag, to separate the flour from the husks, which is done by rubbing and beating it on a plank, laid a-cross the mouth of the empty vessel, that is to receive the flour.

As the vessels are filled with this liquid flour, there is seen swimming a-top, a reddish water, which is to be carefully scum off from time to time, and clean water put in its place; which, after stirring the whole together, is all to be strained through a cloth or sieve, and what is left behind, put into the vessel with new water, and exposed to the sun for some time; and as the sediment thickens at the bottom, they drain off the water four or five times, by inclining the vessel, but without passing it through the sieve. What remains at the bottom, is the *starch*, which they cut in pieces to get out, and leave it to dry in the sun. When dry it is laid up for use.

The best *starch* is white, soft, and friable, easily broke into powder.

Starch is used along with smalt, or stone blue, to stiffen and clear linen. The powder thereof is also used to whiten and powder the hair.

It is also used by the dyers to dispose their stuffs to take colours the better.

STEREOMETRY.

STEREOMETRY is the art of measuring solid bodies, *i. e.* of finding the solidity or solid contents of bodies, as globes, cylinders, cubes, vessels, ships, *&c.*

Solidity, as understood here, is the quantity of space, contained in a solid body; called also the solid content, and the cube thereof.

To *measure the surface, and solidity of a prism*; find the area of the base, and multiply it by 2; find the areas of the planes, or parallelograms, that include or circumscribe it, and add their sum to the former product. The sum is the whole surface of the *prism*.

Multiply then the base by the altitude; the product is the solidity of the cube.

All *prisms* are in a ratio compounded of their bases and attitudes: If then their bases be equal, they are to each other as their heights; and *vice versâ*. Similar *prisms*, &c. are in a triplicate ratio

ratio of their homologous sides, as also of their altitudes.

To measure the surface and solidity of a pyramid.—Find the solidity of a prism, that has the same base with the given pyramed; and divide this by three; the quotient will be the solidity of the *pyramid.*

Suppose *v. gr.* the solidity of the prism be found 67011328, the solidity of the *pyramid* will be thus found 22336770.

The surface of a pyramid is had by finding the areas both of the base, and of the lateral triangles. The sum of these is the area of the *pyramid.*

The external surface of a right *pyramid*, standing on a regular poligonal base, is equal to the altitude of one of the triangles which compose it, multiplied by the whole circumference of the base of the *pyramid.*

A *sphere* is equal to a pyramid, whose base is equal to the surface, and its height to the radius of the *sphere.*

Hence a *sphere* being esteemed such a pyramid, its *cube* or *solid content* is found like that of a pyramid.

2. A *sphere* is to a cylinder, standing on an equal basis, and of the same height, as 2 to 3. Hence also may the cube or content of the *sphere* be found.

3. The cube of the diameter of a sphere, is to the solid content of the *sphere*, nearly as 300 to 157; and thus also may the content of the *sphere* be measured.

4. The surface of a *sphere* is quadruple the area of a circle described with the radius of the *sphere.* For since a *sphere* is equal to a pyramid, whose base is the surface, and its altitude the radius of the *sphere:* the surface of the *sphere* is had by dividing its solidity by a third part of its diameter. If now the diameter of the circle be 100, the area will be 7850; consequently the solidity 1570000; which divided by a third of the semi-diameter, 100, the quotient is the surface of the *sphere* 31400, which is manifestly quadruple the area of the circle.

The *diameter of a sphere being given to find its surface and solidity.* Find the periphery of the circle described by the radius of the *sphere.* Multiply this, found, into the diameter; the product is the surface of the *sphere.* Multiply the surface by a sixth part of the diameter, the product is the solidity of the *sphere.*

Thus supposing the diameter of the *sphere* 56, the periphery will be found 175; which multiplied by the diameter, the product 9800 is the surface of the *sphere*; which multiplied by one sixth part of the diameter, gives the solidity 919057, or thus;

Find the cube of the diameter 175616; then to 300157, and the cube found, find a fourth proportional 919057. This is the soldity of the sphere required.

A gentleman was pleased to favour me with the following method, which he says he used for the mensuration of a globe, whose axis is 21 inches.

A GLOBE, *whose* axis *is* 21 *inches.*

21. *circumference.*
66
———
126
126
———
1386
$35\frac{1}{2}$ *of the axis.*
———
6930
4158
———
1728) 48510 (2 *feet*, 1395 *inch.*
3456
———
1395.
———

F. In.
4851 2. 1395
3456
———
1395
———

21
21
———
21
42
———
441
21
———
441
882
———
9261
11
———
9261
9261
———
21) 101871 (1728
84
———
178
168
———
107
105
———
21
21
———
00

F. In.
1.75
1.75
———
875
1225
175
———
3.0625
1.75
———
153125
214375
30625
———
5.359375
5236
———
32156250
16078125
10718750
26796875
———
2.8061687500
———

9261 *cube of* 21
5236
———
55566
27783
18522
46305
———
1728) 48490596 (2. 1393
3456
———
1393
———

1393
806
———
0507

Before

Before we attempt to give the method of meafuring a *cylinder*, we muft remember, that a *cylinder* is a folid body contained under three furfaces; fuppofed to be generated by the rotation of a parallelogram, about one of its fides.

If the generating parallelogram be rectangular, the *cylinder* introduced will be a right *cylinder*, i. e. a *cylinder*, whofe axis is perpendicular to its bafe.

If the parallelogram be a *rhombus* or *rhomboides*, the *cylinder* will be *oblique* or *fcabuous*.

The furface of a *right cylinder*, exclufive of its bafes, is demonftrated to be equal to a rectangle contained under the periphery, and the altitude of the *cylinder*.

The periphery, therefore, of the bafe, and thence the bafe itfelf, being found, and multiplied by two, and the product added to the rectangle of the height, and periphery of the *cylinder*; the fum will be the area or fuperficies of the *cylinder*: Multiply this by the area of the bafe, and the product will be the folidity of the *cylinder*.

For it is demonftrated, that a circle is equal to a triangle, whofe bafe is equal to a periphery, and height to the radius; and alfo that a *cylinder* is equal to a triangular prifm, having the fame bafe and altitude with itfelf; its folidity, therefore, muft be had by multiplying the fuperficies into the bafe.

Again, fince a *cone* may be efteemed an infinite angular pyramid; and a *cylinder* an infinite angular prifm; a *cone* is one third part of a *cylinder*, upon an equal bafe, and of the fame height.

Further, a *cylinder* is to a fphere of the fame bafe and altitude, as 3 to 2.

Laftly, it being demonftrated in mechanicks, that every figure, whether fuperficial or folid, generated either by the motion of a line, or of a figure, is equal to the factum of the generative magnitude into the way of its center of gravity, or the line its center of gravity defcribes: Hence, if a rectangle revolves about its axis, it will defcribe a *cylinder*, and its fide the furface of the *cylinder*. But the center of gravity of the right line is in the middle; and the center of gravity of the generating plane in the middle of the right line. The way of this, therefore, is the periphery of a circle defcribed by the radius, *i. e.* into the bafe: but the folidity of the *cylinder* is the factum of the generating rectangle, into the periphery of the circle defcribed by the other radius, which is fubduple of the femi-diameter of the *cylinder*.

Suppofe, *v. gr.* the latitude of the defcribing plane, aud therefore of the *cylinder* $BC = a$, the femi-diameter of the bafe $DC = r$; then will $EG = \frac{1}{2} r$; and fuppofing the ratio of the femi-diameter to the periphery $= 1 : m$; the periphery defcribed by the radius $\frac{1}{2} r$ will be equal to $\frac{1}{2} m r$. Therefore multiplying $\frac{1}{2} m r$ into the area of the rectangle $AC = a r$; the folidity of the *cylinder* $= \frac{1}{2} m a r$; but $\frac{1}{2} m a r 2 = \frac{1}{2} r m r a$, and $\frac{1}{2} r m r a$ and $\frac{1}{2} r m r$, the area of the circle defcribed by the radius DG, the folidity of the *cylinder*, therefore, is equal to the factum of the bafe and the altitude.

To *determine the furface and folidity of a cube*. As the furface of a *cube* confifts of fix equal fquares, a fide multiplied by itfelf, and the product by fix, will give the fuperficies; and the fame product again multiplied by the fide, the folidity.

Hence if the fide of a *cube* be 10, the folidity will be 1000; if that be 12, this will be 1728: wherefore the geometrical perch being 10 foot, and the geometrical foot 10 digits, &c. the *cubick* perch is 1000 *cubick feet*, and a *cubick* foot is 1000 *cubick* digits, &c.

Hence alfo *cubes* are in a triplicate ratio of their fides, and are equal if their fides be fo.

To *meafure the folidity of a cone*. Find the folidity of a prifm or cylinder, having the fame bafe with the cone; which found, divided by three, the quotient will be the folidity of a cone. Thus, *v. gr.* if the folidity of a cylinder be 605592960, the folidity of the cone will be found 201864320.

As to the *meafure of the folidity of a truncated cone*: As the difference of the femi-diameter is to the altitude of the truncated cone, fo is the greater femi-diameter to the altitude of the entire cone. This found, fubftract the altitude of the truncated cone, which will leave that of the cone taken off. Find the folidity of the two cones, fubftract one from the other; the remainder will be the folidity of the truncated cone.

To find the folidity of a hollow body.—If the body be comprifed in the number of regular bodies, the folidity firft of the whole body, including the cavity, then that of the cavity, which is fuppofed to have the fame figure with the body itfelf, is to be found; and the latter being fubftracted from the former, the remainder is the folidity of the hollow body required.

As to the *meafuring of* TIMBER.—*Timber* is ufually meafured and eftimated by the load or ton, which is a folid meafure containing 40 feet of round *timber*, or 50 of hewn *timber*. The denomination of load, &c. we fuppofe arifes from hence, that 40 or 50 folid feet of fuch *timber* weighs about a ton, *i. e.* twenty hundred weight, which is ufually accounted a cart load.

1. For the *meafuring of round timber*: The practice is, to gird the tree about in the middle of the length, and folding the line twice, to take one length or quarter of the whole, and account that

for the true side of the square: then for the length, it is counted from the but-end of the tree, so far up as the tree will hold *half a foot girt*, as they call it, *i. e.* so long as the line twice folded is half a foot.

The dimensions thus taken, the quantity of *timber* is had, either by multiplying the side of the square into itself, and that product by the length, by the method of cross-multiplication.

Or more easily and speedily on Gunter's line, by extending the compasses from 12 to the side of the square in inches; for that extent turned twice (the same way) from the length in feet, will reach to the content in feet.

Or the better still, on *Coggeshal*'s sliding-rule, by setting 12 on the girt-line D, to the length in feet on the line C; then against the side of the square, on the girt-line D, taken in inches, you have on the line C the content of the *timber* in feet.

This method of measuring round timber, tho' common, is yet erroneous, and the contents found hereby, it is demonstrated, is less than the true contents or measure in the ratio of 11 to 14. How to avoid this error, and measure it justly, I have shewn under the use of *Coggeshal's* sliding-rule.

If the tree have any great boughs that are *timber*, as the phrase is, *i. e.* which will hold feet girt, they are commonly measured, and added to the rest: the solidity of the whole being thus found, they divide it by 40, which brings it into loads.

In measuring round timber for sale, they usually cast away an inch out of the square for the bark, if oak; so that a tree 10 inches square, they only account as if 9; but for ash, elm, beech, *&c.* an inch is too much.

For the measuring hewn or square timber; the practice is to find the middle of the length of the tree, and there to measure its breadth, by clapping two rules, or other strait things to the sides of the tree, and measuring the distance between them: in the like manner they measure the breadth the other way. If the two be found unequal, they add them together, and take half the sum for the true side of the square.

The dimensions thus taken, the content is found, either by cross-multiplication, Gunter's scale, or the sliding-rule, after the manner already directed.

The contents divided by 50, gives the number of loads.

If the *timber* be unequally sided, this method of measuring is erroneous, always giving the content more than the truth, and the more so, as the difference of the sides is greater; yet custom has authorised it.

To measure such *timber* justly, a mean proportion should be found between the unequal sides and this mean be accounted the side of the square.

STOCKING-MAKING.

STOCKING-MAKING is the forming a kind of cloathing of the leg and foot, which immediately covers their nudity, and skreens them from the rigour of the cold.

Stockings are either knit or wove.

Knit Stockings are wrought with needles made of polished iron or brass wire. There must be five of them, four to hold the mashes the *stocking* consists of, and one to work with.

The first process in knitting *stockings*, whether they be of silk, wool, cotton, thread, *&c.* is to twist loosely three threads together, the *stockings* made of two threads only being very slight, and of very little service. Then you form on each of the four needles a certain number of mashes, greater or less, according to the size the *stocking* must be of; observing that there must be an equal number of mashes on each needle; which number is to be diminished or increased in the process of the work, according as the shape of the *stocking* requires it. To diminish the number, they work two or three mashes together at once.

The invention of this operation it were difficult to fix precisely, though it is commonly attributed to the *Scots*.

The islands of *Jersey* and *Guernsey* are famous for this sort of work; and it is almost their sole commerce, and the sole occupation of the female inhabitants, who are so much used to it from their infancy, that they work with an incredible quickness, whether they be sitting or walking, and whether in the dark or in the light; for they seldom look on their work. They also knit breeches, waistcoats, petticoats, and the like.

Woven stockings are ordinarly very fine; they are manufactured on a frame or machine made of polished iron; the structure whereof is exceedingly ingenious, but withal exceeding complex, so that

it

it were very difficult to describe it well, by reason of the diversity and number of its parts; nor is it even conceived, without a deal of difficulty, when working before the face.

The *English* and *French* have greatly contested the honour of the invention of the *stocking-loom*; but the matter of fact (says an *English* author) waving all national prejudices, seems to be this: that it was a *Frenchman* first invented this useful and surprising machine, who finding some difficulties in procuring an exclusive privilege, which he required to settle himself at *Paris*, went over into *England*, where his machine was admired, and the workman rewarded according to his merit.

SUGAR-REFINING.

SUGAR-REFINING is the art of purifying it of all its coarser particles, and render it drier, more compact, more agreeable to the palate, and more beautiful.

The first preparation the sugar-canes undergo after they are cut, and their leaves cleared off, is to be carried in bundles to the mills; which mills consist of three wooden rollers, covered with steel plates, and have their motion either from the water, the wind, cattle, or even the hands of slaves.

The juice coming out of the canes when pressed and broke between the rollers, runs through a little canal into the sugar-house, which is near the mill, where it falls into a vessel, whence it is conveyed into a copper or cauldron, to receive its first preparation, only heated by a slow fire to make it simmer. With the liquor is here mixed a quantity of ashes and quick-lime; the effect of which mixture, assisted by the action of the fire, is, that the unctious parts are separated from the rest, and raised to the top, in form of a thick scum, which is kept constantly skimming off, and serves to feed the poultry, *&c.* withal.

The juice, in the next place, is purified in a second copper, where a brisker fire makes it boil; and all the time the casting up of its scum is promoted by means of a strong lye, composed of lime-water and other ingredients.

This done, it is purified and skimm'd in a third boiler, wherein is cast a kind of lye, that assists in purging it, collects together its impurities, and makes them rise to the surface, whence they are taken with a skimmer.

From the third it is removed to a fourth boiler, where the juice is farther purified by a more violent fire: and hence to a fifth, where it is brought to the consistence of a syrup.

In the sixth boiler the syrup receives its full coction; and here all the impurities left from the former lyes, are taken away by a new lye, and a water of lime and allum cast into it. In this last copper there is scarce found one third of what was in the first, the rest being wasted in scum.

By thus passing successively a number of coppers, the sugar-juice is purified, thickened, and rendered fit to be converted into any of the kinds of *sugar* hereafter mentioned. The size of the several coppers always diminishes from the first to the last; each being furnished with a furnace to give a heat proportionable to the degree of coction the juice has received. In some large sugar-works there are also particular coppers for the boiling and preparing the scum.

F. *Labat* mentions several kinds of *sugars*, prepared in the *Caribbee Islands*, viz. *crude sugar*, or *muscovado*; *strained*, or *brown sugar*; *earthen*, or *white sugar* in powder; *refined sugar*, either in powder or loaves; *royal sugar*, *candied sugar*, *sugar of fine syrup*, *sugar of coarse syrup*, *sugar of the scum*.

Crude sugar, or *muscovado*, is that first drawn from the juice of the cane, and whereof all the rest are composed. The method of making it, is that already described for *sugar* in general. We need only add, that when taken out of the sixth copper, it is put in a cooler, where stirring it briskly together, it is let stand to settle, till a crust of the thickness of a crown-piece be formed thereon. The crust being formed, they stir it up again, then put it into vessels, where it stands to settle till it be fit to barrel.

Strained or *brown sugar*, though whiter and harder, does not differ much from the crude sugar: tho' it is held a medium between this last, and the earthen sugar, which is the white powder *sugar*. The preparation of this is the same of that of the muscovado, with this difference, that to whiten it they strain the liquor through blankets, as it comes out of the first copper. The invention of *strained sugar* is owing to the *English*, who are more careful than their neighbours in the preparation thereof; for they not only strain it, but when boiled put it in square wooden forms or moulds, of a pyramidal figure; and when it has purified itself well, they cut it in pieces, dry it in the sun, and barrel it up.

As

As to the preparation of *earthen sugar* (which is that *sugar* whitened by means of earth laid on the top of the form it is put in, to purge itself) they begin it after the same manner as that of crude *sugar*, except that they only use the best that comes in it; that they work with more care and nicety; that when the liquor is in the first copper, the ashes they put in are little or nothing mixed with lime, for fear of reddening it; and that they strain it through a blanket, from the first to the second copper.

Having passed all the six coppers, it is laden out into a cooler; whence it is put into conical moulds or forms, the tops whereof are perforated, but now stopped with linen, or other stuff; and this ranged even before the furnace. When it has been a quarter of an hour in the forms, it is cut with a sugar-knife, then it is stirred briskly this way and that, for half an hour.

This serves not only to promote the forming of the grain, and the diffusing it equally throughout; but also to determine the unctuous parts of the *sugar* to mount to the top, that they may be skimmed off.

They leave the forms to stand fifteen hours in this state, and unstop the holes at the bottom to give a passage to the syrup, and to determine it to take that way. When enough of these forms are filled, to fill a stove, which usually contains five or six hundred forms; they visit the sugar in all the forms to examine the quality thereof, and to see if it quits the form easily; that it may either have the earth given it, as the refiner who assists it judges proper; or be melted over again, if it does not prove well.

This done, the forms are planted each on its pot, with the tip of the cone downwards; the top is taken off, and in lieu thereof they put in some *sugar* in grain, to within an inch of the edge; which space is left for the earth prepared for it.

The earths here used are of various kinds, the good qualities of each whereof are, that they do not tinge the water, that they let it filtrate easily through, and that they do not imbibe the fatty part of the *sugar*. Before put in the forms, the earth is steeped in water twenty-four hours; and at length applied in the consistence of a pulp.

As soon as the earth is on the *sugar*, all the windows of the refining-room are shut, that the air and heat may not dry the earth. When it is quite dry, which usually happens in nine or ten days time, it is taken off; and after cleaning the surface of the sugar with brushes, and racking it up an inch deep, and laying it level as before, they give it a second earth.

The whiteness of the *sugar* of each form is seen from the first earth, experience shewing that a second or third earth do not make the *sugar* any whiter, but only whitens the head of the loaf. When the second earth is taken off, they clean the surface of the *sugar* with a brush, and with a knife loosen the edge of it, where it sticks to the form, that neither form nor the sugar-loaf be damaged in taking out the latter. The windows are now opened, and the form left to stand eight or ten days to dry. While the *sugar* is draining in its forms a stove is prepared to receive them.

The stove being sufficiently heated by means of the furnace therein; the loaves are taken out of the forms one after another; and such as are white from one end to the other, are carried to the stove, as are also the rest, after cutting off what is not white, to be further refined.

When the loaves are all ranged in the stove, a moderate fire is made for about two days, during which time they visit every part of the stove very carefully, to see that every thing is in good order, and to repair every thing that may go amiss. After these two days they shut the trap-door a-top of the building, and increase the fire. Eight or ten days and nights continued violent fire usually suffice to dry a stove of sugar.

When they judge it sufficiently done, they open the trap-door, and chuse a hot dry day to pound the sugar, which is performed with huge, hard, heavy wooden pestles; when pounded it is put up in barrels, and well trodden down as it is put in, that the barrels may hold the more.

Sugar of the scum, is all made of the scum of the two last coppers; that of the former being reserved for making of rum.

The scum designed to make *sugar* is kept in a vessel for that purpose, and boiled every morning in a copper set apart for that use. With the scum is put into the copper a fourth part of water, to retard the boiling, and give time for its purging; when it begins to boil, the usual lye is put in, and it is carefully skimmed: when almost enough boiled, lime and allum-water are thrown in. And when it is ready to be taken out, they sprinkle it with a little powder'd allum.

There are three kinds of syrup that run from *sugar*. The first from the barrels of raw *sugar*, which is the coarsest of all: the second from the forms or moulds, after they are perforated, and before they receive their earth: the third, that coming from the forms after they have had their earth, which last is the best.

The coarse syrups should only be used for rum; but *sugar* being grown dear, endeavours have been used to make some hereof, and that with tolerable success. They are first clarified with lime-water, and

and when boiled are put up in barrels, with a sugar-cane in the middle to make them purify themselves. After twenty days a quantity of coarse earth is thrown in, to make them cast the remainder of their syrup, and fit them to be returned into a crude *sugar*. The *Dutch* and *German* refiners first taught the islanders how to make this *sugar of treacle*.

The second syrup is wrought somewhat differently. After the copper it is to be boiled in is half full, eight or ten quarts of lime-water are cast in: it is then boiled with a brisk fire, and carefully skimmed: some add a lye, and others none. Father *Labat* takes the former method to be the better, though it requires more trouble and attention. This *sugar* may be earthed alone, or at least with the heads of loaves, the dried tops, and such other kinds of *sugars*, as may not be mixed with the true earthed *sugar*, nor yet with the crude *sugar*.

For the third syrup, after boiling and skimming it as the former, they put it instantly into coolers, the bottoms whereof are covered, half an inch thick, with white *sugar* very dry, and well pounded; and the whole is well stirred, to incorporate the two together. This done, they strew the surface over with the same pounded *sugar*, to the thickness of one fifth of an inch, this assisting the *sugar* in forming its grain. When settled, and the crust gathered at the top, a hole is made in the crust five or six inches diameter.

By this aperture they fill the cooler with a new syrup poured gently in, which insensibly raises up the former crust. When all the syrups are boiled, and the cooler is full, they break all the crusts; and after mixing them well, put it up in forms or moulds.

The rest is performed in the same manner as for the earthed *sugar*, from which it only differs in that it falls short of its gloss and brightness; being in reality sometimes whiter and finer, though of a flatter and duller white.

Crude *sugar*, strained *sugar*, and the tops or heads of loaves that have not whitened well, are the basis or ground of refined sugar.

In a refinery are usually two coppers, the one serving to clarify, the other to boil the clarified liquor; tho' sometimes they clarify in both, and boil afterwards.

For the *operation of refining*, the same weight of lime-water, and of *sugar*, are put in the copper; and as the scum is raised by the heat, it is taken off, and when it ceases to raise any more, the syrup is strained through a cloth. After this it is clarified; that is, a dozen of eggs is thrown in, white, yolks, shells and all, after having first broke and beaten them well in lime-water. When the fat and other impurities of the *sugar*, which this composition gathers together on the surface of the syrup, have been skimmed off, a few more eggs are thrown in, and it is skimmed afresh. This they repeat till the *sugar* is sufficiently clarified; which done, it is again strained thro' the cloth.

When taken out of this copper, it is boiled in the second; which done, it is put out into coolers, the bottoms whereof are first covered half an inch thick with fine white powdered *sugar*. As soon as it is there, it is briskly stirred about, and the surface strewed over with pounded *sugar*. The rest is performed as in *sugars* of fine syrups, or in earthed *sugar*, only more care and exactness is used.

For *royal sugar*, the basis hereof ought to be the finest refined *sugar* to be found. This they melt with a weak lime-water, and sometimes, to make it the whiter, and prevent the lime-water from reddening it, they use allum-water.

This they clarify three times, and pass as often through a close cloth, using the very best earth: when prepared with those precautions it is whiter than snow, and so transparent, that we see a finger touching it, even through the thickest part of the loaf.

SURVEYING.

SURVEYING is the art or act of measuring lands, *i. e.* of taking the dimensions of any tract of ground, laying down the same in a map or draught, and finding the content or area thereof.

Surveying consists of three parts or measures: the first is the taking of the necessary measures, and making the necessary observations on the ground itself: the second, is the laying down of these measures and observations on paper; and the third, the finding the area or quantity of the ground thus laid down

The first is what we properly call *surveying*; the second we call *plotting*, or *protracting*, or *mapping*; and the third *casting up*.

The first again consists of two parts, *viz.* the making of observations for the angles, and the taking of measures for the distances.

The former of these is performed by some one or other of the following instruments, *viz.* the *theodolite*,

theodolite, circumferentor, ſemi-circle, plain table, or *compaſs*.

The theodolite is a mathematical inſtrument made variouſly; ſeveral perſons having their ſeveral ways of contriving it, each more ſimple and portable, more accurate and expeditious than others. The following one is not inferior to any. It conſiſts of a braſs circle, about a foot diameter, cut in form of *fig.* 25. having its limb divided into 360 degrees, and each degree divided, either diagonally or otherwiſe into minutes.

Underneath, at *c c*, are fixed two little pillars, *b b*, *fig.* 25. N. 2. which ſupport an axis, whereon is fixed a teleſcope, conſiſting of two glaſſes, in a ſquare braſs tube, for the viewing of remote objects.

On the center of the circle, moves the index C, which is a circular plate, having a compaſs in the middle, whoſe meridian anſwers to the fiducial line *a a*: at *b b*, are fixed two pillars to ſupport an axis, which bears a teleſcope like the former, whoſe line of collimation anſwers the fiducial line *a a*. At each end of either teleſcope is fixed a plain ſight for the viewing nearer objects.

The ends of the index *a a*, are cut circularly to fit the diviſions of the limb B; and when that limb is diagonally divided, the fiducical line at one end of the index ſhews the degrees and minutes upon the limb. The whole inſtrument is mounted with a ball and a ſocket, upon a three-legged ſtaff.

Moſt theodolites have no teleſcopes, but only four plain ſights, two of them faſtened on the limb, and two on the ends of the index.

The semicircle, called alſo *graphometer*, conſiſts of a ſemicircular limb, as F I G, fig. 16. divided into 180 degrees, and ſometimes ſubdivided diagonally, or otherwiſe, into minutes. This limb is ſubtended by a diameter F G, at the extremities whereof are erected two ſights. In the center of the *ſemicircle*, or the middle of the diameter, is fixed a box, and on the ſame center is fitted an alidade or moveable index, carrying two other ſights, as H I. The whole is mounted on a ſtaff, with a ball and ſocket.

The *ſemicircle*, then, is nothing elſe but half a theodolite, with this only difference; that whereas the limb of the theodolite, being an entire circle, takes in all the 360° ſucceſſively; in the *ſemicircle*, the degrees only going from 1 to 180°, it is uſual to have the remaining 180°, or thoſe from 180° to 360°, graduated in another line on the limb, within the former.

An angle is taken with a ſemicircle, by placing the inſtrument in ſuch manner, as that the radius C G, may hang over one leg of the angle to be meaſured, and the center C, over the vertex of the ſame. The firſt is done by looking through the ſights F and G, at the extremities of the diameter, to a mark fixed up in one extremity of the leg: the latter is had by letting fall a plummet from the center of the inſtrument. This done, turn the moveable index H I, on its center, towards the other leg of the *ſemicircle*, till, through the ſights fixed on it, you ſee a mark in the extremity of the leg. Then the degree, which the index cuts on the limb, is the quantity of the angle.

The plain table is an inſtrument, fig. 31. N. 1. conſiſting of a parallelogram of wood, about fifteen inches long, and twelve broad; round which goes a boxen jointed frame, by means whereof a ſheet of paper is faſtened tight to the table, ſo as lines may be conveniently drawn upon it.

On each ſide the frame, which may be put on either ſide upwards, towards the inward edge are ſcales of inches, ſubdivided, for the ready drawing of parallel lines. Beſides which, on one ſide are projected the 360 degrees of a circle, from a braſs centre in the middle of the table (each degree halved) with two numbers to every tenth degree, the one expreſſing the degree, the other its complement to 360°, to ſave ſubſtraction on the other ſide, are projected the 180° of a ſemicircle, from a braſs center in the middle of the table's length, and at $\frac{1}{4}$ of its breadth; each degree halved, and every tenth noted with two numbers, *viz.* the degree, and its complement to 180°.

To one ſide of the table is fitted a compaſs, for placing the inſtrument by; and the whole is fixed by a ſocket, upon a three-legg'd ſtaff for a ſtand, on which it is turned round, or faſtened by a ſcrew, as occaſion requires. Laſtly, to the table belongs an index, which is a ruler, at leaſt ſixteen inches long, and two broad; uſually graduated with ſcales, *&c.* and having two ſights perpendicularly placed on its extremities.

We underſtand here by ſights two thin pieces of braſs, raiſed perpendicularly on the two extremes of an alidade, or index of a theodolite, circumferentor, or other like inſtrument, each whereof has an aperture or ſlit up the middle, through which the viſual rays paſs to the eye, and diſtant objects are ſeen. Their uſe is for the juſt direction of the index to the line of the object. Sometimes the ſlits or apertures have glaſſes or lens's fitted into them; in which caſe they are called *teleſcopick ſights*, by way of diſtinction from the former, which in reſpect hereof are denominated *plain ſights*.

Staff, in ſurveying, is a kind of ſtand, whereon to mount a theodolite, circumferentor, plain

plain table, or the like, for uſe. It conſiſts of three legs of wood joined together at one end, whereon the inſtrument is placed: and made peeked at the other, to enter the ground. Its upper end is uſually fitted with a ball and ſocket.

Ball and ſocket, is a machine, contrived to give an inſtrument full play and motion every way. It conſiſts of a ball or ſphere of braſs, fitted within a concave ſemi-globe, ſo as to be moveable every way, both horizontally, vertically, and obliquely. It is carried by an endleſs ſcrew, and is principally uſed for the managing of ſurveying inſtruments; to which it is a very neceſſary appendage. The antient *balls and ſockets*, had two concaves or channels, the one for the horizontal, the other for the vertical direction. But to proceed to *the uſe of the plain tables*, after we have given the deſcription thereof.

To take an angle by the *plain table*, or to find the diſtance of two places acceſſible by the ſame third.—Suppoſing D A, D B, fig. 32, N. 2. the ſides of the angle required; we'll place the inſtrument horizontally, as near the angle as poſſible; and aſſume a point in the paper on the table, *v. gr.* to this point we'll apply the edge of the index, turning it about this and that way, till through the ſights we ſee the point B, and in this ſituation of the ruler, we'll draw by its edge the line *c c*, indefinitely. Turning about the index, after the ſame manner, on the ſame point, till through the ſights we ſee the point A; and drawing the right line *c d* indefinitely.—Thus we have the quantity of the angle laid down.

We'll next meaſure the lines D A, D B, with a chain, and from a ſcale ſet off the meaſures thus found, on the reſpective lines; which we ſuppoſe to reach from *c* to *b*, and from *c* to *a*.—Thus will *c b* and *c a* be proportional to D B and D A.

We'll transfer the diſtance *a b* to the ſame ſcale, and find its length; the length thus found, will be the length or diſtance of A B required.

If we want to *find the diſtance of two places, one whereof is inacceſſible*, by the plain table: we'll ſuppoſe A B. fig. 33. the diſtance required, and A the acceſſible point. Then we'll place, 1. the *plain table* in C, looking through the ſights till we ſee A and B, and drawing *a c* and *c b*, we'll meaſure the diſtance from our ſtation to A; and ſet it off from the ſcale upon *c a*. 2. We'll remove the table to A, placing it ſo as that the point *a* repreſenting A, and the index laid along the line *a c*, we'll ſee backward the former ſtation C.

In this fixing the inſtrument, lies the uſe of the compaſs; for the needle will hang over the ſame degree of the card in the firſt and the ſecond caſe; ſo that ſome ſet the inſtrument by the needle alone; others only uſe it to ſhorten the trouble, by bringing the inſtrument nearly to its due poſition by means thereof; and then fixing for good by the back ſight.

3. The inſtrument fixed, we'll turn the ſights to B; and draw the line *a b*.

4. On the ſcale we'll meaſure the interval *a b*, which will be the diſtance of A B required.

But if we ſhould want *to find the diſtance of two inacceſſible places by the plain table*; we would ſuppoſe A B, fig. 34, the diſtance required. Then chuſing, 1. two ſtations in C and D; we would place the *plain table* in the firſt C, and through the ſights look to D, B, and A, drawing by the edge of the index, the lines *c d*, *c b*, *c a*. We would, 2. meaſure the diſtance of the ſtations C D; and ſet this off from a ſcale on *c d*. 3. Removing the *table* from C, we would fix it in D; ſo as the point *d*, hanging over the place D, and the index laying along the line *c d*, through the ſights we ſhould ſee the former ſtation C. The inſtrument thus fixed, we would direct the ſights to A and B; and drawing right lines *d a* and *d b*. Laſtly, we would find the diſtance of *a b* on the ſcale; this would be the diſtance of A B required.

After the ſame manner may the diſtance of any number of places be found from two ſtations; and thus may a field, part of a country, &c. be ſurveyed.

To *take the plot of a field from one ſtation, whence all the angles may be ſeen, with the plain table.*—Placing the inſtrument on the ſtation, aſſume a point in the paper to repreſent the ſame, *v. gr.* C, fig. 21. laying the edge of the index to this point, direct it to the ſeveral angles of the field, A B C D E F, &c. and drawing indefinite lines by its edge, towards every angle, *viz.* C *a*, C *b*, C *c*, &c. meaſure the diſtance of each angle from the ſtation, *viz.* C A, C B, C C, C D, &c. and from a ſcale ſet theſe off from C on their correſponding lines; the extremities thereof will give points, which being connected by lines, will repreſent the field.

The *plot of a field, wood, or the like, is taken by going round the ſame, on the plain table*, by placing the inſtrument horizontally at the firſt angle, *v. gr.* A, the needle on the meridian of the card; aſſuming a point on the paper to repreſent it; laying the index to that point, and directing it till through the ſights you ſee a mark in the angle B, and drawing

drawing an indefinite line along it; meaſure the diſtance of A and B, and from a ſcale ſet it off on the line thus drawn; the extremity of this diſtance will repreſent the point B. Remove the inſtrument to B, where ſet it ſo as that the needle hang over the meridian of the cord; and ſo as the index laying along the line laſt drawn, you ſee the former ſtation A through the ſights: here faſten it, lay the index to the point B, and turn it, till through the ſights you ſee the next angle C; in this ſituation draw a line as before, meaſure the diſtance B C, and ſet it off from a ſcale on the line. Remove the inſtrument to C, where fixing it by the needle, and the back ſight, as before, turn the index on the point C, till you ſee the next angle D; draw the line, meaſure, and ſet off the diſtance C D, as before, and remove the *plain table* to E; where fix it as before, look to the next angle F, draw the line, meaſure, and ſet off the diſtance, &c.

In this manner having compaſſed the whole field, you will have its whole perimeter plotted on the table; which may be now caſt up, and its content found.

When in large parcels of ground, the plot is found to exceed the dimenſions of the *plain table*, and to run off from the paper, the ſheet muſt be taken off the table, and a freſh one put on; the way of managing which ſhifting is as follows. Suppoſe H, K, M, Z, fig. 35. the limits of the *plain table*; ſo that having laid down the field from A to B, thence to C and D, you want room, the line D E running off the paper: draw as much of the line D E, as the paper will well hold, *viz.* D O, and by means of the diviſions on the edge of the frame, draw the line P Q through G, parallel to the edge of the table H M; and through the point of Interſection O, draw O N parallel to M Z. This done, take off the frame, remove the ſheet, and clap a freſh one, fig. 36. in its ſtead; drawing on it a line R S, near the other edge parallel thereto. Then lay the firſt ſheet on the table, ſo as the line P Q lie exactly on the line R S, to the beſt advantage, as at O. Laſtly, draw as much of the line O D, on the freſh ſheet, as the table will hold; and from O continue the remainder of the line D to E; from E proceed with the walk as before, to F, G, and A.

The great inconveniency of the plain table is, that its paper renders it impracticable in moiſt weather. Even the dew of the morning and evening is found to ſwell the paper conſiderably, and of conſequence to ſtretch and diſtort the work. To avoid this inconvenience, and render the inſtrument uſeful in all weathers; by leaving off the paper, and ſetting up a pin in the center, it becomes a theodolite, a ſemicircle, or a circumferentor, and applicable like them.

The *plain table* ſtripped of its paper, becomes either a theodolite, or a ſemicircle, as that ſide of of the frame which has the projection of the degrees of a circle, or a ſemicircle is turned upwards. If it be to ſerve for a theodolite; the index, which as a *plain table*, turns on any point as a center, is conſtantly to turn about the braſs center hole, in the middle of the table.

If for a ſemicircle, it muſt turn on the other braſs center hole: in both caſes it is done by means of a pin raiſed in the holes.

When the *plain table* is to ſerve as a circumferentor, ſcrew the compaſs to the index, and both of them to the head of the ſtaff, with a braſs ſcrew pin fitted for the purpoſe; ſo as the ſtaff and table ſtanding fixed, the index, ſights, &c. may be turn'd about, and *vice verſa.*

To take an angle by the plain table conſidered as a theodolite.—Suppoſe the quantity of the angle E K G, fig. 20. is required. Place the inſtrument, or K, the theodolite ſide of the frame upwards, laying the index on the diameter. Turn the whole inſtrument about, the index remaining on the diameter, till through the ſights you ſpy E. Screw the inſtrument faſt there, and run the index on its center, till through the ſight you ſpy G. The degree here cut on the frame by the index, is the quantity of the angle ſought; which may be laid down on paper by the rules of common protraction.

Thus may you proceed to do every thing with the *plain table*, as with the common theodolite.

If we want to make an angle with a plain table conſidered as a ſemicircle. We muſt proceed in the ſame manner with the inſtrument, conſider'd as a ſemicircle, as when conſider'd as a theodolite; only laying the ſemicircular ſide upwards, and turning the index on the other center-hole in the middle of the length, and at about $\frac{1}{4}$ of the breadth of the table.

If you want to take an angle with the plain table conſidered as a circumferentor. Suppoſe the former angle E K G, required. Place the inſtrument in K, the flower-de-luce towards you. Direct the ſights to E, and obſerve the degree cut by the ſouth end of the needle, which ſuppoſe 296, turn the inſtrument about, the flower-de-luce ſtill towards you. Direct the ſights to G, noting the degree cut by the other end of the needle, which ſuppoſe 182. Subſtract the leſs from the greater, the remainder 114° is the quantity of the angle ſought. If the remainder chance to be more than 180°, then it muſt be again ſubſtracted from 360. This ſecond

cond remainder will be the angle required; which may be protracted, &c.

Thus you may proceed to do every thing with the plain table, as with the common *circumferentor*.

The CIRCUMFERENTOR, is an instrument used in *surveying*, to take angles by.

The *circumferentor* is very simple, yet expeditious in the practice; it consists of a brass circle, and an index, all of a piece (fig. 19.) On the circle is a card or compass divided into 360 degrees; the meridian lines whereof answers to the middle of the breadth of the index. On the limb, or circumference of the circle, is foldered a brass ring; which, with another fitted in a glass, make a kind of box for the needle, which is suspended on a pivot in the center of the circle. To each extreme of the index is fitted a sight.

The whole is mounted on a staff, with a ball and socket for the conveniency of its motion.

If we want to take an angle by the circumferentor. Suppose E K G (fig. 20.) the angle required, we'll place the instrument, *v. gr.* at K, with the flower-de-luce on the card towards us; then direct the sights, till thro' them we spy E; and observe what degree is pointed at by the south end of the needle, which suppose 296, then turn the instrument, the flower-de-luce still towards us, and direct the sights to G; noting the degree at which the south end of the needle points, which suppose 182.

This done, substracting the lesser number 182, from the greater 296, the remainder 114, is the number of degrees of the angle E K G.

If the remainder chance to be more than 180 degrees, it must be again substracted from 360 degrees; the last remainder is the quantity of the angle sought.

To take the plot of a field, wood, &c. by the circumferentor; suppose ABCDEFGK (fig. 21.) an inclosure to be surveyed by the *circumferentor*.

1. Placing the instrument at A, the flower-de luce towards you, direct the sights to B; where suppose the south end of the needle to cut 191°; and the ditch, wall, or hedge, measured with the chain, to contain 10 chains, 75 links, which enter down.

2. Placing the instrument at B, direct the sight as before to C; the south end of the needle, *v. gr.* will cut 279°; and the line B C contains six chains, 83 links, to be noted as before. Then move the instrument to C; turn the sights to D, and measure C D as before.

In the same manner proceed to D, E, F, G, H, and lastly to K; still noting down the degrees of every bearing or angle, and the distances of every side.

Having thus gone round the field, you will have a table in the following form:

Stations.	*Degrees.*	*Min.*	*Chains.*	*Links.*
A	191	00	10	75
B	279	00	6	83
C	216	30	7	82.

From this table the field is to be plotted or protracted; the manner whereof we'll see hereafter.

Note, That where security is to be consulted rather than dispatch, it may be convenient to take back-sights, *i. e.* to place the instrument so at each station, as that looking backwards through the sights to the last station, the north end of the needle may point to the same degree, as the south end did in looking forward from the last station to this.

The COMPASS used in *surveying*, is in the main much like the mariner's *compass*; consisting, like that of a box and needle: the principal difference consist in this, that instead of the needle being fitted into the card, and playing with it on a pivot, it here plays alone; the card being drawn on the bottom of the box, and a circle divided into 360 degrees on the limb (fig. 15.) This instrument is of obvious use to travellers, to direct them in their road; and to miners, to shew them what way to dig, &c. but it has other uses, though less easy, yet more considerable, *viz.*

1. *To take the declination of a wall by the compass.* Apply that side of the compass whereon the north is marked along the side of the wall; the number of degrees over which the north end of the needle fixes, will be the declination of the wall, and on that side, *v. gr.* if the north point of the needle tends towards the wall, that wall may be shone on by the sun at noon; if it fixes over 50 degrees, counting from the north towards the east, the declination is so many degrees from the north towards the east.

But since the needle itself declines from the north towards the west with us, 13°; it must be noted that to retrieve the irregularity, 13° are always to be added to the degrees shewn by the needle, when the declination of the wall is towards the east; on the contrary, when the declination is towards the west, the declination of the needle to be substracted.

2. If we want to take an angle with the compass. Suppose the angle required be D A E (fig. 11.) we'll apply the side of the *compass* whereon the north is marked to one of the lines A D, observing, when the needle rests, the degrees at which

which its north point ftands, which fuppofe 80: fo many degrees does the line decline from the meridian.

In the fame manner take the declination of the line A E, which fuppofe 215°; fubftract 80° from 215, the remainder is 135; which fubftracted from 188, there will remain 75°, the quantity of the angle required.

But if the difference between the declination of the two lines exceed 180°; in that cafe 180° muft be fubftracted from that difference: the remainder is the angle required. We'll fee the method of laying this on paper, when I'll fpeak of plotting.

In meafuring angles by the *compafs*, there needs not any regard to be had to the variation; that being fuppofed the fame in all the lines of the angles.

3. If it be wanted *to take the plot of a field by the compafs*. Suppofe A, B, C, D, F, (fig. 12.) to be the field. For the greater accuracy let there be two fights fitted to the meridian line of the *compafs*, place it horizontally, and through the fights look along the fide A B, or a line parallel to it; applying the eye to the fight at the fouth point of the *compafs*, draw a rough fketch of the field by the eye, and on the correfponding line enter down the degree to which the needle points, which fuppofe 90; meafure the length of the fide, and enter that too, which fuppofe 10 chains.

In this manner proceed with all the reft of the fides and angles of the field; the fides which fuppofe 70, 65, 70, 50, 94 chains; and the angle which fuppofe 30, 100, 130, 240, 300 degrees.

To protract the field, fet down the feveral angles obferved one after another; and fubftract the leffer from the next greater: thus you will have the quantity of the feveral angles, and the length of the lines that will include them. More of this under the article plotting.

All the angles of the figures taken together, muft make twice as many right angles, abating two.

We have thus far given the defcription of the inftruments ufed in the former part of the firft branch of furveying; and of the different ufes thereof; therefore we proceed to the explication of the latter part of our firft divifion.

The *latter part* is performed by means either of the *chain*, or the *perambulator*.

The PERAMBULATOR, is an inftrument for the meafuring of diftances, called alfo *pedameter*, *way wifer*, and *furveying wheel*. Its advantages are its handinefs and expedition: its contrivance is fuch, that it may be fitted to the wheel of a coach; in which it performs its office, and meafures the road without any trouble at all. There is fome difference in its make: that now moft in ufe as moft convenient, is as follows.

The *perambulator* (fig. 23) confifts of a wheel two feet feven inches and a half in diameter; confequently half a pole, or eight feet and three inches in circumference. On one end of the axis is a nut three quarters of an inch in diameter, divided into eight teeth, which upon moving the wheel round, falls into the eight teeth of another nut *c*, fixed on one end of an iron rod Q, and thus turn the rod once round, in the time the wheel makes one revolution. This rod laying along a groove in the fide of the carriage of the inftrument, has at its other end a fquare hole, into which fixes the end *b*, of the little cylinder P. This cylinder is difpofed under the dial-plate of a movement, at the end of the carriage B, in fuch a manner as to be moveable about its axis. Its end *a* is cut into a perpetual fcrew, which falling into the thirty-two teeth of a wheel perpendicular thereto; upon driving the inftrument forward, that wheel makes a revolution, each fixteen poles. On the axis of this wheel is a pinion with fix teeth, which falling into the teeth of another wheel of fixty teeth, carries it round every hundred and fixtieth pole, or half a mile.

This laft wheel then carrying a hand or index round with it, over the divifions of the dial-plate, whofe outer limb is divided into one hundred and fixty parts, correfponding to the one hundred and fixty poles; points out the number of poles paffed over. Again, on the axis of this laft wheel, is a pinion, containing twenty teeth, which falling into the teeth of a third wheel that has forty teeth, drives once round in three hundred and twenty poles, or a mile. On the axis of this wheel, is a pinion of twelve teeth, which falling into the teeth of a fourth wheel that has feventy-two teeth, drives it once round in twelve miles.

This fourth wheel carrying another index, over the inner limb of the dial-plate, divided into twelve, for miles, and each mile fubdivided into halves, quarters, and furlongs, ferves to regifter the revolutions of the other hand; and to keep account of the half miles and miles paffed over, as far as twelve miles.

The *application* of this inftrument is obvious from its conftruction. Its proper office is in the furveying of roads, and large diftances, where a great deal of expedition, and not much accuracy is required. It is evident that driving it along, and obferving the hands, has the fame effect as dragging the *chain*, and taking account of the chains and links.

The

The CHAIN, in *surveying*, is a measure consisting of a certain number of links of iron wire, usually 100; serving to take the dimensions of fields, &c. by. This is what *Mersene* takes to be the *arvipendium* of the antients.

The *chain* is of various dimensions, as the length or number of links varies: that commonly used in measuring land, called *Gunter's chain*, is in length four poles or perches, or sixty-six foot, or a hundred links, each link being seven inches $\frac{92}{100}$.

That ordinarily used for large distances, is in length 100 feet; each link one foot.

For small parcels, as gardens, &c. is sometimes used a small *chain* of one pole, or sixteen feet and a half in length; each link one inch $\frac{98}{100}$.

Some in lieu of *chains* use ropes; but these are liable to several irregularities; both from the different degrees of moisture, and of the force which stretches them. *Schwenterus*, in his practical geometry, tells us, he has observed a rope sixteen foot long, reduced to fifteen in an hour's time, by the mere falling of a hoar frost. To obviate these inconveniencies, *Wolfius* directs, that the little strands whereof the rope consists, be twisted contrary ways, and the rope dipped in boiling-hot oil, and when dry drawn through melted wax. A rope thus prepared will not get or lose any thing in length, even though kept under water all day.

The manner of applying the *chain* in measuring lengths is too popular to need description. In entring down the dimensions taken by the *chain*, the chains and links are separated by a dot: thus a line sixty-three *chains*, fifty-five links long, is wrote 63, 55. If the links be short of 10, a cypher is prefixed, thus 10 chains, 8 links, are wrote 10. 08.

If we want to *find the area of a field*, &c. *the dimensions whereof are given in chains and links*. 1. We multiply the lines by one another, and from the product we cut off five figures towards the right; those remaining on the left will be acres. 2. We multiply the five figures cut off by four; and cutting off five again from the product on the right, those remaining on the left will be roods. Lastly, we multiply the five thus cut off by forty; and cutting off five as before on the right, those remaining at the left are square perches.

To *take an angle* D A E (fig. 1.) by the chain: measure a small distance from the vertex A along each leg, *v. gr.* to *d* and *c*; then measure the distance *d c*: to lay this down, draw A E at pleasure, and from your scale set off the distance measured on it. Then taking in your compasses the length measured on the other side, on the point A, as a Center, describe an arch *a c*; and on the point *c*, as a center, with the measured distance of *c d*, describe another arch *a b*: through the point where this intersects the former arch, draw a line A D. So is the angle plotted, and its quantity, if required, may be measured on a line of chords.

If we want to *take the plane or plot of any place*, as A B C D E (fig. 2.) *by the* chain. We'll draw a rough sketch of the place by the eye; and measuring the several sides A B, B C, C D, D E, we'll enter down the lengths on the respective lines: then if the plan be to be taken within-side of the place, instead of measuring the angles, as before, measure the diagonals A D, B D. Thus will the figure be reduced into three triangles, whose sides are all known, as in the former case; and may be laid down on paper, according to the method above.

If the plan be to be taken without-side the place, the angles must be taken thus, *v. gr.* for the angle B C D, produce the lines B C and C D, to any certain equal distance, *v. gr.* to *a* and *b*, five *chains*; and measure the distance of *a b*. Thus have you an isosceles triangle *c a b*, wherein the angle *a c b*=B C D, its opposite one is had. Thus is the quantity of B C D found, and the angle laid down as before.

To *find, by the chain the distance between two objects inaccessible in respect of each other*. From some place, as C (fig. 3.) whence the common distance to each object A and B, is accessible in right line; measure the distance C A, which suppose fifty *chains*, and continue the line to D, *viz.* fifty more: measure also B C, which suppose thirty chains; and produce the line to E, *viz.* thirty more. Thus will be formed the triangle C D E, equal and similar to the triangle A B C; consequently the distance D E being measured, will give the inaccessible distance required.

By the chain to find the distance of an inaccessible object, v. gr. the breadth of a river. On one side place a pole, four or five foot high, perpendicularly, having a slit a-top, with a strait piece of wire, or the like, two or three inches long; put through the same. This is to be slipped up or down, till looking along it, you find it point full on the other side of the river; then turning the pole with the wire in the same direction, observe the point on the dry land, to which it points when looked along as before: measure the distance from the pole to this last point; it is the same with that of the first required. Thus far we have done with the *first branch of surveying*, properly so called.

The

The *second branch of surveying* is performed by means of the *protractor* and *plotting scale*.

The PROTRACTOR, in *surveying*, is an instrument, whereby the angles taken in the field with a theodolite, circumferentor, or the like, are plotted, or laid down on paper.

The *protractor* consists of a semicircular limb B A G, (fig. 29.) of brass, silver, horn, or the like, divided into 180°, and subtended by a diameter B A; in the middle whereof is a little notch or lip *o*, called *the centre of the protractor*.

On the limb of the *protractor* are sometimes also placed numbers, denoting the angles at the centers of regular polygons: thus, against the number 5, denoting the sides of a pentagon, is found 72, the angle at the center of a pentagon.

As to *the use of the protractor*.— 1. To lay down an angle of any given quantity or number of degrees. Suppose, *e. gr.* an angle of 50°, with the line A *o* B, required on the point *o*, lay the center of the *protractor* on the given line. Make a mark against the given degree 5°, on the limb of the *protractor*; through which from the given point, draw a line *o p*; this gives the angle requir'd.

2. *To find the quantity of a given angle*, v. gr. the angle *p o* A, lay the center of the *protractor* on the point of the angle *o*, and the diameter on the line. The degree of the limb cut by the other line *o p*, viz. 5°, is the number of degrees of the angle requir'd.

3. *To inscribe any given regular polygon*, e. gr. *a pentagon in a circle*. Lay the center and diameter of the *protractor* on the center and diameter of the circle; and make a dot against the number of degrees of the angle at the center, *viz.* 72. Through this dot, and the center of the circle, draw a line, cutting the circumference of the circle. To the point of intersection, from the point where the diameter cuts the circumference, draw a right line. This line will be a side of the pentagon, which being taken in the compasses, and set off, as often as it will go in the circumference, will give points, which being connected by the lines, will form the pentagon requir'd.

4. *To describe any regular polygon*, e. gr. *an octagon, on a given line*. Substract the angle at the center, which the *protractor* gives, 45° from 18°, the remainder 135° is the angle included between two sides of the octagon; one half whereof, is 67½, applying then the diameter of the *protractor* over the given line, with the center over one extreme; make a dot against 67½, to which from the center draw a line. Apply the *protractor* to the other end of the line, so as the center be over the extreme, and there set off another angle of 67½. From the point where the two lines, thus drawn, intersect as a center, describe a circle with the interval of the given line. The given line will be one side of the octagon, which being set off as often as it will go in the circumference thus drawn, will give points, which being connected, will form the octagon requir'd.

The PROTRACTOR *improved* is an instrument much like the former, only furnished with a little more apparatus, whereby we are enabled to set off an angle to a minute; which is impracticable in the other.

The chief addition is an index fitted on the center, and moveable thereon; so as to play freely and steadily over the limb. Beyond the limb, the index is divided on both edges, into 60 equal parts of the portions of circles, intercepted by two other right lines drawn from the center; so as each makes an angle of one degree, with lines drawn to the assumed points from the center.

To set off an angle of any number of degrees and minutes, with this *protractor*. Move the index, so that one of the lines drawn on the limb, from one of the fore-mentioned points, may fall upon the number of degrees given; and pick off as many of the equal parts on the proper edge of the index, as there are minutes given; thus drawing a line from the center, to that point so pricked off, you have an angle with the diameter of the *protractor* of the proposed number of degrees and minutes.

Indeed it may be of good use to lay down an angle to a minute, when we are able to take it to a minute: but till we have other sorts of needles, and juster theodolites, than are yet made, the old *protractor* may serve very well.

The PLOTTING *scale*, is an instrument usually made of wood, sometimes of brass, or other matter; and either a foot, or half a foot long. On one side of the instrument, (fig. 32.) are seven several scales or lines, divided into equal parts. The first division of the first scale, is sub-divided into ten equal parts, to which is prefixed the number 10, signifying that 10 of those sub-divisions make an inch; or that the divisions of that scale are decimals of inches.

The first division of the second scale is likewise sub-divided into 10, to which is prefixed the number 16, denoting that 16 of those divisions make an inch. The first division of the third scale is sub-divided in like manner into 10, to which is prefixed the number 20. To that of the fourth scale is prefixed the number 24: to that of the fifth 32; that of the sixth 40; that of the seventh 48; denoting the number of sub-divisions equal to an inch, in each respectively.

The

The two laſt ſcales are broken off before the end, to give room for two hours of chords marked by the letter *c c*.

On the backſide of the inſtrument is a diagonal ſcale, the firſt of whoſe diviſions, which is an inch long, if the ſcale be a foot, is ſub-divided, diagonally, into 100 equal parts. At the other end of the ſcale is another diagonal ſub-diviſion, of half the length of the former, into the ſame number of parts, *viz.* 100.

Next the ſcales is a line divided into a hundredth part of a foot, number'd 10, 20, 30, *&c.* and a line of inches divided into tenth parts, marked 1, 2, 3, *&c.*

The *plotting-ſcale* is uſed in the following manner.—1. *Any diſtance being meaſured with the chain, to lay it down on a paper.*—Suppoſe the diſtance to be 6 chains, 50 links, draw an indefinite line; ſet one foot of the compaſſes at figure 6, on the ſcale, *e. gr.* the ſcale of 20 in an inch, and extend the other to 5 of the ſub-diviſions, for the 50 links: this diſtance being transferred to the line, will exhibit the 6 chains, 50 links, required.

If it be deſired to have 6 chains, 50 links, take up more or leſs ſpace, take them off from a greater or leſſer ſcale, *i. e.* from a ſcale that has more or leſs diviſions in an inch.

To find the chains and links contained in a right line, e. gr. *that juſt drawn, according to any ſcale,* e. gr. *that of* 20 *in an inch.*—Take the length of the line in the compaſſes, and applying it to the given ſcale, you will find it extend from the number 6 of the great diviſions, to 5 of the ſmall ones: hence the given line contains 6 chains, 50 links.

From this *plotting ſcale*, this ſecond branch of *ſurveying*, borrows its name of *plotting*.

In *ſurveying* with the *plain table*, the plotting is ſaved; the ſeveral angles and diſtances being laid down on the ſpot, as faſt as they are taken, as we have obſerved in the firſt branch of *ſurveying*.

But in working with the theodolite, ſemicircle, or circumferentor, as the angles are taken in degrees; and the diſtances in chains, and links; there remains an after-operation, to reduce thoſe numbers into lines, and ſo to form a draught, plan, or map; which operation is called *plotting*.

Plotting, then, is performed by means of two inſtruments, the *protractor*, and *plotting-ſcale*. By the former, as already obſerved, the ſeveral angles obſerved in the field with a theodolite, or the like, and enter'd down in degrees in the field-book, are protracted on paper, in their juſt Quantity.

By the latter, the ſeveral diſtances, meaſured with the chain, and enter'd down in like manner in the field-book, are laid down in their juſt proportion.

Therefore having given already ſeverally the uſe of thoſe reſpective Inſtruments, in the laying down of angles and diſtances; I ſhall here give their uſe conjointly, in the *plotting* of a field, ſurveyed either with the circumferentor or theodolite.

The *method of plotting from the circumferentor*, is thus: Suppoſe an incloſure, *e. gr.* A B C D E F G H K, fig. 21. to have been ſurveyed; and the ſeveral angles; as taken by a Circumferentor in going round the field, and the diſtances as meaſured by a chain, to be found enter'd in the field-book, as in the following table:

	Deg.	*Min.*	*Chains.*	*Links.*
A	191	00	10	75
B	197	00	6	83
C	260	30	7	82
D	325	00	6	96
E	12	24	9	71
F	324	30	7	54
G	98	30	7	54
H	71	00	7	78
K	161	30	8	22.

1. On a paper of the proper dimenſions, as L M N O, fig. 31. draw a number of parallel and equi-diſtant lines, repreſenting meridians, expreſſed in dotted lines. Their uſe is to direct the poſition of the protractor; the diameter whereof muſt always be laid, either upon one of them, or parallel thereto; the ſemi-circular lines downwards for angles greater than 180°, and upwards for thoſe leſs than 180°.

The paper thus prepared; aſſume a point on ſome meridian, as A, whereon lay the center of the protractor, and the diameter along the line. Conſult the field-book for the firſt angle, *i. e.* for the degree cut by the needle at A, which the table gives you, 191°.

Now, ſince 191° is more than a ſemicircle or 180°, the ſemicircle of the protractor is to be laid downwards; where keeping it to the point, with the *protracting pin*, make a mark againſt 191; through which mark, from A, draw an indefinite line A *b*.

The firſt angle thus protracted, again conſult the book, for the length of the firſt line A B, this you find 10 chains, 75 links. From a convenient ſcale, therefore, on the *plotting ſcale*, take the extent of 10 chains, 75 links, between the compaſſes; and ſetting one point in A, mark where the other falls in the line A *b*, which ſuppoſe in B; draw therefore the full line A B, for the firſt ſide of the incloſure.

Proceed then to the ſecond angle; and laying the ſide of the protractor on the point B, with the diameter, as before directed, make a mark, as *c*, againſt

againſt 297°, the degrees cut at B, and draw the indefinite line B *c*. On this line, from the *plotting ſcale*, as before, ſet off the length of your ſecond line, *viz.* 6 chains, 83 links; which extending from B to the point C, draw the line B C, for the ſecond ſide.

Proceed now to the third angle or ſtation: lay then the center of the protractor, as before, on the point C; make a mark, as *d*, againſt the number of degrees, cut at C, *viz.* 216; draw the indefinite line C *d*, and thereon ſet off the third diſtance, *viz.* 7 chains, 82 links; which terminating, *e. gr.* at D, draw the full line CD, for the third ſide.

Proceed now to the fourth angle D, and laying the center of the protractor over the point D, againſt 325°, the degree cut by the needle, make a mark *e*; draw the dry line D *e*, and thereon ſet off the diſtance 6 chains, 96 links, which terminating in E, draw D E for the fourth Line: and proceed to the fifth angle, *viz.* E.

Here the Degrees, cut by the needle, being 10° 24′, (which is leſs than a ſemicircle) the center of the protractor muſt be laid on the point E, and the diameter on the meridian, with the ſemicircular line turned upwards. In this ſituation make a mark, as before, againſt the number of degrees, *viz.* 12° 24′ cut by the needle at E; draw the dry line E *f*, on which ſet off the fifth diſtance, *viz.* 9 chains, 71 links; which extending from E to *f*, draw the full line E F for the fifth ſide of the incloſure.

After the ſame manner proceeding orderly to the angles F, G, H, and K; placing the protractor, making marks againſt the reſpective degrees, drawing indefinite dry lines, and ſetting off the reſpective diſtances, as above, you will have the *plot* of the whole incloſure A B C, &c.

Such is the general method of *plotting* from this inſtrument; but it muſt be obſerved, that in this proceſs, the ſtationary lines, *i. e.* the lines wherein the circumferentor is placed to take the angles, and wherein the chain is run to meaſure the diſtances, are properly, the lines here *plotted.* When, therefore, in *ſurveying*, the ſtationary lines are at any diſtance from the fence or boundaries of the field, &c. Off-ſets are taken, *i. e.* the diſtance of the fence from the ſtationary line, is meaſured at each ſtation; and even at intermediate places, if there prove any conſiderable bends in the fence.

In *plotting*, therefore, the ſtationary lines being laid down as above, the off-ſets muſt be laid down from them, *i. e.* perpendicular of the proper length, let fall at the proper places from the ſtationary lines. The extremes of which perpendiculars being connected by lines, give the *plot* deſired.

If inſtead of going round the field, the angles, and diſtances have been all taken from one ſtation; the proceſs of *plotting* is obvious from the example above: all here required, being to protract, after the manner already deſcribed, the ſeveral angles and diſtances, taken from the ſame ſtationary pin in the field; from the ſame point or center on the paper. The extremities of the lines thus determined, being then connected by lines, will give the plot required.

The method of *plotting*, where the angles are taken by the theodolite, *i. e.* by back-ſight and fore-ſight, as it is called, is ſomewhat different.

To prepare the angles for *plotting*, the quantity of each muſt be firſt found, by ſubſtracting the degree of back-ſight and fore-ſight from each other: the remainder is the angle to be protracted.

The uſe of parallel lines is here excluded, and inſtead of laying the protractor conſtantly on, or parallel to meridians; its direction is varied at every angle. The practice is thus:

Suppoſe the former incloſure to have been ſurveyed with the theodolite, after the manner of back-ſight and fore-ſight, and ſuppoſe the quantity of each angle to be found by ſubſtraction. An indefinite line is drawn at random, as A K, fig. 31. and on this the meaſured diſtance, *e. gr.* 8 chains, 22 links, ſet off, as in the former example: if now the quantity of the angle A have been found 140°, the diameter of the protractor is to be laid on the line A K, with the center over A, and againſt the number of degrees, *viz.* 140, a mark made an indeterminate dry line drawn through it, and the diſtance of the line A B laid down from the ſcale thereupon.

Thus we gain the point B; upon which laying the center of the protractor, the diameter, along with the line A B, the angle B is protracted, by making a mark againſt its number of degrees, drawing a dry line, and ſetting off the diſtance B C as before.

Thus proceed to C, laying the diameter of the protractor on B C, the center on C, protract the angle C, and draw the line C D: thus proceeding, orderly, to all the angles and ſides, you will have the plot of the whole incloſure A B C, &c. as before.

The *third branch of* SURVEYING is performed, by reducing the ſeveral diviſions, incloſures, &c. into triangles, ſquares, trapeziums, parallelograms, &c. but eſpecially triangles; and finding the areas or contents of theſe ſeveral figures, by the following rules; which I'll begin by thoſe relating to *areas.*

An AREA is the ſuperficial content of any figure.—Thus, if a figure, *e. gr.* a field be in form of of a square, and its side 40 foot long, its area is said to be 1600 square feet, or contain 1600 little squares, each a foot every way.

Hence to find the *area* of a triangle, square, parallelogram, rectangle, trapezium, rhombus, polygon, circle, or other figure, is to find the magnitude, or capacity thereof, in square measure.

To find the *area* of fields, and other inclosures, they first survey or take the angles thereof, then plot them on paper, and thus cast up their contents, acres, roods, &c. after the usual manner of other plain figures.

This last branch of *surveying* belongs more properly to *trigonometry*: therefore I'll refer to that treatise, all that can be said relating to it.

TANNING.

TANNING is the art of preparing of skins or hides in a pit, with *tan* and water.

What we call *tan*, in this preparation (from which the art borrows its name) is the bark of oak, chapped and ground, by a tanning-mill, into a coarse powder.

Not only the bark, but every part of the oak-tree, of what age or growth soever, all oaken coppice, &c. cut in barking time, makes good *tan*; as good at least as the best bark.

This when got is to be well dried in the sun, house-dry'd, and kept so. To use it, the greater wood may be shaved small, or cleft, fit to be cut small by a tanning engine for the purpose; which done, it is well dried again on a kiln, and then ground by the mill. Where oak is scarce, thorns may supply the defect.

New tan is the most esteemed; when old and stale, it loses a deal of its effect, which consists in condensing, or closing the pores of the skin; so that the longer the skins are kept in *tan*, the greater strength and fineness they acquire.

The operation of *tanning* regards only bullocks, cows, calves, and horse-hides; the method thereof, for bullocks or oxes hides, is as follows:

The skin being flead off the carcass, if it is intended to be kept, it is salted with sea-salt and allum, or with a kind of saltpetre called *natron*, if it is not for keeping, the salting is saved, as being of no use, but to prevent the hide from corrupting before it can be conveniently carried to the tan-house.

Whether the hides have been salted or not, the *tanner* begins with taking off the horns, the ears, and the tail; after which it is thrown into a running water for about thirty hours, to wash off the blood, and other impurities adhering to the inside.

This done, it is laid over-night in a lime-pit, already used; whence it is taken, and left to drain three or four days on the edge of the pit.

This first and slightest preparation over, it is returned into a strong lime-pit for two days, then taken out for four more; and thus for six weeks alternately, taken out and put in twice a week.

At the six weeks end it is put into a fresh pit, where it continues eight days, and is taken out for so many; and this alternately for a year or eighteen months, according to the strength of the leather, or the weather. For in great heat they put in fresh lime twice a week; and in frost they sometimes do not touch them for three months. Every fresh lime-pit they throw them into is stronger and stronger.

At four, five, or six weeks end, the *tanner* scrapes off the hair on a wooden leg or horse, with a kind of knife for that purpose. And after a year or eighteen months, when the hair is perfectly gone, he carries it to a river to wash, pares off the flesh on the leg with a kind of cutting knife, and rubs it briskly with a kind of whet-stone, to take off any remains of flesh or filth on the side of the hair.

The skin is now put into *tan*; that is, cover'd over with *tan*, as it is stretched in the pit, and water let in upon it: if the skin be strong, five coverings of *tan* will be required; for weaker, three or four may suffice. When the skin has not been kept long enough in lime, or the *tan-pit* is upon clearing it, in the middle is seen a whitish streak, called the horn, or crudity of the skin; and this is the reason why the soals of shoes, boots, &c. stretch so easily, and take water.

When the hides are sufficiently *tanned*, they are taken out of the pit to be dried, by hanging in the air. Then the *tan* is cleaned off them, and they are put in a place neither too dry, nor too moist; they are well stretched over one another, with weights a-top, to keep them tight and straight; and under this condition are sold under the denomination of *kind leather*.

Cows, calves, and horses skins are *tanned* much after the same manner as those of oxen, except that the former are only kept four months in the lime-pit; and that before they be put in the *tan*, there is a preparation required thus: cold water is poured into a wooden fat or tub, wherein the ſkins are put, which are kept ſtirring, while ſome of the water is warming in a kettle; and as ſoon as the water is a little more than luke-warm, it is poured gently into the fat, and upon this is caſt a baſket of *tan*; during which time, the ſkins are ſtill kept turning, that the water and tan may not ſcorch them.

After an hour they are taken out, and caſt for a day in cold water, then returned into the former fat, and the ſame water they had been in before; and here they are left eight days; which expired, they are put in the *tan pit*, and three coverings of *tan* given them, the firſt of which laſts five weeks, the ſecond ſix, and the third two months.

The reſt of the proceſs is in all reſpects the ſame as that above delivered. In ſome countries, as *Champagne*, &c. the *tanners* give the firſt preparation with barley inſtead of lime.

See SHAMOISING *in Letter S.*

THEOLOGY.

THEOLOGY, or DIVINITY, a ſcience which inſtructs us in the knowledge of God, or divine things; or which has God, and the things he has revealed, for its object.

Hence theology may be diſtinguiſhed into natural, which comprehends the knowledge we have of God from his works, by the light of reaſon alone; and ſupernatural, which contains what we are taught concerning God in revelation.

Theology is again diſtinguiſhed into poſitive, moral, and ſcholaſtic. Poſitive theology is the knowledge of the holy ſcriptures, and of the ſignification thereof, conformably to the opinions of the fathers and councils, without the aſſiſtance of any argumentation. Some will have it, that this ought to be called expoſitive, rather than poſitive. Moral theology, is that which teaches us the divine laws relating to our manners and actions. Scholaſtic, or ſchool theology, is that which proceeds by reaſoning; or that derives the knowledge of ſeveral divine things from certain eſtabliſhed principles of faith.

TRIGONOMETRY.

TRIGONOMETRY is the art of finding the dimenſions of the parts of a triangle unknown, from other parts known; or the art whereby from any three parts of a triangle given, all the reſt are found.

The Word literally ſignifies the *meaſuring of triangles*, formed from the *Greek* τρίγωνον, *triangle*, and μέτρον, *meaſure*. Yet does not the art extend to the meaſuring of the area, or ſurface of *triangles*, which comes under *geometry*: *trigonometry* only conſiders the lines and angles thereof.

Trigonometry, or the ſolution of *triangles*, is founded on that mutual proportion, which is between the ſides and angles of a *triangle*; which proportion is known, by finding the proportion which the radius of a circle has to certain other lines, called *chords*, *ſines*, *tangents*, and *ſecants*.

This proportion of the ſines and tangents to their radius, is ſometimes expreſſed in common or natural numbers, which conſtitute what we call the *tables of natural ſines and tangents*, &c. Sometimes it is expreſſed in logarithms, and in that caſe conſtitute *the Tables of artificial ſines*, &c.

Laſtly, ſometimes the proportion is not expreſſed in numbers; but the ſeveral *ſines*, *tangents*, &c. are actually laid down upon *lines* or *ſcales*; whence the *line of ſines*, *tangents*, &c.

Note, That before I proceed to the diviſion of *trigonometry*, I muſt explain what is underſtood by *ſines*, *tangents*, and *ſecants in trigonometry*.

SINE, or *right* SINE, in *trigonometry*, is a right line drawn from an extremity of an arch, perpendicularly upon the radius drawn from the other extremity; or the *ſine* is half the chord of twice the arch.

Whole SINE, *ſine totus*, is the ſine of a quadrant, or of 90 degrees; that is, the whole ſine is the ſame with the radius.

Verſed SINE is a part of the whole *ſine* or radius, intercepted between the right *ſine* and the arch.

It is demonſtrated, 1. that the right *ſine*, being perpendicular to the radius; all *ſines* drawn to the ſame radius are parallel to each other.

2. Two angles contiguous have the ſame *ſine*.

3. The *ſines* of obtuſe angles are the ſame with thoſe of their complements to two right angles.

4. All *ſines* of ſimilar arches have the ſame ratio to their radii.

SINE-

SINE-*complement*, or CO-SINE, is the fine of an arch, which is the complement of another arch to a quadrant.

In eftimating the quantity of *fines*, &c. we affume the radius for unity, and determine the quantity of the *fines*, *tangents* and *fecants* in fractions thereof. From *Ptolemy's almageft*, we learn that the ancients divided the radius into 60 parts, which they called degrees, and thence determined the chords in minutes, feconds and thirds, that is in fexagefimal fractions of the radius; which they likewife ufed in the refolution of *triangles*. The *fines* of half chords, for ought appears, were firft ufed by the *Saracens*.

Regiomontanus, at firft, with the antients, divided the radius into 60 degrees; and determined the *fines* of the feveral degrees into decimal fractions thereof, but he afterwards found it would be more commodious to affume the radius for one; and thus introduced the prefent method into *trigonometry*.

In the common tables of *fines* and *tangents* the radius is conceived divided into 10000000 parts; beyond which we never go in determining the quantity of the *fines* and *tangents*. Hence, as the fide of a hexagon fubtends the fixth part of a circle, and is equal to the radius; the fine of 30° is 5000000.

1. *The fine being given to find the fine-complement.* From the fquare of the radius, fubftract the fquare of the *fine*: the remainder will be the fquare of the *fine-comflement*: whence the fquare root being extracted, gives the *fine-complement*.

2. *The fine of the arch being given, to find the fine of the half arch.* Find the chord of the arch, for half of this is its *fine*.

3. *The fine of an arch being given to find the fine of a double arch.* This is found by the rule of *proportion*.

To conftruct a canon of SINES. The *fines* of 30°, 15°, 45° 36° being had, we can thence conftruct a cannon of all the *fines* to every minute, or every fecond, for from the *fine* of 36°, we find thofe of 18°, 9°, 4°, 30′; and 2°, 15′, by the fecond problem: the *fines* of 54°, 72°, 81°, 85°, 30′, and 87°, 45′, &c. by the firft problem. Again, from the *fine* of 45° find the *fine* of 22°, 30′; 11°, 15′, &c. From the *fines* of 30° and the *fines* of 54° find the *fign* of 12°. From the *fine* of 12° find the *fines* of 6°, 3°, 1°, 30′. 35′. 78°, &c. From the *fine* of 15°, find the *fine* of 7, 30′, 45′, &c. 'till you have 120 *fines* fucceding each other orderly, at an interval of 45 minutes. Between thefe find the intermediate *fine*: thus will the canon be compleat. From the *fine* I'll pafs to the explication of the *tangent*.

TANGENT in *trigonometry*, is a right line arched perpendicularly on the extreme of the diameter of an arch, and continued to a point, where it is cut by a fecant, that is, by a line drawn from the centre, through the extremity of the arch, whereof it is a *tangent*.

CO-TANGENT, or TANGENT *of the complimert*, is the *tangent* of an arch, which is the complement of another arch to a quadrant.

Artificial TANGENTS are the logarithms of the *tangents* of arches.

Sine of TANGENTS is a fine ufually placed on the fector and Gunter's Scale.

TANGENT *of a conic fection*, as of a parabola, is a right line which only touches or meets the curve in one point, and does not cut or enter within the curve.

The method of *tangents* is a method of determining the quantity of the *tangent* of any algebraic curve; the equation defining that.

This method is one of the great refults of the *calculus differentialis*.

SECANT, in *trigonometry*, denotes a right line, drawn from the centre of a circle, which cutting the circumference, proceeds 'till it meets with a tangent to the fame circle.

To find the logarithm of the *fecant* of any arch, the fine of the complement of the arch being given, multiply the whole fine of the logarithm by two, and from the product, fubftract the logarithm of the fine complement; the remainder is the logarithm of the *fecant*.——from this I'll pafs to the divifion of *trigonometry*.

TRIGONOMETRY, is divided into *plain*, and *fpherical*; the firft confidering rectilineal triangles; and the fecond fpherical ones.--The firft is of obvious and continual ufe in navigation, meafuring, furveying, and other operations of geometry.

The fecond is only learned with a view to aftronomy, and its kindred arts, geography, and dialing.-----It is generally efteemed exceeding difficult, by reafon of the vaft number of cafes wherewith it is perplex'd; but the excellent *wolfius* has remov'd moft of the difficulties. That author has not only fhewn how all the cafes of rectangled triangles may be folved the common way, by the rules of figns and tangents; but has likewife laid down an univerfal rule, whereby all problems, both in plain and fpherical rectangled triangles, are folved; and even obliquangular triangles he teaches to folve with equal eafe.

Plain TRIGONOMERTY is an art whereby, from three given parts of a plain triangle, we find the reft.

The great principle of *plain trigonometry* is, that in every plain triangle, the fides are, as the fines of the oppoſite angles: the doctrine thereof, which is that of the learned *Wolfius*, is contained in the following problems.

For the *ſolution of the plain triangles.* ----- 1. Two angles being given, together with a ſide oppoſite to one of them; to find the ſide oppoſite to the other, the rule or canon is this; as the ſine of the angle, is to the given ſide oppoſite to the ſame; ſo is the ſine of the other angle, to the ſide required; the oppoſite ſide therefore is commodiouſly found by the logarithms, from the rule for finding a fourth proportional to the three numbers given.

For an example; ſuppoſe one of the given angles $=78° 35'$. and the other $=57° 28$, the ſide oppoſite to one of them $=74'$, the operation will ſtand thus.

Logar. of ſine of one angle	9. 8750142
Logar. of the oppoſite ſide	1. 8692317
Logar. of ſine of the other angle	9. 9258681
Sum of logar. of the oppoſite ſide, and of the ſine of one angle	11. 7950998
Log. of the ſide oppoſite to the other	1. 9200856

The number correſponding to which in the table of logarithms, is 83, the quantity of the ſide ſought.

2. Two ſides together with the angle oppoſite to one of them given; to find the other angles. ——The rule is this; as one ſide is to the ſine of the given angle oppoſite thereto; ſo is the other ſide, to the ſine of the angle required oppoſite thereto.

For example, ſuppoſe one of the ſides $=94'$, and the other ſide $=63'$, the angle oppoſite to one of them $=72° 15'$.

Log. of one ſide	1. 9731279
Log. of the ſine of the angle	3. 9788175
Log. of the other ſide	1. 8388491
Sum of loga. of ſine of the oppoſite angle, and of one of the ſides	11. 8176666
Logar. of ſine of the other ſide	9. 9444387

The number correſponding to which, in the table of logarithms, is $61° 37'$, now the given angle being $72°, 15'$, the ſum of the two $133° 52'$ ſubtracted from 180, the ſum of the three gives $46° 8'$, for the other angle ſought.

In like manner, ſuppoſe, in a right angled triangle, that beſide the right angle, is given the hypothenuſe, 49, and the cathetus, 36, to find the angle ſought; then will the operation ſtand thus:

Log. of the hypot.	1. 6901961
Log. of the whole ſine	10. 0000000
Log. of the cathetus	1. 5563025
Log. of ſine of the angle ſought	9. 8661064

The correſponding number to which, in the table of logarithms, is $47° 16'$.

3. Two ſides, together with the included angle being given, to find the two remaining angles. ——1. If the triangle be rectangular, take one of the ſides including the right angle, for radius, then will the other ſide be the tangent of the oppoſite angle.—The rule then is, as one leg is to the other; ſo is the whole ſine to the tangent of the oppoſite angle.

E. gr. ſuppoſe one of the ſigns 79. and the other 54.

Log. of one ſide	18976271
Log. of the other	17323938
Log. of the whole ſine.	100000000
Logar. of Tang. of the angle ſought	9. 8247667

The correſponding number to which, in the table of logarithms, is $34° 21'$, therefore one of the angles of the triangle is $55° 39'$.

II. If the included angle be oblique, the rule is; as the ſum of the given ſides, is to their difference, ſo is the tangent of half the ſum of the ſought angles, to the tangent of half the difference; adding, therefore, the half difference to the half ſum; the aggregate will be the greater angle; and ſubtracting the half difference from the half ſum, the remainder is the leſs angle.

As for example, ſuppoſe the given ſides $=75'$, $=58'$, the oblique angle $=180° 24'$, then will the given ſides,

75 = 75		
58 = 58	+	179° 60′
		118° 24 the oblique angle.
Sum 133 diff. 17		71° 30′ ſought angles
		35° 48′ ½ thereof

Log. of the given ſides	2. 1238516
Log. of the angles ſought	1. 2334489
Log. of tangent ½	9. 8580695
Sum of log.	12. 0885183
Log of tangent ½	8. 9646667

The correſponding number to which is $5° 16'$.

Spherical TRIGONOMETRY, is the art whereby from the three given parts of a ſpherical triangle, we find the reſt, *e. gr.* from two ſides and one angle, we find the two other angles, and the third ſide.

The

The principles of *spherical trigonometry*, as reformed by *Wolfius*, are as follows. 1. In every rectangled spherical triangle, the whole sine is to the sine of the hypothenuse, as the sine of either of the acute angles, is to the sine of the leg opposite thereto, or the sine of the angle to the sine of its opposite leg; whence we deduce, that the rectangle of the whole sine, into the sine of one leg, is equal to the rectangle of the sine of the angle opposite thereto, into the sine of the hypothenuse.

2. In every right angled spherical triangle, none of whose sides is a quadrant; if the complements of the legs to a quadrant, be considered as the legs themselves: the rectangle of the whole sine into the co-sine of the middle part, is equal to the rectangle of the sines, disjunct parts, or extremes.

Hence, 1. If the sine be artificial, that is, the logarithms of the natural ones; the whole sine, with the co-sine of the middle part, will be equal to the sines of the disjunct part.

2. Since, in a rectangular triangle, the whole sine is to the hypothenuse, as the sine of the angle, to the sine of the opposite leg; if instead of the sines of the sides, we take the sides themselves; here, too, the whole sine, with the co-sine of the middle part, will be equal to the sine of the disjunct parts.

This *Wolfius* calls *regula sinuum catholica*, or th first part of the *catholick rule of trigonometry*; by means whereof all the problems of either *trigonometry* are solved, when the thing is effected by sines alone.—My Lord *Napier* had the first thought of such a rule; but he used the complements of the hypothenuse, and the angles, for the hypothenuse and angles themselves: so that the tenor of his catholick rule is this:

The whole sine, with the sine of the middle part, is equal to the co-sines of the disjunct, or as he calls them, opposite parts.—But in this, that harmony between plain and spherical *trigonometry*, visible in *Wolfius*'s rule, does not appear.

3. In a rectangled spherical triangle, none of whose sides is a quadrant; as the whole sine is to the sine of the adjacent leg; so is the tangent of the adjacent angle, to the tangent of the leg.

Whence, 1. As the co-tangent of the angle, is to the whole sine, as the whole sine is to the tangent of the angle, so is the sine of the adjacent leg, to the tangent of the other leg; therefore the co-tangent of the adjacent angle, will be to the whole sine, as the sine of the leg adjacent thereto, is to the tangent of the opposite one. 2. The rectangle, therefore, of the whole sine, into the sine of one leg, is equal to the rectangle of the tangent of the other leg, into the co-tangent of the angle opposite to the same. And, in like manner, the rectangle of the whole sine, into the sine of one of the legs, is equal to the rectangle of the tangent of the adjacent leg, into the co-tangent of the angle sought.

4. In every right angled spherical triangle. none of whose sides is a quadrant; if the complements of the legs to a quadrant, or their excesses beyond a quadrant, be considered as the legs themselves; the rectangle of the whole sine, into the co-sine of the middle part, will be equal to the rectangle of the co-tangents of the conjunct parts. 2. Since in a rectilinear, right angled triangle, we use the tangents, when from the legs given, the adjacent angle is to be found; and in that case the whole sine is to the co-tangent of the angle, as one leg to the other; therefore, also, in a rectilinear triangle, if for the sines and tangents of the sides, be taken the sines themselves; the whole sine, with the co-sine of the middle part, is equal to the co-tangents of the conjunct parts.

This *Wolfius* calls *regula tangentium catholica*, and constitutes the other part of the catholick rule of *trigonometry*; whereby all problems, in each *trigonometry*. where tangents are required, are solved.

My Lord *Napier*'s rule to the like effect is thus. —That the whole sine, with the sine of the middle part, is equal to the tangents of the contiguous parts.

'Tis therefore a catholick rule, which holds in all *trigonometry*, that in a rectangled triangle, (*notatis notandis*) the whole sine, with the co-sine of the mean or middle part, is equal to the sines of the disjunct or separate parts, and the co-tangents of the conjunct or contiguous part.

For an illustration and application of this rule, we'll give the solution of the various cases of spherical triangles, *viz.*

Solution of right angled spherical TRIANGLES, by the common rules, 1. In a right angled *spherical triangle*, any two parts, besides the right angle, being given to find the rest.

1. Consider whether the parts, which come to the question be conjunct or disjunct. If the disjunct be opposite to each other; as, if the hypothenuse and an angle be given, to find the opposite leg. Then the rule is; as the whole sine is to the sine of the hypothenuse, so is the sine of the angle to the sine of the opposite leg. 2. If the disjunct parts be not opposite to each other, the sides of the *triangle* are to be continued one way, till they become quadrants, that you may thus have a new *triangle*, wherein the parts that come into the question, are mutually opposite to each other.

3. If the hypothenuse be not among the conjunct parts, as if the legs be given for an angle opposite to one of them, the rule is—As the sine of

of one of the legs is to the whole ſine, ſo is the tangent of the other leg to the tangent of the angle.

4. But if the hypothenuſe be found among the conjunct parts, as if the hypothenuſe and the angle be given, to find the adjacent ſide; the ſides of the triangle are to be continued one way, till they become quadrants, that we may have a new *triangle*, wherein the *hypothenuſe* is not among the parts that come into the queſtion; *e. gr.* in our caſe, the *triangle*, wherein are given the complement of the *hypothenuſe*, and the complement of an angle, and another angle the complement of the leg; ſince then in the *triangle* the *hypotheneuſe* does not come in queſtion, the rule is as before.

5. When the ſides of a *triangle* are to be continued, it is the ſame thing which way ſoever they be produced, provided no acute angle come into the queſtion, otherwiſe the ſides are to be continued through the other oblique one. If both be in the connection, the ſides are to be continued through that adjacent to the ſide in queſtion.

By this means a *triangle* is always obtained, wherein the thing required is found, either by the rules of ſines or tangents.

Solution of right angled ſpherical TRIANGLES, *by a catholick rule*.—Conſider, as before, whether the parts that come in queſtion be conjunct or disjunct.

If either one, or both the ſides, including the right angle, come into the queſtion; for it, among the data, writes its complement to a quadrant. Since, then, by the catholick rule already delivered, the whole ſine, with the ſine complement of the middle part, is equal to the ſines of the disjunct parts, and the co-tangents of the conjunct parts; from the ſum of thoſe data ſubſtract the third datum; the remainder will be ſome ſine or tangent, the ſine or angle corroſponding to which, in the artificial canon of *triangle*, is the ſide or angle ſought.

This univerſal rule being of great ſervice in *trigonometry*, we ſhall apply it to the various caſes thereof, and illuſtrate it with examples; which examples in the caſe of disjunct or ſeparate parts, will, at the ſame time, illuſtrate the common method, but in the caſe of contiguous parts admit of other ſolutions.

The *hypothenuſe* 60°, and the angle 23° 30′, being given, to find the oppoſite leg. Since the oppoſite leg is the middle part, the angle an hypothenuſe are disjunct; the whole ſine, with the co-ſine of the complement of the leg, *i. e.* with the whole ſine of the leg, is equal to the ſines of the angle and hypothenuſe.

Therefore from the ſine of the angle	96006997
Sine of the hypothenuſe	99375306
Sum	195382303
Subſtract the whole ſine	100000000
Remain ſine of the hypoth.	9.5382303

the correſponding number to which, in the canon, is 20°, 12′, 6″.

2. Given the hypothenuſe 60°, and one of the legs, 20°, 12′, 6″, to find the oppoſite angle.—It is evident from the preceding problem, that from the ſum of the whole ſine, and the ſine of the leg, the ſine of the hypothenuſe is to be ſubſtracted, the remainder is the ſine of the angle. The example, therefore, of the former caſe, is eaſily converted into an example of this.

3. Given the leg 20°, 12′, 6″, and the oppoſite angle 23°, 30′, to find the hypothenuſe.—'Tis evident from the firſt caſe, that from the ſum of the whole ſine, and the ſine of the leg, is to be ſubſtracted the ſine of the angle, and the remainder is the ſine of the hypothenuſe.

4. Given the hypothenuſe 60°, and one leg 20°, 12′, 16″, to find the other leg.—Since the hypothenuſe is a mean part, and the two legs are disjunct parts, the whole ſine, with the co-ſine of the hypothenuſe, are equal to the ſines of the complements; *i. e.* to the co-ſines of the two legs.

Therefore from the whole ſine	100000000
Co-ſine of the hypothenuſe	96989700
Sum	196989700
Subſtract co-ſine of a leg	99724279
Remains co-ſine of the other leg	97265421

the correſponding number to which, in the canon, is 32°, 11′, 34″; therefore the leg ſought, 57°, 48′, 26″.

5. Given this leg 57° 48′ 26″, and the other leg 20° 12′ 6″. to find the hypothenuſe. 'Tis evident from the preceding caſe, that the whole ſine is to be ſubſtracted, from the ſum of the co-ſines of the two legs; the remainder is the co-ſine of the hypothenuſe. The example, therefore, of the preceding caſe is eaſily applied to this.

6. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the oppoſite angle.—Since the oppoſite angle is a middle part, and the leg and adjacent angle disjunct parts; the whole ſine, with the co-ſine of the oppoſite angle, is equal to the ſine of the adjacent angle, and the ſine of the complement, *i. e.* to the co-ſine of the leg.

Therefore

Therefore from the fine of the adjacent angle	96006997
Co-fine of the leg	97265421
Sum	193272418
Subftract the whole fine	100000000
Remains co-fine of the oppofite angle.	93272418,

The number correfponding to which, in the canon, is 12° 15′ 56″; therefore the oppofite angle is 77° 44′ 4″.

7. Given the leg 57° 48′ 26″, and the oppofite angle 77° 44′ 4″, to find the adjacent angle.—'Tis evident from the preceding cafe, that the co-fine of the leg is to be fubftracted from the fum of the whole fine, and the co-fine of the oppofite angle; the remainder is the fine of the adjacent angle. The former example, therefore, is eafily accommodated to the prefent cafe.

8. Given the oblique angles 77° 44′ 4″, and 23° 30′, to find the leg adjacent to the other. —From problem the fixth, 'tis evident, that the fine of the angle 23° 30′, is to be fubftracted from the fum of the whole fine, and the co-fine of the angle 77° 44′ 4″, and that the remainder is the co-fine of the adjacent leg. The example of the fixth Problem is eafily applied to this.

9. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the oppofite leg.—Since the leg 57° 48′ 26″ is a mean part; and the adjacent angle and oppofite leg conjunct parts; the whole fine, with the fine of the leg 57° 48′ 26″, is equal to the co-tangent of the adjacent angle, and the tangent of the oppofite leg.

Therefore from the whole fine	100000000
Sine of the leg 57° 48′ 26″	99275039
Sum,	199275039
Subftract the co-tangent of the adjacent angle	103616981
Remains the tangent of the oppofite leg.	95658058

to which the correfponding number in the canon, is 20° 12′ 6″.

10. Given the leg 20° 12′ 6″, and the oppofite angle 23° 30′, to find the adjacent leg.---From the fum of the co-tangent of the oppofite angle, and the tangent of the given leg, fubftract the whole fine; the remainder is the fine of the adjacent leg.

11. Given the legs 20′ 12′ 6″, and 57° 48′ 26″, to find the angle oppofite to one of them.---From the fum of the whole fine, and fine of the leg 57° 48′ 26″, fubftract the tangent of the other leg; the remainder is the co-tangent of the oppofite angle.

12. Given the hypothenufe 60°, and the oblique angle 23° 30′, to find the adjacent leg.---Since the oblique angle is a middle part; and the hypothenufe and adjacent leg conjunct parts, the whole fine, with the co-fine of the oblique angle, will be equal to the co-tangent of the adjacent leg.

Therefore from the whole fine	100000000
Co-fine of the oblique angle	99623978
Sum,	199623978
Subftract the co-tangent of the hypoth.	97614394
Remains the tangent of the adjacent leg	102009594

The number correfponding to which in the tables is, 57° 48′ 26″.

13. Given the leg 57° 48′ 26″, and the adjacent angle 23° 30′, to find the hypothenufe. From the fum of the whole fine, and the co-fine of the adjacent angle, fubftract the tangent of the leg, the remainder is the co-tangent of the hypothenufe.

14. Given the hypothenufe 60°, and the leg 57° 48′ 26″, to find the adjacent angle.

From the fum of the co-tangent of the hypothenufe, and tangent of the leg, fubftract the whole fine; the remainder is the co-fine of the adjacent angle.

15. Given the hypothenufe 60°, and one angle 23° 30′, to find the other angle.

Since the hypothenufe is the middle part, and both angles disjunct Parts, the whole fine, with the co-fine of the hypothenufe, will be equal to the co-tangents of the two angles.

Therefore from the whole fine	100000000
Co-fine of the Hypoth.	96989700
Sum,	196989700
Subftract the co-tangent of the angle 23° 30′	103616981
Remain the co-tangent of the other angle	93372719

the correfponding number, to which, in the canon, is 12° 15′ 56″; therefore the angle fought is 77° 44′ 4″.

16. Given the oblique angles 77° 44′ 4″, and 23° 30′, to find the hypothenufe.—From the fum of the co-tangents of the angles, fubtract the whole fine; the remainder is the co-fine of the hypothenufe. From this I'll pafs to the *folution of the oblique-angled fpherical triangles.*

1. In an *oblique-angled fpherical triangle,* two fides,

sides being given together with an angle opposite to one of them, to find the other. The rule is,

As the sine of one of the sides, is to the sine of the opposite angle; so is the sine of the other side to the sine of the angle opposite to it likewise

Suppose, for example, the side 39° 29′; the opposite angle 43° 20′; the other side 66° 45′: then will,

The sine of the first side	98033572
The sine of the opposite angle	98364771
The sine of the other side	99632168
Sum	197996939
Sine of the angle, opposite to the second side	99963367

the corresponding number to which, in the tables, is 82° 34′ 7″.

2. Given two angles, 82° 34′ 7″, and 43° 20′, together with the side 60° 44′, opposite to one of them; to find the side opposite to the other of them.---Say, as the sine of the first angle 82° 34′ 7″, is to the sine of the opposite side 60° 45′; so is the sine of the angle 43° 20′, to the sine of the other side opposite to it.---The former example may suffice for the present case.

3. Given two sides 66° 45′, and 39° 29′, together with an angle opposite to one of them 45° 20′; to find the angle included by them.---Suppose the angle included to be acute, since the other angle is also acute, the perpendicular falls in with the triangles. In the rectangle triangle, therefore, from the given angle and side, find another angle. Since the perpendicular is assumed as a lateral part in the triangle, the third angle is a middle part, and the side 39° 29′ a conjoint part; the co-sine of the third angle, and the co-tangent of the side 39° 29′; if then the second and third angles be added together, or in case the perpendicular falls without the triangle, be substracted from each other; you will have the angle required.

E. gr. the whole sine	100000000
Co-sine of the first side	95963154
Sum	195963154
Co-tangent of the opposite angle	100252805
Co-tangent of the 2d angle	95710349

the Number corresponding to which, in the tables, is 20°, 25′, 35″; the first side, therefore, is 69°, 34′, 25′.

The co-sine of the other angle	95428300.
The co-tang. of the other side	100141529.
Sum	196269829.
Co-tang. of the first side	96330085.
Co-sine of the 3d angle	99938544.

The number corresponding to which, in the tables, is 80°, 24′, 26″.

4. Given two angles, 43°, 20′, and 79°, 9′, 59″, together with the adjacent side, 66°. 45, to find the side opposite to one of them.

From one of the given angles, let fall a perpendicular to the unknown side, and in the rectangled *triangle*, from the given angle, and hypothenuse, find another angle, which, substracted from the first angle, leaves a third angle; but if the perpendicular should fall without the *triangle*, the first angle should have been substracted, since as the perpendicular is taken from one of the lateral parts, the middle part in the *triangle* is the angle 79°, 9′, 59″, the co-tangent of the second side is found by substracting the co-sine from the sum of the co-tangent of the adjacent side, and the co-sine of the angle found first of the other angles. The example of the preceding case is easily applied to this:

5. Given two sides 66° 45′, and 39° 29′, with the angle opposite to one of them 43° 20′; to find the third side.

Letting fall, as before, the perpendicular; in the rectangled *triangle*, from the given angle and hypothenuse, find another side. Since assuming the perpendicular, for a lateral part in the *triangle*, the side 66° 45′ is the middle part, and the side found the separate part, and the two other angles a disjunct part: the co-sine of these two angles is found by substracting the co-sine of the first side, from the sum of the co-sines of the hypothenuse, and the side found.

6. Given two angles 43° 20′, and 77° 9′ 59″, together with the side 39° 29′, opposite to one of them; to find the side adjacent to both.

Letting fall the perpendicular, find in the rectangled *triangle*, the sequent of the side sought; which, substracted from the third side, leaves two angles. If the perpendicular falls without the *triangle*, the third side is to be substracted from the side found, since by assuming the perpendicular for a literal part in the *triangle*, the hypothenuse becomes a middle part, and the side found from it and the angle given, a separate part.

7. Given

7. Given two angles 43°, 20′, and 79°, 9′, 59″, together with the ſide 39°, 29′, oppoſite to one of them, to find the ſide adjacent to both.

Letting fall the perpendicular from the unknown angle to the oppoſite ſide, and that falling within the *triangle*, from the given angle 79°, 9′, and 59″, and the hypothenuſe, ſeek in the rectangled *triangle* the ſegment; ſince aſſuming the perpendicular for a lateral part in one *triangle*, two angles of that triangle are the mean part, and the angle 79°, 9′, 59″, a conjuct part; and in the other triangle two angles thereof are the middle part, and the other angle a conjunct part. The ſine of the ſegment is found by ſubſtracting the co-tangent of the angle 79°, 9′, 59″, from the ſum of the ſine, and the co-tangent of the angle 43°, 20′. If then the two ſegments be added, or in caſe the perpendicular fall without the *triangle*, be ſubſtracted from each other, the reſult will be in the ſide required.

8. Given two ſides 66°, 45′, and 39°, 29′, with the included angle 49°, 9′, 59″, to find the angle oppoſite to one of them.

Letting fall the perpendicular, find the ſegment, as in the preceeding problem. This ſubſtracted from the ſide 66°, 45′, leaves another ſide. If the perpendicular falls without the triangle, the ſide 66°, 45′, is to be added. And ſince by aſſuming the perpendicular for a lateral part in the other triangle, the ſegment is the middle part, and the firſt angle given a conjunct part. The co-tangent of this angle is found by ſubſtracting the ſine from the ſum of the co-tangent of the other angle given, and of the other ſine.

9. Given two angles 43°, 20′, and 79°, 9′, 59″, together with the adjacent ſide 66°, 45′, to find the angle oppoſite to the ſame.

From one of the given angles, letting fall the perpendicular to the oppoſite ſide; in the rectangled *triangle* from the firſt given angle, and hypothenuſe, we find an angle; which ſubſtracted from the triangle, leaves another angle. In caſe the perpendicular falls without the triangle, from which this laſt angle is taken, the ſecond angle is to be ſubſtracted from the firſt angle. Since by aſſuming the perpendicular for a lateral part in the triangle, the angle oppoſite to the ſecond angle given is the middle part, and the other angle a disjunct part; and in the other triangle the firſt angle given is the middle part, and the angle found from the firſt given angle, and the hypothenuſe the diſjunct part: the co-ſine of the angle oppoſite to the ſecond angle given is found by ſubſtracting the ſine of the angle taken from the firſt angle given, and the hypothenuſe from the ſum of the co-ſine of the firſt angle given, and the ſine of the angle found by the ſubſtraction of that angle.

1. Given two angles 43°, 20′, and 82°, 34′, together with a ſide 66°, 45′, oppoſite to one of them, to find the other angle.

From the ſought angle let fall a perpendicular, and in the right angled triangle, from the firſt given angle and hypothenuſe, find another angle. Since aſſuming a perpendicular for a lateral part in another triangle, the ſecond angle given is the middle part, and the other angle a disjunct part; and in the firſt triangle the firſt angle given is the middle part, and the firſt angle is found a disjunct part: the ſine of the ſecond angle found, is found by ſubſtracting the co-ſine of the firſt angle given, from the ſum of the co-ſine of the ſecond angle given, and of the ſine of the firſt *triangle*; if then the two firſt angles found be added, or in caſe the perpendicular falls without the *triangle*, be ſubſtracted from each other, the reſult will be the angle required.

2. Given the three ſides to find an angle oppoſite to one of them. 1. If one ſide be a quadrant, and the leg leſs than a quadrant, find the firſt angle. Continue the leg to a certain diſtance, till that diſtance, and the beginning of the leg become equal to a quadrant, and from the firſt pole draw an arch to cut the arch of the end of the leg and the diſtance, at right angles in the diſtance. Since in the rectangled *triangle*, we have given the hypothenuſe, and the ſide, or its complement to a quadrant, we ſhall find the perpendicular, which being the meaſure of the angle ſought, that angle is found of courſe.

2. If one ſide be a quadrant, and the other greater than a quadrant, ſeek again the firſt angle; from the ſecond ſide ſubſtract a quadrant, and from the firſt angle deſcribe an arch, cutting that arch at right angles. Since in the rectangled *triangle*, the hypothenuſe and ſide, or exceſs of the ſide beyond a quadrant is given, the perpendicular C. D. will be found as before, which is the meaſure of the angle required.

Trigonometry is of the utmoſt uſe in various mathematical arts. It is by means hereof that moſt of the operations of *geometry* and *aſtronomy* are performed. Without it the magnitude of the earth and the ſtars, with diſtances, motions, eclipſes, &c. would be utterly unknown. *Trigonometry* therefore muſt be owned an art, whereby the moſt hidden things, and thoſe remoteſt from the knowledge of men, are brought to light. A perſon ignorant of *trigonometry* can make no great progreſs in mixed mathematicks: but will often be gravelled, even in natural philoſophy, particularly in accounting for the phænomena of the rainbow and other meteors.

TURNING.

TURNERY, or TURNING, is the art of faſhioning hard bodies, as braſs, ivory, wood, *&c.* into a round or oval form in a lathe.

The *lathe* is compoſed of two wooden cheeks, or ſides, parallel to the horizon, having a groove or opening between; perpendicular to theſe are two other pieces, called *puppets*, made to ſlide between the cheeks, and to be fixed down at any point at pleaſure.

Theſe have two points, between which the piece to be turned is ſuſtained; the piece is turned round, backwards and forwards, by means of a ſtring put round it, and faſtened above to the end of a pliable pole, and underneath to a treddle or board, moved with the foot: there is alſo a reſt which bears up the tool, and keeps it ſteady.

The invention of the *lathe* is very antient: *Diodorus Siculus* ſays, the firſt who uſed it was a grandſon of *Dedalus*, named *Talus*. *Pliny* aſcribes it to *Theodore* of *Samos*, and mentions one *Thericles*, who rendered himſelf very famous by his dexterity in managing the *lathe*. ---With this inſtrument the antients turned all kinds of vaſes, many whereof they enriched with figures and ornaments in baſſo-relievo. Thus *Virgil*,

Lenta quibus turno facili ſuperaddita vitis.

the *Greek* and *Latin* authors make frequent mention of the *lathe*; and *Cicero* calls the workmen, who uſed it, *Vaſcularii*. It was a proverb among the ancients, to ſay one thing was formed in the *lathe*, to expreſs its delicacy and juſtneſs. The ſame proverb is retained to this day among the *French*; and they ſay of a man, who is exceedingly well ſhaped, *il eſt fait au tour*.

There is a kind of wooden pulley, making a member of the *turner*'s lathe, which is called *mandrel*. Of theſe there are ſeveral kinds; as

Flat mandrels which have three or more little pegs or points, near the verge, and are uſed for turning flat boards on.

Pin mandrels, which have a long wooden ſhank to fit into a round hole made in the work to be done.

Hollow mandrels, which are hollow of themſelves, and uſed for turning hollow work.

Screw mandrels, for turning ſcrews.

The other inſtruments uſed in *turning*, are chiſſels of different kinds.

Turning is performed, by putting the ſubſtance to be turned upon two points, as an axis; and moving it about on that axis, while an edge-tool, ſet ſteady to the outſide of the ſubſtance, in a circumvolution thereof, cuts off all the parts that lie farther off the axis, and makes the outſide of that ſubſtance concentrick to the axis.

The workman ſtands, or is ſeated at his *lathe*, with his right foot on the treddle to give the motion, which muſt be very moderate and even; he places his chiſſel on a reſt, faſtened to the *lathe*, ſome diſtance from his piece which is to be worked, and a little underneath it he approaches gently his chiſſel to the piece, ſo that the edge thereof may reach it; and goes on gradually to work, without leaving any ridges; but when a piece is to be cut off quite, and when he meets with a knot, he muſt go on ſtill more gently, otherwiſe he would run the riſk of ſplitting his work, and notch his tool.

TAPESTRY.

TAPESTRY, with the needle, is done upon canvas, finer or coarſer, according to the fineneſs or coarſneſs whereof the work is intended to be; on which is drawn the deſign of the work with a *crayon*; after which, the artiſt traces ſlightly with a worſted thread, if the work is to be of wool, all the contours, then frames it and ſets himſelf to work; which work conſiſts in ſingle, double, and croſs ſtitches.

Tapeſtry on the loom, being more curious, and done with more expedition, I'll enter into a more particular detail of its manufacture; informing firſt the reader, that there are two kinds of *tapeſtry*, viz. *tapeſtry* of the *high*, and the *low-warp*; tho' the difference is rather in the manner of working, than in the work itſelf, which is in effect the ſame in both; only the loom, and conſequently the *warps*, are differently ſituated; thoſe of the *low-*

low-warp being placed flat, and parallel to the horizon; and those on the contrary of the *high-warp*, erected perpendicularly.

We must endeavour to inform ourselves how both kinds are work'd, and as *tapestry* of the *high-warp* is the most esteemed, we will begin by examining the loom it is made upon, which is placed perpendicularly, and consists of four principal pieces; two long planks or cheeks of wood, and two thick rollers or beams. The planks are set upright, and the beams across them, one a-top, and the other at bottom, a foot distance from the ground. They have each their trunnions, by which they are suspended on the planks, and are turned with bars. In each roller is a groove, from one end to the other, capable of containing a long round piece of wood, fastened therein with hooks; its use is to tie the ends of the *warp* to the *warp*, which is a kind of worsted; a twisted woollen thread is wound on the upper roller; and the work, as fast as wove, is wound on the lower.

Within side the planks, which are seven or eight foot high, fourteen or fifteen inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end, serving to sustain the coat-stave: these pieces of iron have also holes pierced, by putting a pin in which the stave is drawn nearer or set farther off; and thus the coats, or threads, are stretched or loosened at pleasure. The coat-stave is about three inches diameter, and runs all the length of the loom: on this are fixed the coats or threads, which make the threads of the *warp* cross each other. It has much the same effect here, as the spring-stave and treddles have in the common looms. The coats are little threads fastened to each thread of the *warp*, with a kind of sliding knot, which forms a sort of march or ring. They serve to keep the *warp* open, for the passage of broaches wound with silks, woollen, or other matters used in the piece of *tapestry*. Lastly, there are a number of little sticks, of different lengths, but all about an inch diameter, which the workman keeps by him in baskets, to serve to make the threads of the *warp* cross each other, by passing them a-cross; and that the threads thus crossed, may retain their proper situation, a pack-thread is run along the threads above the stick.

The loom thus formed and mounted with its *warp*, the first thing the workman does, is to draw on the threads of this *warp*, the principal lines or strokes of the design, to be represented on the piece of *tapestry*, which is done by applying cartoons, made from the painting he intends to copy, to the side that is to be the wrong side of the piece, and then with a black-lead pencil, following and tracing out the contours thereof, on the threads of the right side; so that the strokes appear equally both before and behind. As to the original design the work is to be finished by, it is hung up behind the workman, and wound on a long staff, from which a piece is unrolled from time to time, as the work proceeds.

Besides the loom here describ'd, are required a broach, a reed, and an iron needle, for working the silk, or wool of the hoof within the threads of the *warp*. The broach is of hard wood, 7 or 8 inches long, and two-thirds of an inch thick, ending in a point, with a little handle, and serves as a shuttle, the silk, woollen, gold or silver to be used in the work, being wound on it. The reed or comb, is also of wood, eight or nine inches long, and an inch thick at the back; whence it usually grows less and less, to the extremity of the teeth, which are more or less apart, according to the great or less degree of fineness of the intended work. Lastly, the needle is in form of a common needle, only bigger and longer. Its use is to press close the wool and silks, when there is any line or colour that does not sit well.

All things being prepared for the work, and the workman ready to begin, he places himself on the wrong side the piece, with his back towards the design; so that he works as it were blind-fold, seeing nothing of what he does, and being obliged to quit his post, and go to the other side the loom, whenever he will view and examine the piece, to correct it with his pressing needle. To put any silk, woollen, &c. in the *warp*, he first turns and looks at his design; then taking a broach full of the proper colour, he places it among the threads of the *warp*, which he brings across each other with his fingers, by means of the coats or threads fastened to the staff, which he repeats every time he changes his colours. The silk or wool being placed, he beats it with his reed or comb, and when he has thus wrought in several rows over each other, he goes to see the effect they have, in order to reform the contours with his needle, if there be occasion. As the work advances, they roll it up on the lower beam, and unroll as much *warp* from the upper beam as suffices them to continue the piece; the like they do of the design behind them. When the pieces are wide, several workmen may be employed at once.

The *high-warp tapestry* goes on much slower than the *low-warp*, and takes almost double the time and trouble. And that all the difference the eye can observe between the two kinds, conſiſts in this, that in the *low-warp* there is a red fillet, about one-twelfth of an inch broad, running on each ſide from top to bottom, which is wanting in the *high-warp*.

The loom, or frame, on which the *low-warp tapeſtry* is worked, is much like that of the weavers: the principal parts thereof are two ſtrong pieces of wood, forming the ſides of the loom, and bearing a beam or roller at each end: they are ſuſtained at bottom with other ſtrong pieces of wood, in manner of treſſels; and to keep them the firmer, are likewiſe faſtened to the floor with a kind of buttreſſes, which prevent any ſhaking, though there are ſometimes four or five workmen leaning on the fore-beam at once. The rollers have each their trunnions, by which they are ſuſtained: they are turned by large iron pins, three foot long. Along each beam runs a groove, wherein is placed the wich, a piece of wood of about two inches diameter, and almoſt the length of the roller: this piece fills the groove entirely, and is faſtened therein from ſpace to ſpace by wooden pins; to the two wiches are faſtened the two extremities of the *warp*, which is wound on the further roller; and the work, as it advances, on the nearer. Acroſs the two ſides, almoſt in the middle of the loom, paſſes a wooden bar, which ſuſtains little pieces of wood, not unlike the beam of a ballance: to theſe pieces are faſtened ſtrings, which bear certain ſpring-ſtaves, wherewith the workman, by means of two treddles under the loom whereon he ſets his feet, gives a motion to the coats, and makes the threads of the *warp* riſe and fall alternately. Each loom has more or fewer of theſe ſpring-ſtaves, and each ſtave more or fewer coats, as the *tapeſtry* conſiſts of more or fewer threads.

The deſign or painting the workman is to follow, is placed underneath the *warp*, where it is ſuſtained, from ſpace to ſpace, with ſtrings, by which the deſign is brought nearer the *warp*.

The loom being mounted, there are two inſtruments uſed in working it, *viz.* the reed and the flute. The flute does the office of a weaver's ſhuttle: it is made of a hard poliſhed wood, three or four lines thick at the ends, and ſomewhat more in the middle, and three or four inches long. On it are wound the ſilks and other matters to be uſed as the woof of the *tapeſtry*. The comb, or reed, is of wood or ivory; it has uſually teeth on both ſides; it is about an inch thick in the middle, but diminiſhes each way to the extremity of the teeth: it ſerves to beat the threads of the woof cloſe to each other, as faſt as the workman has paſſed and placed them with his flute among the threads of the *warp*.

The workman is ſeated on a bench before the loom, with his breaſt againſt the beam, only a cuſhion or pillow between them; and in this poſture ſeparating with his fingers the threads of the *warp*, that he may ſee the deſign underneath; and taking a flute, mounted with the proper colour, he paſſes it among the threads, after he has raiſed or lowered them, by means of the needles moving the ſpring-ſtaves and coats. Laſtly, to preſs and cloſe the threads of the ſilk or yarn, *&c.* thus placed, he ſtrikes each courſe (*i. e.* what the flute leaves in its paſſing and coming back again) with the reed.

The *low-warp* has this in common with the *high-warp*, that all is wrought on the wrong ſide; ſo that the workman cannot ſee the right ſide of his *tapeſtry* till the piece be finiſhed and taken off his loom.

Note, alſo, That the uſual widths of *tapeſtries*, are from two ells to three ells and a half, *Paris* meaſure.

The invention of tapeſtry ſeems to have come from the *Levant*; and what makes this the more probable is, that formerly the workmen concerned herein were called, at leaſt in *France*, *Sarazins* or *Sarazinois*. It is ſuppoſed that the *Engliſh* and *Flemiſh*, who were the firſt that excelled therein, might bring the art with them from ſome of the Croiſades, or expeditions againſt the *Sarazens*. Be this as it will, it is certain thoſe two nations, particularly the *Engliſh*, were the firſt who ſet on foot this noble and rich manufacture in *Europe*; now one of the fineſt ornaments of palaces, baſiliſks, churches, *&c.* Hence if they be not allow'd the inventors, they have, at leaſt, the glory of being the reſtorers of ſo curious and admirable an art, as gives a kind of life to wools and ſilks, in no reſpect inferior to the painting of the beſt maſters.

It was late before the *French* applied themſelves to *tapeſtry*: the firſt eſtabliſhment of that kind was under *Henry* IV. in the year 1607, in the *Fauxbourg St. Marcel*; but this fell at the death of that Prince. Under *Lewis* XIV. the manufacture was retrieved by the care and addreſs of the great M. *Colbert*, at the *Goblins*, (at preſent called the *Hotel Royal of the Goblins*, in conſequence of an edict of *Lewis* XIV.) where during his ſuperintendency, and that of his ſucceſſor, M. *de Louvois*, the making of *tapeſtry* has been practiſed to a degree of perfection, which ſurpaſſes what was antiently done by the *Flemiſh*. The battles of *Alexander*, the four ſeaſons, the four elements, the King's palaces, and a series of the principal actions of the life of *Lewis* XIV. from the time of his marriage to the first conquest of *Franche Comté*, done from the designs of M. *le Brun*, director of the manufactory of the *Goblins*, are master-pieces in their kind. The manufacture of the *tapestry* of the *Goblins* subsists yet, with the same glory, and produces by intervals some very extraordinary pieces, not at all inferior to what was done under the direction of *le Brun*. The late Czar of *Muscovy*, *Peter the Great*, was presented while at *Paris*, in 1718, by the present King, *Lewis* XV. with a set of hangings, made at the *Goblins*, esteemed at 20 or 25000 *l.* sterling.

VARNISH.

VARNISH, or VERNISH, a thick, viscid, shining liquor, used by painters, gilders, and various other artificers, to give a gloss and lustre to their works; as also to defend them from the weather, dust, &c.

There are several kinds of varnishes in use; as the siccative or drying varnish, made of oil of aspin, turpentine, and sandarach melted together. White varnish, called also Venetian varnish, made of oil of turpentine, fine turpentine, and mastic. Spirit of wine varnish, made of sandarach, white amber, gum elemi, and mastic; serving to gild leather, picture-frames, &c. withal. Also the gilt-varnish, china-varnish, common varnish, &c.

1. To make the white varnish: take gum sandarach, of the clearest and whitest sort, eight ounces; gum mastic, of the clearest sort, half an ounce; of sarcocolla, the whitest, three quarters of an ounce; Venice turpentine, an ounce and a half; benzoin, the clearest, one quarter of an ounce; white rosin, one quarter of an ounce; gum animæ three quarters of an ounce: let all these be dissolved, and mixed in the manner following:

Put the sarcocolla and rosin into a little more spirits than will cover them, to dissolve; then add the benzoin, gum animæ, and Venice turpentine, into either a glass or glazed earthen vessel, and pour on as much spirits as will cover them an inch; then put the gum mastic into a glass or glazed vessel, and pour strong spirits upon it, covering it also about an inch thick, to dissolve it rightly; then put your gum elemi in a distinct vessel as before, and cover it with spirits to dissolve.

For this purpose, you need only break the rosin a little, and powder the gum animæ, sarcocolla, and benzoin.

Let all stand three or four days to dissolve, shaking the glasses, &c. two or three times a day, and afterwards put them all together into a glazed vessel, stirring them well, and strain the liquor and gums gently, beginning with the gums, thro' a linen cloth.

Then put it into a bottle, and let it stand a week before you use it, and pour off as much of the clear only, as you think sufficient for present use.

2. The white amber-varnish is thus made, according to Mr. Boyle: take white rosin four drams, melt it over the fire in a clean glazed pipkin; then put into it two ounces of the whitest amber you can get, finely powdered. This is to be put in, by a little and a little, gradually, keeping it stirring all the while with a small stick, over a gentle fire, till it dissolves, pouring in now and then a little oil of turpentine, as you find it growing stiff; and continue so to do till all your amber is melted.

But great care must be taken not to set the house on fire, for the very vapours of the oil of turpentine will take fire by heat only; but if it should happen so to do, immediately put a flat board or wet blanket over the fiery pot, and by keeping the air from it, you will put it out, or suffocate it.

Therefore it will be best to melt the rosin, in a glass of a cylindrick figure, in a bed of hot sand, after the glass has been well annealed, or warmed by degrees in the sand, under which you must keep a gentle fire.

When the varnish has been thus made, pour it into a coarse linen bag, and press it between two hot boards of oak or flat plates of iron; after which it may be used with any colours in painting, and also for varnishing them over when painted.

But for covering gold, you must use the following varnish: mean time, it is to be observed, that when you have varnished with white varnish, you may put the things varnished into a declining oven, which will harden the varnish.

3. A hard varnish, that will bear the muffle, may be thus made: take of colophony, an ounce; set it over the fire in a well-glazed earthen vessel, till

till it is melted; then by little and little, strew in two ounces of powder of amber, keeping it stirring all the while with a stick; and when you perceive it to begin to harden or resist the stick, then put in a little turpentine oil, which will thin and soften it immediately; then put in two ounces of gum copal, finely powdered, sprinkling it in as you did the amber, now and then pouring in a little oil of turpentine; and when it is done, strain it as before directed.

This is proper to varnish over gold; and the things done with it must be set into a declining oven, three or four days successively, and then it will resist even the fire itself.

4. To make a varnish for brass, that will cause it to look like gold. Take two quarts of spirit of wine, and put it into a retort glass; then add to it an ounce of gamboge, two ounces of lacca, and two ounces of mastic; set this in a sand-heat for six days, or else near a fire, or you may put the body of the bolt head frequently into warm water, and shake it two or three times a day; then set it over a pan of warm saw-dust. But before this varnish is laid over the metal, let it be well cleaned.

This is a good varnish to mix with any colours that incline to red, and the amber-varnish for mixing with those that are pale.

5. To make a varnish for gold, or metals made in imitation of gold. Take colophony, and, having melted it, put in two ounces of amber finely powdered, and some spirit of turpentine, and, as the amber thickens, keep it well stirring; then put in an ounce of gum elemi, well pulverized, and more spirit of turpentine; constantly stirring the liquor till all is well mixed and incorporated: but take care, however, to use as little turpentine as you can, because, the thicker the varnish is made, the harder it will be. Let this be done over a sand-heat, in an open glass; then strain it, as is directed for the preceding varnish. This varnish is to be used alone, first warming the vessels made of paper-paste; and lay it on with a painting-brush before the fire, but not too near, least the fire raise it into blisters. After this has been done, harden it three several times in ovens; first with a slack heat, the next with a warmer, and the third with a very hot one; and the vessels will look like polished gold.

And as for such vessels, &c. as shall be made with saw-dust and gums, the varnish may be made of the same ingredients as above-mentioned, except the gum-elemi; and this will dry in the sun, or in a gentle warmth.

6. To make a varnish for any thing covered with leaf-silver. First paint the thing over with size, and ground chalk or whiting; let them stand till they are thoroughly dry, and then do them over with very good gold-size, of a bright colour (for there is much difference in the colour of it; some being yellow, and others almost white; the first is most proper for gold, and the last for silver). When this size is so dry as that it will just stick a little to the touch, lay on the leaf silver, and close it well to the size.

7. To make a varnish for silver. Melt in a well glazed pipkin, some fine turpentine, and put in three ounces of white amber, finely powdered (more or less, according to the quantity your work will require) put it in by little and little, keeping it continually stirring, adding by degrees some spirit of turpentine, till all the amber is dissolved; and then add to it an ounce of sarcocolla well beaten, and an ounce of gum elemi well levigated, adding now and then a little spirit of turpentine, till all is dissolved: do this over a gentle fire, and keep it constantly stirring.

This varnish will be as white and strong as the former; and is to be used warm, and hardened by degrees in an oven, as varnished gold, whereby it will look like polished silver.

Laying on of Varnishes. 1. If you varnish wood, let your wood be very smooth, close-grained, free from grease, and rubbed with rushes. 2. Lay on your colours as smooth as possible; and, if the varnish has any blisters in it, take them off by a polish with rushes. 3. While you are varnishing, keep your work warm, but not too hot. 4. In laying on your varnish, begin in the middle, and stroke the brush to the outside; then to another extreme part, and so on till all be covered; for if you begin at the edges, the brush will leave blots there, and make the work unequal. 5. In fine works use the finest tripoli in polishing: do not polish it at one time only; but, after the first time, let it dry for two or three days, and polish it again for the last time. 6. In the first polishing you must use a good deal of tripoli, but in the next a very little will serve; when you have done, wash off your tripoli with a sponge and water: dry the varnish with a dry linen rag; and clear the work, if a white ground, with oil and whiting; or, if black, with oil and lamp-black.

Varnish also signifies a sort of shining coat, wherewith potter's ware, delft ware, china ware, &c. are covered, which gives them a smoothness and lustre. Melted lead is generally used for the first, and smalt for the second. See the article Glazing.

Varnish, among medalists, signifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit,

terfeit, enhances the value of them; that is, the colour, which certain soils, in which they have a long time lain, tinges the metals withal; some of which are blue, almost as beautiful as the turquoise; others with an inimitable vermilion colour; others with a certain shining polished brown, vastly finer than brasil figures.

The most usual varnish is a beautiful green, which hangs to the finest strokes without effacing them, more accurately than the finest enamel does on metals.

No metal but brass is susceptible of this; for the green rust that gathers on silver always spoils it, and it must be got off with vinegar or lemon juice.

Falsifiers of metals have a false or modern varnish, which they use on their counterfeits, to give them the appearance, or air, of being antique. But this may be discovered by its softness, it being softer than the natural varnish, which is as hard as the metal itself.

Some deposite their spurious metals in the earth for a considerable time, by which means they contract a sort of varnish, which may impose upon the less knowing; others use sal armoniac, and others burnt paper.

V E N E E R I N G.

VENEERING, Vaneering, or Fineering, a kind of marquetry, or inlaying, whereby several thin slices or leaves of fine woods, of different kinds, are applied and fastened on a ground of some common wood.

There are two kinds of inlaying; the one, which is the most common and more ordinary, goes no farther than the making of compartments of different woods; the other requires much more art, in representing flowers, birds, and the like figures.

The first kind is properly called veneering; the latter is more properly called marquetry.

The wood used in veneering is first sawed out into slices or leaves about a line in thickness, *i. e.* the twelfth part of an inch. In order to saw them, the blocks or planks are placed upright, in a kind of sawing-press. See Sawing-mill.

These slices are afterwards cut into narrow slips, and fashioned divers ways, according to the design proposed; then the joints having been exactly and nicely adjusted, and the pieces brought down to their proper thickness, with several planes for the purpose, they are glued down on a ground or block, with good strong English glue.

The pieces being thus jointed and glued, the work, if small, is put in a press; if large, 'tis laid on a bench covered with a board, and pressed down with poles or pieces of wood, one end of which reaches to the cieling of the room, and the other bears on the board.

When the glue is thoroughly dry, it is taken out of the press and finished; first with little planes, then with divers scrapers, some of which resemble rasps, which take off the dents, &c. left by the planes.

After it has been sufficiently scraped, they polish it with the skin of a sea-dog, wax and a brush, or polisher of shave-grass; which is the last operation.

V I N E G A R.

VINEGAR is an acid penetrating liquor, prepared from wine, cyder, beer, &c. of considerable use both as a medicine and sauce.

The process of turning vegetable matters to vinegar, is thus delivered by Dr. Shaw: take the skins of raisins, after they have been used in making wine; and pour three or four times their own quantity of boiling water upon them, so as to make a thin aqueous mixture. Then set the containing cask, loosely covered, in a warmer place than is used for vinous fermentation; and the liquor, in a few weeks time, will become a clear and sound vinegar; which being drawn off from its sediment, and preserved in another cask, well stopped down, will continue perfect, and fit for use.

This experiment shews us a cheap and ready way of making vinegar from refuse materials; such as the husks of grapes, decayed raisins, the lees of wine, grounds of ale, beer, &c. which are frequently thrown away as useless. Thus, in many wine-countries, the marc, rape, or dry pressing of grapes are thrown in heaps, and suffered to putrify

trify unregarded; though capable of affording as good vinegar, as the wine itſelf. In ſome places they bury copper-plates in theſe huſks, in order to make verdigreaſe; but this practice ſeems chiefly confined to the ſouthern parts of France. Our preſent experiment ſhews us how to convert them to another uſe; and the direction extends to all the matters that have once undergone, or are fit to undergo a vinous fermentation, for that all ſuch matters will afford vinegar. Thus all our ſummer-fruits in England, even blackberries; all the refuſe waſhings of a ſugar-houſe, cyder-preſſings, or the like, will make vinegar, by means of water, the open air, and warmth.

The whole proceſs, whereby this change is effected, deſerves to be attentively conſidered. And, firſt, the liquor to be thus changed, being kept warmer than in vinous fermentation, it, in a few days, begins to grow thick or turbid; and without throwing up bubbles, or making any conſiderable tumult, as happens in vinous fermentation, depoſits a copious ſediment. The effect of this ſeparation begins to appear firſt on the ſurface of the liquor, which gathers a white ſkin, that daily increaſes in thickneſs, till at length it becomes like leather; and now, if continued longer in this ſtate, the ſkin turns blue, or green, and would at laſt grow ſolid, and putrify: therefore in keeping down this ſkin as it grows, and thruſting it gently down to the bottom of the veſſel, conſiſts much of the art of vinegar-making, eſpecially from malt.

*Method of making cyder-*VINEGAR. The cyder (the meaneſt of which will ſerve the purpoſe) is firſt to be drawn off fine into another veſſel, and a quantity of the muſt, or pouz of apples, to be added: the whole is ſet in the ſun, if there be a conveniency for the purpoſe; and, at a week or nine days end, it may be drawn off.

*Method of making beer-*VINEGAR. Take a middling ſort of beer, indifferently well hopped; into which, when it has worked well, and is grown fine, put ſome rape, or huſks of grapes, uſually brought home for that purpoſe: maſh them together in a tub; then, letting the rape ſettle, draw off the liquid part, put it into a caſk, and ſet it in the ſun as hot as may be; the bung being only covered with a tile or ſlate ſtone: and in about thirty or forty days, it will become a good vinegar, and may paſs in uſe as well as that made of wine, if it be refined and kept from turning muſty.

Or thus: to every gallon of ſpring-water, add three pounds of Malaga-raiſins; which put into an earthen jar, and place them where they may have the hotteſt ſun from May till Michaelmas: then, preſſing all well, turn the liquor up in a very ſtrong iron-hooped veſſel, to prevent its burſting: it will appear very thick and muddy, when newly preſſed; but will refine in the veſſel, and be as clear as wine. Thus let it remain untouched for three months, before it be drawn off, and it will prove excellent vinegar.

*Method of making wine-*VINEGAR. Any ſort of vinous liquor, being mixed with its own fæces, flowers, or ferment, and its tartar firſt reduced to powder; or elſe with the acid and auſtere ſtalks of the vegetable from whence the wine was obtained, which hold a large proportion of tartar: and the whole being kept frequently ſtirring in a veſſel which has formerly held vinegar, or ſet in a warm place full of the ſteams of the ſame, will begin to ferment a-new, conceive heat, grow ſour by degrees, and ſoon after turn into vinegar.

The remote ſubjects of acetous fermentation are the ſame with thoſe of vinous; but the immediate ſubjects of it are all kinds of vegetable juices, after they have once undergone that fermentation which reduces them to wine: for it is abſolutely impoſſible to make vinegar of muſt, the crude juice of grapes, or other ripe fruits, without the previous aſſiſtance of vinous fermentation.

The proper ferments for this operation, whereby vinegar is prepared, are, 1. The fæces of all acid wines. 2. The lees of vinegar. 3. Pulveriſed tartar; eſpecially that of rheniſh wine, or the cream or cryſtals thereof. 4. Vinegar itſelf. 5. A wooden veſſel, well drenched with vinegar, or one that has been long employed to contain it. 6. Wine that has often been mixed with its own fæces. 7. The twigs of vines, and the ſtalks of grapes, currants, cherries, or other vegetables of an acid auſtere taſte. 8. Bakers leaven after it is turned acid. 9. All manner of ferments, compounded of thoſe already mentioned.

The French uſe a method of making vinegar different from that above deſcribed. They take two very large open veſſels, the larger the better, open at the top; in each whereof they place a wooden grate, within a foot of the bottom: upon theſe grates, they firſt lay twigs, or cuttings of vines, and afterwards the ſtalks of the branches, without the grapes themſelves, or their ſtones, till the whole pile reaches within a foot of the brim of the veſſels: then they fill one of theſe veſſels with wine to the very top, and half fill the other; and with liquor drawn out of the full veſſel, fill up that which was only half full before; daily repeating the ſame operation, and pouring the liquor back from one veſſel to the other; ſo that each of them is full, and half full, by turns.

When this proceſs has been continued for two or three days, a degree of heat will ariſe in the veſſel, which is then but half full, and increaſe

for

for ſeveral days ſucceſſively, without any appearance of the like in the veſſel which happens to be full during thoſe days; the liquor whereof will ſtill remain cool: and as ſoon as the heat ceaſes in the veſſel that is half full, the vinegar is prepared: which, in the ſummer, happens on the fourteen or fifteenth day from the beginning; but in the winter, the fermentation proceeds much ſlower: ſo that they are obliged to forward it by artificial warmth, or the uſe of ſtoves.

When the weather is exceeding hot, the liquor ought to be poured off from the full veſſel into the other twice a day: otherwiſe, the liquor would be over-heated, and the fermentation prove too ſtrong; whence the ſpirituous parts would fly away, and leave a vapid wine, inſtead of vinegar, behind.

The full veſſel is always to be left open at the top, but the mouth of the other muſt be cloſed with a cover of wood, in order the better to keep down and fix the ſpirit in the body of the liquor; for otherwiſe it might eaſily fly off in the heat of fermentation. The veſſel that is only half full ſeems to grow hot, rather than the other, becauſe it contains a much greater quantity of the vine twigs and ſtalks, than that, in proportion to the liquor; above which the pile, riſing to a conſiderable height, conceives heat the more, and ſo conveys it to the wine below.

Vinegar is a medicine of excellent uſe in all kinds of inflammatory and putrid diſorders, either internal or external: in ardent, bilious fevers, peſtilential, and other malignant diſtempers, it is recommended by Boerhaave as one of the moſt certain ſudorifics. Weakneſs, fainting, vomiting, hyſterical and hypochondriacal complaints have alſo been frequently relieved by vinegar applied to the mouth and noſe, or received into the ſtomach. Diſtilled vinegar has the ſame virtues, only in a ſtronger degree.

USURY.

USURY, in the general, denotes a gain or profit which a perſon makes of his money, by lending the ſame; or it is an increaſe of the principal, exacted for the loan thereof; or the price a borrower gives for the uſe of a ſum credited to him by the lender, called, alſo, intereſt; and, in ſome antient ſtatutes, dry exchange. See the article EXCHANGE.

The word uſury is generally taken in an evil ſenſe, *viz.* for an unlawful profit which a perſon makes of his money; in which ſenſe it is, that uſury is forbidden by the civil and eccleſiaſtical, and even by the law of nature.

By ſtat. 12. Ann. c. 16. which is called The Statute againſt Exceſſive Uſury, it is ordained, that no perſon ſhall take, for the loan of any money or other thing, above the value of five pounds for the forbearance of one hundred pounds for a year; and ſo in proportion for a greater or leſſer ſum: and it is declared, that all bonds, contracts, and aſſurances, made for payment of any principal ſum to be lent on uſury, above that rate, ſhall be void; and that whoſoever ſhall take, accept, or receive, by way of corrupt bargain, loan, *&c.* a greater intereſt than that laſt above-mentioned, ſhall forfeit treble the value of the money lent; and alſo, that ſcriveners, ſolicitors, and drivers of bargains, ſhall not take or receive above five ſhillings for the procuring the loan of one hundred pounds for one year, on pain of forfeiting twenty pounds, *&c.*

There can be no uſury without a loan, between which and a bargain the court has diſtinguiſhed: and though a perſon is to pay double the ſum borrowed, *&c.* by way of penalty, for the non-payment of the principal debt, it is not uſury; ſo it alſo is in reſpect to the grant of an annuity for lives, or on condition, where it exceeds the uſual intereſt, and the proportion attending contracts of this kind. Even if one ſecures a large intereſt and principal, and it is at the will of the party who is to pay; or where it happens that both the principal money and extraordinary intereſt are in hazard, or that a perſon may have leſs than his principal; as when a bond is made to pay money upon the return of a ſhip from ſea, *&c.* either of theſe caſes are not held to be uſury.

In an action brought for uſury, the ſtatute made againſt it muſt be pleaded; and in pleading an uſurious contract, as a bar to an action, the whole matter is to be ſet forth ſpecially, becauſe it lies within the party's own privity; yet on an information on the ſtatute for making ſuch contract, it is ſufficient to mention the corrupt bargain generally; becauſe matters of this kind are ſuppoſed to be privily tranſacted; and ſuch information may be brought by a ſtranger. 1 Hawk. P. C. 248. Likewiſe upon an information on the ſtatute againſt uſury, he that borrows the money may be a witneſs, after he has paid the ſame.

WEAVING.

WEAVING is the art or act of working a web of cloth, ſilk, linen, or other ſtuff, on a loom with a ſhuttle.

I'll explain all theſe different manners of *weaving*, each in order, beginning by that of weaving of cloth, which, though not the moſt curious of them all, deſerves, notwithſtanding, the firſt rank, as being the beſt and richeſt manufacture in *England*.

Cloth, as underſtood here, is a web, or a tiſſue of woollen threads, interwoven; whereof ſome called the *warp* are extended lengthways, from one end of the piece to the other; the reſt, called the *woof*, diſpoſed a-croſs the firſt, a breadthways of the piece. *Cloths* are woven on the loom, as well as linens, druggets, ſerges, camblets, *&c.* they are of various qualities, fine, coarſe, ſtrong, *&c.* Some are made of wool, and theſe of different colours; the wools being dyed and dreſs'd, are firſt ſpun, then wove; others are worked white, deſigned to be dyed in ſcarlet, black, blue, green, yellow, *&c.*

To manufacture cloth for dying, the beſt wools for the purpoſe are thoſe of *England* and *Spain*, eſpecially thoſe of *Lincolnſhire* and *Segovia*.----To uſe them to the beſt advantage; when taken out of the bales, they muſt be ſcowered by putting them into a liquor ſomewhat more than lukewarm, compoſed of three parts of fair water and one of urine; after the wool has continued long enough in the liquor to diſſolve and looſen the greaſe, it is taken out, drained, and waſhed in running water; it is known to be well ſcoured, when it feels dry to the touch, and has no ſmell but the natural ſmell of the ſheep: in this ſtate it is hung out to dry in the ſhade, the heat of the ſun being apt to make it harſh and untractable: when dry, it is beat with rods on hurdles of wood, or on ropes, to clear out the duſt and groſſer filth; the more it is thus beat and cleared, the more ſoft it becomes, and the better it ſpins.---After beating, it is well picked, to clear the reſt of the filth, that had eſcaped the rods.

It is now in a ſtate to be oiled, whereof one fourth of the weight of the wool is required, for the wool deſigned for the *woof*, and one eighth for that of the *warp*.---The wool thus oiled, is to be *carded*; which operation is performed by means of two inſtruments called *cards*, all which has a double row of long points, or teeth, ranged againſt one another, and faſtened in a wooden handle, taking up the whole breadth of the handle a top, but narrower at the end. Theſe two cards they put to heat, *i. e.* the extremity thereof, in a furnace made for the purpoſe; on the other part thereof, is a ſlit, nearer the bottom than the top, thro' which the extremity of the card is introduced, the other part thereof being ſupported by ſtones, or ſomething elſe, placed underneath; when the cards are hot enough, the carder takes out one of them, ſeats himſelf on a chair or bench, and laying the head of the card on his knees, the extremity thereof upwards, holding the handle with his left hand, he takes with the right a handful of the wool, placed near him, and lays that wool on his card, by ſtriking the card with it, which lays hold of the wool; and thus continue taking wool, and ſtriking it on the card, till it very near reaches the end which has been heated. This done, he puts again the extremity of the card, thus filled, to heat, and takes out another card, which he fills in the ſame manner; which done, he takes the firſt filled from off the fire, faſtens it to a hook made for the purpoſe, one part thereof enters the handle of the card, and the other lays hold of that part where the ſpindles are faſtened; then draws off the wool.

The wool thus carded, is ſpun on the wheel; obſerving to make the thread of the warps ſmaller by one third than that of the woof, and much cloſer twiſted; in order to this, the latter muſt be ſpun with the band or ſtring open, and the former with it croſſed.

The thread thus ſpun, reel'd, and made into ſkains; that deſigned for the woof is wound on *ſpools*, i. e. on little tubes, or pieces of paper, or ruſhes, ſo diſpoſed as that they may eaſily be put in the eye of the ſhuttle.---That for the warp is wound on a kind of rochets, or large wooden bobbins, to diſpoſe it for warping. When warped, it is ſtiffened with ſize, whereof that made of the ſhreds of parchment is the beſt; and when dry, it is given to the weavers, who mount it on the loom.

The warp being on the loom, the weavers, who are two to each loom, one on each ſide, tread at the ſame time alternately, on the ſame threads, i. e. now on the right ſtep, and now on the left, which raiſes and lowers the threads of the warp equally, between which they throw tranſverſly the ſhuttle, one

one to the other; and each time that the shuttle is thrown, and so a thread of the woof inserted within the warps, they strike it conjointly with the same thread, wherein is fastened the comb, or reed, between whose teeth the threads of the warp are passed; repeating the stroke as often as is necessary; in some cloths, no less than twelve or thirteen times, *viz.* six with the warp open, and seven shut.

It may be observed, that the more the threads of the woof are struck against each other, the closer the cloth is; hence it becomes enabled to sustain the violence of the fulling-mill, as well as of the teazle, or fulling-thistle, without fretting or opening.

The weavers having continued their work till the whole warp is filled with woof, the *cloth* is finished; it is taken off the loom, by unrolling it from the beam whereon it had been rolled, in proportion as it was wove; and now given to be cleared of the knots, ends of thread, straws, and other filth; which is done with little iron nippers.

In this condition it is carried to the fullery, to be scoured with urine, or a kind of potter's clay, well cleaned and steeped in water, put along with the *cloth* in the trough wherein it is fulled.

The *cloth* being again cleared from the earth or urine, by washing it in water, is returned to the former hands, to have the lesser filth, small straws, and almost imperceptible knots taken off as before: then it is returned to the fuller, to be beat and fulled with hot water, wherein five or six pounds of soap have been dissolved. The soaps most esteemed for this operation is the white, especially that of *Genoa*. After fulling an hour and a half, it is taken out to be smoothed, *i. e.* to be pulled by the lists lengthways, to take out the wrinkles and cracks occasioned by the force of the mallets, or pestles falling on the cloth when in the troughs.

The smoothing is repeated every two hours, till the fulling be finished, and the *cloth* brought to its proper breadth; after which it is washed in clear water, to purge it of the soap, and given all wet to the carders, to raise the hair or nap, on the right side, with the thistle, or wad, wherewith they give it two rubs or courses, the first against the grain, the second with the grain.

The *cloth* being dried, after this preparation, the cloth-worker takes it, and gives it its first cut, or sheering.—This done the carders resume it, and after wetting it, give it as many more rubs or courses with the teazle, as the quality of the stuff requires; always observing to begin against the hair, and to end with it; and to begin with a smoother thistle, proceeding still to a sharper, and sharper, as far as the sixth degree.

After this, the *cloth* being dried, is returned to the *cloth-worker*, who sheers it a second time, and returns it to the carder; who, wetting it, gives it as many courses as he thinks fit, dries it, and gives it back again to the cloth-worker, who after sheering it the third and last time, returns it to the carders, who repeat their operation as before, 'till the hair or nap be well ranged on the surface of the *cloth*, from one end of the piece to the other.

It must be observed, that it is indispensably necessary the *cloth* be wet, while in the carder's hands; in order to which it is sprinkled from time to time with water.

The nap finished, and the *cloth* dried, the cloth-worker gives it as many cuts as he thinks requisite for the perfection of the stuff. It must also be observed, that all the sheerings must be on the right side, except the two last, which must be on the other, and that the *cloth* cannot be too dry for sheering.

The *cloth*, thus wove, scowr'd, napp'd, and shorne, is sent to the dyer. When dyed it is washed in fair water, and the cloth-worker takes it again, wet as it is, lays the hair or nap with a brush on a table, and hangs it on the tenters; where it is stretched both in length and breadth, enough to smooth it, set it square, and bring it to its proper dimensions, without straining it too much; observing to brush it a-fresh, the way of the hair, while yet a little moist on the tenter.

When quite dry, the *cloth* is taken off from the tenter, and brushed again on a table, to finish the laying of the nap; it is then folded, and laid cold under a press, to make it perfectly smooth and even, and to give it a little gloss. The gloss is given by laying a leaf of vellum or cap-paper in each plait of the piece; and over the whole a square plank of wood: on which, by means of a lever, the screw of a press is brought down with the degree of force judged necessary, with regard to the quality of the *cloth*. In *France*, none but scarlet, green, blue, *&c.* receive this last preparation; blacks being judged better without it.

Lastly, the *cloth* being taken out of the *press*, and the papers removed, it is in a condition for sale or use.

As to the manufacture of *mixt* CLOTHS, or those wherein the wools are first dy'd, then mixed, spun and wove of the colours intended; the process, except in what relates to the colour, is mostly the same with that just spoke of.

The method of adjusting the mixture, is first by making a felt or flock of the colours of the intended *cloth*, as a specimen: the wool of each colour is weighed; and when the specimen is to the manufacturer's mind, he mixes, for use, a quantity

tity in the ſame proportion, eſtimating each grain of the ſpecimen at 20 pounds weight of the ſame wool in the *cloth* to be made.

Thus, if he would mix three colours, *v. gr.* coffee-colour, feuille-mort, and pale blue, the firſt to be the prevailing colour; he weighs a quantity of each: for inſtance, 70 grains of the firſt, 25 of the ſecond, and 20 of the third, then multiply each by 20 pounds of wool, and thus gains 1400 pounds for the coffee-wool, 500 pounds for the feuille-mort, and 400 pounds for the pale blue.

The wools of the ſpecimen thus weighed, are mixed, oiled, carded, moiſtened with clear water, rubbed with black ſoap, and in this ſtate wrought a long time in the hands, till they be reduced into a piece of felt, like that uſed by hatters.

It is then rinſed in water, to purge out the oil and ſoap; and when dry, the hair or nap is carded out with the teazle; then ſhorn once again, 'till the ground appear, and the ſeveral colours be diſcernable.

Laſtly, wetting it a little, and preſſing it, he examines it well, and if he be not contented with it, makes another felt; if he be, he proceeds to mix wools; when mixed it is beat on hurdles, cleaned, oiled, carded, ſpun, wove, *&c.* as in white cloth.

The goodneſs of *cloth* conſiſts, 1. In the wool being fine and well dreſſed. 2. In its being ſpun equally; always obſerving, however, that the thread of the warp be finer, and better twiſted than that of the woof. 3. In the *cloth* being well wrought and beaten on the loom, ſo as to be every where cloſe and compact. 4. In the wool's not being finer and better at one end of the piece than in the reſt. 5. In the liſts being ſufficiently ſtrong, and of the ſame length with the ſtuff; and that they conſiſt of good matter, as wool, hair, or oſtrich feathers, or the hair of *Daniſh* dogs, which laſt is the beſt. 6. In the *cloth* being well cleared of knots and other imperfections. 7. In its being firſt well ſcour'd with good fuller's earth, then fulled with the beſt white ſoap, and waſhed out in clear water. 8. In the hair or nap being well drawn out with the teazle or thiſtle on the pole, without being too much opened. 9. In its not being ſtretched or pulled farther than is neceſſary to ſet it ſquare, and bring it to its juſt length and breadth. 10. In its being only preſſed cold.

The *Engliſh cloth* is preferred throughout all *Europe*, eſpecially the beſt ſorts to all others: though the manufacture of *Vanrobes* at *Abbeville*, in *Picardy*, is arrived to a great degree of perfection; but the *French* black *cloth* is preferred to all others for the beauty of the colour.

From *cloth* I'll paſs to CAMBLET, which is a ſtuff, ſometimes of wool, ſometimes ſilk, and ſometimes hair, eſpecially that of goats with wool or ſilk: in others the warp is ſilk and wool twiſted together, and the woof hair. *France*, *England*, *Flanders* and *Holland*, are the chief places of this manufacture; *Bruſſels* exceeds them all in the beauty and quality of its *camblets*.

There are different ſorts of *camblets*, viz. *figur'd camblets*, *water camblets* and *wove camblets*.

Figured CAMBLETS are thoſe of one colour, whereon are ſtamped various figures, flowers, foliages, *&c.* by means of hot irons, which are a kind of moulds, preſſed together with the ſtuff under a preſs. Theſe are chiefly brought from *Amiens* and *Flanders*; the commerce of theſe was antiently much more conſiderable than at preſent.

Water CAMBLETS are thoſe which, after woven, receive a certain preparation with water, and are afterwards preſſed under a hot preſs, which give them a ſmoothneſs and luſtre.

Waved CAMBLETS, are thoſe whereon waves are impreſſed, as on tabbies; by means of a calender, under which they are paſſed and repaſſed ſeveral times.

The manufacturers, *&c.* of *camblets*, are to take care they do not acquire any falſe and needleſs plaits; it being almoſt impoſſible to get them out again.

From this I'll paſs to DRUGGETS, which is a ſort of ſtuff, very thin and narrow, uſually all wool, and ſometimes half wool and half ſilk; having ſometimes the whale, but more uſually without; and woven on a worſted chain. Thoſe without the whale are wove on a loom with two treddles, after the ſame manner as linnen, camblet, *&c.*—Mr. *Savary* invented a kind of gold and ſilver *druggets*; the warp being partly gold and ſilver thread, and the woof linnen.

Next comes SERGE, which is a woollen quilted ſtuff, manufactured on a loom with four treddles, after the manner of rateens, and other ſtuffs that have whale.

In regard to the manufacture of the *London ſerges*.—For wool, the longeſt is choſen for the warp, and the ſhorteſt for the woof. Before either kind is uſed, it is firſt ſcoured, by putting it in a copper of liquor, ſomewhat more than luke-warm, compoſed of three quarts of fair water, and one of urine. After having ſtaid therein long enough to diſſolve, and take off the greaſe, *&c.* it is ſtirred briſkly with a wooden peel; taken out of the liquor, drained and waſhed in a running water; dried in the ſhade, beaten with ſticks on a wooden rack to drive out the coarſer duſt and filth; and then picked clean with the hand. Thus far prepared, it is greaſed with oil of olives, and the longeſt

longest part destined for the warp, combed in the manner mentioned under the article cloth.—To clear off the oil again the wool is put in a liquor composed of hot water, with soap melted therein: whence being taken out, wrung and dried, it is spun on the wheel.

As to the shortest wool intended for the woof, it is only carded on the knee with small fine cards, then spun on the wheel, without being scoured of its oil.

The wool both for the warp and woof being spun, and the threads divided into skains; that of the woof is put on spools (unless it has been spun upon them) fit for the cavity or eye of the shuttle; and that for the warp wound on a kind of wooden bobbins, to fit it for warping. When warped, it is stiffened with a kind of size, used for the warp of cloth; and when dry, it is put on the loom.

When mounted on the loom, the workman raising and falling the threads (which are passed through a reed) by means of four treddles placed underneath the loom, which he makes to work transversely equally, and alternately, one after another, with his feet, in proportion as the threads are raised and lowered, throws the shuttle a-cross, from one side to the other; and each time that the shuttle is thrown, and the threads of the woof crossed between those of the warp, strikes it with the frame to which the reed is fastened, thro' whose teeth the threads of the warp pass; and this stroke he repeats twice or thrice, or even more, till he judges the crossing of the serge sufficiently clod. Thus he proceeds till the warp is all filled with woof.

The *serge* now taken off the loom, is carried to the fuller, who fulls or scours it in the trough of his mill, with a kind of fat earth for the purpose, first purged of all stones and filth. After three or four hours scouring, the fuller's earth is washed out in fair water, brought by little and little into the trough, out of which it is taken when all the earth is cleared: then with a kind of iron pincers or plyers, they pull off all the knots, ends, straws, &c. sticking out on the surface on either side: then return it into the fulling trough, where it is worked with water somewhat more than luke-warm, with soap dissolved therein for near two hours. It is then washed out till such time as the water becomes quite clear, and there be no signs of soap left: then it is taken out of the trough, the knots, &c. pulled off, and then put on the tenter to dry, taking care as fast as it dries, to stretch it out both in length and breadth, till it be brought to its just dimensions. When half dried, it is taken off the tenter, dyed, sheared, and pressed.

There are various kinds of *serges*, denominated either from the qualities thereof, or from the places where they are wrought.---The most considerable is the *London serge*, now highly valued abroad, particularly in *France*, where the manufacture is carried on with good success, under the title of *serge façon de Londres*.---The goodness of *serge* is known by the quilting, as that of cloths by the spinning.

Next comes RATEEN, which is a thick woollen stuff quilted, wove on a loom with four treddles, like serges and other stuffs, that have the whale or quilting. There are some *rateens* dressed and prepared like cloth; others left simply in hair, and others where the hair or nap is freezed.---*Rateens* are chiefly manufactered in *France*, *Holland*, and *Italy*, and are mostly used in linings.

From RATEENS I'll pass to FRIZE or FREEZE, which is a kind of woollen cloth or stuff for winter's wear, being frized or napt on one side; whence in all probability it derives its name.

Of *frizes*, some are crossed, others not crossed. The former are chiefly of *English* manufacture; the latter of *Irish*.

As to freezing of cloth, it is forming the nap of a cloth or stuff into a number of little hard burs, or prominences, covering almost the whole ground thereof.

Some cloths are only *freezed* on the back side, as black cloths; others on the right side, as colour'd and mix'd cloths, rateens, bays, frizes, &c.

Freezing may be performed two ways; one with the hand, *i. e.* by means of two workmen, who conduct a kind of plank, that serves as a frizing instrument. The other by a mill, worked either by water or a horse; or sometimes by men. This latter is esteemed the better way of frizing; by reason the motion being uniform and regular, the little knots of the *freezing* are formed more equably, and alike. The structure of this useful machine is as follows.

The three principal parts are, the *freezer* or *crisper*, the *freezing table*, and the *drawer* or *beam*.—The two first are two equal planks or boards, each about ten foot long, and fifteen inches broad; differing only in this, that the *frizing-table* is lined or covered with a kind of coarse woollen stuff, or rough sturdy nap; and that the *frizer* is incrustated with a kind of cement, composed of glue, gum arabick, and yellow sand, with a little aqua vitæ or urine. The beam, or drawer, thus called by reason it draws the stuff from between the *frizer* and *frizing-table*, is a wooden roller, beset all over with little fine short points or ends of wire, like those of cards used in carding of wool.

Next

Next come bays, which is a kind of coarse, open woollen stuff, having a long nap; sometimes frized on one side, and sometimes not frized, according to the uses it is intended for.--This stuff is without whale, being wrought on a loom with two treddles, like flannel. The manufacture of *bays* is very considerable in *England*, particularly about *Colchester*; and in *Flanders* about *Lisle* and *Tournay*, &c.

Formerly the *French*, as well as *Italians*, were furnished with *bays* from *England*; but of late the *French* workmen have undertaken to counterfeit them, and set up manufactures of their own, and that with success, especially at *Nismes*, *Montpelier*, &c.

The export of *bays* is very considerable to *Spain*, *Portugal*, and *Italy*. Their chief use is for linings, especially in the army. The looking-glass makers also use them behind their glasses, to preserve the tin or quicksilver; and the case-makers to line their cases.

Flanel, or flannel, is next, which is a kind of slight, loose, woollen stuff, not quilted, but very warm; composed of a woof and warp, and wove on a loom with two treddles, after the manner of bays, *&c.*

Say, or saye, is a kind of serge, or a very light crossed stuff, all wool; much used abroad for linings, and by the Religious for shirts; and in *England* the quakers for aprons, for which purpose it is usually green.

There are very considerable manufactures hereof at *Sudbury* near *Colchestor*; also at *Ypres*, *Hondscot*, &c. in *Flanders*, &c.---Those made in *England* are chiefly exported to *Portugal* and *Leghorn*.

The working of the several commodities heretofore mentioned, and of many others, is called *woollen manufactory*; which makes the principal article in the foreign and domestick trade of *Great Britain*; being that which furnishes the cargoes of their vessels, that employs their people, *&c.* and may be said to have had its rise in the 15th century.

Till that time the *English* wool was all sold in the fleece, to such of their neighbours as came to fetch it. Among these customers, however, the principal were the *Flemings* and *Brabanters*; and particularly the merchants of *Ghent* and *Louvain*; who took off vast quantities to supply two manufactories that had flourished in these two cities from the 10th century; and had furnished the greatest part of *Europe*, and even *England* itself, with all sorts of woollen cloths, *&c.*---But the richness of the manufactories of *Ghent*, and the incredible number of hands employed therein, having spirited up the inhabitants to revolt divers times against their sovereign, on account of certain taxes which they refused to pay; the seditions were at length punished and dispersed, and part of them took refuge in *Holland*, and the rest in *Louvain*.

These last, together with their art of manufacturing cloths, carried with them their spirit of sedition; and it was not long ere several of them, to avoid the punishment they had deserved for killing some of the magistrates, removed into *England*; where they instructed the *English* how to work their own wool.

This establishment is referred to the year 1420, from which time no endeavours have been spared to keep the *English* wool in the kingdom.

The president *Thuanus* makes this epocha 100 years later; and attributes the establishment of the *woollen manufacture* in *England* to queen *Elizabeth*, and the troubles about religion, which the severity of the duke of *Alva* and the *Spanish* inquisition had occasioned and kept up so long in the *Low Countries*.—But what that noble author says, is rather to be understood of their perfection than their first establishment; and of the several great manufactories then set up at *Norwich*, *Colchester*, *Sandwich*, *Hampton*, *&c.*—For in the *English* and *Flemish* historians, we find mention made of the manufactures of *London*, long before any part of the seventeen provinces had attempted to throw off the *Spanish* yoke.

As this manufacture now stands, Dr. *Davenant* and Mr. *King* computes the product thereof to be eight millions *per annum*; three fourths whereof are consumed at home, and the rest exported.

So jealous are now the *English* of their woollens, that besides the precautions taken to use all their own wool themselves, they have added that of selling them themselves, and of carrying them to the places where they are required; not admitting strangers to come and buy any in *England*.

And hence the establishment of those famous magazines in *Holland*, the *Levant*, and the north, where their woollen are reposited, to be vended by factors or commissioners. The magazine in *Holland* has changed place divers times; and it has been successively at *Middleburgh*, *Delf*, *Rotterdam*, and *Dort*, where it now remains; and where all the *Germans* come to furnish themselves.—That for the *Levant* is at *Smyrna*; and that for the north at *Archangel*.

From the woollen manufactures I will pass to the silk ones, informing ourselves, previously to it, what *silk* is, and how many different sorts of *silks* there are.

Silk is a very soft, fine, bright delicate thread, the

the work of an insect called *Bombyx*, or the *silk-worm*.

The antients were but little acquainted with the use and manufacture of *silk*: they took it for the work of a sort of spider or beetle, who spun it out of its entrails, and wound it with its feet about the little branches of trees.—This insect they called *Ser*, from *Seres*, a people in *Scythia*, who kept it; whence the *silk* itself they called *sericum*.—But the *Ser* has very little affinity with our *silk-worm*, *Bombyx*: the former living five years, but the latter dying annually, enveloped in a yellowish bag, or ball; which wound out into little threads, makes what we call *silk*.

It was in the isle of *Cos* that the art of manufacturing *silk* was first invented; and *Pamphila*, daughter of *Platis*, is honoured as the inventor. The discovery was not long unknown to the *Romans*. *Silk* was brought them from *Serica*, where the worm was a native. But so far were they from profiting by the discovery, that they could not be induced to believe that so fine a thread should be the work of a worm, and thereupon formed a thousand chimerical conjectures of their own.

This temper rendered *silk* a very scarce commodity among them for many ages; it was even sold weight for weight with gold, insomuch that *Vopiscus* tells us, the emperor *Aurelian* refused the empress his spouse a suit of *silk*, which she sollicited of him with much earnestness, merely on account of its dearness. At length two monks coming from the *Indies* to *Constantinople* in 555, brought with them great quantities of *silk-worms*, with instructions for the hatching of their eggs, rearing and feeding the worms, drawing out the *silk*, spinning and working it. Upon this manufactures were set up at *Athens*, *Thebes*, and *Corinth*.

About the year 1130, *Roger*, king of *Sicily*, established a silk manufacture at *Palermo*, and another in *Calabria*, managed by workmen who were part of the plunder brought from *Athens*, *Corinth*, &c. whereof that prince made a conquest, in his expedition to the holy land. By degrees, *Mezeray* adds, the rest of *Italy* and *Spain* learned from the *Sicilians* and *Calabrians*, the management of the *silk-worms*, and the working of *silk*: And at length the *French*, by right of neighbourhood, a little before the reign of *Francis* I. began to imitate them.

The great advantage the new manufacture turned to, made *James* I. king of *England*, very earnest for its being introduced into his dominions: accordingly it was recommended several times from the throne, and in the most earnest terms to plant mulberry-trees, &c. for the propagation of *silk-worms*; but unhappily without effect; though from the various experiments we meet withal in the philosophical transactions and other places, it appears that the *silk-worm* thrives, and works as well in all respects in *England*, as in any other part of *Europe*.

In ten days time the *silk-worm* having brought its ball to its perfection, it must be taken down from the branches of the mulberry-tree, where it is hung. But this point requires a deal of attention; for there are some worms more lazy than others; and it is very dangerous waiting till they make themselves a passage, which usually happens about the 15th day of the month.

The first, finest, and strongest balls are kept for the grain; the rest are carefully wound: or, if it is desired to keep them all, or if there be more than can be well wound at once, they lay them for some time in an oven moderately hot, or else expose them for several days successively to the greatest heat of the sun, in order to kill the insect; which, without this precaution, would not fail to open itself a way to go, and use all those new wings abroad it has acquired within.

Ordinarily, they only wind the more perfect balls. Those that are double, or too weak, or too coarse, are laid aside; not as altogether useless, but that being improper for winding, they are reserved to be drawn out into skains.

The balls are of different colours; the most common are yellow, orange-colour, isabella, and flesh-colour. There are some also of a sea-green; others of a sulphur-colour, and others white: but there is no necessity for separating the colours and shades to wind them apart; as all the colours are to be lost in the future scouring and preparing of the *silk*.

To wind the *silk* from off the balls, two machines are necessary; the one a furnace, with its copper; the other a reel or frame to draw the *silk*. The winder then seated near the furnace, throws into the copper of water over the furnace (first heated and boiled to a certain degree, which custom alone can teach) a handful or two of balls which have been first well purged of their loose furry substance. He then stirs the whole very briskly about with birchin rods, bound and cut like brushes; and when the heat and agitation have detached the ends of the *silk* off the rods, which are apt to catch on the rods, he draws them forth; and joining ten or twelve, or even fourteen of them together, he forms them into threads, according to the bigness required, to the work they are destined for: eight ends sufficing for ribbands; and velvets, &c. requiring no less than

than fourteen. The ends thus joined into two or three threads, are firſt paſſed into the holes of three iron rods, in the fore part of the reel, then upon the bobbins or pullies, and at laſt are drawn out to the reel itſelf, and there faſtened; each to an end of an arm or branch of the reel. Thus diſpoſed, the workman giving motion to the reel, by turning the handle, guides his threads, ſubſtitutes new ones when any of them break, or any of the balls are wound out; ſtrengthens them where neceſſary, by adding others; and takes away the balls worn out, or that having been pierced are full of water.

In this manner two workmen will ſpin and reel three pounds of *ſilk* in a day; which is another quicker diſpatch than is made by the ſpinning-wheel, or diſtaff. Indeed all *ſilks* cannot be ſpun and reeled after this manner; either by reaſon the balls have been perforated by the *ſilk-worms* themſelves, or becauſe they are double, or too weak to bear the water; or becauſe they are coarſe, &c. of all theſe together, they make a particular kind of *ſilk* called *floretta*; which being carded, or even ſpun on the diſtaff, or the wheel, in the condition it comes from the ball, makes a tolerable *ſilk*.

As to the balls, after opening them with ſciſſars, and taking out the inſects (which are of ſome uſe for the feeding of poultry) they are ſteeped three or four days in troughs, the water whereof is changed every day, to prevent their ſtinking.

When they are all well ſoftened by this ſcouring, and cleared of that gummy matter the worm had lined the inſide withal, and which renders it impenetrable to the water, and even to air itſelf, they boil them half an hour in a lye of aſhes, very clear, and well ſtrained: and after waſhing them out in the river, and drying them in the ſun, they card and ſpin them on the wheel, &c. and thus make another kind of *floretta*, ſomewhat inferior to the former.

The ſeveral preparations which *ſilks* undergo, to fit them to be uſed in the manufacture of ſilken ſtuffs, are *ſpinning*, *reeling*, *milling*, *bleaching*, and *dying*.

The two firſt we have already ſpoke of, as they are concerned in drawing the *ſilks* from off the balls. As to the *ſpinning* and *reeling* of *raw ſilk* off the balls, ſuch as they are brought hither from *Italy*, the *Levant*, &c. the firſt is chiefly performed on the ſpinning-wheel, and the latter, either on hand-reels, or on reels mounted on machines, which ſerve to reel ſeveral ſkains at the ſame time.

Milling, or *throwing of ſilk*, is the laſt preparation thereof before dying; ſerving to twiſt it more or leſs, according to the work it is intended for.

To prepare the *ſilk* for milling, they are put in water, incloſed between two linnen cloths.—The mill is a ſquare machine, compoſed of ſeveral pieces of wood mortified in each other, ſo as to form a kind of large cage, in the center whereof are two wheels, placed parallel over each other, whoſe axis bears on two poſts. When the machine is ſimple, a ſingle man turns thoſe wheels by means of a little cogg, in which they catch, and a large handle.

The wheels put in motion by the handle, communicate their motion to eight windles or reels, or even more, according to the largeneſs of the machine; the flights or arms whereof the ſilk is wound, from off two rows of bobbins placed on each ſide the machine, each row at the height of the two wheels in the center. Theſe bobbins have their motion by means of leathern thongs, which beat on little cylinders of wood that ſupport them, and turn at length on the two wheels at the center, ſo that the *ſilk* on each bobbin twiſts as it winds and forms its ſeparate ſkain.

The ſmalleſt wheel moves two hundred of theſe bobbins, over which a ſingle perſon is ſufficient to inſpect, to put new bobbins or pools in lieu of thoſe diſcharged of their ſilk, and to knot the ends when they break.

For white ſtuffs the *ſilk* is bleached, which is done while it is yet raw, by putting it in a thin linnen bag, and thrown into a veſſel of boiling river water, wherein ſoap has been diſſolved, then boiled two or three hours, and the bag being turned ſeveral times, taken out, beaten, and waſhed in cold water, mixed with ſoap and a little indigo: the indigo gives it the bluiſh caſt always obſerved in white ſilks. After taking it out of the ſecond veſſel it is wrung out, and all the water and ſoap expreſſed, ſhook out to untwiſt and ſeparate the threads, and hung out in the air, in a kind of ſtove made on purpoſe, wherein is burnt ſulphur, the vapour whereof gives the laſt degree of whiteneſs to the *ſilks*.

There are ſeveral ſorts of *ſilks*, viz. *raw ſilk*, *boiled ſilk*, *trowed* or *twiſted ſilk*, *ſlack ſilk*, *Eaſtern*, *French*, *Sicilian*, *Italian*, *Spaniſh*, *Turky*, *China*, *Japan*, and *Indian ſilk*.

Raw SILK, is that taken from the ball, without any coction, ſuch as is moſt, if not all, that is brought into *England* from the *Levant*.

In the French *ſilk-works*, the greateſt part of this raw ſilk paſſes for little better than a kind of fine floretta; yet, when ſpun, it makes a fine thread, and ſerves for the manufacture of ſtuffs of moderate

moderate value and lustre. But the *raw silks* of the *Levant*, whence most of the *English* come, are exceeding fine and beautiful.—This difference arises hence, that in *France* the best balls are spun and wound in boiling water, and only the refuse made into *raw silk*: whereas in the *Levant* there is no such thing as spinning and winding on the fire; but the silks are all sent in bales or packs, as they are drawn from off the balls: so that they are only distinguished by their quality of fine, middling, and coarse.

Boiled SILK, is that which has been boiled in water, to facilitate the spinning and winding. This is the finest of all the sorts of silks manufactured in *France*, and is seldom used but in the richest stuffs; as velvets, taffaties, damasks, brocades, &c.—There is also another kind of *boiled silk*, which is prepared by boiling to be milled, and which cannot receive that preparation without being first passed through hot water.—By the laws of *France*, it is prohibited to mix raw with boiled silk; both as such a practice spoils the dying, and as the raw silk corrupts and cuts the boiled.

Thrown, or *twisted* SILKS, are such, as besides their spinning and winding, have received their milling or throwing.

This they receive in a different degree, as they are passed oftener or seldomer over the mill; properly, however, *thrown silks* are those wherein the threads are pretty thick thrown, and are twisted several times.

Slack SILKS, are such as are not twisted, but are prepared and dyed, for tapestry, and other works with the needle.

Eastern, or *East-India* SILK, properly so called, is not the work of the *silk-worm*, but comes from a plant that produces it, in pods, much like those of the cotton-tree. The matter this pod contains is extremely white, and moderately glossy; it spins easily, and is made into a kind of *silk* that enters the manufacture of several *Indian* and *Chinese* stuffs.

French SILKS, are those of the provinces of *Languedoc*, *Dauphiné*, *Provence*, *Avignon*, *Savoy*, and *Lyons*.—This last place indeed furnishes very few *silks* of its own growth, but is the great staple whence the merchants of *Paris*, and the other cities are to fetch them: at least they are obliged to have them pass through *Lyons*, if they bring them from elsewhere, either by land or sea.—There are computed to enter *Lyons*, *communibus annis*, 6000 bales; the bale valued at 160 lb. weight; of which 6000 bales, there are 1400 from the *Levant*, 1600 from *Sicily*, 1500 from *Italy*, 300 from *Spain*, and 1200 from *Languedoc*, *Provence*, and *Dauphiné*.

At the time when the manufactures of *Lyons* were in the height of their prosperity, there were reckoned 18,000 looms employed in the silk manufacture; but ever since several other nations, who had no notion of those manufactures, have been instructed in it, by the *French* who have deserted their own country, either by a motive of religion, or on some other account, the number of looms has been considerably reduced at *Lyons*; so that at present there are not above 8000 going. Tho' there be no silk manufacture in any country whatever which comes near that of *Lyons*, either for the strength of the stuffs, the beauty of the pattern, and the vivacity of the colours.—They had formerly at *Tours* 700 mills for winding and preparing the *silks*; 8000 looms to weave them, and 40,000 persons employed in the preparation and manufacturing thereof; which number is also considerably reduced.

The commerce of the *silks* of *Sicily* is very considerable; and the *Florentines*, *Genoese*, and *Lucchese*, are the people who chiefly make it. Great quantities are yearly brought thence, especially from *Messina*; part whereof they use in their own manufactures, and sell the rest to their neighbours the *French*, &c. with profit.—The *Italians* have this advantage, especially the *Genoese*, over other people, that having large establishments in the island, they are reputed as natives, and pay no duty for the export.—Part of the *Sicilian silks* are raw; the rest spun and milled; of which last kind those of *S. Lucia* and *Messina* are the most valued. The raw unwrought silks are always sold for ready money; the others sometimes in exchange for other goods.—The *silks* brought from *Italy* are partly wrought, and partly raw, and unwrought. *Milan*, *Parma*, *Lucca*, and *Modena*, furnishes none but the latter kind; *Genoa* most of the former; *Bologna* afford both kinds.

The *Spanish* SILKS are all raw; and are spun, milled, &c. in *England*, according to the several works they are to be used in.

Turky SILKS are all raw.—One advantage the *English* say they have in the commerce of the *Levant* in *silks*, wanting in those of *Sicily*, is, that the latter is confined to a particular season of the year; whereas the former are brought at all times. They are brought from *Aleppo*, *Tripoli*, *Sayda*, from the isles of *Cyprus*, *Candia*, &c.—But the principal place of commerce, especially for the *Persian silks*, is *Smyrna*. The *silks* are brought hither in caravans, from the month of *January* to *September*. The caravans in *January* are loaded with the finest *silks*; those of *February* and *March* being indifferent ones; the rest the coarsest.

They all come from the several provinces of *Persia*, chiefly those of *Quillan* and *Schiruvan*, and the city of *Schamachia*, situate near the edge of the *Caspian* sea, from which three places, a *Dutch* author assures us, there do not come less than 30,000 bales of silk in a year. *Ardenil*, or *Ardebil*, another city of *Persia*, not far distant from these silk countries, is the place where these *silks* are laid up, and whence the caravans set out for *Smyrna*, *Aleppo*, and *Constantinople*; and it is this city, with *Schamachia*, that have always been esteemed the center of the *silk* trade; which has been several times attempted to be removed from *Smyrna*, and the *Mediterranean*, in favour of *Archangel* and the *White Sea*, by carrying them across *Muscovy*, by the *Volga* and *Dwyna*, two rivers that traverse the principal provinces of that vast empire.

This new course of the *Persian silks* into *Europe*, was first proposed by *Paolo Centurio*, a *Genoese*, to the Czar *Basil*, under the pontificate of *Leo* X. The *French* had the same design in 1626. The duke of *Holstein*, in 1633, sent embassadors to the court of *Persia*, purely with the same view: and in 1668, the Czar *Alexis Michael* attempted the thing himself, but was disappointed by the rebellion of the *Cossacks*, and the surprize of *Astracan*.

Several provinces of *China* are so fertile in mulberry-trees, and their climate so agreeable to the nature of *silk-worms*, that the quantity of *silk* here produced is incredible: the single province of *Tchekiam* might supply all *China*, and even a great part of *Europe* with this commodity. The *silks* of this province are the most esteemed, though those of *Nanquin* and *Canton* be excellent.

The *silk* trade is the principal in *China*, and that which employs the most hands: but the *European* merchants who deal in it, especially in wrought *silks*, are to be careful of the spinning, *&c.* the waste being usually very great.

The *silks* of the state of the great mogul are brought almost wholly from *Kasem-bazar*, a *Mediterranean* place, whence they are conveyed by a canal of 15 leagues, into the *Ganges*, by which they are forwarded 15 leagues further, to the mouth of the famous river of *Indostan*. The *silk* of *Kasem-bazar* is yellowish, as are also those of *Persia* and *Sicily*; there being none, as we know of, naturally white, but that of *Palestine*. The *Indians*, however, whiten it with a lye made of the ashes of a tree, called *Adam's fig-tree*; but as the tree is pretty scarce, the *Europeans* are forced to take the greatest part of their *silks* in the native yellow.

Kasem-bazar alone is computed to furnish every year 22,000 bales of *silk*, each bale weighing 100 lb. The *Dutch* buy it almost all up, not to bring it into *Europe*, but to exchange it for other rich merchandizes, particularly bars of silver, *&c.*

Thus furnished with all sorts of *silks* at our choice, we will set ourselves to work, beginning by the most easy manufacture, which is that of *ribbands*.

Ribband, or *Ribbond*, is a narrow sort of silk, chiefly used for head-ornaments, badges of chivalry, *&c.*

There are plain *ribbands* and figured *ribbands*, which are all wove in the same manner, the difference consisting only in the passing of the threads, agreeable to the design proposed.

Next comes Taffety, or Taffaty, is a kind of fine, smooth, silken stuff, having usually a remarkable lustre or gloss.

There are *taffeties* of all colours, some plain, others striped with gold, silver, silk, *&c.* others chequered, others flowered, others in the *Chinese* point, others the *Hungarian*, with various others, to which the mode or the caprice of the workman gives such whimsical names, that it would be as difficult as it is useless to rehearse them; besides that, they seldom hold beyond the year wherein they first rose. The old names of *taffeties*, and which still subsist, are *taffeties* of *Lyons*, *Spain*, *England*, *Florence*, *Avignon*, &c.

The chief consumption of *taffaties* is in summer-dresses for women, in linings, scarves, coifs, window-curtains, *&c.*

There are three things which contribute chiefly to the perfection of *taffaties*, viz. the silk, the water, and the fire. The silk is not only to be of the finest kind, but it must be worked a long time, and very much, before it is used. The watering, besides that it is to be given very lightly, seems only intended to give that fine lustre, by a particular property not found in all waters. Lastly, the fire, which is passed under it to dry the water, has its particular manner of application, whereon the perfection of the stuff depends very much.

Octavio May of *Lyons* is held the first author of the manufacture of glossy *taffeties*, and tradition tells us the occasion of it. — *Octavio*, it seems, going backward in the world, and not able to retrieve himself by the manufacture of taffeties, such as where then made, was one day musing on his misfortunes, and in musing, chanced to chew a few hairs of silk which he had in his mouth. His reverie being over, the silk he spit out seemed to shine, and on that account engaged his attention. He was soon led to reflect on the reason;

reaſon; and, after a good deal of thought, concluded that the luſtre of that ſilk muſt come, 1. From his having preſſed it between his teeth. 2. From his having wet it with his *ſaliva*, which had ſomething glutinous in it: and, 3. From its having been heated by the natural warmth of his mouth. All this he executed upon the next *taffeties* he made; and immediately acquired immenſe riches to himſelf, and to the city of *Lyons* the reputation it ſtill maintains, of giving the gloſs to *taffeties*, better than any other city in the world.

It will not, we conceive, be leſs uſeful than curious, to give here the deſcription of the engine contrived by *Octavio* to give the gloſs to *taffety*; to add the manner of applying it, and the compoſition of the water uſed therein.

The machine is much like a ſilk loom, except that inſtead of iron points, here are uſed a kind of crooked needles, to prevent the *taffety* from ſlipping: at the two extremities are two beams; on one of which is rolled the *taffety* to take the gloſs; and on the other, the ſame *taffety* as faſt as it had received it. The firſt beam is kept firm by a weight of about 200 pounds; and the other turned by means of a little lever paſſing through mortices at each end. The more the *taffety* is ſtretched, the greater luſtre it takes; care however is to be uſed it be not over-ſtretched.

Beſides this inſtrument for keeping the ſtuff ſtretched, there is another to give it the fire: this is a kind of carriage in form of a long ſquare, and the breadth of the *taffaties*. It moves on trundles, and carries a charcoal fire under the *taffety*, at the diſtance of about half a foot.

The two machines prepared, and the *taffety* mounted, the luſtre is given it by rubbing it gently with a ball, or handful of liſts of fine cloth, as it rolls from one beam to the other, the fire, at the ſame time, being carried underneath it to dry it. As ſoon as the piece has its luſtre, it is put on new beams to be ſtretched a day or two, and the oftener this laſt preparation is repeated, the more it increaſes the gloſs.

For black *taffeties*, the gloſs is given with double beer, and orange or lemon juice; but this laſt is the leaſt proper, as being apt to whiten. The proportion of theſe two liquors is a gallon of orange-juice to a pint of beer, to be boiled together to the conſiſtence of a broth. For colour'd *taffeties* they uſe gourd-water diſtilled in an alembick.

Next comes SATTIN, or SATIN, which is a kind of ſilken ſtuff, very ſmooth and ſhining, the warp whereof is very fine, and ſtands out, the woof coarſer, and hid underneath; on which depends that gloſs and beauty which gives it its price.

There are *ſattins* quite plain, others wrought, ſome flowered with gold or ſilk, others ſtrip'd &c. All the varieties in the fabrick of *ſattins* are made by uſing new warps or woofs. The fineſt *ſattins* are thoſe of *Florence* and *Genoa*; yet the *French* will not allow thoſe of *Lyons* any thing inferior thereto. The *ſattins* of *Bruges* have their warp of ſilk, and their woof of thread.

Indian ſattins, or *ſattins* of *China*, are ſilken ſtuffs, much like thoſe manufactured in *Europe*. Of theſe ſome are plain, either white, or of other colours; others worked, either with gold or ſilk, flower'd, damaſk'd, ſtrip'd, &c. They are moſtly valued becauſe of their cleaning and bleaching eaſily, without loſing any thing of their luſtre. In other reſpects they are inferior to thoſe of *Europe*.

Father *Le Compte* obſerves, that the *Chineſe* prepare their *ſattins* in oil, to give them the greater luſtre; but this makes the duſt liable to hang to them.

SATTINET, or SATTINADE, is a very ſlight, thin ſort of *ſattin*, chiefly uſed by the ladies for ſummer night-gowns, &c. and ordinarily ſtrip'd.

We'll paſs from this to *damaſk*, which is a ſort of ſilken ſtuff, having ſome parts raiſed above the ground, repreſenting flowers, or other figures.

Damaſk is properly a ſort of mohair and ſattin intermixed, in ſuch manner as that what is not ſattin on one ſide, is on the other. The elevation which the ſattin makes on one ſide is the ground on the other. The flowers have a ſattin grain, and the ground a grain of taffetas. It has its name from its being originally brought from *Damaſcus* in *Syria*.

Next comes BROCADE, which is a ſort of ſtuff or cloth of gold, ſilver, or ſilk, raiſed and enriched with flowers, foliages, or other figures, according to the fancy of the manufacturer.

Formerly the term was reſtrained to cloth wove, either wholly of gold, both woof and warp, or of ſilver, or of both together; but by degrees it came likewiſe to paſs for ſuch as had ſilk intermix'd, to fill up, and terminate the flowers of gold and ſilver.

At preſent, any ſtuff of ſilk, ſattin, or even ſimple *taffety*, when wrought and enriched with flowers, &c. obtains the denomination of *brocade*.

Next comes TABBY, which is a kind of coarſe taffety water'd. It is manufactured like the common taffety, excepting that it is ſtronger and thicker both in the woof and warp.

The watering is given it by means of a calender, the rolls whereof are of iron or copper, variouſly engraven, which, bearing unequally on the ſtuff, renders the ſurface thereof unequal, ſo as to reflect the rays of light differently.

Mohair is a kind of stuff, ordinarily of silk, both woof and warp, having its grain wove very close.

There are two kinds of *mohairs*, the one smooth and plain, the other water'd like tabbies: the difference between the two only consists in this, that the latter is calendered, the other not. There are also *mohairs* both plain and watered, whose woof is woollen, cotton or thread.

From this I'll pass to velvet, which is a rich kind of stuff, all silk, cover'd on the outside with a close, short, fine, soft shag; the other side being a very strong close tissue.

The nap of shag, called also the *velveting* of this stuff, is formed of part of the threads of the warp, which the workman puts on a long channelled ruler or needle; and which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the end of the warp.

The principal and best manufactories of *velvet* are in *France* and *Italy*, particularly at *Venice*, *Milan*, *Florence*, *Genoa* and *Lucca*: there are others in *Holland*, set up by the *French* refugees; whereof that at *Haerlem* is the most considerable: but these all come short (says an *English* author) of the beauty of those of *France*; and accordingly are sold for 10 or 15 *per cent.* less. There are even some brought from *China*, but they are the worst of all.

There are *velvets* of various kinds, as *plain*, that is uniform and smooth, without either figures or stripes.

Figur'd velvet, that is adorned and worked with divers figures; though the grounds be the same with the figures; that is the whole surface velveted.

Ramaged or *branched* velvet, representing long stalks, branches, &c. on a sattin ground, which is sometimes of the same colour with the *velvet*, but more usually of a different one. Sometimes, instead of sattin, they make the ground of gold and silver; whence the denomination of *velvets* with gold ground, &c.

Shorn velvet, is that wherein the threads, that make the *velveting*, have been ranged in the channelled ruler, but not cut there.

Strip'd velvet, is that wherein there are stripes of divers colours running along the warp; whether those stripes be partly *velvet*, and partly satin, or all *velveted*.

Cut Velvet, is that wherein the ground is a kind of taffety, or *gros de tours*, and the figures *velvet*.

Velvets are likewise distinguished, with regard to their different degrees of strength and goodness; into *velvets* of four threads, three threads, two threads, and a thread and half: the first are those where there are eighteen threads of shag, or *velveting* to each tooth of the reed; and the second have only six, and the rest four. In general, all *velvets* both worked and cut, shorn and flowered, have their warp and shag of organsin, spun and twisted, or thrown in the mill; and their woof of silk well boiled, &c. They are all of the same breadth.

From the silk manufactures, I'll pass to the *linnen ones*.

The *linnen* manufacture borrows its name from *line*, *linum*, which is a plant with a slender hollow stem, usually about two feet high (though I have seen some which measured above three feet) whose bark consists of fibres or threads, much like those of hemp; which being dressed and worked in due manner, makes that noble commodity *linnen-cloth*. The preparations *line* must undergo to fit it for spinning, are pulling, drying, and swingling; which operations are inserted in my treatise of agriculture under the letter A.

Line, after it has been prepared fit for spinning, is called flax, of which there is different sorts, with regard to the degrees of fineness; which degrees it acquir'd through the cards, which card is much like that of perriwig-makers, except that the points are longer. For if the *flax* be designed for fine thread, it must pass through a closer card, than when for coarse thread.

Flax is spun either with the distaff or the wheel, and the thread acquires its degree of fineness between the fingers of the operator. Of this thread the *linen-cloth* is wove on a loom, with two tredles, the warp being always coarser than the woof. If the cloth is to be very white, the thread is bleached before it is wove; if not it is wove as it comes from off the distaff without any other preparation.

The finest of all *linnen-cloth* is commonly cambrick, because wove of the finest thread that can be spun; and the best manufactures of this sort of cloth are in *French Flanders*.

The *linnen-cloth*, commonly called *holland*, is next to *cambrick* for fineness; and there are even *Hollands* much finer than some *Cambricks*. This sort of *linnen-cloth* is chiefly wrought in the provinces of *Holland*, *Frizeland*, and other parts of the united provinces, whence the appellation. The principal mart or staple of this cloth is at *Haerlem*, whither it is sent from most other parts as soon as wove, there to be whitened the ensuing spring.

That manufacture in *Frizeland* is the most esteemed and called *Frize-Holland*. It is the strongest and the best coloured of any of that fineness. It is never calender'd nor thickened as the rest, but is imported just as it comes from the whitster. It is distinguished by its being yard, quarter and half wide, which is a half quarter more than those commonly called *Frize-Hollands*, which are not right.

Guilix Holland is very white and fine, and is chiefly used for shirts, being the strongest of any for

for its fineneſs, except true *Frieze*. It is juſt yard wide.

Alcmaer HOLLAND is a very ſtrong *cloth*, and wears exceeding well. It is about yard, quarter, and half wide.

There is a manufacture of *linnen-cloth* at *Pontivy* in *Lower Britany*, which is nothing inferior to thoſe of *Holland*, and which even excels in the ſtrength of the cloth, which wears to the full as well, and is of much more ſervice, though not ſo dear.

They have brought lately the *linnen manufacture* to a very great perfection, both in *Scotland* and *Ireland*.

After *Hollands*, or *fine Linnens* are taken from the loom, while yet raw, they are ſteeped a day in fair water, waſhed out and cleared of their filth, and thrown into a bucking tub, filled with cold lixivium, or lye of wood-aſhes and water: when taken out of the lye they are waſhed in clear water, ſpread in a meadow, and watered from time to time, with water from little diſhes, or canals along the ground, by means of ſcoops, or hollow peels of wood, called by the *Dutch*, who pretend to be the inventors of them, *gieter:* after lying a certain time on the ground, they are paſſed through a new lye poured on hot; and again waſhed in clear water, and laid a ſecond time on the ground, and every thing repeated as before; then paſſed through a ſoft gentle lye, to diſpoſe them to reſume the ſoftneſs which the other harſheſt lye had taken from them, waſhed in clear water, ſoaped with black ſoap, and that ſoap again waſhed out in clear water; they are then ſteeped in cow's milk, the cream firſt ſkimmed off, which finiſhes their whitening; and ſcowering gives them a ſoftneſs, and makes them caſt a little nap: when taken out of the milk, they are waſhed in clear water for the laſt time. After all this proceſs, they give the linnen its firſt blue, by paſſing it through a water wherein a little ſtarch, ſmalt, and *Dutch* lapis have been ſteeped. Laſtly, the proper ſtiffneſs and luſtre is given with ſtarch, pale ſmalt, and other gums, the quantity and quality whereof may be adjuſted according to occaſion.

In fine weather, the whole proceſs of *bleaching* is compleated in a month's time; in bad weather it takes up ſix weeks, or more.

To *bleach coarſe linnens*; they are taken from the loom and laid in wooden frames, full of cold water; where, by means of wooden hammers, worked by a water mill, they are beat ſo, as inſenſibly to waſh and purge them of their filth, then ſpread on the ground, where the dew, which they receive for eight days, takes off more of their impurity; then put in a kind of wooden tubs or pans, with a hot lye over them, thus lixiviated, they are again purged in the milk, laid afreſh on the ground, and after eight days more, paſſed through a ſecond lye, and all things repeated, till ſuch time as they have acquired a juſt degree of whiteneſs.

Perſons appointed by the truſtees, for improving the hempen and flaxen manufactures in *Scotland*, may enter into any bleach yard, back houſe, *&c.* and ſearch all rooms, reives, and boilers therein, and view the lyes, refuſe, and dregs thereof; to ſee whether there have been any lime, pigeons dung, or ſoap-dregs uſed in the *bleaching* of linnen cloth or yarn, contrary to the ſtatutes, 13 *G. c.* 26. § 16.

MUSLIN is alſo a fine ſort of cloth, wholly cotton; ſo called as not being bare, but not having a downy nap on its ſurface, reſembling moſs, which the *French* call *Mouſſe*.

There are various kinds of *muſlins* brought from the *Eaſt-Indies*, *Chyl*, *Bengal*, *Betelles*, *Tarnatans*, *Mulmuls*, *Tangeels*, *Terrindans*, *Douas*, &c.

W E I G H T.

WEIGHT, GRAVITY, in phyſics, a quality in natural bodies whereby they tend downwards, towards the center of the earth. Or, weight may be defined, in a leſs limited manner, to be a power inherent in all bodies whereby they tend to ſome common point, called the center of gravity; and that with a greater or leſs velocity, as they are more or leſs denſe, or as the medium they paſs through is more or leſs rare.

In the common uſe of language, weight and gravity are conſidered as one and the ſame thing. Some authors, however, make a difference between them; and hold gravity only to expreſs a niſus or endeavour to deſcend, but weight an actual deſcent. But there is room for a better diſtinction. In effect, one may conceive gravity to be the quality as inherent in the body; and weight the ſame quality, exerting itſelf either againſt an obſtacle, or otherwiſe. Hence, weight may be diſtinguiſhed, like gravity, into abſolute and ſpecific.

Sir Iſaac Newton demonſtrates, that the weights of all bodies, at equal diſtances from the center of the earth, are proportionable to the quantities of matter each contains. Whence it follows, that the weights of bodies have not any dependence on their forms, or textures; and that all ſpaces are not equally full of matter. Hence, alſo, it fol-

lows,

lows, that the weight of the ſame body is different, on the ſurface of different parts of the earth; by reaſon its figure is not a ſphere, but a ſpheroid.

WEIGHT, in mechanics, is any thing to be raiſed, ſuſtained, or moved by a machine, or any thing that in any manner reſiſts the motion to be produced.

WEIGHT, in commerce, denotes a body of a known weight, appointed to be put in the ballance againſt other bodies, whoſe weight is required.

The ſecurity of commerce depending, in good meaſure, on the juſtneſs of weights, which are uſually of lead, iron, or braſs, moſt nations have taken care to prevent the falſification thereof, by ſtamping or marking them by proper officers, after being adjuſted by ſome original ſtandard. Thus, in England, the ſtandard of weights is kept in the exchequer, by a particular officer called the clerk of the market.

Weights may be diſtinguiſhed into ancient and modern, foreign and domeſtic.

Antient WEIGHTS, 1. Thoſe of the antient Jews, reduced to the Engliſh troy weights, will ſtand as in the following table:

			lb.	oz.	dwt.	gr.
Shekel			00	00	09	$02\frac{4}{7}$
60	Manch		02	03	06	$10\frac{2}{7}$
3000	50	Talent	113	10	01	$10\frac{2}{7}$

2. Grecian and Roman weights, reduced to Engliſh troy weight, will ſtand as in the following table.

										oz.	dwt.	gr.
Lentes										00	00	$00\frac{85}{112}$
4	Siliquæ									00	00	$00\frac{1}{28}$
12	3	Obolus								00	00	$09\frac{3}{28}$
24	6	2	Scriptulum							00	00	$18\frac{3}{14}$
72	18	6	3	Drachma						00	02	$06\frac{9}{14}$
96	24	8	4	$1\frac{1}{3}$	Sextula					00	03	$00\frac{6}{7}$
144	56	12	6	2	$1\frac{1}{2}$	Sicilicus				00	04	$13\frac{2}{7}$
192	48	16	8	$2\frac{2}{3}$	2	$1\frac{1}{3}$	Duella			00	06	$01\frac{5}{7}$
576	144	48	24	8	6	4	3	Uncia		00	18	$05\frac{1}{7}$
6912	1728	576	288	96	72	48	36	12	Libra	10	18	$13\frac{5}{7}$

The Roman ounce is the Engliſh avoirdupois ounce, which they divided into ſeven denarii, as well as eight drachms; and ſince they reckoned their denarius equal to the attic drachm, this will make the attic weights one eighth heavier than the correſponding Roman weights.

Modern European WEIGHTS. 1. Engliſh weights: By the twenty-ſeventh chapter of magna charta, the weights all over England are to be the ſame; but for different commodities, there are two different ſorts, *viz.* Troy weight and avoirdupoiſe weight. The origin from which they are both raiſed, is a grain of weight, gathered in the middle of the ear.

In troy weight, twenty-four of theſe grains make a penny-weight ſterling; twenty penny-weights make one ounce, and twelve ounces one pound.

By this weight we weigh gold, ſilver, jewels, grains, and liquors. The apothecaries alſo uſe the troy pound, ounce, and grain; but they differ from the reſt in the intermediate diviſions. They divide the ounce into eight drachms; the drachm into three ſcruples, and the ſcruple into twenty grains.

In avoirdupoiſe weight, the pound contains ſixteen ounces, but the ounce is leſs by near one twelfth than the troy ounce; this latter containing 490 grains, and the former only 448. The ounce contains 16 drachms. 80 ounces avoirdupoiſe are only equal to 73 ounces troy; and 17 pounds troy equal to 14 pounds avoirdupoiſe.

By avoirdupoiſe weight are weighed mercury, and grocery wares, baſe metals, wool, tallow, hemp, drugs, bread, &c.

Table

Table of Troy Weight as uſed by the

Goldſmiths.

Grains.			
24	Penny-weight.		
480	20	Ounce.	
5760	240	12	Pound.

Apothecaries.

Grains.				
20	Scruple.			
60	3	Drachm.		
480	24	8	Ounce.	
5760	288	96	12	Pound.

Table of Avoirdupoiſe Weight.

Scruples.					
3	Drachm.				
24	8	Ounce.			
384	128	16	Pound.		
43008	14336	1792	112	Quintal, or Hundred.	
860160	286720	35840	2240	20	Ton.

The moneyers, jewellers, *&c.* have a particular claſs of weights, for gold and precious ſtones, *viz.* carat and grain; and for ſilver, the penny-weight and grain.

The moneyers have alſo a peculiar ſubdiviſion of the grain troy: thus,

The	Grain	into	20 Mites.
	Mite		24 Droits.
	Droit		20 Perits.
	Perit		24 Blanks.

The dealers in wool have likewiſe a particular ſet of weights, *viz.* the ſack, weigh, tod, ſtone, and clove.

2. French weights: the common or Paris pound is 16 ounces; which they divide two ways: the firſt diviſion is into 2 marcs; the marc into 8 ounces; the ounce into 8 gros; the gros into 3 pennyweights; the pennyweight into 24 grains; the grain equivalent to a grain of wheat. The ſecond diviſion of the pound is into 2 half-pounds; the half-pound into 2 quarters; the quarter into 2 half-quarters; the half-quarter into two ounces; and the ounce into two half-ounces.

The weights of the firſt diviſion are uſed to weigh gold, ſilver, and the richer commodities: and the weights of the ſecond diviſion, for commodities of leſs value.

Grains.					
24	Penny-weight.				
72	3	Gros.			
576	24	8	Ounce.		
4608	192	64	8	Marc.	
9216	384	128	16	2	Pound.

Half-ounce.						
2	Ounce.					
4	2	Half-quarter pound.				
8	4	2	Quarter-pound.			
16	8	4	2	Half-pound.		
32	16	8	4	2	Pound.	
3200	1600	800	400	200	100	Quintal.

But the pound is not the ſame throughout France. At Lyons, *e. gr.* the city pound is only 14 ounces: ſo that 100 Lyons pounds makes only 88 Paris pounds. But beſides the city pound, they have another at Lyons for ſilk, containing 16 ounces. At Tholouſe, and throughout the Upper Languedoc, the pound is 13 ounces and a half of Paris weight. At Marſeilles, and throughout Provence, the pound is 13 ounces of Paris weight. At Rouen, beſide the common Paris pound and marc, they have the weight of the vicomte; which is 16 ounces, a half, and five-ſixths of the Paris weight. The weights, enumerated under the two articles of Engliſh and French weights, are the ſame that are uſed throughout the greateſt part of Europe; only under ſomewhat different names, diviſions and proportions.

Particular nations have alſo certain weights peculiar to themſelves: thus, Spain has its arrobas, containing 25 Spaniſh pounds, or one-fourth of the

the common quintal: its quintal macho, containing 150 pounds, or one half common quintal, or 6 arrobas: its adarme, containing one ſixteenth of its ounce. And for gold, it has its caſtillan, or one-hundredth of a pound. Its tomin, containing 12 grains, or one eighth of a caſtillan. The ſame are in uſe in the Spaniſh Weſt-Indies.

Portugal has its arroba, containing 32 Liſbon arratels, or pounds: Savary alſo mentions its faratelle, containing 2 Liſbon pounds: and its rottoli, containing about 12 pounds. And for gold, its chego, containing four carats. The ſame are uſed in the Portugueſe Eaſt-Indies.

Italy, and particularly Venice, have their migliaro, containing four mirres; the mirre containing 30 Venice pounds: the ſaggio, containing a ſixth part of an ounce. Genoa has five kinds of weights, *viz.* large weights, whereby all merchandizes are weighed at the cuſtom-houſe: caſh weights for piaſtres, and other ſpecies: the cantara, or quintal, for the coarſeſt commodities: the large ballance for raw ſilks; and the ſmall ballance for the finer commodities. Sicily has its rottolo, 32 and a half pounds of Meſſina.

Germany, Flanders, Holland, the Hanſe towns, Sweden, Denmark, Poland, &c. have their ſchippondt, which at Antwerp and Hamburgh, is 300 pounds; at Lubeck, 320; and at Coningſberg, 400 pounds. In Sweden, the ſchippondt for copper is 320 pounds; and the ſchippondt for proviſions 400 pounds. At Riga and Revel, the ſchippondt is 400 pounds; at Dantzic, 340 pounds; in Norway, 300 pounds; at Amſterdam, 300: containing 20 lyſpondts, each weighing 15 pounds.

In Muſcovy, they weigh their large commodities by the bercheroct, or berkewits, containing 400 of their pounds. They have alſo the poet, or poede, containing 40 pounds, or one tenth of the bercheroct.

In order to ſhew the proportion of the ſeveral weights uſed throughout Europe, we ſhall add a reduction of them to one ſtandard, *viz.* the London and Amſterdam pound.

1. Proportion of the weights of the principal places of Europe.

The 100lb. of England, Scotland, and Ireland, are equal to

lb.	oz.	
91	8	of Amſterdam, Paris, &c.
96	8	of Antwerp or Brabant.
88	0	of Roaen, the viſcounty weight.
106	0	of Lyons, the city weight.
90	9	of Rochelle.
107	11	of Toulouſe and upper Languedoc.
113	0	of Marſeilles or Provence.
81	7	of Geneva.
93	5	of Hamburgh.
89	7	of Francfort, &c.
96	1	of Leipſick, &c.
137	4	of Genoa.
132	11	of Leghorn.
153	11	of Milan.
152	0	of Venice.
154	10	of Naples.
97	0	of Seville, Cadiz, &c.
104	13	of Portugal.
96	5	of Leige.
112	$\frac{2}{5}$	of Ruſſia.
107	$\frac{1}{24}$	of Sweden.
89	$\frac{1}{2}$	of Denmark.

2. Proportion of weights of the chief cities in Europe, to thoſe of Amſterdam.

An 100 pounds of Amſterdam are equal to

lb.	
108	of Alicant.
105	of Antwerp.
120	of Archangel, or 3 poedes.
105	of Arſchot.
120	of Avignon.
98	of Baſil in Switzerland.
100	of Bayonne in France.
166	of Bergamo.
97	of Bergen-op-zom.
95 $\frac{1}{4}$	of Bergen in Norway.
111	of Bern.
100	of Beſançon.
100	of Bilboa.
105	of Bois le duc.
151	of Bologna.
100	of Bourdeaux.
104	of Bourg en Breſſe.
103	of Bremen.
125	of Breſlaw.
105	of Bruges.
105	of Bruſſels.
105	of Cadiz.
105	of Cologne.
125	of Coningſberg.
107 $\frac{1}{2}$	of Copenhagen.
87	rottos of Conſtantinople.
113 $\frac{1}{2}$	of Dantzic.
100	of Dort.
97	of Dublin.
97	of Edinburgh.
143	of Florence.
98	of Francfort on the Maine.
105	of Gaunt.
89	of Geneva.

lb.	
163	of Genoa, caſh weight.
102	of Hamburgh.
106	of Leyden.
105	of Leipſic.
105 ½	of Liege.
114	of Liſle.
143	of Leghorn.
106 ½	of Liſbon.
109	of London, avoirdupoiſe weight.
105	of Lovaine.
105	of Lubec.
141 ½	of Lucca, light weight.
116	of Lyons, city weight.
114	of Madrid.
105	of Marlines.
123 ½	of Marſeilles.
154	of Meſſina, light weight.
168	of Milan.
120	of Montpelier.
125	bercheroćts of Muſcovy.
100	of Nantes.
106	of Nancy.
169	of Naples.
98	of Nuremberg.
100	of Paris.
112 ½	of Revel.
109	of Riga.
100	of Rochelle.
146	of Rome.
100	of Rotterdam.
96	of Rouen, viſcounty weight.
100	of St. Malo.
100	of St. Sebaſtian.
158 ½	of Saragoſa.
106	of Seville.
114	of Smyrna.
110	of Stetin.
81	of Tholouſe and upper Languedoc.
151	of Turin.
158 ½	of Valencia.
182	of Venice, ſmall weight.

Weights, *uſed in the ſeveral parts of Aſia, the Eaſt-Indies, China, Perſia, &c.* In Turky, at Smyrna, &c. they uſe the batman, or battemant, containing ſix occos; the occo weighing three pounds four-fifths Engliſh. They have another batman much leſs, conſiſting, as the former, of ſix occos: but the occo only containing fifteen ounces Engliſh: 44 occos of the firſt kind make the Turkiſh quintal. At Cairo, Alexandretta, Aleppo, and Alexandria, they uſe the rotto, rotton, or rottoli. The rottoli at Cairo, and other parts of Egypt, is 144 drachms; being ſomewhat over an Engliſh pound. At Aleppo there are three ſorts of rottos: the firſt 720 drachms, making about ſeven pounds Engliſh, and ſerving to weigh cottons, galls, and other large commodities; the ſecond is 624 drachms, uſed for all ſilks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant, not named here, uſe ſome of theſe weights; particularly the occo ar ocqua, the rottoli, and rotto.

The Chineſe weights are the piece for large commodities; it is divided into 100 catis, or cattis; though ſome ſome ſay into 125; the cati into 16 taels, or tales; each tael equivalent to 1 ⅓ of an ounce Engliſh, or the weight of one rial and $\frac{1}{12}$, and containing 12 mas or maſſes, and each mas 10 condrins. So that the Chineſe piece amounts to 137 pounds Engliſh avoirdupoiſe, and the cati to 1 pound 8 ounces. The picol for ſilk containinſi 66 catis and ¾, the bahar, bakaire, or barr, containing 300 catis.

Tonquin has alſo the ſame weights, meaſures, &c. as China. Japan has only one weight, *viz.* the cati; which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the ſtates of the great Mogul, they uſe the man, or maund, whereof they have two kinds; the king's man, or king's weight; and the man ſimply; the firſt uſed for the weighing of common proviſions, containing 40 ſeers or ſerres; and each ſeer a juſt Paris pound. The common man, uſed in the weighing of merchandize, conſiſts likewiſe of 40 ſeers, but each ſeer is only eſtimated at 12 Paris ounces, or ¾ of the other ſeer.

The man may be looked on as the common weight of the Eaſt-Indies, though under ſome difference of name, or rather of pronunciation; it being called mao at Cambaya, and in other places mein, and maun. The ſeer is properly the Indian pound, and of univerſal uſe; the like may be ſaid of the bahar, tael, and catti above-mentioned.

The weights of Siam, are the piece, containing two ſhans, or cattis; but the Siameſe catti is only half the Japoneſe, the latter containing 20 taels, and the former only 10; though ſome make the Chineſe catti only 16 taels, and the Siameſe 8. The tael contains four baats or ticals; each about a Paris ounce; the baat 4 ſelings or mayons; the mayon 2 fouangs; the fouang four payes; the paye 2 clams; and the ſompaye half a fouang.

It is to be obſerved, that thoſe are the names of their coins as well as weights; ſilver and gold being commodities there ſold, as other things, by their weights.

In the iſle of Java, and particularly at Bantam, they uſe the gantan, which amounts to near three Dutch pounds. In Golconda, at Viſapour and Goa, they have the furatelle, containing 1 pound 14 ounces Engliſh; the mangalis or mangelin for weighing diamonds and precious ſtones, weighing at Goa 5 grains, at Golconda, *&c.* 5 $\frac{1}{2}$ grains. They have alſo the rotolo containing 14 $\frac{1}{4}$ ounces Engliſh; the metricol containing the ſixth part of an ounce; the wall for piaſters and ducats, containing the 73d part of a rial.

In Perſia they uſe two kinds of batmans or mans, the one called cahi or cheray, which is the King's weight; and the other batman of Tauris. The firſt weighs 13 pounds 10 ounces Engliſh; the ſecond 6 pounds $\frac{1}{2}$. Its diviſions are the ratel, or a 16th; the derhem or drachm, which is the 50th; the meſchal, which is half the derhem; the dung, which is the 6th part of the meſchal, being equivalent to ſix carat-grains; and, laſtly, the grain, which is the fourth part of the dung. They have alſo the vakie, which exceeds a little our ounce; the ſah-cheray, equal to the 1170th part of the derhem; and the toman uſed to weigh our large payments of money, without telling; its weight is that of 50 abaſſis.

African and American weights. We have little to ſay as to the weights of America: the ſeveral European colonies there making uſe of the weights of the ſtates or kingdoms of Europe they belong to. For, as to the aroue of Peru, which weighs 27 pounds, it is evidently no other than the Spaniſh arroba with a little difference in the name.

As to the weights of Africa, there are few places that have any, except Egypt, and the countries bordering on the Mediterranean, whoſe weights have been already enumerated among thoſe of the ports of the Levant. The iſland of Madagaſcar indeed has weights, but none that exceed the drachm, nor are they uſed for any thing but gold and ſilver.

W I N E.

WINE, a briſk, agreable, ſpirituous and cordial liquor, drawn from vegetable bodies and fermented.

The character of a wine, according to Boerhaave, is, that the firſt thing it affords by diſtillation, be a thin, oily, inflammable fluid called a ſpirit.

This diſtinguiſhes wines from another claſs of fermented vegetable juices, *viz.* vinegar, which inſtead of ſuch ſpirit, yields, for the firſt thing, an acid uninflammable matter.

All ſorts of vegetables, fruits, ſeeds, roots, *&c.* afford wine; as grapes, currants, mulberries, elder-berries, cherries, apples, pulſe, beans, peaſe, turneps, radiſhes, and even graſs itſelf. Hence under the claſs of wines, or vinous liquors, come not only wines abſolutely ſo called, but alſo ale, cyder, *&c.*

Wine is, in a more peculiar manner, appropriated to that, which is drawn from the fruit of the vine, by ſtamping its grapes in a vat, or cruſhing and expreſſing the juice out of them in a preſs, and then fermenting, *&c.*

The goodneſs of wine conſiſts in its being neat, dry, fine, bright, and briſk, without any taſte of the ſoil, of a clean ſteddy colour, having a ſtrength without being heady, a body without being ſour, and keeping without growing hard or eager. The difference of flavour, taſte, colour, and body, in wines, is, perhaps, as much owing to the different manner and time of preſſing, gathering, fermenting *&c.* the grape, as to any difference of the grape itſelf. In Hungary, whence tockay and ſome of the richeſt and higheſt flavoured wines come, they are extremely curious in theſe reſpects: for their prime and moſt delicate wines, the grape is ſuffered to continue upon the vine, till it is half dried by the heat of the ſun; and, if the ſun's heat ſhould not prove ſufficient, they are dried by the gentle heat of a furnace, and then picked one by one from the ſtalks; the juice of this grape, when preſſed out, is of a fine flavour, and ſweet as ſugar: this, after due fermentation, is kept for a year, and then racked from the lees, when it proves a generous, oily, rich wine, and is ſold at a very high rate. The Hungarians prepare a ſecond ſort of wine, by collecting together the better kind of grapes, carefully picking the better kind of grapes, carefully picking the fruit from the ſtalks, and then preſſing out the juice: this is extremely ſweet, and is made richer by infuſing in it, after it has fermented for ſome days, a ſufficient quantity of half dried grapes. This wine is very ſweet, oily of a grateful taſte, and retains theſe qualities for a long time. There is a third ſort made from the pure juice of the ſame kind of grape, without any addition. This is a more briſk and lively wine, and far leſs ſweet. They likewiſe prepare a fourth ſort, from grapes of different goodneſs mixed together; this though not ſo generous, is nevertheleſs an excellent wine. Theſe Hungarian wines are

are remarkable for preserving their sweetness, and for the delicacy of their taste and smell; they, likewise, do not grow easily vapid, and may be kept in perfection for many years.

Wine being a liquor mostly of foreign produce, the divers names, forms, kinds, distinctions, &c. thereof, are borrowed from the countries where it is produced; the principal whereof, at this day, is France, to wines of which country, a good part of what we have to say of this noble liquor, will more immediately belong.

Wine in France is distinguished from the several degrees and steps of its preparation, into, 1. *Mere goutte*, mother drop, which is the virgin wine, or that which runs of itself out at the top of the vat wherein the grapes are laid, before the vintager enters to tred or stamp the grapes. 2. Must, surmust, or stum, which is the wine or liquor in the vat, after the grapes have been trod or stamped. 3. Pressed wine, being that squeezed with a press out of the grapes half bruised by the treading. The husks left of the grapes are called rope, murk, or mark, by throwing water upon which, and pressing them afresh, they make a liquor for servants use, answerable to our cyderkin, and called *boison*, which is of some use in medicine, in the cure of disorders occasioned by viscid humours. 4. Sweet wine, is that which has not yet worked nor fermented. 5. Bouru, that which has been prevented working by casting in cold water. 6. Worked wine, that which has been let work in the vat, to give it a colour. 7. Boiled wine, that which has had a boiling before it worked, and which by that means still retains its native sweetness. 8. Strained wine, that made by steeping dry grapes in water, and letting it ferment of itself. Wines are also distinguished with regard to their colour into white wine, red wine, claret wine, pale wine, rose, or black wine; and with regard to their country, or the soil that produces them, into French wines, Spanish wines, Rhenish wines, Hungary wines, Greek wines, Canary wines, &c. and more particularly into Port wine, Madeira wine, Burgundy wine, Champaign wine, Falernian wine, Tockay wine, Schiras wine, &c.

Method of making, fining, &c. WINE. In the southern parts of France, their way is with red wines to tread or squeeze the grapes between the hands, and to let the whole stand, juice and husks, till the tincture be to their liking; after which they press it. But for white wines, they press the grapes immediately; when pressed, they tun the must and stop up the vessel, only leaving the dept of a foot or more to give room for it to work.

At the end of ten days they fill this space with some other proper wine, that will not provoke it to work again. This they repeat from time to time, new wine spending itself a little before it comes to perfection.

The usual method of fining down wines, so as to render them expeditiously bright, clear, and fit for use, is this. Take an ounce of isinglass, beat it into thin shreads with a hammer, and dissolve it, by boiling, in a pint of water; this, when cold, becomes a stiff jelly. Whisk up some of this jelly into a froth with a little of the wine intended to be fined, then stir it well among the rest in the cask, and bung it down tight; by this means the wine will become bright in eight or ten days. This method, however, is found to be best suited to the white wines; for the red ones, the wine-coopers commonly use the whites of eggs beat up to a froth, and mixed in the same manner with their wines.

They fine it down also by putting the shavings of green beech into the vessel, having first taken off all the rind, and boiled them an hour in water to extract their rankness, and afterwards dried them in the sun, or in an oven. A bushel of these serve for a tun of wine; and being mashed, they serve again and again, till almost quite consumed.

For English wine, the method recommended by Mortimer, is first to gather the grapes when very dry, to pick them from the stalks, then to press them, and let the juice stand twenty-four hours in a vat covered. Afterwards to draw it off from the gross lees, and then put it up in a cask, and to add a pint or quart of strong red or white port to every gallon of juice, and let the whole work, bunging it up close, and letting it stand till January; then bottle it in dry weather. Bradley chuses to have the liquor, when pressed, stand with the husks, stalks, and all in the vat, to ferment for fifteen days.

The method of converting white-wine into red, so much practised by the modern wine-coopers, Dr. Shaw observes, is this. Put four ounces of turnesole rags into an earthen vessel, and pour upon them a pint of boiling water; cover the vessel close, and leave it to cool; strain off the liquor, which will be of a fine deep red, inclining to purple. A small portion of this colours a large quantity of wine. This tincture might be either made in brandy, or mixed with it, or else made into a syrup, with sugar, for keeping. A common way with the wine-coopers is to infuse the rags cold in wine for a night or more, and then wring them out with their hands; but the inconveniency of this method is, that it gives the wine a disagreeable taste; or what is commonly called the taste of the rag; whence the wines, thus coloured, usually pass among judges for pressed wines, which have all this taſte from the canvas rags in which the lees are preſſed.

The way of extracting the tincture, as here directed, is not attended with this inconvenience; but it loads the wine with water; and if made into a ſyrup, or mixed in brandy, it would load the wine with things not wanted, ſince the colour alone is required. Hence the colouring of wines has always its inconveniencies.

In thoſe countries which do not produce the tinging grape, which affords a blood-red juice, wherewith the wines of France are often ſtained, in defect of this, the juice of elder-berries is uſed, and ſometimes logwood is uſed at Oporto.

The colour afforded by the method here propoſed, gives wine the tinge of the Bourdeaux-red, not the Port; whence the foreign coopers are often diſtreſſed for want of a proper colouring for red wines in bad years. This might, perhaps, be ſupplied by an extract made by boiling ſtick-lack in water. The ſkins of tinging-grapes might alſo be uſed, and the matter of the turneſole procured in a ſolid form, not imbibed in rags.

Stahl obſerves, that it is a common accident, and a diſeaſe in wines, to be kept too hot; which is not eaſy to cure when it has been of any long continuance, otherwiſe it may be cured by introducing a ſmall artificial fermentation, that new ranges the parts of the wine, or rather recovers their former texture: but the actual expoſing of wine to the fire, or the ſun, preſently diſpoſes it to turn eager; and the making it boiling hot, is one of the quickeſt ways of expediting the proceſs of making of vinegar.

On the other hand, wine kept in a cool vault, and well ſecured from the external air, will preſerve its texture entire in all the conſtituent parts; and ſufficiently ſtrong for many years, as appears not only from old wines, but other foreign fermented liquors, particularly thoſe of China, prepared from a decoction of rice, which being well cloſed down in a veſſel, and buried deep under ground, will continue, for a long ſeries of years, rich, generous, and good, as the hiſtories of that country univerſally agree in aſſuring us.

The moſt general remedy hitherto known for all the diſeaſes of wines, is a prudent uſe of tartarized ſpirit of wine, which not only enriches, but diſpoſes all ordinary wines to grow fine.

If either by fraud or accident a larger portion of water is mixed with wine than is proper for its conſiſtence, and no way neceſſary or eſſential, this ſuperfluous water does not only deprave the taſte, and ſpoil the excellence of the wine, but alſo renders it leſs durable; for humidity in general, and much more a ſuperfluous aqueous humidity, is the primary and reſtleſs inſtrument of all the changes that are brought on by fermentation. It may doubtleſs, therefore, be uſeful, and ſometimes abſolutely neceſſary, to take away this ſuperfluous water from the other part which ſtrictly and properly conſtitutes the wine. This has been agreed upon on all hands as a thing proper; but the manner of doing it has not been well agreed on; ſome have propoſed the effecting it by means of heat and evaporation, others by percolation, and others by various other methods, all found unſucceſsful when brought to the trial; but the way propoſed by Dr. Shaw from Stahl, is the moſt certain and commodious; this is done by a concentration of the wine, not by means of heat, but of cold.

If any kind of wine, but particularly ſuch as has never been adulterated, be in a ſufficient quantity, as that of a gallon or more, expoſed to a ſufficient degree of cold in froſty weather, or be put into any place where ice continues all the year, as in our ice-houſes, and there ſuffered to freeze, the ſuperfluous water that was originally contained in the wine, will be frozen into ice, and will leave the proper and truly eſſential part of the wine unfrozen, unleſs the degree of cold ſhould be very intenſe, or the wine but weak and poor. This is the principle on which Stahl founds his whole ſyſtem of condenſing wines by cold. When the froſt is moderate, the experiment has no difficulty, becauſe not above a third or a fourth part of the ſuperfluous water will be froze in a whole night; but if the cold be very intenſe, the beſt way is, at the end of a few hours, when a tolerable quantity of ice is formed, to pour out the remaining fluid liquor, and ſet it in another veſſel to freeze again by itſelf. If the veſſel, that thus by degrees receives the ſeveral parcels of the condenſed wine, be ſuffered to ſtand in the cold freezing place where the operation is performed, the quantity lying thin in the pouring out, or otherwiſe, will be very apt to freeze anew; and if it be ſet in a warm place, ſome of this aqueous part thaws again, and ſo weakens the reſt. The condenſed wine, therefore, ſhould be emptied in ſome place of a moderate degree as to cold or heat, where neither the ice may diſſolve, nor the vinous ſubſtance mixed among it be congealed. But the beſt expedient of all is to perform the operation with a large quantity of wine, or that of ſeveral gallons, where the utmoſt exactneſs, or the danger of a trifling waſte, need not be regarded.

By this method, when properly performed, there firſt freezes about one third part of the whole liquor; and this is properly the more

purely

purely aqueous part of it, insomuch that when all the vinous fluid is poured off, to be again exposed to a concentration, the ice remaining behind, from this first freezing, being set to thaw in a warm place, dissolves into a pure and tasteless water. The frozen part, or ice, consists only of the watery part of the wine, and may be thrown away, and the liquid part retains all the strength, and is to be preserved. This will never grow sour, musty, or mouldy afterwards, and may at any time be reduced to wine of the common kind again, by adding to it as much water as will make it up to the quantity that it was before.

Wines in general may by this method be reduced to any degree of vinosity or perfection.

The benefit and advantage of this method of congelation, if reduced to practice in the large way, in the wine countries, must be evident to every body. Concentrated wines, in this manner, might be sent into foreign countries, instead of wine and water, which is what i usually now sent, the wines they export being loaded, and in danger of being spoiled by three or four times their own quantity of unnecessary, superfluous, and prejudicial water.

An easy method of recovering pricked wines, may be learned from the following experiment: take a bottle of red port that is pricked, add to it half an ounce of tartarized spirit of wine, shake the liquor well together, and set it by for a few days, and it will be found very remarkably altered for the better.

This experiment depends upon the useful doctrine of acids and alkalies. All perfect wines have naturally some acidity, and when this acidity prevails too much, the wine is said to be pricked, which is truly a state of the wine tending to vinegar: but the introduction of a fine alkaline salt, such as that of tartar, imbibed by spirit of wine, has a direct power of taking off the acidity, and the spirit of wine also contributes to this, as a great preservative in general of wines.

If this operation be dextrously performed, pricked wines may be absolutely recovered by it, and remain saleable for some time: and the same method may be used to malt liquors just turned sour.

The age of wine is properly reckoned by leaves; thus they say wine of two, four, or six leaves, to signify wine of two, four, or six years old; taking each new leaf put forth by the vine, since the wine was made, for a year.

The net duties to be paid on importation of all wines into the port of London, and repaid on exportation, are as follows.

Wines imported by British for sale. Rhenish, German, or Hungary wines, the ton, filled in casks, pay, on importation, 35l. 2s [illegible] d. and on exportation, draw back 26l. 13s. 8 [illegible] d. in bottles, on importation, 35l. 15s. $3\frac{12}{100}$d. and draw back, on exportation, 27l. 5s. $4\frac{8}{100}$d. Portugal or Madeira wine, the ton filled in casks, pays on importation, 28l. 8s. 3 [illegible] d. and, on exportation, draws back 20l. 6s. 4 [illegible] d. in bottles, on importation, 31l. 5s. 3 [illegible] d. and, on exportation, draws back 22l. 15s. 4 [illegible] d. French wine, the ton filled in cask, on importation, pays 60l. 16s. $4\frac{3}{100}$d. and, on exportation, draws back, 26l. 2s. $11\frac{12}{100}$d. in bottles, on importation, 64l. 5s. 4 [illegible] d. and, on exportation, draws back 27l. 18s. 8 [illegible] d. Levant and all other wines, the ton filled in casks pays, on importation, 29l. 4s. $9\frac{12}{100}$d. and, on exportation, draws back 21l. 2s. $10\frac{1}{100}$d. in bottles, on importation, pays 32l. 3s. $9\frac{12}{100}$d. and, on exportation, draws back, 23l. 13s. $10\frac{8}{100}$d. Wines imported by British for private use. Rhenish, German, or Hungary wine, the ton filled in casks, pays, on importation, 36l. $3\frac{60}{100}$d. and, on exportation, draws back 27l. 5s. $10\frac{20}{100}$d. in bottles, on importation, the ton pays 36l. 13s 6d. and, on exportation, draws back, 27l. 17s. 6d. Portugal or Madeira wine, the ton filled in casks, on importation, pays 29l. 6s. 6d. and, on exportation, draws back 20l. 18s. 6d. in bottles, on importation, 32l. 3s. 6d, and, on exportation, draws back 23l. 7s. 6d. French wine, the ton filled in casks, pays, on importation, 61l. 8s. 6d. and, on exportation, draws back 26l. 11s. $\frac{40}{100}$d. in bottles, on importation, 64l. 17s. 6d. and, on exportation, draws back 28l. 6s. 10d. Levant and all all other wines, the ton filled in casks, pays, on importation, 30l. 3s. and, on exportation, draws back 21l. 15s. in bottles, on importation, 33l. 2s. and, on exportation, draws back 24l. 6s. And besides the afore-mentioned duties, all wines imported into the Port of London, are to pay to the use of the orphans of the said city, for every ton, 4s.

Wines imported by foreigners are to pay, besides the aforesaid duties, the under-mentioned, which must be added respectively to the duties payable by British. Rhenish, German or Hungary wines, the ton filled in casks, on importation, pays 4l. 8s. $2\frac{40}{100}$d. and, on exportation, draws back 4l. 3s. $2\frac{40}{100}$d. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. French wine, the ton in casks, pays, on importation, 4l. 4s. $7\frac{20}{100}$d. and, on exportation, draws back 3l. 19s. $7\frac{20}{100}$d. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. Levant and all other wines, filled in casks, the ton pays, on importation, 4l. 1s. and, on exportation, draws back 3l. 16s. in bottles, on importation, 4l. 10s. and, on exportation, draws back 4l. 5s. And besides those duties,

duties, all wines of the growth of the Levant, imported into any port by foreigners, are to pay to the uſe of the town of Southampton, for every butt or pipe, 10s.

Wine is alſo a denomination applied in medicine and pharmacy to divers mixtures and compoſitions wherein the juice of the grape is a principal ingredient.

With regard to the medical uſes of wines, it is obſerved, that among the great variety of wines in common uſe among us, five are employed in the ſhops as menſtrua for medicinal ſimples; that is, the vinum album Hiſpanicum, or mountain wine; the vinum album gallicum, or French white wine; the Canary wine, or ſack; the rheniſh wine; and the red port. The effects of theſe liquors on the human body, are to chear the ſpirits, warm the habit, promote perſpiration, render the veſſels full and turgid, raiſe the pulſe, and quicken the circulation. The effects of the full bodied wines are much more durable than thoſe of the thinner; all ſweet wines, as Canary, abound with a glutinous, nutritious ſubſtance, whilſt the others are not nutrimental, or only accidentally ſo, by ſtrengthening the organs employed in digeſtion. Sweet wines, in general, do not paſs off freely by urine; and they heat the conſtitution more than an equal quantity of any other, though containing full as much ſpirit: red port, and moſt of the red wines, have an aſtringent quality, by which they ſtrenghen the tone of the ſtomach, and thus prove ſerviceable for reſtraining immoderate ſecretions; thoſe which are of an acid nature, as rheniſh, paſs freely by the kidneys, and gently looſen the belly. It is ſuppoſed that theſe laſt exaſperate and occaſion gouty calculous diſorders, and that new wines of every kind have this effect.

Wine-spirit, a term uſed by our diſtillers, and which may ſeem to mean the ſame thing with the phraſe of ſpirit of wine; but they are taken in very different ſenſes in the trade.

Spirit of wine is the name given to the common malt ſpirit, when reduced to an alcohol, or totally inflammable ſtate; but the phraſe wine-ſpirit is uſed to expreſs a very clean and fine ſpirit, of the ordinary proof ſtrength, and made in England from wines of foreign growth.

The way of producing it is by ſimple diſtillation, and it is never rectified any higher than common bubble proof. The ſeveral wines of different natures, yield very different proportions of ſpirit; but, in general, the ſtrongeſt yield one fourth, the weakeſt in ſpirits one eight part of proof-ſpirit; that is, they contain from a ſixteenth to an eight part of their quantity of pure alcohol.

W I R E.

Wire, wiar, wier, or wyre, a piece of metal drawn through the hole an iron into a thread of a fineneſs anſwerable to the hole it paſſed through.

Wires are frequently drawn ſo fine, as to be wrought along with other threads of ſilk, wool, flax, *&c.*

The metals moſt commonly drawn into wire, are gold, ſilver, copper, and iron.

Gold wire is made of cylindrical ingots of ſilver, covered over with a ſkin of gold, and thus drawn ſucceſſively through a vaſt number of holes, each ſmaller and ſmaller; till at laſt it is brought to a fineneſs exceeding that of a hair. That admirable ductility which makes one of the diſtinguiſhing characters of gold, is no where more conſpicuous, than in this gilt wire. A cylinder of forty eight ounces of ſilver, covered with a coat of gold, only weighing one ounce, as Dr. Halley informs us, is uſually drawn into a wire, two yards of which weigh no more than one grain; whence ninety-eight yards of the wire weigh no more then forty-nine grains, and one ſingle grain of gold covers the ninety-eight yards; ſo that the ten-thouſandth part of a grain is above one eight of an inch long. The author computing the thickneſs of the ſkin of gold, found it to be $\frac{1}{134500}$ part of an inch. Yet ſo perfectly does it cover the ſilver, that even a microſcope does not diſcover any appearance of the ſilver underneath. M. Rohault likewiſe obſerves, that a like cylinder of ſilver, covered with gold, two feet eight inches long, and two inches nine lines in circumference, is drawn into a wire 307200 feet long, *i. e.* into 115200 times its former length. Mr. Boyle relates, that eight grains of gold, covering a cylinder of ſilver, is commonly drawn into a wire 13000 feet long.

Silver-wire is the ſame with gold-wire, except that the latter is gilt, or covered with gold, and the other is not.

There are alſo counterfeit gold and ſilver-wires; the firſt made of a cylinder of copper, ſilvered over, and then covered with gold; and the ſecond of a like cylinder of copper, ſilvered over, and drawn through the iron, after the ſame manner as gold and ſilver-wire.

Braſs-wire is drawn after the ſame manner as the former. Of this there are divers ſizes, ſuited to the different kinds of works. The fineſt is uſed for the ſtrings of muſical inſtruments, as ſpinets, harpſichords, manichords, *&c.* See the article spinet, *&c.*

The

The pin-makers, likewise, use vast quantities of brass-wire, to make their pins of.

Iron-wire is drawn of various sizes, from half an inch to one tenth of an inch diameter.

The first iron that runs from the stone, when melting, being the softest and toughest, is preserved to make wire of. Iron-wire is made from small bars of iron called esleom iron, which are first drawn out to a greater length, and to about the thickness of ones little finger, at a furnace, with a hammer gently moved by water. These thinner pieces are bored round, and put into a furnace to aneal for twelve hours. A pretty strong fire is used for this operation. After this they are laid under water for three or four months, the longer the better; then they are delivered to the workmen, called rippers, who draw them into wire thro' two or three holes. After this they aneal them again for six hours, and water them a second time for about a week, and they are then delivered again to the rippers, who draw them into wire of the thickness of a large packthread. They are then anealed a third time, and then watered for a week longer, and delivered to the small wire-drawers, called over-house men.

In the mill where this work is performed, there are several barrels hooped with iron, which have two hooks on their upper sides, on each whereof hang two links, which stand across, and are fastened to the two ends of the tongs, which catch hold of the wire, and draw it through the hole. The axis on which the barrel moves does not run through the center, but is placed on one side, which is that on which the hooks are placed; and underneath their is fastened to the barrel a spoke of wood, which they call a swingle, which is drawn back a good way by the cogs in the axis of the wheel, and draws back the barrel, which falls to again by its own weight. The tongs hanging on the hooks of the barrel, are by the workmen fastened to the end of the wire, and by the force of the wheel, the hooks being pulled back, draw the wire through the holes. The plate in which the holes are, is iron on the outside, and steel on the inside; and the wire is anointed with train-oil, to make it run the easier.

Wire *of Lapland.* The inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver-wire, and is therefore called, by those who do not examine its structure or substance, Lapland-wire. It is made of the sinews of the rein-deer, which being carefully separated in the eating, are by the women, after soaking in water, and beaten, spun into a sort of thread, of admirable fineness and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads, covered with tin. The women do this business, and the way they take is to melt a piece of tin, and placing at the edge of it a horn with a hole through it, they draw these sinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a small piece of bone placed at the top of the hole, where the wire is made flat, so that we always find it rounded on all sides but one, where it is flat.

This wire they use in embroidering their cloaths as we do gold and silver; they often sell it to strangers, under the notion of its having certain magical virtues.

WITCHCRAFT.

WITCHCRAFT, a kind of sorcery, especially in women, in which it is ridiculously supposed that an old woman, by entering into a contract with the devil, is enabled, in many instances, to change the course of nature; to raise winds; perform actions that require more than human strength; and to afflict those who offend them with the sharpest pains, &c.

In the times of ignorance and superstition, many severe laws were made against witches, by which great numbers of innocent persons, distressed with poverty and age, were brought to a violent death; but these are now happily repealed.

WITENA-MOT, or WITENA-GEMOT, among our saxon ancestors, was a term which literally signified the assembly of the wise men, and was applied to the great council of the nation, of latter days called the parliament.

W O O L.

WOOL, the covering of sheep. Each fleece consists of wool of several qualities and degrees of fineness, which the dealers therein take care to separate.

The English and French usually separate each fleece into three principal sorts, viz. 1. Mother-wool, which is that of the back and neck. 2. The wool of the tails and legs. 3. That of the breast and under the belly. The wool most esteemed is the English, chiefly that about Leominster, Cotswold, and the Isle of Wight; the Spanish, principally that about Segovia; and the French, about Berry.

The fineness and plenty of our wool is owing in a great measure to the short sweet grass in many of our pastures and downs; though the advantage of our sheeps feeding on this grass all the year, without being obliged to be shut up under cover during the winter, or to secure them from wolves at other times, contributes not a little to it.

Antiently, the principal commerce of the nation consisted in wool unmanufactured; which foreigners, especially the French, Dutch, and Flemish, bought of us, insomuch, that the customs paid on wool exported in the reign of Edward III. amounted, at 50s. a pack, to 250,000 l. per annum. An immense sum in those days! But as wool is now accounted a staple commodity, the employment of an infinite number of people at home, and our most beneficial trade abroad, depending upon it, very severe laws have been made to prevent its being exported, and persons that export wool beyond the seas, are liable to a forfeiture of the ships or vessels in which it is found, with treble the value, and the persons aiding and assisting in it shall suffer three years imprisonment. It is also enacted, that no sheep shall be carried on board any ship with intent to be exported, upon forfeiture of 20s. for every sheep; that the owners knowing thereof, are to forfeit their interest therein; that if they be aliens, or natural born subjects not inhabiting this kingdom, such ships shall be wholly forfeited; that the masters and mariners knowing thereof, and assisting therein, are to forfeit all their goods and chattels, and to suffer three months imprisonment; and that the exporter, besides other penalties, shall be rendered incapable of suing for any debt, &c. As to the importation of wool, Irish wool, combed or uncombed, Spanish and Polish wool may be imported duty free.

WOOL is also used for the soft hair growing on several wild beasts, the skins of which are distinguished by the name of furrs.

These kinds of wool, on being imported, pay the following duties: bever-wool, cut and combed, 14s. $\frac{3}{4}$d. the pound: the whole of which is drawn back on exportation: but if this wool be combed in Russia, and imported from thence in British ships, it is free. Coney-wool, the pound,

$$1\frac{43\frac{5}{8}}{100}\text{d. draw back } 1\frac{29\frac{5}{8}}{100}\text{d.}$$

Estridge wool, imported in British-built ships, free; but if imported in those that are foreign built, it pays 6s. 8$\frac{43}{100}$d. the 112 pounds: draw back, 6s. $\frac{45}{100}$d. Stanes-wool, the pound $\frac{71\frac{13}{16}}{100}$d. draw back $\frac{64\frac{11}{16}}{100}$d.

WOOLEN MANUFACTORY includes the several sorts of commodities into which wool is wrought, as broad cloth, long and short kerseys, bays, serges, flannel, perpetuanas, says, stuffs, frize, pennistones, stockings, caps, rugs, &c.

W O R D.

WORD, in language, an articulate sound designed to represent some Idea.

The Port-royalists define words to be distinct articulate sounds, agreed on by mankind to convey their thoughts and sentiments by.

Word, in writing, is defined to be an assemblage of several letters forming one or more syllables, and expressing the name, quality, or manner of a thing.

Etymology and syntax being the two parts of grammar conversant about words, the first of these explains the nature and propriety of words, and the other treats of the right composition of words in discourse.

The most remarkable thing in the pronouncing of words, is the accent, or the elevation of the voice, on some particular syllable of the word, which elevation is necessarily followed by a depression of the voice.

Grammarians

Grammarians generally divide words into eight claſſes, called parts of ſpeech.

Words are again divided into primatives and derivatives, ſimple and compound, ſynonimous and equivocal.

With regard to their ſyllables, words are farther divided into monoſyllables and polyſyllables.

The grammatical figures of words which occaſion changes in the form, *&c.* thereof are proſtheſis, aphæreſis, ſyncope, epentheſis, apocope, paragoge, craſis, diæreſis, metatheſis, and anitheſis.

The uſe of words, we have obſerved, is to ſerve as ſenſible ſigns of our ideas; and the ideas they ſtand for in the mind of the perſon that ſpeaks, are their proper ſignifications.

Simple and primitive words have no natural connection with the things they ſignify, whence there is no rationale to be given of them; it is by mere arbitrary inſtitution and agreement of men, that they come to ſignify any thing. Certain words have no natural propriety or aptitude to expreſs certain thoughts more than others; were that the caſe there could have been but one language. But in derivative and compound words the caſe is ſomewhat different. In the forming of theſe, we ſee regard is had to agreement, relation, and analogy; thus moſt words that have the ſame ending, have one common and general way of denoting or ſignifying things; and thoſe compounded with the ſame prepoſitions, have a ſimilar manner of expreſſing and ſignifying ſimilar ideas, in all the learned languages where they occur.

For the perfection of language, it is not enough, Mr. Locke obſerves, that ſounds can be made ſigns of ideas, unleſs theſe can be made uſe of ſo as to comprehend ſeveral particular things; for the multiplication of words would have perplexed their uſe, had every particular thing needed a diſtinct name to be ſignified by. To remedy this inconvenience, language had a further improvement in the uſe of general terms, whereby one word was made to mark a multitude of particular exiſtences; which advantageous uſe of ſounds was obtained by the difference of the ideas they were made ſigns of, thoſe names becoming general which are made to ſtand for general ideas, and thoſe remaining particular, where the ideas they are uſed for are particular.

It is obſervable, that the words which ſtand for actions and notions, quite removed from ſenſe, are borrowed from ſenſible ideas; as to imagine, apprehend, comprehend, underſtand, adhere, conceive, inſtil, diſguſt, diſturbance, tranquility, &c. which are all taken from the operations of things ſenſible, and applied to modes of thinking. Spirit, in its original ſignification, is no more than breath; angel, a meſſenger. By which we may gueſs what kind of notions they were, and whence derived, which filled the minds of the firſt beginners of languages; and how nature, even in the naming of things unawares, ſuggeſted to men the originals of all their knowledge: whilſt to give names that might make known to others any operations they felt in themſelves, or any other ideas that came not under their ſenſes, they were forced to borrow words from the ordinary and known ideas of ſenſation.

The ends of language in our diſcourſe with others, are chiefly three; firſt, to make our thoughts or ideas known one to another. This we fail in, 1. when we uſe names without clear and diſtinct ideas in our mind. 2. When we apply received names to ideas, to which the common uſe of that language doth not apply them. 3. When we apply them unſteadily, making them ſtand now for one, and anon for another idea. Secondly, to make known our thoughts with as much eaſe and quickneſs as poſſible. This men fail in, when they have complex ideas, without having diſtinct names for them, which may happen either through the defect of a language which has none, or the fault of the man who has not yet learned them. Thirdly, to convey the knowledge of things. This cannot be done, but when our ideas agree to the reality of things. He that has names without ideas, wants meaning in his words, and ſpeaks only empty ſounds. He that has complex ideas, without names for them, wants diſpatch in his expreſſion. He that uſes his words looſely and unſteadily, will either not be minded or not underſtood. He that applies names to ideas, different from the common uſe, wants propriety in his language, and ſpeaks gibberiſh; and he that has ideas of ſubſtances diſagreeing with the real exiſtence of things, ſo far, wants the materials of true knowledge.

W O R L D.

WORLD, *mundus*, the aſſemblage of parts which compoſe the univerſe.

The duration of the world is a thing which has been greatly diſputed. Plato, after Ocellus Lucanus, held it to be eternal, and to have flowed from God as rays flow from the ſun. Ariſtotle was much of the ſame mind; he aſſerts, that the world was not generated ſo as to begin to be a world, which before was none: he lays down a pre-exiſting and eternal matter as a principle, and thence argues the world eternal. His arguments amount to this, that it is impoſſible an eternal agent, having an eternal paſſive ſubject, ſhould continue long without action. His opinion was generally followed, as ſeeming to be the fitteſt to end the diſpute among ſo many ſects about the firſt cauſe.

Epicurus, however, though he makes matter eternal, yet ſhews the world to be but a new thing formed out of a fortuitous concourſe of atoms.

Some of the modern philoſopers refute the imaginary eternity of the world by this argument, that if it be *ab eterno*, there muſt have been a generation of individuals in a continual ſucceſſion from all eternity, ſince no cauſe can be aſſigned why they ſhould not be generated, *viz.* one from another. Therefore to conſider the origin of things, and the ſeries of cauſes, we muſt go back in infinitum, *i. e.* there muſt have been an infinite number of men and other individuals already generated, which ſubverts the very notion of number. And if the cauſe which now generates has been produced by an infinite ſeries of cauſes, how ſhall an infinite ſeries be? Dr. Halley ſuggeſts a new method of finding the age of the world, from the degree of the ſaltneſs of the ocean.

W O R M S.

WORMS, in the linnæan ſyſtem of nature, a claſs of inſects of the order of the apteria, and of the claſs of the anarthra.

The diſtinguiſhing character of this claſs is, that they have the muſcles of their body affixed to a ſolid baſis. The ſeveral ſpecies of worms are very numerous; as the chætia, or the hair-worm, called alſo the guinea-worm; the aſcaris, the lumbricus, or earth-worm, and ſea-worm; the tænia, or tape-worm; the ſicyania, or gourd-worm; the iulus or gally-worm, *&c.*

WORMS, in huſbandry, are very prejudicial to corn-fields, eating up the roots of the young corn, and deſtroying great quantities of the crop. Sea-ſalt is the beſt of all things for deſtroying them. Sea-water is proper to ſprinkle on the land, where it can be had? where the ſalt-ſprings are, their water will do; and where neither are at hand, a little common or bay-ſalt does as well. Soot will deſtroy them in ſome lands, but is not to be depended upon, for it does not always ſucceed. Some farmers ſtrew on their lands a mixture of chalk and lime; and others truſt wholly to their winter fallowing to do it, if this is done in a wet ſeaſon, when they come up to the ſurface of the ground, and ſome nails with ſharp heads be driven into the bottom of the plough. If they are troubleſome in gardens, the refuſe brine of ſalted meat will ſerve the purpoſe, or ſome walnut leaves ſteeped in a ciſtern of water for a fortnight or three weeks, will give it ſuch a bitterneſs, that it will be a certain poiſon to them. A decoction of wood-aſhes, ſprinkled on the ground, will anſwer the ſame purpoſe; and any particular plant may be ſecured both from worms and ſnails by ſtrewing a mixture of lime and aſhes about its roots. It is a general caution among the farmers to ſow their corn as ſhallow as they can, where the field is very ſubject to worms.

WORMS, in medicine, a diſeaſe ariſing from ſome of theſe reptiles being ingendered in the body, particularly in the ſtomach and inteſtines.

When children begin to uſe crude aliments, ſummer fruits, fleſh, cheeſe, and other things of the like kind, they are frequently troubled with the worms, occaſioned by the eggs of inſects, which either float in the air, or live on the earth, and which being caſually ſwallowed, are not digeſtible by their tender ſtomachs. For theſe, the inteſtinal or gaſtric pituit, afford a neſt in which they

they reside, are nourished, breed, and increase in bulk. Hence they are not so common in adults, except in the dull and sluggish, and in the leucophlegmatic.

There are three species of worms, most frequent in the human body; the lumbrici, the ascarides, and the tænia. The lumbrici are found in the ilion, and are thus called, because they are generally broad and long, and roll themselves up in a strange manner. The ascarides have their seat chiefly in the gross intestines, and are more plentiful in the rectum; they are round and small, and are thrown out in large quantities. The broad worm called tænia is like a swathe, commonly two ells long, but sometimes much longer, and divided through the whole length with cross joints or knots. This is said to be always single; and lies variously convoluted, being sometimes as long as all the guts, and sometimes vastly exceeding even that length. Heister observes, that there are other kinds of insects, or worms, generated in an human body, which physicians have not placed in any particular class, but have looked upon them as uncommon productions.

Worms by their irritation, create nauseas, vomitings, loosenesses, faintings; a slender, deficient, intermitting pulse; itching of the nose, and epileptic fits. By the consumption of the chyle, they produce hunger, paleness, weakness, and costiveness; whence arises a tumour of the abdomen, eructations, and rumbling of the intestines.

A child may be known to have the worms from his age, cold temperament, paleness of the countenance, livid eyelids, hollow eyes, itching of the nose, voracity, startings, and grinding the teeth in sleep; and more especially by a singular stinking breath; but when they are voided by the mouth, or anus, there remains no manner of doubt.

The cure is to be performed chiefly by destroying their nests, which is to be attempted by alkalious salts, gums which purge phlegm, mercurials, antimonials, and bitter aromatics.

Y.

Y, or y, the twenty-third letter of our alphabet: its sound is formed by expressing the breath with a sudden expansion of the lips from that configuration by which we express the vowel *u*. It is one of the ambigenial letters, being a consonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no consonant. At the end of words it is a vowel, and is substituted for the sound of *i*, as in *try*, *descry*, &c. In the middle of words it is not used so frequently as *i* is, unless in words derived from the Greek, as in *chyle*, *empyreal*, &c. though it is admitted into the middle of some pure English words, as in *dying*, *flying*, &c. The Romans had no capital of this letter, but used the small one in the middle and last syllables of words, as in *coryambus*, *onyx*, *martyr*. Y is also a numeral, signifying 150, or according to Baronius, 159; and with a dash a-top as $\bar{Y}$, it signified 150,000.

Y A R N.

YARN, wool or flax, spun into thread, of which they weave cloth, &c.

Yarn is ordered after the following manner: after it has been spun upon spindles, spools, or the like, they reel it upon reels, which are hardly two feet in length, and have but two contrary crossbars, being the best, and the least liable to ravelling. In reeling of fine yarn, the better to keep it from ravelling, you must, as it is reeled, with a tye-band of big twist, divide the slipping or skain into several leys, allowing to every ley eighty threads, and twenty leys to every slipping, if the yarn is very fine; otherwise less of both kinds. The yarn being spun, reeled, and in the slippings, the next thing is to scour it. In order to fetch out the spots, it should be laid in lukewarm water for three or four days, each day shifting it once, wringing it out, and laying it in another water of the same nature: then carry it to a well or brook, and rinse it till nothing comes from it but pure clean water: that done, take a bucking tub, and cover the bottom thereof with very fine ashen ashes; and then having opened and spread the slippings,

pings, lay them on thoſe aſhes, and put more aſhes above, and lay in more ſlippings, covering them with aſhes as before; and thus lay one upon another, till all the yarn be put in: afterwards cover the uppermoſt yarn with a bucking cloth, and, in proportion to the bigneſs of the tub, lay therein a peck or two more of aſhes: this done, pour upon the uppermoſt cloth a great deal of warm water, till the tub can receive no more, and let it ſtand ſo all night. Next morning you are to ſet a kettle of clean water on the fire; and when it is warm, pull out the ſpiggot of the bucking tub, to let the water run out of it, into another clean veſſel; as the bucking tub waſtes, fill it up again with the warm water on the fire: and as the water on the fire waſtes, ſo likewiſe fill that up with the lye that comes from the bucking-tub; ever obſerving to make the lye hotter and hotter, till it boils: then you muſt, as before, ply it with the boiling lye at leaſt four hours together, which is called the driving of a buck of yarn.

All this being done, for the whitning of it, you muſt take off the bucking cloth; then putting the yarn with the lye-aſhes into large tubs, with your hands labour the yarn, aſhes, and lye pretty well together; afterwards carry it to a well, or river, and rinſe it clean; then hang it upon poles in the air all day, and in the evening take the ſlippings down, and lay them in water all night; the next day hang them up again, and throw water upon them as they dry, obſerving to turn that ſide outmoſt which whitens ſloweſt. After having done this for a week together, put all the yarn again into a bucking-tub, without aſhes, covering it as before with a bucking-cloth; lay thereon good ſtore of freſh aſhes, and drive that buck, as before, with very ſtrong boiling lye, for half a day, or more; then take it out, and rinſe it, hanging it up, as before, in the day-time, to dry, and laying it in water at night, another week: laſtly, waſh it over in fair water, and ſo dry it up. Your yarn being thus ſcoured and whitened, wind it up into round balls of a moderate ſize. See REEL.

Cable yarn pays, on importation, for the hundred weight 7 s. $3\frac{5}{100}$d. there is no drawback on exportation. Camel or mohair-yarn pays on importation for the hundred weight $5\frac{77\frac{1}{2}}{100}$d. and draws back $5\frac{6\frac{1}{4}}{100}$d. Cotton-yarn, not of the Eaſt-indies, on importation, pays per pound $2\frac{87\frac{1}{4}}{100}$d. and on exportation draws back $2\frac{58\frac{3}{4}}{100}$d. Cotton-yarn of the Eaſt-indies, on importation, pays per pound $4\frac{56}{100}$d. and on exportation draws back $4\frac{27\frac{1}{2}}{100}$d. Grogram-yarn, on importation, pays per pound $6\frac{92}{100}$d. and on exportation draws back $6\frac{7\frac{1}{2}}{100}$d. Iriſh yarn, in packs containing four hundred weight, at ſix ſcore pound to the hundred, if by certificate, is free from any duty on importation. Sail-yarn, on importation, pays per pound $1\frac{47\frac{5}{8}}{100}$d. and on exportation draws back $1\frac{29\frac{3}{8}}{100}$d. For every pound weight of French, Dutch, Muſcovia or ſpruce, and all other raw linnen-yarn, there is a duty of 1 d. on importation; and no draw-back on exportation. Wick-yarn on importation, pays, the dozen pound, 2 s. $1\frac{85\frac{1}{4}}{100}$d. and on exportation draws back 1 s. $11\frac{28\frac{3}{4}}{100}$d. Woollen or bay-yarn, on importation, pays the hundred 12 s. 10 d. and on exportation draws back 11 s. 3 d. Worſted-yarn, being two or more threads twiſted or thrown, on importation, pays the pound $2\frac{87\frac{1}{4}}{100}$d. and on exportation draws back $2\frac{58\frac{3}{4}}{100}$d.

Y A W S.

YAWS, in the ſea-language. A ſhip is ſaid to make yaws, when ſhe does not ſteer ſteady, but goes in and out when there is a ſtiff gale.

YAWS, a diſtemper endemial to Guinea and the hotter climates in Africa. It makes its firſt appearance in little ſpots on the cuticle, not bigger than a pin's point, which increaſes daily, and become protuberant, like pimples. Soon after, the cuticle frets off, and then, inſtead of pus or ichor, there appears white ſloughs or ſordes, under which is a ſmall red fungus. Theſe increaſe gradually, ſome fome to the fize of a fmall wood ftrawberry, others to that of a rafpberry, others again exceed the largeft mulberry, which in fhape they very much refemble. In the mean time the black hair growing in the yaws turns to a tranfparent white. It is not eafy to determine the exact time which the yaws take in going through their different ftages. Lufty well fed negroes have had feveral yaws as big as a mulberry in a month's time, whereas the low in flefh, with a fcanty allowance, have paffed three months without their growing to the fize of a ftrawberry. They appear in all parts of the body, but are moft plentiful, and of the largeft fize, about the groin, privy parts, anus, armpits, and face: they are largeft when feweft in number, and *vice verfa*. They are not painful, unlefs handled roughly, nor caufe a lofs of appetite. They continue long without any fenfible alteration; and fome are of opinion, that as foon as the funguſes become dry, the infection is exhaufted.

The yaws are not dangerous, if the cure is fkillfully managed at a proper time. But if the patient has been once falivated, or has taken any quantity of mercury, and his fkin once cleared thereby, the cure will be very difficult, if not impracticable. The following form of medicine is recommended as a cure: take of flowers of fulphur, one fcruple; of camphor diffolved in fpirits of wine, five grains; of theriaca andromachi, one drachm; and as much of fyrup of faffron as will make a bolus. Let the bolus be taken at going to reft, which muft be repeated for a fortnight or three weeks, till the yaws come to the height. Then throw the patient into a gentle falivation, with calomel given in fmall dofes, without farther preparation. After falivation, fweat the patient twice or thrice, on a frame or chair, with fpirit of wine, and give the following electuary, *viz.* of æthiops mineral, one once and a half, of gum guaiacum, half an ounce; theriaca andromachi, and conferve of red rofes, of each one ounce; oil of faffafras, twenty drops; and as much of fyrup of faffron as is requifite for an electuary. Of this let two drachms be taken in the morning and at night. He may likewife drink the decoction of guaiacum and faffafras, fermented with molaffes, for his conftant drink, while the electuary is taking, and a week or a fortnight after the electuary is fpent. Sometimes there remains one large yaw, high and knobed, red and moift; this is called the mafter-yaw. This muft be confumed an eighth or a tenth part of an inch below the fkin, with corrofive red mercury, and burnt alum, of each an equal quantity, and digefted with one ounce of yellow bafilicon, and one drachm of red corrofive mercury, and cicatrized with lint preffed out of fpirit of wine, and with the vitriol-ftone.

Z.

Z, or z, the twenty-fourth and laft letter, and the nineteenth confonant of our alphabet; the found of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a fhutting and opening of the teeth at the fame time. This letter has been reputed a double confonant, having the found *d s*; but fome think with very little reafon; and, as if we thought otherwife, we often double it, as in *puzzle*, *muzzle*, &c. Among the antients, Z was a numeral letter, fignifying two thoufand, and with a dafh added a-top, $\overline{Z}$ fignified two thoufand times two thoufand, or four millions.

In abreviations this letter formerly ftood as a mark for feveral forts of weights; fometimes it fignified an ounce and a half, and very frequently it ftood for half an ounce; fometimes for the eighth part of an ounce, or a drachm troy weight; and it has in earlieft times been ufed to exprefs the third part of an ounce, or eight fcruples. ZZ were ufed by fome of the antient phyficians to exprefs myrrh, and at prefent they are often ufed to fignify zinziber, or ginger.

ZOOLOGY.

ZOOLOGY, ζωολογια, the fcience of animals. Artedi obferves, that this makes one of the three kingdoms, as they are called, of natural hiftory; the vegetable and the mineral being the two others: in thefe, however, there is this difference made by writers, that while vegitables and minerals are treated of together, as all of a piece

piece in each, the subjects of zoology are divided; and it is made to compose, as it were, several kingdoms. Whoever is to write on plants and minerals, calls his work a treatise of botany, or mineralogy; and we have no words to express any subdivision of them into kingdoms: but, in zoology, we treat as different subjects, the different parts of it; and the history of birds is seperated by some from the rest under the name of ornithology; that of quadrupeds under the name of tetrapodology; and we have for the rest, the words entomology, amphibiology, and the like, expressing these things which are properly but the parts of zoology, as so many distinct and seperate studies.

The same author observes, that this may easily be amended, by our considering the animal world as we do the vegetable and mineral, and dividing it, as we do the others, into its proper families; it will then be found that these are no better distinctions than those of the families of these things, and that the authors may as well set up seperate studies under the names of bulbology, umbelliferology, and the like, as those.

A natural division of the subjects of zoology, on this principle, will afford six several families of its subjects. 1. The hairy quadrupeds. 2. The birds. 3. The amphibious animals, such as serpents, lizards, frogs, and tortoises. 4. The fishes. 5. The insects.—And sixthly, those lowest order of animated beings the zoophytes.

ZOOTOMY.

ZOOTOMY, is the art or act of dissecting living creatures.

Zootomy amounts to the same with *comparitive anatomy*, which is that branch of anatomy which considers the same parts of different animals, with relation to the particular structure and formation, which is best suited to the manner of living, and to the necessity of every creature.

Thus in the *comparative anatomy* of stomachs, for instance, it is remarkable that those creatures which have the opportunities of frequent feeding, have their stomach very small, in comparison to some creatures of prey, which probably may be under a necessity of fasting a long time; and therefore have stomachs large enough to hold food sufficient for such a time.

Ruminating animals have four stomachs; yet it is observed that some of these, which have four in *Europe*, have only two in *Africa*, probably by reason the herbs in *Africa* are more nourishing.

Ruminants, Mr. *Ray* observes, are all quadrupedal, hairy, and viviparous; some with hollow and perpetual horns, others with deciduous ones.

The horned ruminants have all four stomachs, appropriated to the office, *viz.* 1. The *rumen*, *venter magnus*, or what is called in *English* the *paunch*, or inward, which receives the meat slightly chewed, retains it awhile, and then delivers it back again into the mouth, which is called in *English* the *cud*, to be re-chewed.—2. The *reticulum*, called in *English* the *honey-comb*, from its internal coat being divided into cells, like honey-combs.—3. What is commonly called *omasus*, and Mr. *Ray*, *echinus*; this being difficult to clear, is commonly thrown away, and called the manifold.—4. That which *Gaza* calls *abamasus*, the *English* call the *maw*.

The rumen or paunch is much the largest of all the stomachs; as being to contain both the drink, and the whole crude mass of aliment, which there lie and macerate together; to be thence remitted to the mouth, to be rechewed and comminuted, in order to their further digestion in the other ventricles.

In the *rumen*, or first ventricle of camels, are found divers sacculi, which contain a considerable quantity of water; an admirable contrivance for the necessities of that animal, which living in dry countries, and feeding on dry hard food, would be in danger of perishing, but for those reservoirs of water.

Burnet, in his *Thesaur. Med.* gives several instances of men that ruminated, from *falmuth*, *rhodrics*, &c.—Dr. *Slare*, in the *Philosophical Transactions*, gives us a fresher instance, in an *Englishman* living at *Bristol.* His account as it is curious, and may let us see a little how it fares with ruminating animals, we shall here add.

'He begins to chew his meat over again within 'a quarter of an hour after meals, if he drinks 'with it; if not, somewhat later. His chewing 'after a full meal lasts about an hour and a half: 'and if he goes to bed presently after meals, he 'cannot sleep till the usual time of chewing be 'over. The victuals upon the return, taste some'what more pleasantly than at first, bread, meat, 'cheese

'cheeſe, and drink, return much of ſuch colours 'as they would be of, were they mixed together in 'a mortar. Liquids, as ſpoon-meat, return to 'his mouth all one as dry and ſolid food. The vic-'tuals ſeem to him to lie heavy till they have paſſed 'the ſecond chewing; after that they paſs clean 'away. If he eats variety of things, that which paſſes 'down firſt comes up again firſt. If the ruminating 'faculty chance to leave him, it ſignifies ſickneſs; 'and it is never well with him till it return. He 'is about 20 years of age, and was always thus 'ſince he can remember. His father does the like 'ſometimes, but in ſmall quantities.'

Birds that live ordinarily on ſeeds with a tough rind, have a kind of ſtomach called the *crap* or *gizzard*, conſiſting of four large muſcles without-ſide, and a hard callous membrane within.---Such as live on fleſh, as eagles, vultures, *&c.* have only one.

INDEX,

INDEX.

VOL. I.

A.

I N D E X.

I N D E X.

V O L. II.

HIE-

I N D E X.

Affection

I N D E X.

Op-

I N D E X.

DIREC-

DIRECTIONS to the Binder for placing the CUTS.

VOL. I.

VOL. II.