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Krefeldorf, 11. 3. 20

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5/1904. 1904.



*Mechanick Exercises :*  
OR THE  
DOCTRINE  
OF  
HANDY-WORKS.

Applied to the Arts of

{ Smithing  
Joinery  
Carpentry  
Turning  
Wicklavery.

To which is added

*Mechanick Djalling:* Shewing how to draw a true Sun-Dyal on any given Plane, however Situated ; only with the help of a straight Ruler and a pair of *Compasses*, and without any *Aritmetical Calculation*.

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The Third Edition. £, 249.

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By JOSEPH MOXON, Fellow of the Royal Society, and Hydrographer to the late King Charles.

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L O N D O N :

Printed for Dan. Midwinter and Tho. Leigh, at the Rose and Crown in St. Paul's-Church-Yard. 1703.

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# PREFACE.

**I** See no more Reason, why the Sordidness of some Workmen, should be the cause of contempt upon Manual Operations, than that the excellent Invention of a Mill should be dispis'd, because a blind Horse draws in it. And tho' the Mechanicks be, by some, accounted Ignoble and Scandalous? yet it is very well known, that many Gentlemen in this Nation, of good Rank and high Quality, are conversant in Handy-Works: And other Nations exceed us in numbers of such. How pleasant and healthey this their Diversi-  
sion is, their Minds and Bodies find; and how Harmless and Honest, all sober men may judge?

That Geometry, Astronomey, Perspective, Musick, Navigation, Archi-  
tecture, &c. are excellent Sciences, all that know but their very Names will confess: Yet to what purpose would Geometry serve, were it not to contrive Rules for Handy-Works? Or how could Astronomey be known to any perfection, but by Instruments made by Hand?

## P R E F A C E.

What Perspective should we have to delight our Sight ? What Musick to ravish our Ears ? What Navigation to Guard and Enrich our Country ? Or what Architecture to defend us from the Inconveniences of different Weather, without Manual Operations ? Or how waste and useless would many of the Productions of this and other Counties be, were it not for Manufactures.

To dive into the Original of the Mechanicks is impossible, therefore I shall not offer at it ; only I shall say, it is Rational to think, that the Mechanicks began with Man, he being the only Creature that Nature has imposed most Necessity upon to use it, endow'd with greatest Reason to contrive it, and adapted with properest Members (as Instruments) to perform it.

Nor is it easie to find by any Authority, what part of the Mechanicks was first Practised by Man ; therefore I shall wave that too, and only consider, that if we our selves were the first Men, what Branch of the Mechanicks we should first Need, and have recourse to.

I have considered, and Answer, That without the Invention of Smithing primarily, most other Mechanick Invention would

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would be at a stand : The Instruments, or Tools, that are used in them, being either made of Iron, or some other matter, form'd by the help of Iron. But pray take Notice, that by Iron, I also mean Steel, it being originally Iron.

Nor would I have you understand, that when I name the Mechanicks, I mean that rough and Barbarous sort of working which is used by the Natives of America, and some other such Places ; for, though they did indeed make Houses, Canoes, Earthen Pots, Bows, Arrows, &c. without the help of Iron, because they had then none amongst them : Yet since Iron is now known to them, they leave of their old way of working without it, and betake themselves to the use of it. Nor are, at this day, (though now they have in part the use of Iron) their Machines made by good and ready Rules of Art ; for they know neither of Rule, Square, or Compass ; and what they do, is done by Tedious Working, and he that has the best Eye at Guessing, works best upon the Straight, Square or Circle, &c.

The Lord Bacon, in his Natural History, reckons that Philosophy would be improv'd,

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*improv'd, by having the Secrets of all Trades  
lye open; not only because much Experi-  
mental Philosophy, is Coucht amongst them;  
but also that the Trades themselves might,  
by a Philosopher, be improv'd. Besides,  
I find, that one Trade may borrow many  
Eminent Helps in Work of another Trade.*

*Hitherto I cannot learn that any hath under-  
taken this Task, though I could have wisht it  
had been performed by an abler hand then mine;  
yet, since it is not, I have ventured upon it.*

*I thought to have given these Exer-  
cises, the Title of The Doctrine of  
Handy-Crafts; but when I better con-  
sidered the true meaning of the Word  
Handy-Crafts, I found the Doctrine  
would not bear it; because Hand-Craft  
signifies Cunning, or Sleight, or Craft  
of the Hand, which cannot be taught by  
Words, but is only gained by Practise and  
Exercise; therefore I shall not undertake,  
that with the bare reading of these Exer-  
cises, any shall be able to perform these  
Handy-Works; but I may safely tell  
you, that these are the Rules that e-  
very one that will endeavour to perform  
them*

## P R E F A C E.

them must follow; and that by the true observing them, he may, according to his stock of Ingenuity and Diligence, sooner or later, inure his hand to the Cunning or Craft of working like a Handy-Craft, and consequently be able to perform them in time.

For the Reason aforesaid I intend to begin with Smithing, which comprehends not only the Black-Smith's Trade, but takes in all Trades which use either Forge or File, from the Anchor-Smith, to the Watch-Maker; they all working by the same Rules, tho' not with equal exactness, and all using the same Tools, tho' of several Sizes from those the common Black-Smith uses, and that according to the various purposes they are applied to: And in order to it, I shall first shew you how to set up a Forge, and what Tools you must use in the Black-Smith's work; then the Rules, and several Circumstances of Forging, till your Work come to the File: Then of the several Sorts of Iron that are commonly used; and what sort is fitteſt for each purpose. Afterwards of Filing in general, and the Rules to be observed in it, in the making of Jacks,

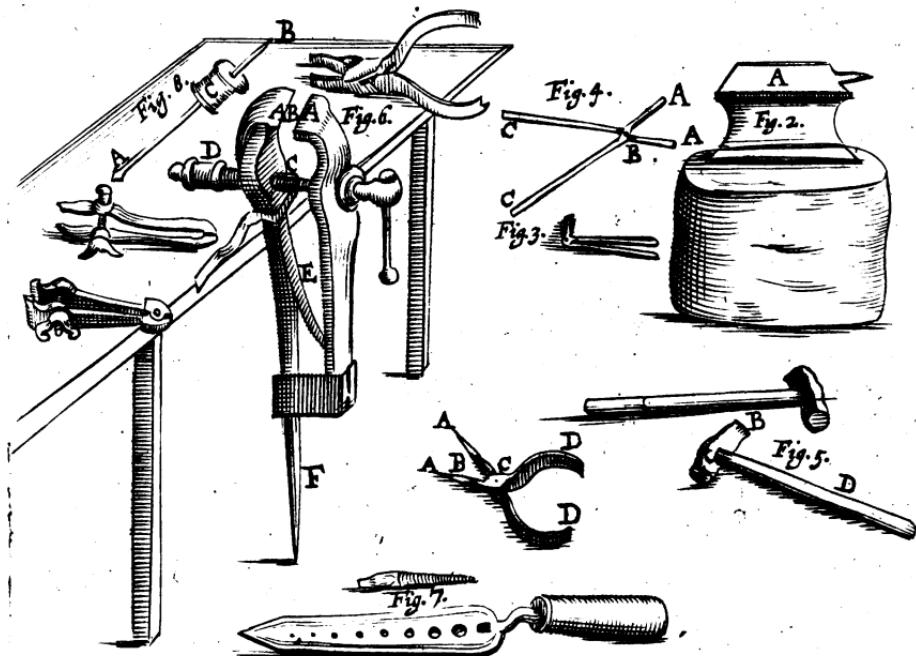
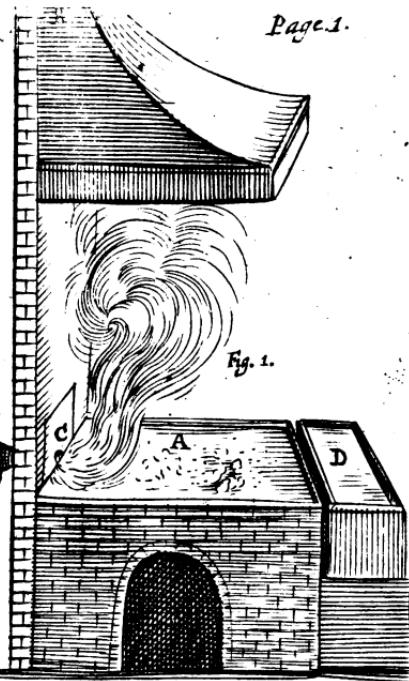
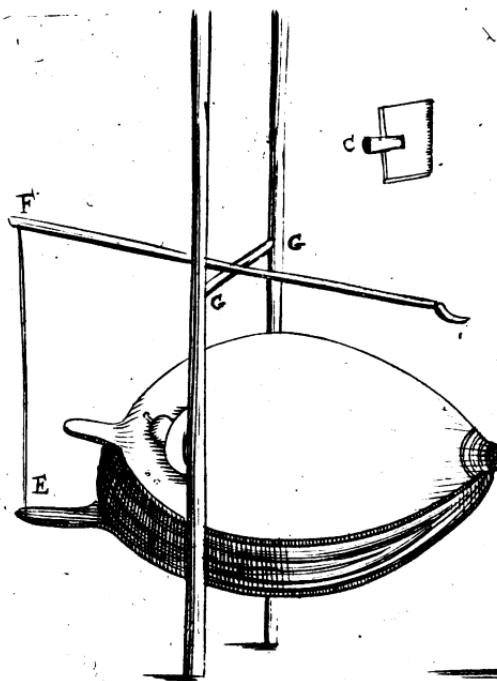
## P R E F A C E.

Jacks, Hinges, Screws, Clocks, Watches, &c. In which Examples, you will find all other Sorts of Forging or Filing work whatsoever comprehended. And lastly, as a close to Smithing, I shall Exercise upon Steel, and its several Sorts, and how to Order and Temper it for its several Uses; and what Sort is fittest for each particular purpose; as which is fittest for Edge-Tools, which for Springs, which for Punches, &c.

Some perhaps would have thought it more Proper, to have introduced these Exercises with a more Curious, and less Vulgar Art, than that of Smithing; but I am not of their Opinion; for Smithing is in all parts, as curious a Handy-Craft, as any is: Besides, it is a great Introduction to most other Handy-Works, as Joinery, Turning, &c. they (with the Smith) working upon the Straight, Square, or Circle, though with different Tools, upon different Matter; and they all having dependance upon the Smith's Trade, and not the Smith upon them.

Joseph Moxon,





## MECHANICK EXERCISES:

OR,

The Doctrine of *Handy-Works*.

## Of SMITHING in General.

*Definition.*

**S**MITHING is an Art-Manual, by which an irregular Lump (or several Lumps) of Iron, is wrought into an intended Shape.

This Definition, needs no Explanations; therefore I shall proceed to give you an Account of the Tools a Smith uses; not but that (they being so common) I suppose you do already know them; but partly because they may require some precaution in setting them up fittest to your use; and partly because it behoves you to know the Names, Smiths call the several parts of them by; that when I name them in Smith's Language (as I shall oft have occasion to do in these Exercises) you may the easier understand them, as you read them.

*Of setting up a Smith's Forge.*

**T**HE Hearth, or Fire-place of the *Forge* marked A. (in Plate 1.) is to be built up from your floor with Brick about two foot and an half, or sometimes two foot nine Inches high, according to the purpose you design your *Forge* for; for if your *Forge* be intended for heavy work, your *Hearth* must lie lower than it need be for light work;

A

work, for easiness of management, and so broad as you think convenient: It may be built with hollow Arches underneath, to set several things out of the way. The Back of the *Forge* is built upright to the top of the Ceiling, and inclosed over the Fire-place with a *Hovel*, which ends in a *Chimney* to carry away the Smoak, as B. In the back of the *Forge* against the Fire-place, is fixed a thick Iron Plate, and a taper Pipe in it about five Inches long, called a *Tewel*, or (as some call it) a *Tewel-Iron* marked \*, which Pipe comes through the Back of the *Forge*, as at C. Into this taper Pipe or *Tewel* is placed the Nose, or Pipe of the *Bellows*. The Office of this *Tewel*, is only to preserve the Pipe of the Bellows, and the back of the *Forge* about the Fire-place from burning. Right against the Back is placed at about twenty Inches, or two foot distance, the *Trough*, and reaches commonly through the whole breadth of the *Forge*, and is as broad and deep as you think good, as at D. The *Bellows* is placed behind the Back of the *Forge*, and hath as aforesaid, its Pipe fitted into the Pipe of the *Tewel*, and hath one of its Boards fixed so that it move not upwards or downwards. At the Ear of the upper Bellows board is fastened a *Rope*, or sometimes a *Thong* of Leather, or an Iron *Chain* or *Rod*, as E; which reaches up to the *Rock*, and is fastened there to the farther end of the Handle, as at F. This *Handle* is fastened across a *Rock-staff*, which moves between two Cheeks upon the *Center-pins*, in two Sockets, as at G. So that by drawing down this Handle, the moving Board of the *Bellows* rises, and by a considerable weight set on the top of its upper Board sinks down again, and by this Agitation performs the Office of a pair of *Bellows*.

Of

*Of the Anvil.*

THE shape of a Black Smith's *Anvil* I have inserted in this Figure, though it is sometimes made with a *Pike*, or *Bickern*, or *Beak-iron*, at one end of it, whose use I shall shew you when I come to round hollow work. Its *Face* must be very flat and smooth, without Flaws, and so hard that a *File* will not touch it (as Smiths say, when a File will not cut, or race it.) The upper Plain A. is called the *Face*; it is commonly set upon a wooden *Block*, that it may stand very steady, and solid, and about two foot high from the floor, or sometimes higher, according to the stature of the Person that is to work at it.

*Of the Tongs.*

There are two sorts of *Tongs* used by Smiths; the one the *Straight-nosed Tongs*, used when the work is short, and somewhat flat, and generally for all Plate Iron. The other *Crooked-nos'd Tongs*, to be used for the forging small Bars, or such thicker work, as will be held within the Returns of their *Chaps*. The *Chaps* are placed near the Joint, because, that considering the length of the *Handles*, they hold the Iron faster than they would do, were they placed farther from the Joint, as in the Fig. 3. 4. A the *Chaps*, B the *Joint*, C the *Handles*.

*Of the Hammer, and the Sledge.*

There are several sorts of *Hammers* used by Black-Smiths; as first the *Hand-hammer*, which is sometimes bigger, or less, according to the Strength of the Work-man; but it is a *Hammer* of such weight, that it may be wielded, or governed, with one hand at the *Anvil*. Secondly, the *Up-hand Sledge*, used by under-Workmen, when the Work is not of the largest, yet requires

help to batter, or *draw it out*; they use it with both their hands before them, and seldom lift their Hammer higher than their head. Thirdly, the *About Sledge* is the biggest Hammer of all, and is also used by under-Workmen, for the battering, or *drawing out* of the largest Work; and then they hold the farther end of the Handle in both their Hands, and swinging the Sledge above their Heads, they at Arms end let fall as heavy a Blow as they can upon the Work. There is also another Hammer used by them, which they call a *Rivetting-hammer*. This is the smallest Hammer of all, and very rarely used at the Forge, unless your Work prove very small; but upon cold Iron it is used for rivetting, or setting straight, or crooking small work. In Fig. 5. A the Face, B the Pen, C the Eye, D the Handle.

#### Of the Vice.

THE Vice must be set up very firmly that it shake not, and stand upright with its Chaps, parallel or range with your Work-bench; because square filing, is a great piece of good Workmanship in a Smith; and should the Vice not stand upright, and range with the Work-bench, the Chaps pinching upon two square sides, would make the top side of your work either lean towards you, or from you; and consequently you filing (as a good Workman ought to do) upon the flat, or Horizontal Plain of your work, would take off more of that Angle, or Edge, which rises higher than the Plain, and less off that Edge, that lies lower than the Plain; so that one Angle being higher, or lower, than the other, your work instead of being filed Square, would be filed Square-wise, when you shall have filed all its flat sides, and that more or less, according to the leaning of the Chaps of your Vice. AA the Face, hath its two

two ends in a straight Line with the middle of its Face, or *Plain*. B the *Chaps* must be cut with a *Bastard Cut*, and very well tempered; C the *Screw Pin*, cut with a square strong *Worm*. D the *Nut*, or *Screw Box*, hath also a square *Worm*, and is brazed into the round *Box*. E the *Spring* must be made of good Steel, and very well temper'd: Where note that the wider the two ends of the *Spring* stand asunder, the wider it throws the *Chaps* of the *Vice* open. F the *Foot* must be straight, and therefore will be the stronger to bear good heavy blows upon the work screwed in the *Chaps* of the *Vice*, that it neither bow, or tremble.

#### *Of the Hand-Vice.*

**O**F the *Hand-Vice* are two Sorts, one is called the *Broad Chapt Hand-Vice*, the other the *Square Nos'd Hand-Vice*. The Office of the *Hand-Vice*, is to hold small work in, that may require often turning about; it is held in the left hand, and each part of your work turned upwards successively, that you have occasion to file with your right. The *Square-nos'd Hand-Vice* is seldom used, but for filing small Globulous Work, as the Heads of Pins that round off towards the Edges, &c. And that because the *Chaps* do not stand shouldering in the way, but that the flat of the *File* may the better come at the Edges. Their *Chaps* must be cut as the *Vice* aforesaid, and well tempered.

#### *Of the Plyers.*

**P**LYERS are of two Sorts, *Flat Nos'd*, and *Round Nos'd*. Their Office is to hold, and fasten upon all small work, and to fit it in its place. The *Round Nos'd Plyers* are used for turning, or bowing Wyer, or small Plate, into a circular Form. The *Chaps* of the *Flat Nos'd Plyers*, must

also be cut and temper'd, as the *Chaps* of the *Vice*. A the *Nose*, B the *Chaps*, C the *Joint*, DD the *Handles*.

*Of the Drill, and Drill-Bow.*

**D**rills are used for the making such Holes as *Punches* will not conveniently serve for; as a piece of work that hath already its Shape, and must have an hole, or more, made in it. Here the force of a *Punch*, will set your work out of order and shape, because it will both batter the Surface of the Iron, and stretch its Sides out: The shank of a Key also, or some such long Hole, the *Punch* cannot strike, because the Shank is not forged with substance sufficient; but the *Drill*, tho' your work be filed and polish'd, never batters or stretches it, but cuts a true round Hole, just in the point you first place it. You must have several Sizes of *Drills*, according as your work may require. The shape in Fig. 8. is enough to shew the Fashion of it; but it must be made of good Steel, and well temper'd. A the *Point*, AB the *Shank*, C the *Drill-barrel*: Where note, that the bigger the *Drill-barrel* is, the easier it runs about, but less swift.

And as you must be provided with several *Drills*, so you may sometimes require more than one *Drill-bow*, or at least, several *Drill-strings*; the strongest Strings for the largest *Drills*, and the smallest Strings for the smaleſt *Drills*: But you must remember, that whether you use a small or strong *String*, you keep your *Drill-Bow* straining your *String* pretty stiff, or else your *String* will not carry your *Barrel* briskly about. But your *String* and *Bow*, must both be accommodated to the Size of your *Drill*; and if both, or either, be too strong, they will break, or bend your *Drill*; or if too weak, they will not carry about the *Barrel*, as aforesaid. The

The *Drill-Plate*, or *Breast-Plate*, is only a piece of flat Iron, fixt upon a flat Board, which Iron hath an hole punched a little way into it, to set the blunt end of the *Shank* of the *Drill* in, when you drill a hole: Workmen instead of it, many times use the *Hammer*, into which they prick a hole a little way on the side of it, and so set the *Hammer* against their Breast.

*Of the Screw-Plate, and its Taps.*

THE *Screw-Plate* is a Plate of Steel well temper'd, with several holes in it, each less than other, and in those *Holes* are *Threds* grooved inwards; into which *Grooves*, fit the respective *Taps* that belong to them. The *Taps* that belong to them, are commonly made tapering towards the Point, as Fig. 7. shews. But these tapering *Taps*, will not serve for some sorts of works, as I shall shew in its proper place.

These are the most Essential Tools used in the Black-Smith's Trade; but some accidental work, may require some accidental Tools, which, as they may fall in, I shall give you an account of in convenient place.

*Of Forging in general.*

I Think it needless to tell you how to make your Fire, or blow it, because they are both but Labourers work; nor how little, or big, it need to be, for your own reason will, by the Size of your work, teach you that; only let me tell you the Phrase Smiths use for [make the Fire] is, *Blow up the Fire*, or sometimes, *Blow up the Coals*.

When it is burning with the Iron in it, you must, with the *Slice*, clap the Coals upon the out-side close together, to keep the heat in the body of the Fire; and as oft as you find the Fire begin to break out, clap them close again, and

with the *Washer* dipt in Water, wet the out-side of the Fire to damp the out-side, as well to save Coals, as to strike the force of the Fire in-to the in-side, that your work may heat the sooner. But you ought oft to draw your work a little way out of the Fire, to see how it *takes its Heat*, and quickly thrust it in again, if it be not hot enough : For each purpose your work is de-signed to, ought to have a proper *Heat* suitable to that pur-pole, as I shall shew you in the several *Heats* of Iron : For if it be too cold, it will not *feel the weight of the Hammer* (as Smiths say, when it will not batter under the *Hammer*) and if it be too hot, it will *Red-scar*, that is, break, or crack under the *Hammer*, while it is working between hot and cold.

*Of the several Heats Smiths take of their Iron.*

**T**HERE are several degrees of *Heats* Smiths take of their Iron, each according to the purpose of their work. As first, a *Blood-red Heat*. Secondly, a *White Flame Heat*. Thirdly, a *Spark-ling, or Welding Heat*.

The *Blood-red Heat* is used when Iron hath already its form and size, as sometimes square Bars, and Iron Plates, &c. have, but may want a little Hammering to smooth it. Use then the Face of your *Hand-hammer*, and with light flat Blows, hammer down the irregular Risings into the Body of your Iron, till it be smooth enough for the File. And note, that it behoves a good Workman, to hammer his Work as true as he can; for one quarter of an hour spent at the *Forge*, may save him an hours work at the *Vice*.

The *Flame, or White Heat*, is used when your Iron hath not its Form or Size, but must be for-ged into both; and then you must take a piece of Iron thick enough, and with the *Pen* of your *Ham-*

*Hammer*, (or sometimes, according to the size of your work, use two or three pair of hands with *Sledges* to) batter it out ; or, as Workmen call it, to *draw it out*, till it comes to its breadth, and pretty near its shape ; and so by several *Heats*, if your work require them, frame it into Form and Size ; then with the Face of your *Hand-hammer*, smooth your work from the Dents the *Pen* made, as you did with a *Blood-red Heat*.

A *Sparkling*, or *Welding-heat*, is only used when you *double up* your Iron (as Smiths call it) to make it thick enough for your purpose, and so *weld*, or work in the *doubling* into one another, and make it become one entire lump ; or it is used when you join several Bars of Iron together to make them thick enough for your purpose, and work them into one Bar ; or else it is used when you are to join, or *weld* two pieces of Iron together end to end, to make them long enough ; but, in this case, you must be very quick at the *Forge* ; for when your two ends are throughout of a good *Heat*, and that the inside of the Iron be almost ready to Run, as well as the outside , you must very hastily snatch them both out of the Fire together, and (after you have with the Edge of your *Hammer* scraped off such Scales or Dirt as may hinder their incorporating) with your utmost diligence clap your left hand-piece, upon your right hand-piece, and with all speed (lest you lose some part of your good Heat) fall to Hammering them together, and work them soundly into one another : and this, if your Bars be large , will require another, or sometimes two or three pair of Hands besides your own to do : but if it be not thoroughly *welded* at the first *Heat*, you must reiterate your *Heats* so oft, till they be thoroughly *welded* ; then with a *Flame-heat* (as before

before) shape it, and afterwards smooth it with a *Blood-red Heat*. To make your Iron come the sooner to a *Welding-heat*, you must now and then with your *Hearth-staff* stir up the Fire, and throw up those Cinders the Iron may have run upon; for they will never burn well, but spoil the rest of the Coals; and take a little white Sand between your Finger and your Thumb, and throw upon the heating Iron, then with your Slice, quickly clap the outside of your Fire down again; and with your *Washer* dipt in Water, damp the outside of the Fire to keep the Heat in.

But you must take special Care that your Iron *burn* not in the Fire, that is, that it do not *run* or melt; for then your Iron will be so brittle, that it will not endure Forging without breaking, and so hard, that a *File* will not touch it.

Some Smiths use to strew a little white Sand upon the *Face* of the *Anvil* also, when they are to hammer upon a *Welding-heat*; for they say it makes the Iron *weld*, or incorporate the better.

If through Mistake, or ill management, your Iron be too thin, or too narrow towards one of the ends; then if you have substance enough (and yet not too long) you may *up-set* it, that is, take a *Flame-heat*, and set the heated end upright upon the *Anvil*, and hammer upon the cold end, till the heated end be beat, or *up-set*, into the Body of your Work. But if it be a long piece of Work, and you fear its length may wrong the middle, you must hold it in your left hand, and lay it flat on the *Anvil*; but so as the heated end intended to be *up-set*, may lie a little over the further side of the *Anvil*, and then with your *Hand-hammer* in your right hand, beat upon the heated end of your work, minding that every stroak you take, you hold your work stiff

stiff against the Face of the Hammer. Afterwards smooth it again with a Blood-red Heat.

If you are to Forge a Shoulder on one, or each side of your work, lay the Shank of your Iron at the place where your Shoulder must be on the edge of your Anvil (that edge which is most convenient to your hand) that if more Shoulders be to be made, turn them all successively, and hammer your Iron so, as that the Shank of the Iron that lies on the flat of the Anvil, feel as well the weight of your Blows, as the Shoulder at the edge of the Anvil; for should you lay your blows on the edge of the Anvil only, it would instead of flattening the Shank to make the Shoulder, cut your work through.

Your Work will sometimes require to have holes punched in it at the Forge, you must then make a Steel Punch to the size and shape of the hole you are to strike, and harden the point of it without tempering, because the heat of the Iron will soften it fast enough, and sometimes too fast, but then you must re-harden it; then taking a Blood-beat of your Iron, or if it be very large, almost a Flame-beat; lay it upon your Anvil, and with your left hand, place the point of the Punch where the hole must be, and with the Hand-hammer in your right hand punch the hole; or if your work be heavy, you may hold it in your left hand, and with your Punch fixed at the end of a Hoop-stick, or some such Wood, hold the stick in your right hand, and place the point of your Punch on the work where the hole must be, and let another Man strike, till your Punch come pretty near the bottom of your work; which when it does, the sides of your work round about the hole, will rise from the Face of the Anvil, and your Punch will print a bunching mark upon the hole of a Bolster, that is, a thick

a thick Iron with a hole in it, and placing your Punch, as before, strike it through. But you must note, that as oft as you see your Punch heat, or change Colour, you take it out of the hole, and pop it into Water to re-harden it, or else it will batter in the hole you intend to strike, and not only spoil it self, but the Work too, by running aside in the Work. Having punched it through on the one side, turn the other side of your work, and with your Hammer set it flat and straight, and with a *Blood-beat* punch it through on the other side also ; so shall that hole be fit for the *File*, or square bore, if the curiosity of your purposed Work cannot allow it to pass without filing. When your Work is Forged, do not quench it in water to cool it, but throw it down upon the *Floor*, or *Hearth*, to cool of it self ; for the quenching it in water will harden it ; as I shall shortly shew you, when I come to the Tempering of Steel.

#### Of Brazing and Soldering.

Y  
OU may have occasion sometimes to *Braze* or *Solder* a piece of work ; but it is used by Smiths only, when their work is so thin, or small, that it will not endure *Welding*. To do this, take small pieces of Brass, and lay them on the place that must be brazed, and strew a little Glass beaten to powder on it to make it run the sooner, and give it a *Heat* in the *Forge*, till (by sometimes drawing it a little way out of the Fire) you see the Brass run. But if your work be so small, or thin, that you may fear the Iron will run as soon as the Brass, and so you lose your work in the Fire, then you must make a *Loam* of three parts Clay, and one part Horse-dung, and after they are wrought and mingled very well together in your hands, wrap your work with the Brass, and a little beaten Glass upon the

the place to be brazed close in the *Loam*, and laying it a while upon the *Hearth* of the *Forge* to dry, put the lump into the Fire, and blow the *Bellows* to it, till you perceive it have a full *Heat*, that is, till the Lump look like a well burnt Coal of Fire; then take it out of the Fire, and let it cool: Afterwards break it up, and take out your Work.

Thus much of Forging in general. It remains now, that you know what sorts of Iron are fittest for the several *Uses*, you may have occasion to apply them.

*Of several Sorts of Iron, and their proper Uses.*

IT is not my purpose, in this place, to tell you how Iron is made, I shall defer that till I come to treat of Mettals, and their Refinings. Let it at present satisfie those that know it not, that Iron is, by a violent Fire, melted out of hard Stones, called *Iron-Stones*; of these *Iron-Stones*, many Countries have great plenty. But because it wastes such great quantities of Wood to draw the Iron from them, it will not, in many Places, quit cost to use them. In most parts of *England*, we have abundance of these *Iron-Stones*; but our *English* Iron, is generally a course sort of Iron, hard and brittle, fit for Fire-bars, and other such course *Uses*; unless it be about the Forrest of *Dean*, and some few places more, where the Iron proves very good.

*Swedish* Iron is of all Sorts, the best we use in *England*. It is a fine tough sort of Iron, will best endure the Hammer, and is softest to file; and therefore most coveted by Workmen, to work upon.

*Spanish* Iron, would be as good as *Swedish* Iron, were it not subject to *Red-fear*; (as Workmen phrase it) that is to crack betwixt hot and cold. Therefore when it falls under your hands, you must

must tend it more earnestly at the Forge. But tho' it be good, tough, soft Iron, yet for many Uses, Workmen will refuse it, because it is so ill, and un-evenly wrought in the Bars, that it costs them a great deal of labour to smooth it ; but it is good for all great works that require *welding*, as the bodies of Anvils, Sledges, large Bell-clappers, large Pestles for Mortars, & all thick strong Bars, &c. But it is particularly chosen by *Anchor-Smiths*, because it abides the Heat better than other Iron, and when it is well wrought, is toughest.

There is some Iron comes from *Holland* (tho' in no great quantity) but is made in *Germany*. This Iron is called *Dort Squares*, only because it comes to us from thence, and is wrought into square Bars three quarters of an Inch square. It is a bad, course Iron, and only fit for slight Uses, as Window-Bars, Brewers-Bars, Fire-Bars, &c.

There is another sort of Iron used for making of *Wyer*, which of all Sorts is the softest and toughest : But this Sort is not peculiar to any Country, but is indifferently made where any Iron is made, though of the worst sort ; for it is the first Iron that runs from the *Stone* when it is melting, and is only preserved or the making of *Wyer*.

By what hath been said, you may see that the softest and toughest Iron is the best : Therefore when you chuse Iron, chuse such as bows oftenest before it break, which is an Argument of toughness ; and see it break sound within, be grey of Colour like broken Lead, and free from such glistering Specks you see in broken *Antimony*, no flaws or divisions in it ; for these are Arguments that it is sound, and well wrought at the Mill.

Of

## Of Filing in General.

THE several sorts of Files that are in common use are the *Square*, the *Flat*, the *three Square*, the *half Round*, the *Round*, the *Thin File*, &c. All these shapes you must have of several Sizes, and of several Cuts. You must have them of several sizes, as well because you may have several sizes of work, as for that it sometimes falls out that one piece of work may have many parts in it joined and fitted to one another, some of them great, and others small; And you must have them of several Cuts, because the *Rough-tooth'd File* cuts faster than the *Bastard-tooth'd File*, the *Fine-tooth'd File* faster than the *Smooth-tooth'd File*.

The *Rough* or *Course-tooth'd File* (which if it be large, is called a *Rubber*) is to take off the unevenness of your work which the *Hammer* made in the Forging; the *Bastard-tooth'd file* is to take out of your work, the deep cuts, or file-strokes, the *Rough-file* made; the *Fine-tooth'd file* is to take out the cuts, or file-strokes, the *Bastard-file* made; and the *Smooth-file* is to take out those cuts, or file-strokes, that the *Fine file* made.

Thus you see how the *Files* of several *Cuts* succeed one another, till your Work is so smooth as it can be filed. You may make it yet smoother with *Emerick*, *Tripoli*, &c. But of that in its proper place, because it suits not with this Section of *Filing*.

You must take care when you use the *Rough File*, that you go very lightly over those dents the *Hammer* made in your work, unless your work be forged somewhat of the strongest, for the dents being irregularities in your work, if you should file away as much in them, as you do off the Eminencies or Risings, your work (whether it be straight or circular) would be as irregular, as it was before you filed it: And when

when you file upon the Prominent, or rising Parts of your Work, with your *course cut File*, you must also take care that you file them not more away than you need, for you may easily be deceived; because the *course File* cuts deep, and makes deep scratches in the Work; and before you can take out those deep scratches with your finer cut Files, those places where the Risings were when your work was forged, may become dents to your Hammer dents; therefore file not those Risings quite so low, as the dents the Hammer made, but only so low as that the scratches the *Rough-file* makes may lie as low, or deep in your work, as your Hammer dents do; for then, when you come with your smoother Cut Files, after your *Rough-file*, the scratches of your *Rough-file*, and your Hammer-strokes, or dents, may both come out together. But to do this with greater certainty, hold your File so, that you may keep so much of the length of your File as you can to rub, range, (or, as near range as you can) upon the length of your work; for so shall the File enter upon the second Rising on your work, before it goes off the first, and will slip over, and not touch the dent or hollow between the two Risings, till your Risings are brought into a straight line with your hollow dent. But of this more shall be said when I come to the Practice of Filing; upon several particular sorts of work.

If it be a square Bar, (or such like) you are to file upon, all its Angles, or Edges, must be left very sharp and straight. Therefore your *Vice* being well set up, according to foregoing Directions, you must in your filing athwart over the *Chaps* of the *Vice*, be sure to carry both your hands you hold the *file* in, truly Horizontal, or flat over the Work; for should you let either of

your

your hands mount, the other would dip, and the edge of that Square it dips upon would be taken off ; and should you let your hand move never so little circularly, both the Edges you file upon would be taken off, and the Middle of your intended Flat would be left with a Rising on it. But this Hand-craft, you must attain to by Practice ; for it is the great Curiosity in Filing.

If it be a round Piece, or Rod of Iron, you are to file upon, what you were forbid upon Square Work, you must perform on the Round for you must dip your Handle-hand, and mount your end-hand a little, and laying pritting near the end of your File to the Work, file circularly upon the Work, by mounting your Handle-hand by degrees, and dipping your End-hand, in such manner, as when the Middle of your File comes about the top of your Work, your File may be flat upon it, and as you continue your stroaks forwards, still keep your hands moving circularly till you have finished your full Stroak, that is, a Stroak the whole length of the File. By this manner of Circular filing, you keep your Piece, or Rod round ; but should you file flat upon the top of your work, so many times as you shall remove, or turn your work in the Vice, so many Flats, or Squares, you would have in your work ; which is contrary to your purpose.

When you thrust your *File* forwards, lean heavy upon it, because the *Teeth* of the *File* are made to cut forwards ; but when you draw your *File* back, to recover another thrust, lift, or bear the *File* lightly just above the work ; for it cuts not coming back.

*Thus much of FILING in General.*

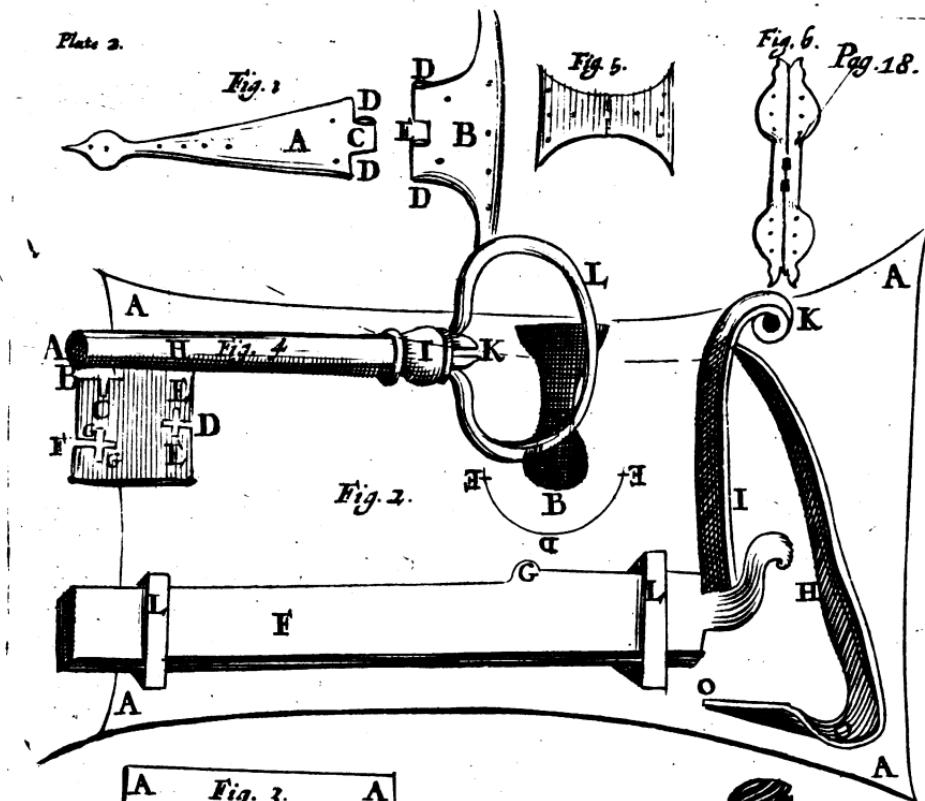
*Of the making of Hinges, Locks, Keys, Screws,  
and Nuts, Small and Great.*

*Of Hinges.*

**I**N Fig. I. A the *Tail*, B the *Cross*, C D D D D E the *Joint*, D D D D the *Pin-hole*. When the *Joint* at C on the *Tail*, is pind in the *Joint* at E in the *Cross*, the whole *Hinge* is called a *Cross-Garnet*.

*Hinges*, if they be small (as for Cup-board doors; Boxes, &c.) are cut out of cold Plate Iron with the (a) *Cold-Chissel*, but you mark the out-lines of your intended *Hinge*, as Fig. I. the *Cross-Garnet*, either with Chalk, or else rase upon the Plate with the corner of the *Cold-Chissel*, or any other hardned Steel that will scratch a bright stroke upon the Plate; and then laying the Plate flat upon the *Anvil*, if the Plate be large, or upon the (b) *Stake*, if the Plate be small, take the *Cold-Chissel* in your left hand, and set the edge of it upon that Mark, or Rase, and with the *Hand-hammer* in your right hand, strike upon the head of the *Cold-Chissel*, till you cut, or rather punch the edge of the *Cold-Chissel*, almost thro' the Plate in that Place, I say, almost through; because, should you strike it quite through, the edge of the *Cold-Chissel* would be in danger of battering, or else breaking; for the *Face* of the *Anvil* is hardned Steel, and a light blow upon its *Face* would wrong the edge of the *Cold-Chissel*; besides, it sometimes happens, that the *Anvil*, or *Stake*, is not all over so hard as it should be, and then the *Cold-Chissel* would cut the *Face* of the *Anvil*, or *Stake*, and consequently spoil it: Therefore when the edge of the *Cold-Chissel* comes pretty near the bot-

Plate 2.

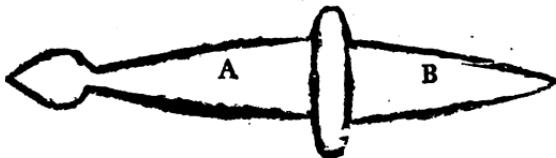




bottom of the Plate, you must lay but light blows upon the *Cold-Cbissel*; and yet you must strike the edge of the *Cold-Cbissel* so near through the bottom of the Plate, that you may break the remaining substance asunder with your Fingers, or with a pair of *Plyers*, or sometimes by pinching the Plate in the *Vice*, with the Cut place close to the Superficies of the *Chaps* of the *Vice*; and then with your Fingers and Thumb, or your whole hand, wriggle it quite asunder. But having cut one breadth of the *Cold-Cbissel*, remove the edge of it forward in the Rase, and cut another breadth, and so move it successively, till your whole intended shape be cut out of the Plate.

When you cut out an *Hinge*, you must leave on the length of the Plate A B in this Figure, Plate enough to lap over for the *Joints*, I mean, to *Turn*, or *Double* about a round Pin, so big as you intend the Pin of your *Hinge* shall be, and also Plate enough to *Weld* upon the inside of the *Hinge* below the *Pin-hole* of the *Joint*, that the *Joint* may be strong.

The size, or diameter of the *Pin-hole*, ought to be about twice the thickness of the Plate you make the *Hinge* of, therefore lay a wyre of such a diameter towards the end B, in this Figure on



the *Tail piece*, a-thwart the Plate as C D, and *Double* the end of the Plate B, over the wyre to lap over it, and reach as far as it can upon the end A; then hammer the Plate that is lap'd over the wyre close to the wyre, to make the *Pin-hole* round; but if your Plate be thick, it will require the taking of an *Heat* to make the

B a

ham-

hammer the closer to the wyre, and consequently make the Pin-hole the rounder : Your work may also sometimes require to be Screwed into the Vice, with the doubled end upwards, and the bottom side of the wyre close against the Chaps of the Vice, and then to hammer upon the very top of the Pin-hole to round it at the end also. When you have made the Pin-hole round in the inside, take the Pin CD out of the Pin-hole, and put the Joint-end of the Hinge into the Fire to make a Welding-beat; which when it hath snatch it quickly out of the Fire, and hammer, or weld, the end B upon the Tail-piece A till they be incorporate together. But you must have a care that you hammer not upon the Plate of the Pin-hole, lest you stop it up, or batter it ; when it is well Welded, you must again put in the Pin CD, and if it will not well go into the Pin-hole, (because you may perhaps have hammer'd either upon it, or too near it, and so have somewhat closed it) you must force it in with your hammer ; and if it require, take a Blood-beat, or a Flame-beat, of the Joint end) and then force the Pin into the Pin-hole, till you find the Pin-hole is again round within, and that the Pin, or Wyre, turn evenly about within it.

Afterwards with a Punch of hardened Steel (as you were taught Page 11. 12.) Punch the Nail-holes in the Plate ; or if your Plate be very thin, you may punch them with a (c) cold Punch. After all, smooth it as well as you can with your Hand-hammer ; take a Blood-red-beat, if your work require it, if not, smooth it cold ; so will the Tail-piece be fit for the File. Double, and Weld the Cross-piece, as you did the Tail-piece.

Having forg'd your Hinge fit for the File, you must proceed to make the Joint, by cutting a Notch in the Middle of the Pin-hole between D D in Plate 2. on the Cross, as at E, and you must cut down the Ends of the Pin-hole on the Tail-

*Tail-piece*, as at D D, till the *Joint* at C fit exactly into the *Notch* in the *Cross*, and that when the *Pin* is put into the *Pin-hole* D D on the *Cross*, the *Pin-hole* in the *Tail-piece* may also receive the *Pin*; then by holding the *Tail-piece* in one Hand, and the *Cross* in the other, double the *Tail* and *Cross* towards one another, to try if they move evenly and smoothly without shaking on the *Pin*; which if they do, the *Joint* is made; if they do not, you must examine where the Fault is, and taking the *Pin* out, mend the Fault in the *Joint*.

Then *File* down all the Irregularities the *Cold-Chisel* made on the Edges of your Work, and (if the Curiosity of Work require it) *file* also the cuter Flat of your Work. But tho' *Smiths* that make Quantities of *Hinges*, do *brighten* them, (as they call it) yet they seldom *file* them, but *Grind* them on a *Grindstone* till they become *bright*, &c.

Having finished the *Joint*, put the *Pin* in again; but take care it be a little longer than the Depth of the *Joint*, because you must batter the Ends of the *Pin* over the outer Edges of the *Pin-hole*, that the *Pin* may not drop out when either Edge of the *Cross* is turned upwards.

The chiefest Curiosity in the making these, and, indeed, all other *Hinges* is, 1. That the *Pin-hole* be exactly round, and not too wide for the *Pin*. 2. That the *Joints* are let exactly into one another, that they have no play between them, lest they shake upwards or downwards, nor yet are forced too hard into one another, lest when they are nailed on the Door, the *Joint* be in Danger of Breaking. 3. That the *Cross*, and the *Tail* lie on the Under-side exactly flat, for should they warp out of flat when they are nailed on, the Nails would draw the *Joint* a-wry, and not only make it move hard, and unevenly, but by oft Opening and Shutting break the *Joint*. 4. If your Work be intended to be curious, the

true *Square-filing* the Upper-side, as you were taught *Page 15, 16, 17.* is a great Ornament.

(a) Smiths call all *Cbissels* they use upon cold Iron, *Cold-Cbissels.*

(b) The *Stake* is a small *Anvil*, which either stands upon a broad Iron Foot, or Basis, on the *Work-Bench*, to remove as Occasion offers; or else it hath a strong Iron *Spike* at the Bottom, which Iron *Spike* is let into some certain Place of the *Work-Bench* not to be removed. Its Office is to set small cold Work straight upon, or to Cut or Punch upon with the *Cold-Cbissel*, or *Cold-Punch*.

(c) Smiths call all *Punches* they use upon cold Iron, *Cold-Punches.*

If the *Hinge* you are to make be large, and Plate-Iron is not strong enough for it, you must *Forge* it out of Flat Bar-Iron, as you were taught from *Page 7* to *Page 12.*

The manner of working *Duftails*, *Fig. 5.* and *Side-binges*, *Fig. 6. &c.* is (the shape considered) in all respects the same I have here shewed you in *Cross-Garnets*; but in these (or others) you may (if your Work require Curiosity) instead of *Doubling* for the *Joint*, *Forge* the *Round* for the *Joint* of full Iron, and afterwards *Drill* a *Hole* through it, for the *Pin-hole*; and by curious *Filing*, work them so true into one another, that both sides of the *Hinge* shall seem but one Piece; as I shall shew more at large, when I come to the making of Compasses, and other Joints for Mathematical Instruments.

### Of Locks and Keys.

**A**S there are *Locks* for several Purposes, as *Street-door Locks*, called *Stock-Locks*; *Chamber-door Locks*, called *Spring-Locks*; *Cupboard-Locks*, *Chest-Locks*, *Trunk-Locks*, *Pad-Locks*, &c. So are there several Inventions in *Locks*, I mean, in the

the Making and Contriving their *Wards*, or *Guards*. But the Contrivances being almost innumerable, according to the various Fancies of Men, shall be referred to another Time to discourse; and I shall now shew you the Working of a *Spring-Lock*, which when you know how to do, your Fancy may play with Inventions, as you best like.

In Fig. 2. AAAA the *Main-plate*, BC the *Key-hole*. EDE the *Top-book*, EE *Cross-wards*, F the *Bolt*, G the *Bolt-Toe*, or *Bolt-Nab*. H the *Draw-back Spring*, I the *Tumbler*, K the *Pin* of the *Tumbler*, LL the *Staples*.

In Fig. 3. AAAA the *Cover-Plate*, B the *Pin*, BC D the *Main-ward*, DD *Cross-wards*, E the *Step-ward* or *Dap-ward*.

In Fig. 4. A the *Pin-hole*, B the *Step*, or *Dap-ward*, C the *Hook-ward*, D the *Middle*, or *Main Cross-ward*, EE the *Cross-ward*, F the *Main-ward*, GG *Cross-ward*, H the *Shank*, I the *Pot*, or *Bread*, K the *Bow-ward*, L the *Bow*, BCDEEFFGG the *Bit*.

First, Cut out of an Iron Plate with a *Cold-Chissel*, the Size and Shape of the *Main-Plate*, as you were taught to cut the *Cross* and *Tail-piece* of the *Cross-Garnet*; then consider what Depth you intend the *Bit* of the *Key* shall have, and set that Depth off on the *Main-Plate*, by leaving about half an Inch of Plate between the Bottom of the *Key-hole*, and the Lower Edge of the *Main-Plate*, as at C (or more or less, according to the Size of the *Lock*.) Then measure with a Pair of *Compasses* between the Bottom of the *Bit*, and the *Centre* of your *Key* (or your intended *Key*) and set that distance off from C to B, near the Middle between the two Ends of the *Main-Plate*, and with the (a) *Prick-punch*, make there a Mark to set one *Foot* of your *Compasses* in, then opening your *Compasses* to the Middle of the *Bit* of your intended *Key*, as

to

to D, describe the Arch E D E for the true Place the Top-boop must stand on.

Then cut one other Piece of Plate as A A A A in Fig. 3. for a Cover-plate, with two Pieces one on each side, long enough to make Studs of to turn downwards, and then outward again as F F, & G, that the Cover-plate may stand off the Main-plate, the Breadth of the Bit of the Key; and at the two End of these Studs Punch holes, as G G, to River the Cover-plate into the Main-plate. In the Middle of this Plate make the Centre, as at B, then open your Compasses to three Quarters the Length of the Bit, and half the Diameter of the Shank of the Key, and placing one Foot in the Point B, describe with the other Foot the Arch D C D for the true Place of the Main-ward, then set your Compasses to a little more than half the Diameter of the Shank, and place one Foot (as before) in the Centre B, and with the other Foot describe the small Arch E, for the true Place the Step-ward, or (as some call it) the Dap-ward must stand: So have you the true Places of the Wards, for an ordinary Spring-Lock; you may (if the Depth of your Bit will bear it) put more Wards in your Plates. But you must note, that the more Wards you put in, the weaker you make your Key; because that to every Ward on the Plates, you must make a Slit, or Ward in the Bit of the Key; and the more Wards you make, the weaker the Iron of the Bit will be; and then if the Bolt shoot not easily backwards, or forwards, the Bit may be in Danger of Breaking.

Having marked on your Plates the Places of all your Wards, you must take thin Plate, and with Hammering and Filing make them both (b) Hammer-hard, and of equal Thickness all the way. Then file one Edge very straight, by laying a straight Ruler just within the Edge of it, and drawing, or racing with a Point of hardened Steel, a bright Line by the side of the Ruler; File away the

the Edge of the Plate to that Line, then draw (as before) another straight Line Parallel to the first straight Line, or which is all one, Parallel to the filed Edge, just of the Breadth you intend the *Wards* shall be, and file as before, only, you must leave two, or sometimes three *Studs* upon this Plate, one near each End, and the other in the Middle, to *Rivet* into the *Main-plate*, to keep the *Ward* fixt in its Place. Therefore you must take care when you elect this thin Piece of Plate, that it be broad enough for the *Ward*, and these *Studs* too. Then laying the Plate a-thwart the *Pike* of the *Bickern*, hold your Hand even with the Face of the *Bickern*, and hammer this Plate down somewhat by the side of the *Pike*, and by Degrees you may (with care taken) bring it unto a circular Form, just of the Size of that Circle you described on the *Main-plate*; which when you have done, you must apply this *Ward* to the Circle you described on the *Main-plate*; setting it in the Position you intend it shall be fixed; and marking with a Steel Peist where the *Studs* stand upon that Circle, in those marks *Punch* holes to *Rivet* the *Studs* to. Work so by all the other *Wards*.

If you have a *Pin* to the *Lock*, *Punch* a Hole through the Centre on the *Cover-plate*, somewhat smaller than the *Wyre* you are to make your *Pin* of, because you may then file one End of the *Pin* away to a *Shank*, which must fit the smaller Hole on the Plate, and the whole Thickness of the *Pin* will be a *Shoulder*, which will keep the *Pin* steddy in the *Centre-hole* of the Plate, when the *Pin* is *riveted* into the Plate. But because there is some Skill to be used in *Rivetting*, I shall, before I proceed any farther, teach you

*The manner of Rivetting.*

**R**ivetting is to batter the Edges of a *Sbank* over a Plate, or other Iron, the *Sbank* is let into, so as the Plate, or other Iron, may be clinched close, and fixed between the Battering at the End of the *Sbank* and the *Sbolder*. So that

When you *Rivet* a *Pin* into a Hole, your *Pin* must have a *Sbolder* to it thicker than the Hole is wide, that the *Sbolder* slip not through the Hole, as well as the *Sbank*; but the *Sbank* of the *Pin* must be exactly of the Size of the Hole the *Sbank* must be *Riveted* into, and somewhat longer than the Plate is thick; file the End of the *Sbank* flat, so shall the Edges of the End, the easier batter over the Plate; then put your *Sbank* into the Hole, wherein it is to be *Riveted*, but be sure you force the *Sbank* close up to the *Sbolder*; then turn the Top of this *Sbolder* downwards (Plate and all) upon your *Stake*, but lay it so, as that the *Sbolder* lie solid, and the *Sbank*, at the same time, stand directly upright, and with your left Hand, keep your Work bearing hard upon the Flat, or *Face* of the *Stake*. Then holding your *Hammer* in your Right-hand, hold the Edge of the *Face* of it Dripping a-slope from the Right-hand outwards, and lay pretty light Blows upon the Edge of the End of the *Sbank*, turning with your Left-hand your Work round to the *Face* of the *Hammer*, till you have battered the Edges of the *Sbank* quite round about; but this is seldom done, with once turning your Work about; therefore you may thus work it round again and again, till you find it is pretty well *Riveted*; then lay heavier Blows upon it, sometimes with the *Face*, sometimes with the *Pen* of the *Hammer*, till the End of the *Sbank* is battered effectually over the Plate.

One main Consideration in *Rivetting* is, that the *Pin* you *rives* in, stand upright to the Plate,

or other Iron you *rivet* it upon; for if it do not stand upright, you will be forced to set it upright, after it is *rivetted*, either in the *Vice*, or with your *Phy whole*, or with your *Hammer*, and that may, if your Plate be thin, bow it, or if it be thick, break the *Shank*, or else the *Shoulder* of your *Rivet*, and so you lose your Labour, and sometimes spoil your Work.

Another Consideration is, that when you *rivet* a Pin to any Plate, and you fear it may afterwards twist about by some force that may be offered it, you must, to provide against this Danger, file the *Shank* you intend to *Rivet*, either Square, or Triangular, and make the Hole in the Plate you *rivet* it into, of the same Size and Form, and then *rivet* in the *Shank*, as before. There are two ways to make your Hole, Square or Triangular, one is by *filling* it into these Forms, when it is first Punched round; the other by making a *Punch* of Steel, of the Size and Shape of the *Shank* you are to *rivet*, and punching that *Punch* into the Plate, make the same Form.

Now to return where I left off. The *Pins* and *Shanks* of these *Wards* must be made of a long Square Form, because, (the Plates of the *Wards* being thin) should you make them no broader than the Plate is thick, the *Studs*, or *Shanks* would be too weak to hold the *Wards*, therefore you must make the *Rivetting-shank* three or four times, or sometimes more, as broad as the Plate is thick, and then *rivet* them in, as you were taught just now.

Then place the *Cover-plate* upon the *Main-plate*, so as the *Centre* of the *Cover-plate*, may stand directly over and against the *Centre* of the *Main-plate*, and make marks through the Hole G G, of the *Studs* of the *Cover-Plate* upon the *Main-plate*, and on those Marks Punch holes, and fit two *Pins* into them, to fasten the *Cover-plate* on to the

the *Main-plate*, but you must not yet rivet them down, till the *Key-hole* be made, because this *Cover-plate* would then stop the Progress of the *File* through the *Main-plate*, when you file the *Key-hole*. When you have placed the *Cover-plate* upon the *Main-plate*, and fitted it on with *Pins*, so, as you may take it off, and put it on again, as your Work may require, you must *Punch* the *Key-hole*, or rather drill two Holes close by one another, if the *Key-hole* falls near the *Wards*, because *Punching* may be apt to set the *Wards* out of Form, and with small *Files*; file the two Holes into one another, to make the Hole big enough to come at it with bigger *Files*, and then file your *Key-hole* to your intended Size and Shape.

The *Key-hole* being finished, forge your *Key*, as you were taught, Page 7. and if your *Key* is to have a *Pin-hole*, drill the Hole in the Middle of the End of the *Shank*, then file the *Wards*, or Slits in the *Bit* with thin *Files*; yet sometimes Smiths *Punch*, or cut them with a *Cold-Chisel*, at the same Distances from the Middle of the *Pin-hole* in the End of the *Shank* (which is the same Centre, which was made before, in the *Main-plate* or the *Cover-plate*) which you placed the *Wards* at, from the Centre of the *Main* and *Cover-plate*. But before you file these *Wards* too deep into the *Bit* of the *Key*, make Trials, by putting the *Bit* into the *Key-hole*, whether the *Wards* in the *Bit*, will agree with the *Wards* on the *Plates*, which if they do, you may boldly cut them to the Depth of the *Wards* on the *Plate*; if not, you must alter your Course till they do; but you must take great Care in Cutting the *Wards* down straight, and square to the Sides of the *Bit*; for if they be not cut down straight, the *Wards* on the *Plates*, will not fall in with the *Wards* in the *Bit* of the *Key*; and if they be not Square to the Sides of the *Bit*, the *Bit* will not only be weaker than it need be, but it will shew

shew unhandsomely, and like a Bitch to the Eye.

The *Cross* and *Hock-wards* is made, or, at least, entred at the *Forge*, when the Iron hath a *Blood*, or almost a *Flame Heat*, yet sometimes Smiths do it on cold Iron, with a thin *Chiffel*, as you was taught. *Page 11. 12.* But you must take care that your *Chiffel* be neither too thick, or too broad, for this Punching of *Wards* is only to give the thin *Fibes* Entrance to the Work; which Entrance when you have, you may easily file your *Cross*, or *Hock-wards*, wider or deeper, as your Work may require; but if your *Chiffel* be too broad, or too thick, it will make the *Wards* in the *Bit* too long, or too wide, and then (as I said before) the *Bit* of your *Key* will prove weaker than it needs to be.

Having made the *Wards* on the *Plate*, and in the *Bit* of the *Key*, you must *Forge* the *Bolt* of a considerable Substance, Thick and Square at the End that shoots into the *Staple* in the *Frame* of the Door, that it may be strong enough to guard the whole Door; but the rest of the *Bolt* that lies between the two *Staples* on the *Main-plate*, may be made very thin inwards, that is, the Side that lies towards the *Main-plate*, which because it cannot be seen when the *Bolt* is fixed upon the *Plate*, I have made a Figure of it, and turned the Inside to View, as in *Fig. 4.* where you may see, that the End A, hath a considerable Substance of Iron to guard the whole Door, as aforesaid, and B is a Square *Stud*, which doth as well keep the Outside flat of the *Bolt* on the Range, as serve for a *Stud* for the *Spring H* in *Fig. 2.* to press hard against, and shoot the *Bolt* forwards: This *Bolt* must be wrought straight on all its Sides, except the Topside, which must be wrought straight only as far as the *Shoulder G*, called the *Toe*, or *Nab* of the *Bolt*, which rises, as you see in the Figure, considerably high, above the Straight on the Top of the *Bolt*: The Office of this *Nab*,

is

is to receive the Bottom of the *Bit* of the *Key*, when in turning it about, it shoots the *Bolt* backwards or forwards.

Having forged and filed the *Bolt*, you must fit the Hollow-side of it towards the *Main-plate*, at that Distance from the *Key-hole*, that when the *Key* is put into the *Key-hole*, and turned towards the *Bolt*, the Bottom of the *Bit* may fall almost to the Bottom of the *Nab*, and shoot the *Bolt* back so much, as it needs to enter the *Staple* in the *Door-frame*. And having found this true Place for the *Bolt*, you must with square *Staples*, just fit to contain the *Bolt* with an easie Play, fasten these *Staples*, by *Rivetting* them with the *Bolt* within them, one near the *Bolt* end, the other near the *Nab* end, as at L L to the *Main-plate*.

Then *Punch* a pretty wide Hole in the *Main-plate*, as at K, to receive a strong *Pin*, and file a *Shoulder* to the *Shank* of the *Pin* that goes into the *Plate*. This *Pin* is called the *Pin of the Tumbler*; the *Tumbler* is marked I, which is a long Piece of *Iron*, with a round Hole at the Top to fit the *Pin of the Tumbler* into, that it may move upon it, as on a *Joint*, and it hath an *Hook* returning at the Lower End of it, to fall into the *Breech* of the *Bolt*, and by the *Spring H* forces the *Bolt* forwards, when it is shot back with the *Key*. This *Spring* is made of *Steel*, and afterwards temper'd (as I shall shew you in proper Place.) It is fixed at the Bottom of the *Main-plate*, by two small *Shanks* proceeding from that Edge of the *Spring* that lies against the *Main-plate*, as at O O: These *Shanks* are to be *riveted* (as you were taught even now) on the other Side of the *Main-plate*.

All things being thus fitted, *punch* an Hole on each Corner of the *Main-plate* for *Nails* to enter, that must nail the *Lock* to the *Door*. Or if you intend to screw your *Lock* on the *Door*, you must make wide Holes, big enough to receive the *Shank*

*Sbank* of the *Screw*. Last of all, *rive* down your *Cover-plate* to the *Main-plate*, and *file* your *Key*, and *polish* it too, if you will; so shall the *Lock* and *Key* be finished.

(a) A *Prick-punch*, is a Piece of temper'd Steel, with a round Point at one End, to prick a round Mark in cold Iron.

(b) *Hammer-hard*, is when you harden Iron, or Steel, with much hammering on it.

*The making of Screws and Nuts.*

The *Shank* of the *Screw* for Doors, and many other Purposes, must be forged square near the *Head*, because it must be let into a Square-hole, that it may not twist about when the *Nut* is turned about hard upon the *Screw-pin*. Therefore take a Square-bar, or Rod of Iron, as near the Size of the *Head* of the *Screw-pin* as you can, and taking a *Flame-heat* of it, lay so much of this Bar as you intend for the Length of the *Shank*, with one Square-side flat, upon the Hither-side of the *Anvil*, and *hammer* it down to your intended Thickness: But have a care you do not strike your Iron on this Side the Edge of the *Anvil*, lest you cut the Iron, as I told you *Page 11*. Thus, at once, you will have two Sides of your *Shank* forged; the Under-side made by the *Anvil*, and the Upper-side beaten flat with the *Hammer*: The *Head* will be in the main Rod of Iron; then if your Iron grows cold, give it another *Heat*, and lay one of the unwrought Sides upon the Hither-side of the *Anvil*, just to the *Head*, and *hammer* that down, as before, so shall the two other Square-sides be made; then *hammer* down the Corners of so much of this *Shank*, as you intend for the *Screw-pin*, and round it, as near as you can, with the *Hammer*; set then the *Chiffel* to the Thickness you intend the *Head* shall have, and strike it about half through, then turn the Sides successively, and cut each Side also half through, till it be quite cut off. If the *Shoulder* be not square enough, hold it in your *Square-nos'd Tonges*,

Tongs, and take another *Heas'*, and with speed (lest your Work cool) screw the *Shank* into the *Vice*, so as the *Shoulder* may fall flat upon the *Chaps* of the *Vice*; then hammer upon the *Head*, and square the *Shoulder* on two Sides, do the like for squaring the other two Sides. This was, in part, taught you before, in *Page 11.* but because the cutting this Iron Rod, or Bar, just above the *Shoulder* makes the *Head*, and for that I did not mention it there, I thought fit (since the Purpose required it) to do it here: The *Forging* of the *Nuts* are taught before, *Page 11. 12.*

Having forged and filed your *Shank* square, and the *Head* either Square or Round, as you intend it shall be, file also the *Screw-pin*, from the Rifings and dents left at the *Forge*; and file it a little Tapering towards the End, that it may enter the *Screw-plate*; the Rule how much it must be Tapering is this, consider how deep the Inner Grooves of the *Screw-plate* lie in the outer *Threads*, and file the End of the *Screw-pin* so much smaller than the rest of the *Screw-pin*, for the outer *Threads* of the *Screw-plate* must make the *Grooves* on the *Screw-pin*, and the *Grooves* in the *Screw-plate*, will make the *Threads* on the *Screw-pin*. Having fitted your self with a Hole in your *Screw-plate* (that is, such a Hole whose Diameter of the hollow *Grooves*, shall be equal to the Diameter of the *Screw-pin*, but not such a Hole, whose Diameter of the outer *Threads*, shall be equal to the Diameter of the *Screw-pin*, for then the *Screw-plate* will indeed turn about the *Screw-pin*, but not cut any *Grooves*, or *Threads* in it) screw the *Shank* with the *Head* downwards in the *Vice*, so as that the *Screw-pin* may stand directly upright, and take the *Handle* of the *Screw-plate* in your Right-hand, and lay that Hole flat upon the *Screw-pin*, and press it very hard down over it, and turn the *Screw-plate* evenly about with its *Handle* towards you, from the Right towards the Left-hand, so shall the outer *Threads*

*Tbreds* of the *Screw-plate* cut *Grooves* into the *Screw-pin*, and the substance of the Iron on the *Screw-pin*, will fill up the *Grooves* of the *Screw-plate*, and be a *Tbred* upon the *Screw-pin*. But take this for Caution, that, as I told you, you must not make your *Screw-pin* too small, because the *Screw-plate* will not cut it, so if you make it too big (if it do enter the *Screw-plate* where it is Taper) it will endanger the breaking it, or, if it do not break it, yet the *Screw-plate* will, after it gets a little below the Tapering, go no farther, but work and wear off the *Tbred* it made about the Tapering.

To fit the *Pin* therefore to a true size, I, in my Practise, use to try into what *hole* of the *Screw-plate*, the *Tap* or place of the *Tap*, (if it be a tapering *Tap*,) I make the *Nut* with, will just slide through; (*Threads* and all;) (which generally in most *Screw-plates* is the *hole* next above that to be used) for then turning my *Pin* about in that *hole*, if the *Pin* be irregularly *filed*, or but a little too big on any part of it, the *Threads* of that *Hole* will cut small marks upon the *Pin*, on the irregular places, or where it is too big; so that afterwards filing those Marks just off, I do at once *file* my *Pin* truly round, and small enough to fit the *Hole*. I make my *Screw-pin* with.

As the *Hole* of the *Screw plate* must be fitted to the *Screw-pin*, so must the *Screw-tap* that makes the *Screw* in the *Nut*, be fitted to to the round *hole* of the *Nut*; but that *Tap* must be of the same size of your *Screw-pin* too, which you may try by the same *hole* of the *Screw-plate* you made the *Screw-pin* with. *Screw* the *Nut* in the *Vice* directly flat, that the *hole* may stand upright, and put the *Screw-tap* upright in the *hole*; then if your *Screw-tap* have an *handle*, turn it by the *handle* hard round in the *Hole*, so will the *Screw-tap* work it self into the *Hole*, and make *Grooves* in it to fit the *Threads* of

the *Screw-pin*. But if the *Screw-tap* have no *handle*, then it hath its upper end filed to a long square, to fit into an hollow square, made near the *handle* of the *Screw-plate*; but that long square hole, over the long square on the top of the *Tap*, and then by turning about the *Screw-plate*, you will also turn about the *Tap* in the *hole*, and make *Grooves* and *Threds* in the *Nut*.

But though small *Screws* are made with *Screw-plates*, yet great *Screws*, such as are for *Vices*, *Hot-Presses*, *Printing-Presses*, &c. are not made with *Screw-plates*, but must be cut out of the main Iron, with heavy blows upon a *Cold-Chisel*. The manner of making them, is as follows.

*The Rules and manner of Cutting Worms upon great Screws.*

**T**HE *Threds* of *Screws*, when they are bigger than can be made in *Screw-plates*, are call'd *Worms*. They consist in length, breadth and depth; the length of a *Worm* begins at the one end of the *Spindle*, and ends at the other; the breadth of the *Worm*, is contain'd between any two *Grooves* on the *Spindle*, viz. The upper and under *Groove* of the *Worm*, in every part of the *Spindle*; the depth of the *Worm*, is cut into the Diameter of the *Spindle*, viz. The depth, between the outside of the *Worm*, and the bottom of the *Groove*.

The depth ought to be about the one seventh part of the Diameter, on each side the *Spindle*:

You ought to make the *Groove* wider than the *Worm* is broad, because the *Worm* being cut out of the same intire piece with the *Spindle*, will be as strong as the *Worm* in the *Nut*, tho' the *Worm* on the *Spindle* be smaller; for you cannot come at the *Worm* in the *Nut*, to cut it with *Files*, as you may the *Spindle*, and therefore you must either

*Turn*

Turn up a Rod of Iron, to twist round about the *Grooves* on the *Spindle*, and then take it off, and *Braze* it into the *Nut*, or else you must *Cast* a *Nut* of *Brass* upon the *Spindle*, which will neither way be so strong as the *Worm* cut out of the whole Iron, by so much as *Brass* is a weaker Metal than Iron, and therefore it is that you ought to allow the *Worm* in the *Nut*, a greater breadth than the *Worm* on the *Spindle*, that the strength of both may, as near as you can, be equaliz'd; for both being put to equal force, ought to have equal strength. The *Worm* may very well be the one seventh part smaller than the *Groove* is wide, as aforesaid.

Having consider'd what breadth the *Worm* on the *Spindle* shall have, take a small thin Plate of *Brass*, or Iron, and *file* a square notch at the end of it, just so wide, and so deep, as your *Worm* is to be broad and deep, and *file* the sides of the Plate that this notch stands between, just to the width of the *Groove*. This Plate, must be a *Gage* to *file* your *Worm* and *Groove* to equal breadth by; then draw a straight and upright Line the whole length of the *Spindle*; divide from this line the Circumference of the whole *Spindle* into eight equal Parts, and through those Divisions, draw seven Lines more parallel to the first Line; then open your *Compasses* just to the breadth of one *Worm*, and one *Groove*, and set off that distance as oft as you can, from the one end of the Spindle to the other, (but I should first have told you, that the end of your Spindle must be square to the outside) and with a *Prick-Punch*, make a mark to every setting off on that line: Do the like to all the other straight upright Lines. Note, that you may chuse one of these eight upright Lines for the first, and make the next towards your left Hand, the second (but then the first must stand towards you) and the

next that, the third, and so on. And the top mark of every one of these upright straight Lines, shall be call'd the first Mark, the next under that the second Mark, the third, the third Mark, and so downwards in Order and Number.

Having marked one of these eight Lines at the top of the *Spindle*, to begin the winding of the *Worm* at, with a Black-lead Pencil, draw a line from that Mark to the second Mark, on the next upright Line towards the left hand, from thence continue drawing on with your Pencil to the third Mark, on the third upright Line, draw on still to the fourth Mark, on the fourth upright Line, and so onwards, till you have drawn over the eight straight Lines, which when you have done, you must still continue on, drawing downwards to each lower Mark on each successive upright Line, till you have drawn your *Worm* from end to end: Then examine, as well as you can, by your Eye, whether the *Worm* you have carried on from Mark to Mark with the Black-led Pencil, do not break into Angles, which if it do anywhere, you must mend it in that place: Then with the edge of an *half-round File*, file a small Line in the Black-lead Line, and be sure that the Line you are *filing*, run exactly through all the Marks that the Black-lead Pencil should have run through (if it did not, for want of good guidance of the Hand.) This small Line is only for a guide to cut the *Groove* down by; for the making of a *Screw* is, indeed nothing else, but the cutting the *Groove* down, for then the *Worm* remains: But you must not *file* in this small line, but leave it as a guide to lie on the middle of the *Worm* (as I said before): Therefore to cut down the *Groove*, take a *Cold-Chisel*, somewhat thinner than you intend the *Groove* shall be wide, viz. about the

the thickness of the breadth of the *Worm*, and, with heavy blows, cut out the *Groove* pretty near. The reason why you should not offer to cut the *Grooves* to their full wedth at the first, is, because your Hand may carry the *Cold-Chissel* somewhat awry, and should your *Cold-Chissel* be as thick as the *Groove* is wide, you could not smooth the Irregularities out, without making the *Worm* narrower than you intended it : Then with a *Flat-file* open and smooth the *Groove*, *filling* in the middle between the two next fine Lines cut by the *half-round File*, till you have wrought the *Spindle* from end to end, so shall the *Worm* remain. But you must not expect, that though the *Groove* be cut, it is therefore finished, for now you must begin to use the thin *Plate-Gage*, and try first, whether the *Worm* have equal breadth all the way. Secondly, whether the *Grove* have equal breadth all the way. And Thirdly, whether the *Groove* have equal depth all the way ; and where ever you find the *Worm* too broad, you must *file* it thinner, and where the *Groove* is not deep enough, *file* it deeper ; therefore in cutting down the *Groove* you may observe, that if, at first, you *file* the *Worm* never so little too narrow or the *Groove* never so little too deep, you shall have all the rest of the *Worm* or *Groove* to *file* over again ; because the whole *Worm* must be brought to the breadth of the smallest part of it, and the whole *Groove* to the depth of the deepest place all the way, especially if the *Nut* be to be *Cast* in *Brass* upon the *Spindle* ; because the Mettal running close to the *Spindle* will bind on that place, and not come off it ; but if the *Nut* be not to be *Cast* in *Brass*, but only hath a *Worm* brazed into it, this niceness is not so absolutely necessary, because that *Worm* is first *Turned up*, and bowed into the *Grooves* of the *Spindle*, and you may try that before it is

Braz'd in the Nut, and if it go not well about, you may mend, or botch it, either by *Hammering* or *Filing*, or both.

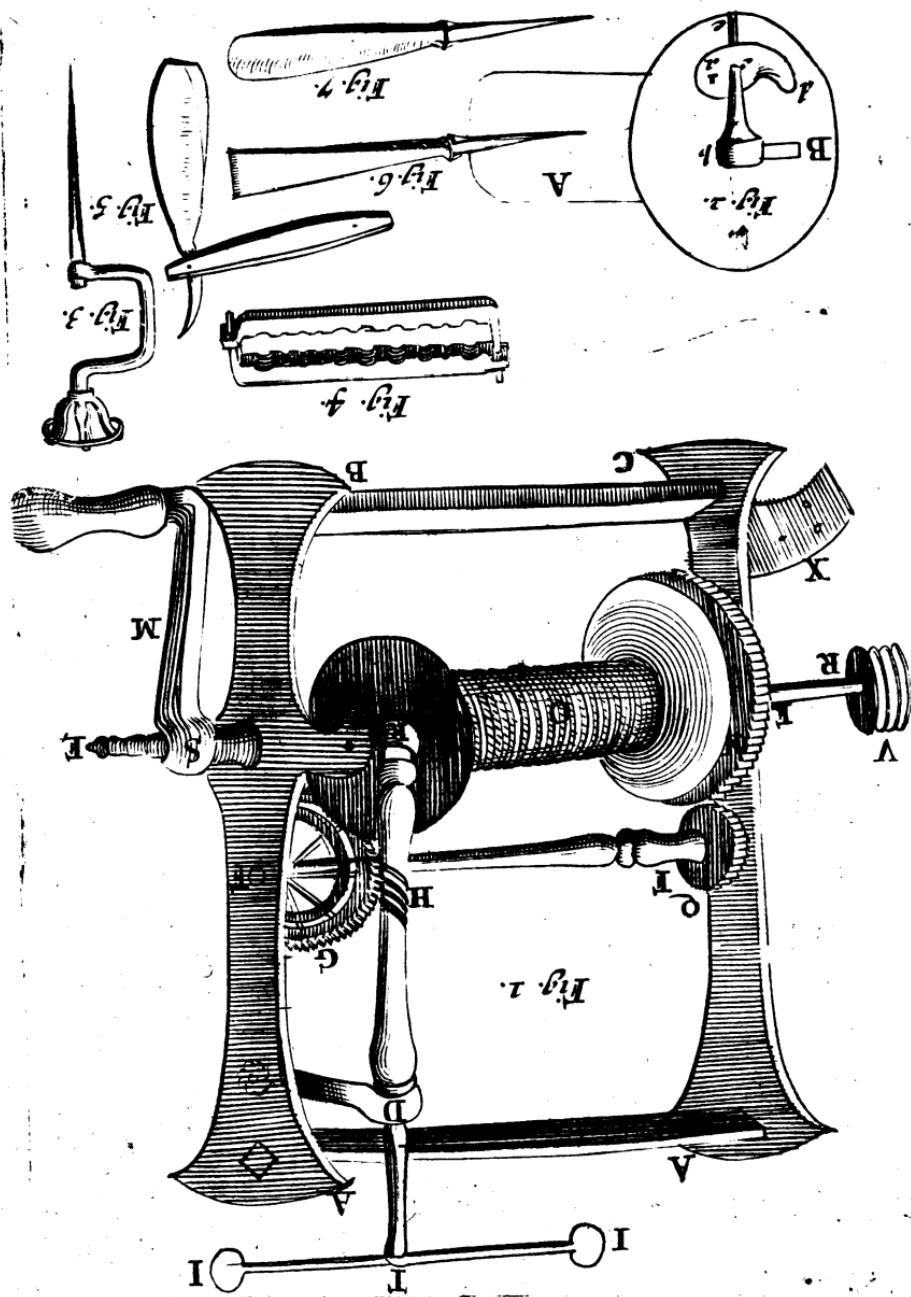
The manner of *Casting* the *Nut* upon the *Spindle*, I shall shew when I come to the *Casting of Metals*; and the manner of *Brazing* hath been Taught already. Num. I. fol. 12, 13.

If your *Spindle* is to have three or four *Worms* winding about it, as *Coining-Presses* and *Printing-Presses* have, that they may not wear out too fast, you must divide the Circumference into three or four equal Parts, and having straight upright Lines, drawn as before, begin a *Worm* at each of those three, or four Divisions, on the Circumference, and considering the breadth of your *Worm* and width of your *Groove*, measure that width as oft as you can on all the upright Lines, and making Marks on those at each Setting off, draw as before, a Line from the end of the *Spindle*, on the first upright Line to the Mark below it, which is the second Mark on the second upright Line, from thence to the third Mark, on the third upright Line, and so on to the other end of the *Spindle*. Having drawn the first *Worm*, work the other *Worm* as this.

Thus much may at present suffice for great *Screws*.

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**MECHANICK EXERCISES;**  
**O R,**  
**The Doctrine of Handy-Works**

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Viz. *The making of Jacks and Bullet-Molds, the twisting of Iron, and Case-hardning it, with the use of some Tools not treated of before: Also of the several sorts of Steel, the manner of Softning, Hardning and Tempering them.*

*Of Jacks.*

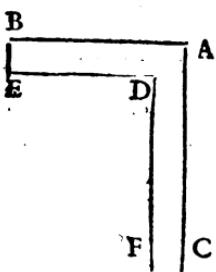
**F**IG. 1. is call'd a *Worm-Jack*. A B the *Fore-side*, AC the *Back-side*, AA the *Top-piece*, BC the *Bottom-piece*, altogether the *Jack-frame*, E E K the *Main-Spindle*, N O N the *Main-Wheel* and *Barrel*, O the *Barrel*, D the *Wind-up-piece*, fastned into the *Barrel*, F F the *Worm-wheel Spindle*, G the *Worm-wheel*, Q the *Worm-Nut*, H the *Worm*, R the *Stud* of the *Worm-Spindle*, D the *Worm-Loop*, L the *Wind-up-piece*, M the *Winch* or *Winder* or *Handle*, the Iron part is the *Winder*, the Wood the *Handle*, S the *Eye of the Winder*, I I the *Fly*, T the *Socket of the Fly*, V the *Struok-Wheel*, X the *Stayes* or *Back fastnings*.

First you are to Forge the *Jack-frame*, and on the left side of the *Fore-side*, a Shank for the *Stud* of the *Worm-spind.e*, as you are taught Numb I. fol. 8, 9, 10, 11, 12. and then file it as you were taught Numb. I. fol. 14, 15, 16.

The *top* and *bottom* *Pieces* are let into square holes at the ends of the *Fore* and *Backside*. But you must Forge the *top* and *bottom* *Pieces* with two small Squares towards the ends of them, and two round ends for *Screw-pins*, beyond those squares. The small squares are to be fitted into square holes into the *Fore* and *Backsides*, and the round *Screw-pins* are to make *Screws* of, to which a square *Nut* is to be fitted to draw the *top* and *bottom* *Pieces* close and right up to the insides of the *Fore* and *Backsides*. The manner of Filing of these Ends you were, in part, taught *Numb. II. fol. 15, 16.* and *Numb. I. fol. 29.* but another way is by trying your Work with an Instrument, call'd by Workmen, a *Square*, as you see describ'd in this Figure.

#### *Of the Square and its Use.*

**T**H E sides ABC are call'd the *Outer-square*; the sides DEF the *Inner-square*. Its Use is



thus. If your Work, as in this Case, be an *Outer-square*, you must use the *Inner-square*, DEF to try it by; applying either the side ED or DF (but suppose the side ED) to one of the sides of your Work, chuse the flattest and truest wrought; if neither of the sides be flat, make of them flat, as you were

taught *Numb. I. fol. 15, 16.* if then you find the side DF of your *Square* lie all the way even upon the adjoining side of your Work, you may conclude those sides are *Square*; but if the adjoining side of your Work comply not all the way with the adjoining side of the *Square*, you must file away your Work where the *Square* rides upon it, till the whole side be wrought to comply with

the

the adjoining side of the *Square*, that is, till both the sides of your Work agree with both the sides of the *Squares*, when they are appl'd to one another. Having tried two sides Square, make a third side of your Work Square, by applying one of the sides of the *Square* to one of those sides of your Work, that are already made square, and as before, try the third untry'd side, and make that Square; and by the same Rule make the fourth side square.

If the Work you are to file be an hollow Square, you must apply the outer Square A B C to it, and try how, when one side of the *Square*, is applied to one side of your Work, the other side of your Work agrees with the other side of the *Square*; which if it do, all is well: But if the *Square* and the Work comply not with one another, you must file the Work where it bears the *Square* off. But to return where I left.

Having made these two ends square, you must fit the length of them to the thickness of the *Fore* and *Backsides* into which they are to enter, but so as the Squares be not full so long as to come quite thro' the *Fore* and *Backsides*, lest when the *Nuts* are screw'd on the *Screw-pins* that are at the ends of these Squares, they screw full up to the Squares, and bear against the corners of them; which if they do, the *Nuts* will not draw the *Fore* and *Back-sides* close against the shoulder of the Squares, on the *top* and *bottom* *Pieces*, and then the whole *Jack Frame* will not stand fast and firm together.

But before you fit this *Frame* thus together, you must consider the Diameter of the *Main-wheel*, that you may punch round Holes in the *Fore* and *Backsides* to enter the *Main-spindle*. Therefore open your Compass to half the intended Diameter of the *Main-wheel*, and half a quarter, or an whole quarter of an Inch more for play, between

the

the Semi-diameter of the *main Wheel*, and the upper flat of the *bottom Piece*, and set that distance off from the upper flat of the *bottom Piece*, on the *Fore* and *Backsides*, and with a round Punch, somewhat smaller than the intended size of the *main Spindle*, Punch Holes at that setting off. Your Punch must be smaller than the *main Spindle*, because the holes may perhaps not be so exactly round, or Punch'd so truly upright, or perfectly smooth as they ought to be ; and should you make the holes so wide at first as they need to be, you could not mend them, without making them wider. These holes must be Punch'd at the *Fire* or *Forge* (as Smiths say, when they take an *Heat* of their Work to Punch it) because the *Fore* and the *Backsides* are *too strong* (as Smiths say) that is, too thick to Punch with the *Cold Punch*. The way of Punching them you were taught *Numb. I. fol. 11, 12.* Besides a *Cold Punch* is commonly made flat at the bottom, and therefore does not prick an Hole, but cut an Hole (if the Iron be not too strong) for that flat bottom, and the upright side about it, met in an Angle or Edge at the bottom, which Edge, by the force of the Hammer, cuts the Iron (if it be not too strong) when it is laid upon a *Bolster*, as it is describ'd *Numb. I. fol. 12.* and should you cut out so much Iron in the *Fore* and *Backsides*, as would entertain the *main Spindle* (it being thick) you will make the *Fore* and *Backsides* too wide ; therefore as I said, the Holes must be prickt in the *Fore* and *Backsides* at the *Fire* or *Forge*, which with a sharp pointed *Punch* is sooner done ; nor does pricking diminish the substance or strength of the Iron, but makes it swell out at the sides, and retain both substance and strength. The irregularity or swelling out that this Punching makes on the flats of the *Fore* and *Backsides*, you must Hammer down again,

again with almost a *Blood-red-beat*, I say, almost a *Blood-red-beat*; because, should you take too great an *Heat*, you may make the *Fore* and *Backsides* stretch, and so put the whole *Jack-frame* out of order.

Having punch'd the Holes for the *main Spindle*, you must Punch the Holes in the *Fore* and *Back-sides* for the *Worm-wheel Spindle*, as you Punch the Holes for the *main Spindle*; but these must be small Holes, to entertain the small Ends or Pins of the *Worm-wheel Spindle*.

These Holes thus Punch'd, may perhaps not be exactly round or fit your size, nor will they be smooth enough within; therefore, with a <sup>a</sup>*Square-bore*, you must <sup>b</sup>open them wider to your size, and that opening them in the inside, will both round and smooth them.

You must also Punch a square hole towards the top of the *Foreside*, for the *Shank* of the *Worm-Loop*.

Then Forge and fit in your *Main-wheel Spindle*, and your *Worm-wheel Spindle*, which Spindles must both be exactly straight between the corners of their two ends (unless you like to have Moldings for Ornaments on them) and Forge a Square towards the ends of both the Spindles, to fit into a square hole in the middle of the *Cross* of their *Wheels*, and leave substance enough for a shoulder beyond the square, to stop the square hole in the *Cross* of the *Wheels* from sliding farther on the *Spindle*, and you must leave substance of Iron enough to Forge the *Nut* of the *Worm-wheel* near the other end. But in this, and indeed in all other Forging remember (as I told you *Numb. I.* fol. 9.) that it behoves you to *Hammer* or *Forge* your Work as true as you can, least it cost you great pains at the *Vice*.

Then

Then Forge the *Worm-spindle*, which is all the way round and straight, unless you will have Moldings for Ornaments (as aforesaid) upon the *Shank* of it: But you must be fure to Forge substance enough for the *Worm* to be cut out of it.

The *Main* and *Worm-wheels* are Forg'd round and flat.

The manner of Forging these Wheels (which in Smith's Language is, *Turning up the Wheels*.) is, first, to draw out a square Rod (as you were taught Numb. I. fol. 9. among the several *Heats of Iron*) somewhat thicker than you intend your *Wheel* shall be; but it must be almost as thin on one side, as you intend the inner edge of the *Wheel* shall be, and the opposite to it above twice that thickness, for the outer edge of the *Wheel*: the reason you will find by and by. Having drawn from your square Rod a convenient length, *viz.* almost three times the Diameter of your intended Wheel, you must take almost a *Flame-beat*, and Hammer all along the whole length upon the thick edge, so will you find the long Rod by this Hammering, turn by degrees rounder and rounder in, upon the thin edge, which you Hammer'd not upon, till it become a Circle, or pretty near a Circle. But you must make it somewhat more than a Circle, for the ends must lap over one another, that they may be *welded* upon one another.

Thus you may see the Reason for making the outer edge of the Rod thick, and the opposite Edge thin; for your Hammering upon the outer edge only, and not on the inner, makes the outer edge a great deal thinner, and at the same time makes the Wheel broader.

The

The Reason why I told you, you should draw fourth the Rod to almost three times the Diameter of the Wheel, and not to the Geometrical proportion ; is, because that in Hammering upon it to make it round, the Rod will stretch so considerably, that it will be long enough to make a *Wheel* of your intended Diameter , and most commonly somewhat to spare. But to return.

Before you take a *welding Heat*, as by *Numb. I.* fol. 9, 10. you must flatten the two ends that are to be *welded* together, to a little more than half their thicknes, that when they are lapt over one another, and *welded* together, they may be no thicker than the other part of the *Wheel*.

If the *Wheel* be not *turned up* so round, that with a little labour you may mend them at the *Vice*; you must with *Blood red Heats* Hammer them round upon the *Pike* or *Bickern* of the *Anvel*, holding with your *Tongs* the inner edge of the *Wheel* upon it, and Hammering upon the outer edge of the *Wheel*, till the *Wheel* be fit for the *Vice*: Their insides must be divided into four equal Parts or four *Dufftail* notches to be filed into them. The *Dufftail* notches are cut in the inner edge of the *Wheel*, somewhat more than a quarter of an Inch deep, and spreading somewhat wider towards the outer edge. The notches are to receive the four ends of a *Cross* Forged somewhat thicker towards the ends than the thicknes of the *Wheel*, and must be filed outer *Dufftails*, to let exactly into the inner *Dufftail* notches made in the inside of the *Wheel*. They must be Forged thicker than the *Wheel*, because they must batter over both the flat sides of the *Wheel*, to keep the *Wheel* strong and steady upon the *Cross*; and sometimes (for more security) they are *brazed* into the *Wheel* (yet that is but seldom) the middle of this *Cross*.

is made broad, that when the square of the *Spindle*, it may have strength enough to bear the violence offered at, as well in winding up the great weight, that keeps the *Wheels* in motion, as in the checking and turning the *Jack-winder* back, to set the *Jack* a going, when by the winding up, it may be subject to stand still, or sometimes, for want of weight. or else for want of Oiling or some other accident.

These *Wheels* thus Forg'd and Filed flat, must be divided, the *main Wheel* commonly into 64 equal parts, and the *worm Wheel* into 32 equal parts; but these Numbers are not exactly observ'd by Smiths, for sometimes they make them more and sometimes less, either according to the size of their *Wheels*, or according as they intend their *Wheels* shall go, swifter or slower about (for the fewer the *Teeth* on a *Wheel* are, the sooner a *Wheel* goes about and the more *Teeth* on a *Wheel*, the slower the *Wheel* goes about) or sometimes as they have open'd their Compasses to divide them: For if by luck, they at first open their Compasses to such a width, as will just measure out on a Circle, (which they describe on the Center of the *Wheel* for that purpose) their intended number, than the *Wheel* shall have the intended Number of *Teeth*; if not, let it somewhat fall short, or exceed that Number, they matter not, but make that Number of *Teeth* on the *Wheel*. And having thus divided the *Wheel*, they by the side of a straight Ruler laid to the Center, and every division markt on the *Wheel*, draw or scratch a straight line from the outer limb of the *Wheels*, to the Circle, which Circle (I should have told you before) is describ'd at that distance from the outer Verge, they intend the *Teeth* shall be cut down to. This is indeed a rough way of working, but the Office of a *Jack* is well enough performed by this rough Work;

Work; and the usual prizes such, as will scarce pay Workmen for better, as they say.

These *Wheels* thus divided, must be cut down into these Divisions with a *Jack-file*, the *Main-wheel* straight thwart the outer Verge, (which to speak Mathematically, makes an Angle of 90 degrees with the flat sides of the *Wheel*,) and the *Worm-wheel* aslope, making an Angle of about 115 degrees with its sides, that is, an Angle of 25 degrees, with a line drawn straight athwart the outer Edge of the *Wheel*, and that *Teeth* of the *Worm-wheel* may gather themselves into the *Grooves* of the *Worm* in the *Worm-spindle*; the *Worm* on the *Worm-spindle* running about 65 degrees aslope from this Axis, or Perpendicular of the *Worm-spindle*; the notches you make with the File must be so wide, as to contain about twice the thickness of each *Tooth*: Therefore you may observe, that the Number of *Teeth* cannot be assign'd, because the Sizes of all *Jack wheels* are not of equal Diameters, and the Sizes of the *Teeth* must be filed very square and smooth, as the corners taken off, and rounded on both sides towards the middle of the top or end of the *Tooth*, which much helps the *Teeth* to gather in upon the *Teeth* of the *Nut*, and the *Worm* on the *Worm-spindle*.

The *Teeth* of the *Wheels* being cut down, and the whole *Wheel* finish'd, they must be forc'd stiff and hard upon the square of the *Spindle*, close up to the Shoulder; which Square being made somewhat longer than the *Cross* of the *Wheel* is thick, must with a *Cold-Chisel* be cut on the top of that Square, to make the Iron that comes through the Square hole of the *Wheel*, spread over the *Cross* of the *Wheel*, and then that spreading must be battered with the *Pen* of the Hammer; that it may stand up stiff against the shoulder of the Square, on the other side of the *Wheel*; but in doing

doing this, you must be very careful that the *Spindle* stand exactly Perpendicular to the flat sides of your *Wheels*; for should the *Spindle* lean never so little to one, or the other side of the *Wheel*, the *Wheel* when it is moving in the *Jack-frame* would not move perpendicular, but wabble towards the *Fore* or *Backsides* of the *Jack-frame*, and perhaps by this irregular motion, before a revolution of the *Wheel* be perform'd, it would go off from the length of the *Teeth* of the *Nut*.

Then file the *Spindle-pins* (which are the ends of the *Spindle*, that go into the Center-holes of the *Fore* and *Backsides* of the *Jack-frame*) exactly round and fit to their Center-holes, and place them into their proper Center holes. Then try if the *Wheels* are exactly round on their outer edges, and that in turning about, their flat sides wabble not, but in a revolution keep Parallel to the *Fore* and *Backsides*. The way Smiths use to try them by is, to turn them about by the *Spindle*, and holding a piece of Chalk steady to the outer Limb of the *Wheel*, not letting the Point of the Chalk slip forwards or backwards; or towards the right or left Hand. for then if the Chalk make a white stroke round the whole *Wheel*, and that white stroke lie exactly Parallel to the two outer Edges of the *Wheel*, the *Wheel* is not only round, but stands also true upon its *Spindle*, that is, Perpendicular to the *Spindle*, and the *Spindle* Perpendicular to the flat of it: But if the Chalk does not touch round the *Wheel*, you must file down so much of the outer Verge of the *Wheel*, where the Chalk does touch, as will bring down or equalize the Diameter of the *Wheel* in that place, to the Diameter of the *Wheel* in the place where it does not touch; so you may conclude the *Wheel* is round. If the Mark of the Chalk lie not exactly in the middle between the two edges of the

the *Wheel*, then it is not Perpendicular to the *Spindle*, and you must with the Hammer set it right, that is Perpendicular, by forcing the *Wheel* over from the side it leans too much to, or else by forcing the *Spindle*, which is all one; yet this is an help you ought not to rely upon but in case of necessity; rather be sure your *Wheel* and *Spindle* stand Perpendicular to one another, before you fasten the *Wheel* upon the square of the *Spindle*, for by this help the square on the *Spindle* will be apt to loosen in the square of the *Wheel*, and you will have your *Wheel* to new fasten upon the Square of the *Spindle* again.

As you try'd the *Wheels* with Chalk; so you must try the *Nut*, the *Worm* and the *Spindle*.

The upper part of the *Worm-spindle*, must be Fil'd truly round to fit into the *Worm-loop*, that it shake not in it, and yet go very easily about, without the least stopping. At the upper end of this round on the *Worm Spindle*, you must file a square to fit the square hole of the *Fly* upon.

The *Shank* of the *Worm-loop* and the *Stud* of the *Worm-spindle*, must stand so far off the left side of the fore side, that the *Teeth* of the *Worm-wheel*, may fall full into the *Grooves* of the *Worm*; for so both being cut with the same slope, the slope *Teeth* of the *Worm-wheel* will gather into the slope *Grooves* of the *Spindle*, and pressing upon the *Worm*, drive about the *Worm-spindle* and the *Fly*.

The *Fly* is made sometimes with two, sometimes with four Arms from the Center, and sometimes the Arms are made longer, sometimes shorter: The more Arms, and also the longer Arms, are to make the *Jack* go slower.

There is yet a small matter more of Iron-work about the *Jack*, which is the *Tumbler*; but it lies in the farther end of the *Barrel*, and cannot well

be describ'd without a particular Figure, which therefore I have inserted. As in Fig. 2. A the *Barrel*, B the *Main-spindle* coming through the *Barrel*, <sup>a</sup> the Center of the *Tumbler* moving up on the *Center-pin*, which is fasten'd into an Iron-plate behind the *Barrel*. <sup>b</sup> The *Collar* upon the *Main-spindle*, from which proceeds a *Tongue*, which passes through a pretty wide hole at <sup>c</sup> in the *Tumbler*, as far as <sup>d</sup> the *Catch of the Tumbler*. The *Tumbler* moves as aforesaid, upon the Center hole <sup>a</sup>, but receives the *Tongue* through it at <sup>c</sup>, and passes as far as <sup>e</sup>. This *Tongue* serves as a *Check* to the *Tumbler*, that it cannot tumble above an Angle of 20 degrees, from the Iron-plate it is fasten'd to; and that the width of its Center-hole, and the width of the *Tongue* passes through, and the motion of the *Collar* about the *Main-spindle* allows it; but were the Center-hole <sup>a</sup>, and its *Center-pin* fit, and the Hole <sup>c</sup>, and the *Tongue* that also passes through it also fit, and the *Collar* fixt, it could not move at all. But this play is enough for it, to do the purpose it is design'd for. The *Tumbler* is so plac'd behind the *Barrel*, that while the *Jack-line* is winding up upon the *Barrel*, its round britch passes forwards by all the *Crosses* of the *Main-wheel*, and the *Point or Catch* <sup>d</sup>, as then claps it self snug or close to the Iron-plate of the *Barrel*: But when the *Barrel* is turn'd to the contrary way, the weight of the *Catch* in half a revolution of the *Barrel* (let the *Tumbler* be posited where it will) makes it open and fall from the Iron-plate, and butt against one or other of the *Crosses* on the *Main-wheel*, and so thrusts the *Main wheel* about with the *Barrel*.

The *Eye* of the *Winch* or *Winder*, is forg'd as you were taught to forge the *Pin-hole* in the *Cross-garnet*, Numb. II. fol. 18. But that was to be a small round hole, and therefore you were directly

ly, to lay a small round piece of Iron or Wyre, where you intended the Pin hole should be, and lap the other end of your Work over it; but this is to be a wide square hole, therefore you must lay a square piece of Iron of your size, where the *Eye* of the *Jack-winch* shall be and lap or double the other end over it, and Weld and Work as you were directed. The rest of the *Winch* is but common *Forging* and *Filing* Work, which hath been sufficiently taught already.

The Wood-work belonging to the *Jack*, is a *Barrel*, a *Spit-wheel* and a *Handing of the Winch*; which being *Turners Work*, I shall say nothing to, till I come to the Art of *Turning*. Only those *Wheels* that have more than one *Groove* in them, are call'd Two, Three, &c. *Struck-wheels*, in Workmens corrupting Language; but I suppose, originally two *Stroak*, three *Stroak-wheels*, &c. from the number of *Grooves* that are in them.

The Excellencies of a good *Jack* are, 1. That the *Jack-frame* be Forg'd and Fild Square, and conveniently Strong, well set together, and will Screw close and tight up. 2. That the *Wheels* be Perpendicularly, and strongly fix'd on the Squares of the *Spindles*. 3. That the *Teeth* be evenly cut and well smooth'd, and that the *Teeth* of the *Worm-wheel* fall evenly into the *Groove* of the *Worm*. 4. That the *Spindle Pins* shake not between the *Fore* and *Backsides*, nor are too big, or too little for their Center holes.

\* The *square Bore*, is a square Steel Point or Shank well Temper'd, fitted into a square Socket in an Iron *Wimble*: It is describ'd, Fig. 3. Its use is to open a Hole and make it truly round and smooth within; when you use it, you must set the Head against your

Breast, and put the Point of the *square Bore* into the Hole you punch'd or would open, and turning the Handle about, you with it turn about the Shank of the *square Bore*, whose Edges cut away the Irregularities of the Iron made in the Punching. But yon must thrust or lean hard with your Breast against the Head of the *square Bore*, that it may cut the faster: And you must be sure to guide the *square Bore* truly straight forwards in the Hole, lest the Hole be wrought a slope in the Iron.

<sup>b</sup> To open an Hole, is in Smith's Language, to make the Hole wider.

<sup>c</sup> A *Duffail*, is a Figure made in the form of a Doves-tail, and is us'd by many other Handycrafts, as well as Smiths, but most especially by Joyners, as I shall shew, when I come to Joynery.

<sup>d</sup> A *Jack-file*, is a broad File somewhat thin on both Edges, and stronger in the Middle.

### The manner of making Molds to Cast Leaden-Bullets in.

**I**nsert the making of *Bullet molds*, because there is some sort of Work in them different from what hath yet been taught. The Handles, and the Heads are Forged as other Work, but the two concave Hemisphers, are first Punch'd with a round ended *Punch*, of the shape and almost of the size you intend the Bullet shall be. They must be Punch'd deep enough at the *Forge* with a *blood red heat*; then are the Edges of the Chaps Filed flat, first with a common File the common way, but afterwards with an using File as Workmen call it. The using File, is a long and broad File, exactly flat on both its cut sides, having a square Iron handle down out at

one

one end with an hole in it ; but the Handle is not to hold it by when you use it, but the hole in it to go over a pin you hang it upon, when you do not use it. When you use it, you must lay it flat upon the Work bench, with its Handle, from you, and you must take care that it lies solid and steady, lest when you Work upon it, it slip from you ; therefore you may strike a Nail in at the hole in the Handle, a little way into the Work bench, that you may draw it again, when you have done with the *using File*, you may drive in a small Tack on each side the *using File*, to keep it steady or you may Tack down two small thin boards on either side and rip them off again when you have done. Your *using File* lying thus straight and steady before you, lay the Chaps of one half of the *Mold* flat upon the hither end of the *using File*, and holding your two Thumbs, and your two Fore-fingers upon the Head of the *Mold*, thrust your Work hard down from you the whole length of the *Using-file*, then draw your Work lightly back, and thrust it again hard from you ; retire these thrusts thus, till upon the Chaps of the *Mold*, you can see no irregularities, or the File-strokes of the common File left, so may you be sure that the Chaps of the *Mold* is truly flat. Do the like by the other half of the *Mold*.

Now you must try whether each of these concaves be an exact half-round ; thus you may describe an Arch a little more than a Semi-circle, just of the Diameter of the *Bullet*, upon the end of a thin piece of Brass-latin, draw a straight Line through the Center, and the Arch on both sides it, for the limits of the Semi-circle ; File very curiously all the Brass away on the end, just to this Semi-circle, and just to the Diametral-

D 3 line,

line, on either side of the Semi-circle, so have you a convex Semi-circle: Put this convex Semi-circle into the Concave *Molds*, if it fits them so as the Convex reaches just the bottom of the *Mold*, when its Shoulder touches just the Chaps of the *Mold*, they are each a true concave Hemisphere. But if the Shoulder of the Convex (that is, a Diametral-line prolong'd) rides upon the Chaps of the Concave, and the bottom of the Convex touch not the bottom of the Concave, the Concave is Punch'd too deep, and must have its Chaps rubb'd upon the *Using-file* again, till it comply with the Convex. Then put into the two Concaves a round *Bullet*, that will just fill them both, and pinching the Heads of the *Mold* close together in a *Vice*, with the *Bullet* in it, drill an hole through both the handles of the *Joint*. The reason why the *Bullet* is put into the *Mold* is, because the Chaps of the two Halves should lie exactly upon one another, whilst the hole for the *Joint* is drilling. Then fit a Rivet-pin for this hole, and Rivet them together, but not so hard, but that the *Mold* may open and shut pretty easie, and yet go true. Then take the *Bullet* out, and File in each half of the Head, half a round hole directly against one another for the *Gear*, which two half holes, when the *Mold* is shut, will make one round hole.

You may now try with Clay, or by casting a leaden *Bullet* in it, whether it be exactly round or no; for making a true round hole in a thin piece of Brass, just of the Circumference of the Chaps, you may try if the *Cast-bullet* will just pass thro', and also fill that hole when the *Bullet* is turn'd every way; which if it do, you may conclude the *Mold* is true. This thin piece of Brass, with a round hold in it, is call'd a *Sizer*.

But

But the inside wants cleansing, for hitherto it is only Punch'd. Therefore you must provide a <sup>b</sup> *Bullet-bore*, with which you may bore the inside of each half to clear it. Or if they be not quite deep enough Punch'd, you may bore them deeper. You may bore them severally, or together, by putting the *Bullet-bore* into the *Mold*, so as the *Sbank* may come through the *Gear*.

In this Section you see, first the use of a *U sing-file*, an Instrument of great use for a flat Filing; for by it you may make two pieces of Iron of somewhat considerable breadth, so true, that by laying the two flat sides upon each other, they shall draw up one another. It is much used by *Clock-makers*, *Watch-makers*, *Letter-mold-makers*, and indeed all others that frame Square-work on Iron, Steel or Brass. Secondly, the use of a *Bullet-bore*, which though it be seldom us'd, yet it may serve not only for *Bullet-molds*, but for other purposes; and by altering its shape into an Oblong, a Cone or Cilinder, you may bore these hollow Figures either for *Mold*s, or some other accidental Uses.

<sup>a</sup> A *Gear*, is the hole through which the Metal runs into the *mold*. The Word is us'd by most *Fonnders*.

<sup>b</sup> The *Bullet-bore*, is a *Shank* of Steel, having a Steel *Globe* or *Bullet* at one end, just of your intended *Bullet* size. This Globular end must be Hatch'd with a fine cut, by a *File-cutter*, and Harden'd and Temper'd. The end of the *Sbank*, this Globular Bore is fastned to, must be round and so small, that when the *Bullet-bore* is in the *mold*, the *Gear* will easily receive it. The other end of the *Sbank* must be fitted into the square Socket of the *Wimble*, and have a Shoulder to it,

to stop the Socket from sliding too far upon the *Shank*. From this Shoulder, the rest of the *Shank* must run Tapering down, to the small end the *Bullet-bore* is fastned to. You must Work with it, as you were taught to Work with the *Square-bore*.

#### *Of Twisting of the Iron.*

**S**quare and flat Bars, sometimes are by Smiths, Twisted for Ornament. It is very easily done; for after the Bar is Square or flat Forg'd (and if the curiosity of your Work require it truly Fil'd) you must take a *Flame-beat*, or if your Work be small, but *Blood-red beat*, and you may twist it about, as much or as little as you please, either with the *Tongs*, *Vice* or *Hand-vise*, &c.

#### *Of Case-hardning.*

**C**ase-hardning is sometimes us'd by *File-cutters*, when they make coarse *Files* for Cheapness, and generally most *Rasps* have formerly been made of Iron and *Case-hardned*, because it makes the outside of them hard. It is us'd also by *Gun-smiths*, for Hardning their Barrels; and it is us'd for *Tobacco-boxes*, *Cod-piece-buttons*, *Heads* for *Walking-staves*, &c. And in these Cases, Workmen to set a greater value on them in the Buyers esteem, call them *Steel-barrels*, *Steel-tobacco-boxes*, *Steel-buttons*, *Steel-heads*, &c. But Iron thus hardned takes a better Polish and keeps the Polish much longer and better, than if the Iron were not *Case hardened*. The manner of *Case-hardning* is thus, Take *Cow-bone* or *Hoof*, dry it thoroughly in an Oven, and then beat it to Powder, put about the same quantity of Bay-Salt to it, and mingle them together with stale Chamberly, or else White-wine-vinegar. Lay some of this mixture upon the Lcain, made as you were taught

taught Numb. I. fol. 13. And cover your Iron all over with it ; then wrap the Loam about all, and lay it upon the Hearth of the Forge to dry and harden : When it is dry and hard, put it into the Fire and blow up the Coals to it, till the whole Lump have just a *Blood-red-heat*, but no higher, lest the quality of your mixture burn away and leave the Iron as soft as at first. Then take it out and quench it : Or, instead of Loam, you may wrap it up in Plate Iron, so as the mixture may touch every part of your Work, and blow the Coals to it, as aforesaid.

*Of several sorts of Steel in common use among Smiths.*

THE difficulty of getting good Steel makes many Workmen (when by good hap they light on it) commend that Country-Steel for best, from whence that Steel came. Thus I have found some cry up *Flemish-steel*, others *Swedish*, *English*, *Spanish*, *Venice*, &c. But according to my Observation and common Consent of the most ingenious Workmen, each Country produces almost indifferently good and bad ; yet each Country doth not equally produce such Steel, as is fit for every particular purpose, as I shall shew you by and by. But the several sorts of Steel, that are in general use here in *England*, are the *English*, the *Flemish*, the *Swedish*, the *Spanish* and the *Venice-steel*.

The *English-steel* is made in several places in *England*, as in *Yorkshire*, *Gloucestershire*, *Sussex*, the *Wild of Kent*, &c. But the best is made about the *Forrest of Dean*, it breaks Fiery, with somewhat a course Grain. But if it be well wrought and proves sound, it makes good Edge-tools, Files and Punches. It will work well at the Forge, and take a good Heat.

The

The *Flemish-steel* is made in *Germany*, in the Country of *Siermark* and in the *Land of Luyck*: From thence brought to *Colen*, and is brought down the River *Rbine* to *Dort*, and other parts of *Holland* and *Flanders*, some in Bars and some in *Gads*, and is therefore by us call'd *Flemish-steel*, and sometimes *Gad-steel*. It is a tough sort of Steel, and the only Steel us'd for Watch-springs. It is also good for Punches; File-cutters also use it to make their Chissels of, with which they cut their Files. It breaks with a fine Grain, works well at the Forge, and will take a welding Heat.

I cannot learn that any Steel comes from *Sweden*, but from *Danzick* comes some which is call'd *Swedish-steel*: It is much of the same Quality and Finesse with *Flemish-steel*.

The *Spanish-steel* is made about *Biscay*. It is a fine sort of Steel, but some of it is very difficult to work at the Forge, because it will not take a good Heat; and it sometimes proves very unsound, as not being well *curried*, that is well wrought. It is too quick (as Workmen call it) that is, too brittle for Springs or Punches, but makes good fine Edg'd-tools.

*Venice-steel* is much like *Spanish-steel*, but much finer, and Works somewhat better at the Forge. It is us'd for Razors, Chirurgeon's Instruments, Gravers, &c. Because it will come to a fine and thin Edge. Razor makers generally clap a small Bar of *Venice-steel* between two small Bars of *Flemish-steel*, and so Work or Weld them together, to strengthen the back of the Razor, and keep it from cracking.

There

There is another sort of Steel, of higher commendations than any of the forgoing sorts. It is call'd *Damascus-steel*; 'tis very rare that any comes into *England* unwrought, but the *Turkish-Cymeters* are generally made of it. It is most difficult of any Steel to Work at the Forge, for you shall scarce be able to strike upon a Blood-heat, but it will *Red-scar*; insomuch that these *Cymeters* are, by many Workmen, thought to be cast Steel. But when it is wrought, it takes the finest and keeps the strongest Edge of any other Steel. Workmen set almost an inestimable value upon it to make Punches, Cold-punches, &c. of. We cannot learn where it is made, and yet as I am inform'd, the Honourable Mr. *Boyl* hath been very careful and industrious in that enquiry; giving it in particular charge to some Travellers to *Damascus*, to bring home an Account of it: But when they came thither they heard of none made there, but were sent about 50 Miles into the Country and then they were told about 50 Miles farther than that: So that no certain Account could be gain'd where it is made. *Kirman* towards the Ocean affords very fine Steel, of which they make Weapons highly priz'd; for a *Cymeter* of that Steel, will cut through an Helmet with an easie blow. *Geog. Rect. fol. 279.*

*The Rule to know good Steel by.*

**B**reak a little piece of the end of the Rod, and observe how it breaks; for good Steel breaks short of all Gray, like frost work Silver. But in the breaking of the bad you will find some veins of Iron shining and doubling in the Steel.

Of

*Of Nealing of Steel.*

**H**aving chose your Steel and forg'd it to your intended shape, if you are either to File Engrave or to Punch upon it, you ought to Neal it first, because it will make it softer and consequently work easier. The common way is to give it a *Blood-red-beat* in the Fire, then take it out, and let it cool of it self.

There are some pretenders to know how to make Steel as soft as Lead; but so oft as my Curiosity has prompted me to try their pretended Proceſſes, so oft have they fail'd me; and not only me, but some others, careful Observers. But the way they most boast of, is the often heating the Iron or Steel in red-hot Lead, and letting it cool of it self with the Lead. I have many times try'd this without any other success, than that it does make Iron or Steel as soft as if it were well Neal'd the common way, but no softer: And could it be otherwise, the small Iron Ladles, that Letter-founders use to the casting of Printing Letters, would be very soft indeed; for their Iron Ladles are kept constantly Month after Month in melting Mettal, whereof the main Body is Lead, and when they cast small Letters, they keep their Mettal red-hot; and I have known them many times left in the Mettal and cool with it, as the Fire has gone out of it self; but yet the Iron Ladles have been no softer, than if they had been well Neal'd the common way. But perhaps these Pretenders mean the Iron or Steel shall be as soft as Lead, when the Iron or Steel is red-hot; if so, we may thank them for nothing.

But

But that which makes Steel a very small matter softer than the common way of Nealing is, by covering Steel with a course Powder of Cow-Horns, or Hoofs, or Rams-Horns, and so inclosing it in a Loam: Then put the whole Lump into a Wooden Fire to heat red-hot and let it lie in the Fire till the Fire go out of it self, and the Steel cool with the Fire.

#### Of Hardning and Tempering Steel.

**E**nghish, Flemish and Swedish-steel, must have a pretty high heat given them, and then suddenly quench in Water to make them very hard; but Spanish and Venice-steel will need but a Blood-red-heat, and then when they are quench'd in Water, will be very hard. If your Steel be too hard, that is to brittle, and it be an edg'd or pointed Instrument you make, the edge or point will be very subject to break; or if it be a Spring, it will not bow, but with the least bending it will snap assunder: Therefore you must *let it down* (as Smiths say) that is, make it softer, by *tempering* it: The manner is thus, take a piece of Grin-stone or Whet-stone and rub hard upon your Work to take the black Scurf off it, and brighten it; then let it heat in the Fire, and as it grows hotter you will see the Colour change by degrees, coming to a light goldish Colour, then to a dark goldish Colour, and at last to a blew Colour; choose which of these Colours your Work requires, and then quench it suddenly in Water. The light goldish Colour is for Files, Cold-chisells and Punches, that Punch into Iron and Steel: The dark goldish Colour for Punches to use on Bras, and generally for most Edge-tools: The blew Colour gives the Temper to Springs in general, and is also us'd to Beautifie both Iron and Steel; but then Workmen sometimes

times grind *Indico* and *Sallad-oyl* together, and rub that mixture upon it, with a woollen Rag, while it is heating, and let it cool of it self.

There is another sort of *Hardning*, call'd *Hammer-hardning*: It is most us'd on Iron or Steel Plates, for *Dripping patts*, *Saws*, *Straight-Rulers*, &c. It is perform'd only, with well Hamnering of the Plates, which both smooths them, and beats the Mettal firmer into its own Body, and somewhat hardens it.

The manner of Forging Steel, either for Edge-tools, Punches, Springs, &c. Is (the several shapes consider'd) the same with forging Iron: Only this general Rule observe, from an old English Verse us'd among Smiths, when they Forge Edge-tools,

*He that will a good Edge win,  
Must Forge thick and Grind thin.*

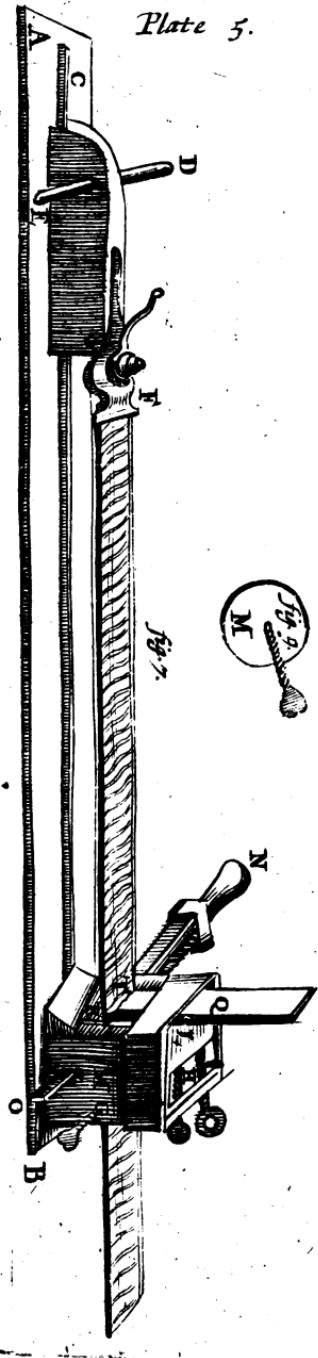
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*The End of Smithing.*

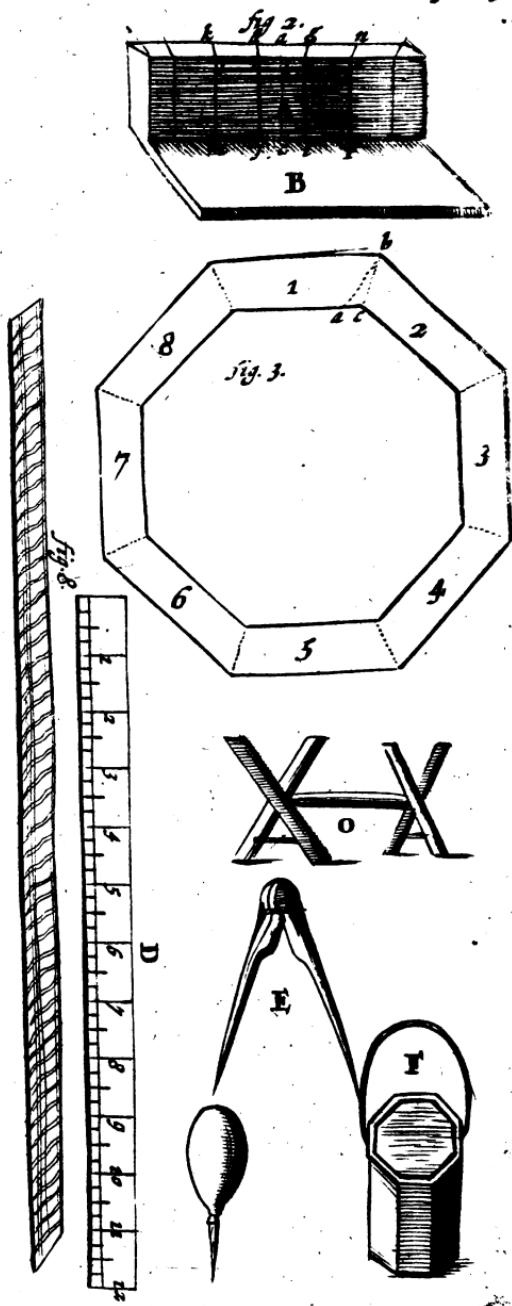
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*MECHANICK*

Plate 5.



Page 63





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## MECHANICK EXERCISES;

O R,

### The Doctrine of *Handy-Works*

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#### *The Art of JOINERY.*

##### *Definition.*

**J**OINERY, is an Art Manual, whereby several Pieces of Wood are so fitted and join'd together by Straight-line, Squares, Miters or any Bevel, that they shall seem one intire Piece.

##### *Explanation.*

By *Straight-Lines* I mean that which in Joyner's Language is call'd a Joint, That is, two Pieces of Wood are Shot (that is Plained,) or else they are Pared, that is, the irregularities that hinder the closing of the two Pieces are cut off with a Pairing-chissel. They are Shot or Pared (as I said) so exactly straight, that when they are set upon one another, light shall not be discern'd betwixt them. This they call Shooting of a Joint, or Paring to a Joint, because these two Pieces are with Glew commonly join'd together, either to make a Board broad enough for their purpose, or to <sup>a</sup> Clamp one piece of Wood to the end of another piece of Wood to keep it from Casting or Warping.

By

By *Squares*, I mean the making of Frames, either for Door-cases or such like, which is the Framing of two pieces of Wood athwart two other pieces of Wood, so as the four Angles of the Frame may comply with the *Square* marked D.

By *Miters* are meant the joining of two pieces of Wood, so as the Joint makes half a Square, and does comply with the *Miter-square* marked E.

By a *Bevel* is meant any other Angle: As Frames that may be made of *Pentagon*, *Hexagon*, *Ottagon*, &c. Figures.

*S i. The Names of Joyners Tools describ'd, in  
Plate IV. pag 68*

**A** A Work-bench. *b* The Hook in it, to lay Boards or other *b* Stuff flat against, whilst they are *c* Trying or Plaining. *c* The Bench-Screw (on its hither side) to Screw Boards in, whilst the Edges of them are Plaining or *d* Shooting; and then the other edge of the Board is set upon a Pin or Pins (if the Board be so long as to reach the other Leg) put into the Holes marked *a a a a a* down the Legs of the Bench; which Pin or Pins may be removed into the higher or lower holes, as the breadth of the Board shall require: So then, the Bench-screw keeps the Board close to the edge of the Bench, and the Pins in the Legs keep it to its height, that it may stand steddy whilst the other edge is working upon: For in the Shooting of a Joint, if the Board keeps not its exact position, but shakes or trembles under the Plain, your Joint will very hardly be truly straight. *d* The Hold-fast, let pretty loose into round holes marked *b b b b b*, in the Bench: Its Office is to keep the Work fast upon the Bench, whilst you either Saw, Tenant,  
Mor-

Mortess, or sometimes Plain upon it, &c. It performs this Office with the knock of an Hammer, or Mallet, upon the head of it; for the Beak of it being made crooked downwards, the end of the Beak falling upon the flat of the Bench, keeps the head of the Hold-fast above the flat of the Bench, and the hole in the Bench the Shank is let into being bored straight down, and wide enough to let the Hold-fast play a little, the head of the Hold-fast being knockt, the point of the Beak throws the Shank a-slope in the hole in the Bench, and presses its back-side hard against the edge of the hole on the upper Superficies of the Bench, and its fore-side hard against the opper-site side of the under Superficies of the Bench, and so by the point of the Beak, the Shank of the Hold-fast is wedged between the upper edge, and its opper-site edge of the round hole in the Bench. Sometimes a double Screw is fixed to the side of the Bench, as at g; or sometimes its farther Cheek is laid an edge upon the flat of the Bench, and fastned with an Hold-fast, or, sometimes, two on the Bench. e A Mallet.

### §. 2. B B B B B B B Plains of several Sorts: as,

B i. **A** Fore Plain. a The Tote. b The Mouth.  
c The Wedge. d The Iron. e The Sole.  
f The Fore-end. g The Britcb. f g b The Stock.  
All together **A Plane**. It is called the Fore Plane because it is used before you come to work either with the Smooth Plane, or with the Foynter. The edge of its Iron is not ground upon the straight, as the Smooth Plane, and the Foynter are, but rises with a Convex-Arch in the middle of it; for its Office being to prepare the Stuff for either the Smoothing Plane, or the Foynter, Workmen set the edge of it e Ranker than the edge either of the Smoothing Plane, or the Foynter; and should the Iron of the Plane be ground to a straight edge,

and it be set never so little *Ranker* on one end of the edge than on the other, the *Ranker* end would (bearing as then upon a point) in working, dig Gutters on the Surface of the *Stuff*; but this *Iron* (being ground to a Convex-Arch) though it should be set a little *Ranker* on one end of its edge than on the other, would not make Gutters on the Surface of the *Stuff*, but (at the most) little hollow dawks on the *Stuff*, and that more or less, according as the *Plane* is ground more or less Arching. Nor is it the Office of this *Plane* to smooth the *Stuff*, but only (as I said) to prepare it, that is, to take off the irregular Risings, whether on the sides, or in the middle, and therefore it is set somewhat *Ranker*, that it may take the Irregularities the sooner off the *Stuff*, that the *Smoothing Plane*, or the *Joynter*, may afterwards the easier work it *Try*. The manner of *Trying* shall be taught, when I come to Treat of the use of the *Rule*.

You must note, that as I told yon in *Smithing*, *Num. I. fol. 14, 15, 16.* it was the Office of the *course tooth'd File* to take off the prominent Irregularities the *Hammer* made in the *Forging*, &c. and that you were not to *file* them more away than you need, so the same Caution is to be given you in the using of this *fore Plane* in *Joynery*, for the reason there alledged in *Smithing*, whether, to avoid Repetition, I refer you; only with this Consideration, that there *Iron*, or *Steel*, was the matter wrought upon, and there a *course File* the *Tool*; but now *Wood* is the matter, and a *Course*, or *Fore-Plane*, the *Tool*.

### §. 3 Of setting the *Iron*.

**W**hen you set the *Iron* of the *Fore-Plane*, consider the *Stuff* you are to work upon, *viz.* Whether it be *hard* or *soft*, or *Curling*, as *Joyners* call

call *Cross grain'd Stuff*: If it be *hard* or *curling*, you must not *set* the *Iron* veay *rank*, because a Man's strength will not cut deep into hard *Wood*; and if it be not hard *Wood*, but *curling*, or *knotty*, and the *Iron Rank-set*, you may indeed work with it till you come to some *Knot*, or *Curl*, but then you may either tear your *Stuff*, or break the edge of your *Iron*; therefore you may perceive a reason to *set* the *Iron* fine for *curling*, and *knotty Stuff*.

But if you ask me how *rank* your *Iron* ought to be set? I answer, If your *Wood* be *soft*, and your *Stuff* *free*, and *frowy*, that is, evenly temper'd all the way, you may *set* the *Iron* to take a shaving off the thickness of an old coined Shilling, but scarce thicker; whereas, if your *Stuff* be *hard*, or *curling*, or *knotty*, you shall scarce be able to take a shaving off the thickness of an old Groat. Therefore you must examine the Temper of your *Stuff*, by easy Trials, how the *Plane* will work upon it, and *set* your *Iron* accordingly. And observe this as a General Rule, that the *Iron* of the *Fore-Plane* is, for the first working with it, to be *set* as *rank* as you can make good work with; and that for speed sake.

If your *Iron* be *set* too *rank*, knock with an *Hamer* upon the *Britcb* of the *Stock*, and afterwards upon the *Wedge*; for this knocking upon the *Britcb*, if you knock hard enough, 'twill raise the *Iron* a little, and *set* it *fine*; if you knock not hard enough, you must knock again, till the *Iron* do rise; but if you knock too hard, it will raise the *Iron* so much, that its edge will rise above the *Sole* into the *Mouth* of the *Stock*, and consequently not touch the *Stuff*: Therefore you must knock softly at first, till, by trials, you find the *Iron* rises to a convenient *fineness*. But as this knocking on the *Britcb* raises the *Iron*, so it also raises and loosens the *Wedge*; therefore (as aforesaid) whenever

E 2

you

you knock upon the *Britch*, you must also knock upon the *Wedge*, to soften the *Iron* again.

If you have raised the edge of the *Iron* too fine, you must knock softly upon the head of the *Iron*, and then again upon the *wedge*, and this you may sometimes do several times, till you fit your *Iron* to a convenient fineness.

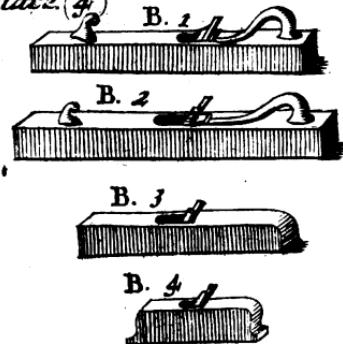
When you have occasion to take your *Iron* out of the *Stock* to rub it, that is, to *whet* it, you may knock pretty smart Blows upon the *Stock*, between the *Mouth* and the *Fore-end*, to loosen the *Wedge*, and consequently the *Iron*.

These ways of *setting*, are used to all other *Planes*, as well as *Fore-planes*.

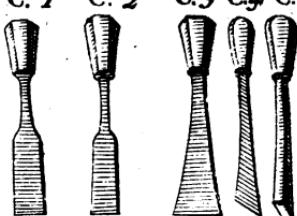
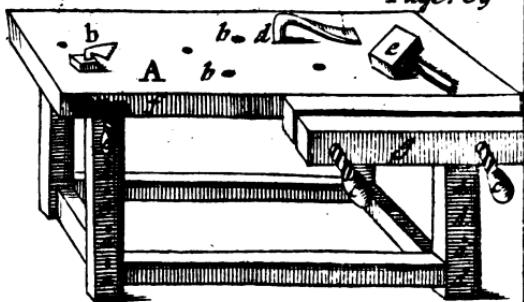
In the using of this, and indeed, all other *Planes*, you must begin at the hinder end of the *Stuff*, the *Grain* of the Wood lying along the length of the *Bench*, and Plane forward, till you come to the fore-end, unless the *Stuff* proves *Cross-grain'd*, in any part of its length; for then you must turn your *Stuff* to Plane it the contrary way, so far as it runs *Cross-grain'd*, and in Planeing, you must, at once, lean pretty hard upon the *Plane*, and also thrust it very hard forwards, not letting the *Plane* totter to, or from you-wards, till you have made a Stroak the whole length of the *Stuff*. And this sometimes, if your *Stuff* be long, will require your making two or three steps forwards, e'er you come to the fore-end of the *Stuff*: But if it do, you must come back, and begin again at the farther end, by the side of the last plan'd Stroak, and so continue your several lays of Planeing, till the whole upside of the *Stuff* be planed.

And if the *Stuff* be broad you are to Plane upon, and it *warp* a little with the *Grain*, or be any ways crooked in the breadth, you must then turn the *Grain* athwart the *Work-bench*, and Plane upon the

Plate (4)



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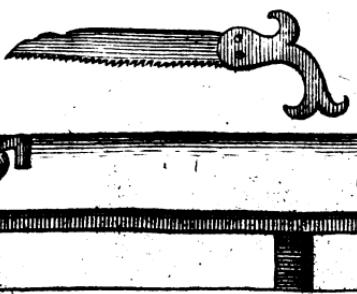
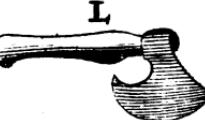
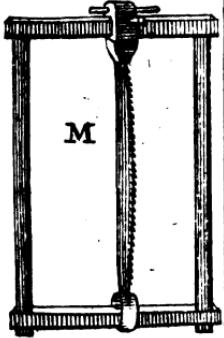
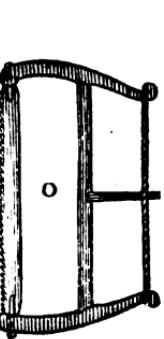
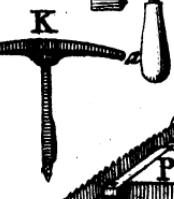
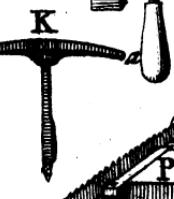
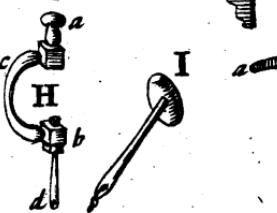
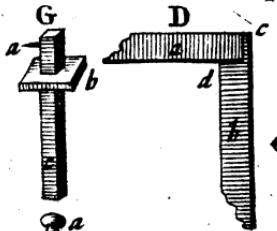
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the *Cross-grain*. For, if your work be hollow in the middle, you must Plane both the Bearing sides thinner, till they come to a *Try* with the middle. Then turn the other side of your work, and working still *Cross-grain'd*, work away the middle, till it come *Try* with the two sides.

This way of *Cross-grain'd* working, is, by Workmen, called *Traversing*.

Thus have you, in general, the use of all the other *Planes*: But the use of those Planes, that are designed for other particular purposes, I shall shew, as they come in Order.

#### §. 4. Of the *Joynter*. B. 2.

**T**HE *Joynter* is made somewhat longer than the *Fore-plane*, and hath its *Sole* perfectly straight from end to end. Its Office is to follow the *Fore-plane*, and to *shoot* an edge perfectly straight, and not only an edge, but also a Board of any thickness; especially when a *Joynt* is to be *shot*. Therefore the Hand must be carried along the whole length, with an equal bearing weight, and so exactly even, and upright to the edges of the Board, that neither side of the *Plane* encline either inward or outwards, but that the whole breadth be exactly square on both its sides; supposing its sides straight: so will two edges of two Boards, when thus *shot*, lie so exactly flat and square upon one another, that light will not be discerned betwixt them. But yet it is counted a piece of good Workmanship in a *Joynter*, to have the Craft of bearing his Hand so curiously even, the whole length of a long Board; and yet it is but a sleight to those, Practice hath inur'd the Hand to. The *Joynter* is also used to *Try* Tables with, ( large or small ) or other such broad Work; and then *Joynters* work, as well upon the *Traverse* with it, as with the Grain of the

Wood, and also Angularly, or Corner-wise, that they may be the more assur'd of the flatness of their Work.

Its *Iron* must be *set very fine*, so fine, that when you wink with one Eye, and set that end the straight side of the *Iron* is next to the other Eye, there appears a little above an hairs breadth of the edge above the Superficies of the *sole* of the *Plane*, and the length of the edge must lie perfectly straight with the flat breadth of the *sole* of the *Plane*: For the *Iron* being then well wedg'd up, and you working with the *Plane* thus *set*, have the greater assurance that the *Iron* cannot run too deep into the *Stuff*, and consequently you have the less danger that the *Joynt* is wrought out of straight.

#### §. 5. The Use of the *Strike-block*.

The *Strike-block* marked B 3. is a *Plane* shorter than the *Joynter*, having its *sole* made exactly flat, and straight, and is used for the *shooting* of a short *Joynt*; because it is more handy than the long *Joynter*. It is also used for the framing, and fitting the *Joynts* of *Miters* and *Bevels*; but then it is used in a different manner from other *Planes*: For if the *Miter* and *Bevel* you are to fit be small, you must hold it very steddy in your left hand, with the *sole* of it upwards, and its fore-end towards your right hand: and you must hold your work in your right hand very steddy: Then apply the fawn *Miter*, or fawn *Bevel* at the end of your *Stuff*, to the fore-end of the *Strike-block*, and so thrust it hard and upright forwards, till it pass over the edge of the *Iron*, so shall the edge of the *Iron*, with several of these thrusts continued, cut, or plane off your *stuff* the roughness that the *Teeth* of your *Saw* made: But if your work be so big that you cannot well weild it

it in your right hand, you must set the end of your work in the *Bench-screw*, and Plane upon it with a *smoothing Plane*.

### §. 6. *The Use of the Smoothing-Plane.*

**T**He *Smoothing-plane* marked B 4. must have its *Iron* set very fine, because its Office is to smoothen the work from those Irregularities the *Fore-plane* made.

### §. 7. *The Use of the Rabbet-Plane.*

**T**He *Rabbet-plane* marked B 5. is to cut part of the upper edge of a Board, or other *Stuff*, straight, that is, square down into the Board, that the edge of another Board also cut down in the same manner, may fit and join into the Square of the first Board thus cut away: And when two Boards are thus *lapped* on the edges over one another; this *lapping* over is called *Rabbetting*.

The *Rabbet-plane* is also sometimes used to strike a *Facia* in a piece of *Molding*; as shall be shewed in its proper place.

The sides of the *Iron* are not inclosed in the *Stock* of this *Plane*, as the fore-going *Planes* are, but the *Iron* is full as broad as the *stock* is thick, that the very Angles of the edge of the *Iron* may not be born off the *Stuff*, to hinder the straight and square cutting it down: Nor doth it deliver its shaving at a *Mouth* on the top of the *Stock* as the other *Planes* do: But it hath its *Mouth* on the sides of the *Plane*, and delivers its shavings there. Its *Iron* is commonly about an Inch broad.

### §. 8. *The Use of the Plow.*

**T**He *Plow* marked B 6. is a narrow *Rabbet-plane*, with some Additions to it: viz. two square *Staves*, marked *aa* (yet some of them

have the upper edges of them rounded off for the better compliance with the Hand.) These *Staves* are let stiff through two square Mortesles in the *Stock*, marked *b b*. They are about seven or eight Inches long, and stand straight and square on the farther side of the *Stock*; and these two *Staves* have shoulders on the hither side of the *Stock*, reaching down to the wooden sole of the *Plane*, (for there is also an *Iron sole* belonging to the *Plow*.) To the bottom of these two Shoulders is, Rivitted with Iron Rivets, a *Fence* (as Workmen call it) which comes close under the *Wooden sole*, and its depth reaches below the *Iron sole* about half an Inch: Because the *Iron* of the *Plow* is very narrow, and the sides of it towards the bottom are not to be inclosed in the *Stock*, for the same reason that was given in the *Rabbet-plane*; therefore upon the *Stock* is let in, and strongly nailed, an *Iron Plate* of the thickness of the *Plow-Iron*, for Wood of that breadth will not be strong enough to endure the force the lower end of the *Plow-Iron* is put to: This *Iron-Plate* is almost of the same thickness that the breadth of a *Plow-Iron* is. *Joiners* have several *Plows*, for several widths of *Grooves*.

The Office of the *Plow* is, to plow a narrow square *Groove* on the edge of a *Board*; which is thus perform'd. The *Board* is set an edge with one end in the *Bench-screw*, and its other edge upon a *Pin*, or *Pins*, put into a *Hole*, or *Holes* in the *Leg*, or *Legs* of the *Bench*, such an *Hole*, or *Holes*, as will, most conveniently for height, fit the breadth of the *Board*: Then the *Fence* of the *Plow* is set to that Distance off the *Iron-Plate* of the *Plow*, that you intend the *Groove* shall lie off the edge of the *Board*: As if you would have the *Groove* lie half an Inch off the *Board*, then the two *staves* must, with the *Mallet*, be knocked through

through the Mortesles in the Stock, till the Fence stands half an Inch off the Iron-Plate ; and if the Staves are fitted stiff enough in the Mortesls of the Stock, it will keep at that Distance whilst you Plow the Groove : For the Fence ( lying lower than the Iron of the Plane) when you set the Iron of the Plow upon the edge of the Board, will lie flat against the farther edge of the Board, and so keep the Iron of the Plow all the length of the Board at the same Distance, from the edge of the Board that the Iron of the Plow hath from the Fence. Therefore your Plow being thus fitted, plow the Groove as you work with other Planes, only as you laid hold on the Stock of other Planes when you use them, now you must lay hold of the two staves and their shoulders, and so thrust your Plow forwards, till your Groove be made to your depth.

If the Staves go not stiff enough in the Mortesls of the Stock, you must stiffen them, by knocking a little wooden Wedge between the Staves and their Mortesles.

#### §. 9. Of Molding-Planes.

There are several other Planes in use amongst Joyners, called *Molding-planes*; as, the *Round*, the *Hollow*, the *Ogee*, the *Snipes-bill*, the *Rabbit-plane*, the *Grooving-plane*, &c. And of these they have several sorts, viz. from half a quarter of an Inch, to an Inch and a half. They are used as other Planes are. In the Planeing of Stuff, you must use Planes whose Irons have different Mountings; and that according to the hardness, or softness of the Wood, you are to work upon: For if the Wood be hard, the Iron must stand more upright than it need do, if the Wood be soft: For soft Wood, as *Deal*, *Pear-tree*, *Maple*, &c. The Iron is set to make an Angle of 45 Degrees,

grees, with the *Sole* of the *Plane*: But if it be very hard Wood you are to Plane upon, as *Box*, *Ebony*, *Lignum Vitæ*, &c. It is set to 80 Degrees, and sometimes quite upright: So that these hard Woods, are, indeed, more properly said to be Scraped, than Planed.

But before you come to use your *Planes*, you must know how to grind, and whet them, for they are not so fitted when they are bought, but every Workman accommodates them to this purpose, as if it be an hard Wood he is to work on, he grinds his *Basil* to a more obtuse Angle, than he would do for soft Wood.

The *Basil*, or Angle, an Iron is ground to, to work on soft Wood is about 12 Degrees, and for hard Wood about 18, or 20 Degrees. Where note, That the more acute, or thinner the *Basil* is, the better and smoother the *Iron* cuts; and the more obtuse and thicker, the stronger the Edge is to work upon hard Work.

#### §. 10. Of Grinding and Whetting the Iron, and other Edge-Tools.

**W**HEN you grind your *Iron*, place your two Thumbs under the *Iron*, and your Fingers of both Hauds upon the *Iron*, and so clap down your *Iron* to the *Stone*, holding it to that Angle with the *Stone* you intend the *Basil* shall have: Keep the *Iron* in this Posture, without either mounting, or sinking its ends all the while the *Stone* is turning about; and when you lift the *Iron* off the *Stone*, to see if it be ground to your Mind; if it be not, you must be sure you place the *Iron* again in the same Position on the *Stone* it had before; for else you will make a double *Basil* on your *Iron*: But if it be true set on the *Stone*, and steddily kept to that Position, your *Basil* will be *Hollow*, and the smaller your *Grind-stone*

*Stone* is, the hollower it will be. You may know when it is well Ground, by the evenness, and entirenes of the Edge all the way.

Having ground your *Iron*, you must smoothen the edge finer with a good *Whet-stone*. Thus, hold the edge of your *Iron* upwards in your left Hand, and your *Whet-stone* in your right, and having first spit upon your Stone to wet it, apply it to the *Basil* of your *Iron*, in such a Position, that it may bear upon the whole breadth of the *Basil*; and so working the *Stone* over the *Basil*, you will quickly wear the courser grating of the *Grind-stone* off the edge on that side: Then turn the flat fide of the *Iron*, and apply the *Stone* flat to it, till you have worn off the course gratings of the *Grind-stone*, on that side too.

Joiners often grind their *Irons* upon a flat *Grind-stone* also: And then they hold the *Iron* also in their Hands, in the same Posture as if it were to be ground on the *Round Grind-stone*: Yet then instead of keeping the *Iron* on one place of the *Stone*, they thrust it hard straight forwards, almost the length of the *Stone*, and draw it lightlier straight back again, keeping it all the while at the same Angle with the Superficies of the *Stone*; and then smoothen its edge with the *Whet-stone*, as if it had been ground upon the round *Grind-stone*. And this they do so often, till they have rubbed the hollownes of the *Basil* to a flat, and then they grind it again upon the round *Grind-stone*.

This Order and Manner of *Setting*, *Grinding* and *Smoothing* a *Basil* and *Edge*, is also used in all other *Edge-tools* *Joiners* use.

S. 10. Of Chisels of several Sorts.  
And first of Formers.

**F**ormers marked C 1. C 3. are of several sizes. They are called *Formers*, because they are used before the *paring Chissel*, even as the *fore Plane* is used before the *smoothing Plane*. The *Stuff* you are to work upon being first scribed, (as I shall shew in its proper place) you must set the edge of the *Former*, a little without the scribed *Stroak*, with its *Basil* outwards, that it may break, and shoulder off the *Chips* from your Work, as the Edge cuts it. And you must bear the *Helve* of the *Former* a little inwards over the *Stuff*, that the *Former* do not at first cut straight down, but a little outwards: For, should you venture to cut straight down at the first, you might with a negligent, or unlucky knock with the *Mallet*, drive the edge of the *Former* under the work, and so cut, before you are aware, more off the under side than the upper side of your Work, and so (perchance) spoil it. Therefore you may make several Cuttings, to cut it straight down by little and little, till your Work is made ready for the *paring Chissel*. When it is used, the *Helve* of it is knockt upon with a *Mallet*, to drive the edge into the *Stuff*.

S. 11. Of the Paring-Chissel.

**T**he *Paring-Chissel* marked C 2. must have a very fine and smooth edge: Its Office is to follow the *Former*, and to *pare off*, and *smoothen*, the Irregularities the *Former* made.

It is not knockt upon with the *Mallet*, but the Blade is clasped upon the out-side of the hindermost Joints of the fore and little Fingers, by the clutched inside of the middle and third Fingers

Fingers of the right Hand, and so its edge being set upon the *scribed line*, and the top of the *Helve* placed against the hollow of the inside of the right shoulder, with pressing the shoulder hard upon the *Helve*, the edge cuts and pares away the Irregularities.

This way of handling, may seem a Preposterous Posture to manage an Iron Tool in, and yet the reason of the Original Contriver of this Posture is to be approved; For, should Workmen hold the *Blade* of the *Paring-Chisel* in their whole Hand, they must either hold their Hand pretty near the *Helve*, where they cannot well manage the *Tool*, or they must hold it pretty near the edge, where the outside of the Fingers will hide the *scribed line* they are to *pare* in. But this Posture, all Workmen are at first taught, and Practice doth so inure them to it, that if they would, they could not well leave it.

#### §. 12. Of the Skew-Former.

The *Skew-Former* marked C 4. is seldom used by Joiners, but for cleansing acute Angles, with its acute Angle on its edge, where the Angles of other *Chisels* will not so well come.

#### §. 13. Of the Mortess-Chisel.

The *Mortess-Chisel* marked C 5. is a narrow *Chisel*, but hath its *Blade* much thicker, and consequently stronger ( that it may endure the heavier blows with the *Mallet* ) than other *Chisels* have, so that in grinding it to an edge, it is ground to a very broad *Bast* as you may see in the Figure. Its Office is to cut deep square holes, called *Mortesses*, in a piece of Wood. Joiners use them of several Breadths according as the Breadths of their *Mortesses* may require.

#### §. 14.

## §. 14. Of the Gouge.

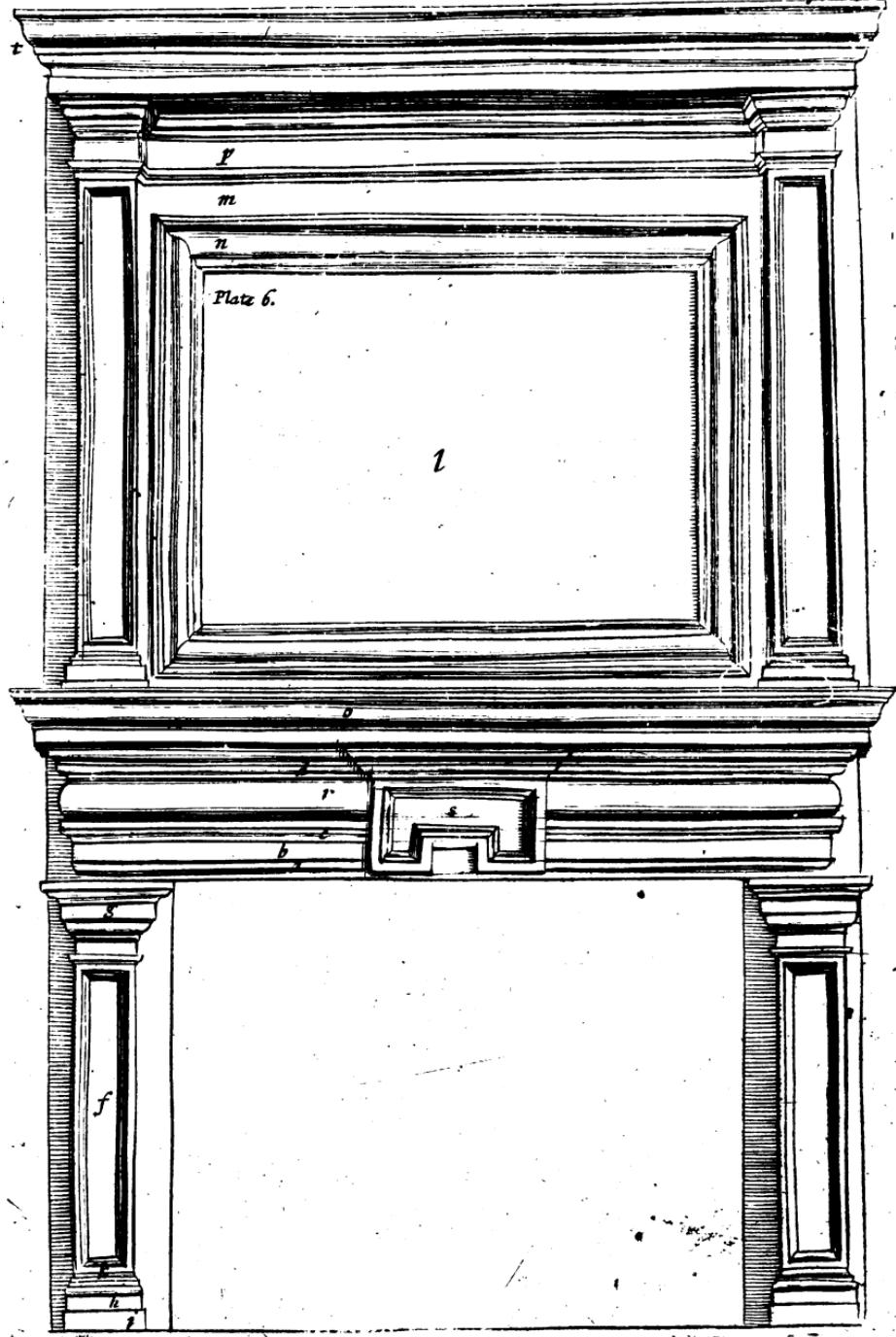
The *Gouge* marked C 6. Is a *Cibbel* having a round edge, for the cutting such Wood as is to be Rounded, or Hollowed.

These several sorts of *Cibbels* Joiners have of several Sizes, that they may be accommodated to do several Sizes of Work.

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MECHANICS.

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## MECHANICK EXERCISES;

O R,

### The Doctrine of *Handy-Works*

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*Continued in the Art of JOINERY.*

§. 15. *Of the Square, and its Use.*

**T**H E *Square*, marked D, is two adjunct Sides of a Geometrical Square. *a* The *Handle*. *b* The *Tongue*. *c* The *Outer Square*. *d* The *Inner Square*. For Joiner's use, it is made of two pieces of Wood, the one about an Inch thick, and the other about a quarter of an Inch thick: These two pieces are severally shot exactly straight, and have each of their Sides parallel to each of their own Sides. The thick Piece ( called the Handle ) hath a Mortess in it, as long within a quarter of an Inch, as the thin piece ( called the Tongue ) is broad, and stify so wide, as to contain the thickness of the Tongue. The Tongue is fastned into the Mortess of the Handle with Glew and wooden Pins, so as the two outer sides ( and then consequently the two inner sides ) may stand at right Angles with one another.

The Reason why the Handle is so much thicker than the Tongue, is, because the Handle should on either side become a Fence to the Tongue.

And

And the reason why the Tongue hath not its whole breadth let into the end of the Handle is, because they may with less care strike a line by the side of a thin than a thick piece: For if instead of holding the Hand upright when they strike a Line, they should hold it never so little inwards, the shank of a Pricker falling against the top edge of the Handle, would throw the Point of a Pricker farther out than a thin Piece would: To avoid which Inconveniencie, the Tongue is left about half an Inch out of the end of the Handle.

Another Reason is, That if with often striking the Pricker against the Tongue it becomes ragged, or uneven, they can with less trouble Plane it again when the Stuff is all the way of an equal strength, than they can, if Cross grain'd Shoulders be added to any part of it.

Its use is for the striking of Lines square either to other Lines, or to straight sides, and to try the squarenes of their Work by; As if they would strike a Line square to a side they have already shot: They apply the inside of the Handle close to the side shot, and lay the Tongue flat upon the Work, than by the outsides of the Tongue, they draw with a Pricker a straight Line: This is called *Striking, or drawing of a Square.* Or, if they would Try the squarenes of a Piece of Stuff shot on two adjoining sides, they apply the insides of the Handle and Tongue to the outsides of the Stuff, and if the outsides of the Stuff do all the way agreed in Line with the insides of the Square, it is true Square. Or if they would try the inward squarenes of Work, they apply the two outsides of the Square to the insides of the Work.

§. 16. *The manner of Plaining and Trying a piece of Stuff-square.*

WE will take, for Example, a Piece of Stuff called a Quarter, which is commonly two Inches thick, four Inches broad, and seven Foot long. To plane this Square, lay one of its broad Sides upon the Bench, with one of its ends shov'd pretty hard into the Teeth of the Bench-hook, that it may lie the steddier. Then with the Fore-Plane, as you were taught, §. 2. Numb. 2. Plane off the roughness the Saw made at the Pit, and work that side of the Quarter as streight in its length and breadth as you can with the Fore-Plane; which you may give a pretty good gues at, if the edge of the Iron have born all the way upon the Work, yet you may try by taking up your Work, and applying one end of it to one Eye, whilst you wink with the other, and observe if any Hollow, or Dawks be in the length; if not, you may conclude it pretty true: For the Work thus held, the Eye will discern pretty nearly. Or, for more certainty, you may apply the edge of the two-foot Rule, or rather a Rule shot the full length of the Quarter to your Work, and if it agree all the way with the Rule, you may conclude it is straight in length. But if you find it not straight, you must still with the Fore-Plane work off those Risings that bear the edge of the Rule off any part of the Stuff: Then try if the Breadth be pretty straight; if it be, (the Dawks the roughness the Fore-plane made excepted) the first office of the Fore-plane is perform'd: If it be not, you must straighten the Breadth as you did the Length.

But tho' this Quarter be thus plained straight in length and breadth, yet because the Iron of the Fore-plane for its first working the Stuff is set

Rank, and therefore makes great Dawks in the Stuff, you must set the Iron of your Fore-plane finer, as you were taught, §. 3. Numb. 2. and with it then work down even almost to the bottom of those Dawks: then try it again, as before, and if you find it try all the way, you may, with the Jointer, or Smoothing-plane, but rather with the Jointer, go over it again, to work out the irregularities of the fine Fore plane: For the Iron of the Fore-plane being ground to a Rising in the middle, as has been shew'd, §. 2. Numb. 2. though it be very fine set, will yet leave some Dawks in the Stuff for the Jointer, or Smoothing-plane, to work out. Thus the first side of the Quarter will be finished.

Having thus tryed one side of the Quarter straight and flat, apply the inside of the Handle to it, and if one of the adjoining sides of the Quarter, comply also with the inside of the Tongue all the way, you need only smooth that adjoining side: But if it do not so comply, that is, if it be not square to the first side, which you will know by the riding of the inside of the Tongue upon one of the Edges; or some other part between the Edges, you must, with the Fore-plane Rank-set, plain away that Stuff which bears off the inside of the Tongue from complying all the way with it. But if the Risings be great, you may, for quicknes, hew away the Risings with the Hatchet: but then you must have a care you let not the edge of your Hatchet cut too deep into the Stuff, lest you either spoil your Stuff, by making it unsizable, if it be already small enough; or if it have substance enough, make your self more labour to get out those Hatchet-strokes with the Plane than you need. Then take off the roughness the Hatchet made with the Fore-plane Rank-set, then fine set, and last

last of all with the Jointer, or Smoothing-plane: So is the second side also finished.

To work the third side, set the Oval of the Gage exactly to that width from the Gage, that you intend the Breadth of the Quarter (when wrought) shall have, which, in this our Example, is four Inches, but will be somewhat less, because working it true will diminish the Stuff: Therefore sliding the Oval on the Staff, measure on your Inch-Rule so much less than four Inches, as you think your Stuff diminishes in working: Measure, I say, between the Oval and the Tooth, your size: If, at the first proffer, your Oval stand too far from the Tooth, hold the Oval in your Hand, and knock the Tooth-end of your Staff upon the Work-bench, till it stand near enough: If the Oval stand too near, knock the other end of the Staff upon the Work-bench till it be fit. Then apply the flat of the Oval to the second wrought side of your Stuff, so as the Tooth may reach athwart the breadth of the Stuff upon the first side, and keeping the Oval close against the second side, pres the Tooth so hard down, that by drawing the Gage in this posture all along the length of the Quarter, the Tooth may strike a Line. In like manner upon the side opposite to the first, *viz.* the fourth side, Gage another line opposite to the first gaged Line, and work your Stuff down to those two gaged Lines on the third side, either with Plaining along, or with Hewing, and afterwards Plaining, as you were taught to work the second side.

To work the fourth side, set the Tooth of the Gage to its exact distance from the Oval; *viz.* two Inches wanting so much as you think the Stuff diminish'd in working, and apply the flat of the Oval to each side of the first side, and Gage as before two Lines, one on the second, the other on

the third wrought side. Work your Stuff then down on the fourth side to those two Gage-lines, either with Plaining alone, or with Hewing, and afterwards Plaining, as you were taught to work the second side

**§. 17. To Frame two Quarters Square into one another.**

Y<sup>O</sup>U must take care in Mortessing and Tenanting, that as near as you can equalize the strength of the sides of the Mortess to the strength of the Tenant. I do not mean that the Stuff should be of an equal Substance, for that is not equalising strength: But the equalising strength must be considered with respect to the Quality, Position and Substance of the Stuff: As if you were to make a Tenant upon a piece of Fur, and a Mortess to receive it in a piece of Oak, and the Fur and Oak have both the same size: The Tenant therefore made upon this piece of Fur, must be considerably bigger than a Tenant need be made of Oak, because Fur is much a weaker Wood than Oak, and therefore ought to have a greater Substance to equalize the strength of Oak. And for Position, the shorter the Stuff that the Tenant is made on, the less Violence the Tenant is subject to. Besides, it is easier to split Wood with the Grain, than to break Wood crofs the Grain; and therefore the same Wood when posited as a Tenant, is stronger than the same Wood of the same size when posited as a Mortess: for the injury a Mortess is subject to, is splitting with the grain of the Wood, which, without good care, it will often do in working; but the force that must injure a Tenant, must offend it, crofs the Grain of the Wood, in which Position it will best endure Violence.

When

When two pieces of Wood, of the same quality and substance (as in this our Example) are elected to make on the one a Tennant, and in the other a Mortess. If you make the Mortess too wide, the sides of the Mortess will be weaker than the sides that contain the Mortess: And if one be weaker than the other, the weakest will give way to the strongest. when an equal Violence is offer'd to both. Therefore you may see a necessity of equallizing the strength of one to the other, as near as you can. But because no Rule is extant to do it by, nor can (for many Considerations, I think,) be made, therefore this equallizing of strength must be referred to the Judgment of the Operator. Now to the Work.

The Mortess to be made is in a Quarter four Inches broad. In this case Workmen make the Mortess an Inch wide, so that an Inch and an half Stuff remains on either side it. Therefore your Stuff being squard, as was taught in the last Section, set the Oval of the Gage an Inch and an half off the Tooth, and gage with it, on either side your Stuff, a straight line at that distance from the end you intend the Mortess shall be, then open your Compasles to two Inches, and prick off that distance in one of the Lines, for the length of the Mortess; then lay the inside of the Handle of the Square to one side of the Stuff, and upon both the pricks successively, and with your Pricker draw straight Lines through them by the side of the Tongue, so shall the bounds of your Mortess be struck out on the Quarter. If your Mortess go through the Quarter, draw the same Lines on the opposite side of the Quarter thus, Turn the Quarter, or its Edge, and apply the inside of the Handle of the Square, to the ends of the former drawn Lines, and by

the side of the Tongue draw two Lines on the edge of the Quarter ; then turn the Quarter again with its other broad side upwards, and apply the inside of the Handle of the Square to the ends of the last Lines drawn on the edge, and by the side of the Tongue, draw two Lines on this broad side also. These two Lines (if your Quarter was truly squar'd) shall be exactly opposite to the two Lines drawn on the first broad side of the Quarter for the length of the Mortefs : And for the width of the Mortefs gage this side also, as you did the first ; then for the Tennant, gage on that end of the Quarter you intend the Tennant shall be made, the same Lines you did for the Mortefs. And because the Quarter is two Inches thick, prick from the end two Inches, and applying the inside of the Handle of the Square to the side of the Quarter, and the Tongue to that Prick, draw by the side of the Tongue a Line through that side the Quarter ; then turn the other sides of the Quarter successively, and draw Lines athwart each side the Quarter, as you were taught to draw the opposite Lines for the Mortefs.

Then place the edge of the Inch-Mortefs-Chisel with its Basil from you, and the Helve bearing a little towards you, within one half quarter of an Inch of one end of the Struck Mortefs, and with your Mallet knock hard upon it, till you find the Basil of the Chisell will no longer force the Chips out of the Mortefs ; then remove the Chisel to the other end of the Mortefs, and work, as with the first end, till the Chips will void no longer : Then work away the Stuff between the two Ends, and begin again at one of the Ends, and then at the other, and work deeper into the Mortefs, then again between both ; and so work deeper by degrees, till you have wrought the Mor-

Mortess through, or (if not through) to the intended Depth; then with the Mortess-chissel work nearer the drawn Lines at the ends of the Mortess, (for before you were directed to work but within half a quarter of an Inch of the drawn Lines,) by laying light blows on it, till you have made it fit to pare smooth with a narrow Paring-chissel, and then pare the ends, as you were taught to work with the Paring-chissel: Then with the broad Paring-chissel, pare the sides of the Mortess just to the struck Lines; so is the Mortess finished.

To work the Tennant, lay the other Quarter on edge upon your Work-bench, and fasten it with the *Holdfast*, as you were taught Sect. I. Then with the Tennant, saw a little without the Struck-line towards the end: You must not Saw just upon the Struck-line, because the Saw cuts rough: Besides, you must leave some Stuff to pare away smooth to the Struck-line, that the *Stile* (that is, the upright Quarter) may make a close Joint with the *Rail* (that is) the lower Quarter: Saw therefore right down with the Tennant-Saw, just almost to the gaged Lines for the thicknes of the Tennant, and have a care to keep the Blade of the Saw exactly upright. Then turn the opposite Side of the Quarter upwards, and work as you were taught to work the first Side.

Then with the Paring-chissel, pare the Work close to the gaged Lines for the Tennant. Then try how it fits the Mortess: If it be not pared enough away, you must pare it where it bears, that is, sticks. But if you should chance to have made it too little, you have spoiled your Work: Therefore you may see how necessary it is, not to make the Mortess too wide at first, or the Tennant too narrow.

Then with the Piercer pierce two holes through the Sides, or Checks of the Mortess, about half an

Inch off either end one. Then knock the Tennant stiff into the Mortess, and set it upright, by applying the Angle of the outer Square, to the Angle the two Quarters make, and with your Pricker, prick round about the insides of the Pierced holes upon the Tennant. Then take the Tennant out again, and Pierce two holes with the same Bit, about the thickness of a Shilling above the Pricked holes on the Tennant, that is, nearer the Sholder of the Tennant, that the Pins you are to drive in, may draw the Sholder of the Tennant the closer to the flat side of the Quarter the Mortess is made in. Then with the Paring-chissel make two Pins somewhat Tapering, full big enough, and setting the two Quarters again square, as before, drive the Pins stiff into the Pierced holes.

If you make another Square, as you did this; and make also a Tennant on each Un-tenanted end of the Stiles, and another Mortess on the top and bottom Rails, you may put them together, and make square Frames of them.

#### §. 18. *Of the Miter Square. And its Use.*

**T**He Miter Square marked E, hath (as the Square) an Handle marked *a*, one Inch thick, and three Inches broad, and a Tongue marked *b*, of about the same breadth: The Handle and the Tongue (as the Square) have both their Sides parallel to their own Sides. The Handle (as the Square) hath in the middle of its narrowest Side a Mortess in it, of an equal depth, the whole length of the Handle: Into this Mortess is fitted one end of the Tongue, but the end of the Handle is first Bereld off to make an Angle of 45 Degrees with its inside. This Tongue is (as the Square) Pin'd and Glewed into the Mortess of the Handle.

It

It is used for striking a Miter-line, as the Square is to strike a Square-line, by applying the inside of the Handle to the outside of the Quarter, or Batten, you are to work upon ; and then by striking a Line by the side of the Tongue : For that Line shall be a Miter-line. And if upon two Battens you strike two such Lines, and Saw and Pare them just off in the Lines, when the flats of those two fawn ends are applied to one another, the ont and inside of the Battens, will form themselves into the Figure of a Square.

Thus Picture Frames, and looking Glass-frames, are commonly made, as by a more full Example you may see in the next Section.

### §. 19. Of the Bevil.

**A**S the Square is made to strike an Angle of 90 Degrees, and the Miter an Angle of 45 Degrees, so the Bevil ( marked F ) having its Tongue movable upon a Center, may be set to strike Angles of any greater, or lesser numbers of Degrees, according as you open the Tongue wider from, or shut it closer to the Handle. It is used as the Square, and the Miter, and will perform the Offices of them both, though it be not purposely made for either ; but for the striking such Bevil-lines, as one part of your work must be cut away to, to make it join with another part of your Work : For Example,

We will propose to make a Frame for a Picture, Looking-glass, &c. containing eight straight Sides ; You may quickly perceive that all the ends of these eight Sides must be cut to Bevils, and what Bevils they must be, you will find if you describe upon a smooth flat Board, a Circle of any bigness, but the larger the better : Divide this Circle into eight equal Parts, and from every point draw a Line to the Center : Draw also straight Lines

from

from every point to its next Point : Then lay the inside of the Handle of your Bevil exactly upon any one of these straight Lines, so as the Angle made by the inside of the Handle, and the inside of the Tongue, lie exactly at the very Angle made by this straight Line, and the Semi-Dianietral Line proceeding from the Center, and move the Tongue nearer, or farther off the Handle, till the inside of the Tongue and the inside of the Handle, lie exactly upon those two Lines, so shall your Bevil be set.

Then having fitted your Pieces to your Scantling, stick your Pricker as near the outward Corner of your Pieces as your Stuff will bear, and apply the inside of your Handle also to the outer sides of your Pieces, and so as the inside of the Tongue may be drawn home to the Pricker. For then Lines drawn on those Pieces by the inside of the Tongue, shall be the Lines the Pieces must be cut in, to make these eight Pieces join evenly together by the sides of each others Bevil : Then with the Strike-block smooth the ends of the Bevils, as you were taught in the Section of the Strike-block.

If you have a Board on the back-side of this Frame, you may Glew the back-sides of these Pieces, piece by piece to the Board ; but first you must fit them to an exact Compliance of every Bevil with its Match, and when they are so fitted, drive two Nails close to the outside of every piece, but drive not the Nails deep into the Board, because when the Frame is set, and Glewed, or otherwife fastned, you must draw the Nails out again : For these Nails are only intended to serve for Fences to set, and fit each piece into its proper Place, before the whole Frame is fastned together. And should you not thus Fence them, though by your Eye you might judge you fitted the Bevils exactly,

exactly, yet one piece being never so little out of its due Position, would drive the next piece more out, and that the next, till at the last, the last piece would not join, but either be too short, or too long, or stand too much out, or in, or else too open, or too close on the out, or inside.

But if you have no Board on the backside, you must, when you Saw the Bevilling Angles upon the square ends of pieces, not sawn quite through the depth of one end of every piece, but about half way through the depth, or thickness, and then with your Chissel either split, or else pare, the upper side of the square end flat away to the Bevil, and so leave part of the square end of your piece, to lap under the piece it is joined to. For Example,

In Fig. 3. Plate 5.  $a\ b$  is the square end of the piece, and  $b\ c$  is the Bevil you work the piece to. Therefore you must work away so much of the thicknaess of the square end, as is comprehended between  $a$  and  $c$ , so that you will see the Triangle  $a\ b\ c$ , is to be wrought away half way down the thicknaess of the Stuff, and so will the Triangle  $a\ b\ c$  be left for the other half thicknaess of the Stuff. But that end of the piece marked 1, which joins to the piece marked 2, must, upon its Bevil-stroak, be sawn quite off, and its underside must have the same Triangle wrought into it, just so fit as to receive the Triangle in piece 2, and just so deep, as that when the Triangle on piece 2, is fitted into the Triangle in piece 1, the Superficies of both the pieces may be even with one another. And thus you may lap the ends of every piece into one another.

These Triangles at the ends of the pieces you may Glew into one another, but if you think Glewing alone not strong enough, you may Pierce an hole near the inner edge of the Frame, because the Triangle hath there most Substance of Stuff; and

and afterwards Pin it, as you are taught to Pin the Rail and Stile together in Sect. 17.

This way of Lapping over, is sometimes used also for square Miters, or other Angular Frames.

### §. 20: Of the Miter-Box.

Here is another way used by Joiners that make many Frames, to save themselves the labour of Drawing, or striking out of Squares, Miters, and several Bevils upon their Stuff: And this is with a Tool called a *Miter-Box*, described in Plate 5. Fig. 2. It is composed of two pieces of Wood, of an Inch thick each, as A the upright piece, B the bottom piece. The Upright piece is nailed upright, fast upon the bottom piece. And this upright piece hath on its upper side the Miter Lines struck with the Miter Square, as d e, on the left hand, and g b on the right hand: On these two Miter Lines the edge of the Saw is set, and a kerf made straight down the upright piece, as from d e on the left hand to f, and from g b on the right hand to i. In like manner any other Bevil is struck upon the upper side of the upright piece with the Bevil, as k l on the left hand, and n o on the right. On these two Bevil Lines the edge of the Saw is set, and a kerf made straight down the upright piece, as from k to l m, and from g b to i. You may make as many Bevils as you please on the upright piece of the Miter Box; Bevils to join Frames of either five, six, seven, eight Sides, &c. and the manner to make them to any number of Sides, was in part taught in the last Section. For as there you were directed to divide the Circle in to eight equal Parts, because eight was the number of Sides, we proposed to make that Frame consist of; So, if for any number of Sides you divide the Circle into the same equal parts, and work as you were there directed, you may find what Bevil

vil the pieces must have that make a Frame that consists of any number of Sides.

So also for Sawing of any Batten, or other small pieces square : Strike at the Point *a*, on the upper side of the upright piece a line straight athwart it, to *b*, and Saw straight down the upper piece, to *c*.

The manner how these Kerfs are sawn straight down with greatest certainty is, thus, Apply the inside of the Handle of the square to the upper side of the upright piece, so as the Tongue lie close to that end of the Miter, Bevil, or Square Line struck through the upper side of the Miter-Box, and with the Pricker strike a Line close by the side of the Tongue, through that side of the upright piece; Turn the Tongue to the other side of the upright piece, and apply the inside of the Handle of the square to the other end of the Miter, Bevil, or Square Line, and with the Pricker strike also a Line close by the side of the Tongue through that side the upright piece. These two Lines struck on either *side* of the upright piece, shall be a Line on each side in which the edge of the Saw must run, to saw it straight down.

#### §. 21. Of the Gage.

**T**He Gage marked *G* ( in Plate 4 ) The Oval *b* is fitted stiff upon the Staff *c*, that it may be set nearer or farther from the Tooth *a*. Its Office is to Gage a Line parallel to any straight fide. It. is used for Gaging Tennants, and for Gaging Stuff to an equal thickness.

When you use it, you must set the Oval to the intended Distance from the Tooth: If the Oval stand too near the Tooth, Hold the Oval in your right hand, and knock the hinder end of the Staff upon the Work-bench, till it remove to its just Distance from the Tooth: If it stand too far off the  
Tooth,

Tooth, knock the fore end of the Staff (*viz.* the Tooth end) till it remove to its just Distance from the Tooth: If the Oval slide not stiff enough upon the Staff, you may stiffen it by striking a wooden Wedge between the Mortefs and the Staff: So may you apply the side of the Oval next the Tooth, to the side of any Table, or any other straight side, with the Tooth Gage a Line parallel (or of equal Distance) all the way from that side.

#### §. 22. Of the Piercer.

**T**HE Piercer H, in *Plate 4*, hath *a* the Head, *b* the Pad, *c* the Stock, *d* the Bitt. Its Office is so well known, that I need say little to it. Only, you must take care to keep the Bitt straight to the hole you pierce, lest you deform the hole, or break the Bitt.

You ought to be provided with Bitts of several sizes, fitted into so many Padds.

#### §. 23. Of the Gimblet.

**T**HE Gimblet is marked I, in *Plate 4*. It hath a Worm at the end of its Bitt. Its Office is to make a round hole in those places of your work where the Stock of the Piercer by reason of its own Sholder, or a Sholder, or Butting out upon the work will not turn about. Its Handle is held in a clutched hand, and its Bitt twisted stiff into your work. You must have them of several sizes.

#### §. 24. Of the Augre.

**T**HE Augre marked K in *Plate 4*, hath *a* the Handle, *b* the Bitt. Its Office is to make great round holes. When you use it, the Stuff you work upon is commonly laid low under you, that you may the easier use your strength upon it: For in twisting the Bitt about by the force of both your Hands,

Hands, on each end of the Handle one, it cuts great Chips out of the Stuff. You must bear your strength Perpendicularly straight to the end of the Bitt ; as with the Piercer,

### §. 25. Of the Hatchet.

**T**He Hatchet marked L, in *Plate 4.* Its use is so well known (even to the most un-intelligent) that I need not use many Words on it, yet thus much I will say, Its use is to Hew the Irregularities off such pieces of Stuff which may be sooner Hewn than Sawn.

When the Edge is downwards, and the Handle towards you, the right *side* of its Edge must be Ground to a Bevil, so as to make an Angle of about 12 Degrees with the left *side* of it : And afterwards set with the Whetstone, as the Irons of Planes, &c.

### §. 26. The Use of the Saw in general.

**I**N my former *Exercises*, I did not teach you how to chuse the Tools a Smith was to use ; Because it is a Smith's Office to make them : And because in those *Exercises* I treated of making Iron-work, and Steel-work in general, and the making and excellency of some Tools in particular, which might serve as a general Notion for the Knowledge of all Smith's Workmanship, especially to those that should concern themselves with Smithing : But to those that shall concern themselves with Joinery, and not with Smithing ; It will be necessary that I teach them how to chuse their Tools that are made by Smiths, that they may use them with more ease and delight, and make both quicker and nearer Work with them.

All sorts of Saws, for Joiner's Use, are to be sold in most Iron-monger's Shops, but especially in *Foster-lane, London* : Chuse those that are made of

of Steel, (for some are made of Iron) for Steel of it self is harder and stronger than Iron: You may know the Steel-Saws from Iron-Saws thus, The Steel-Saws are generally ground bright and smooth, and are (the thickness of the Blade considered) stronger than Iron-Saws: But the Iron-Saws are only Hammer-hardned, and therefore if they could be so hard, yet they cannot be so smooth, as if the Irregularities of the Hammer were well taken off with the Grindstone: See it be free from flaws, and very well Hammered, and smoothly Ground, (that is, evenly Ground,) you may know if it be well Hammered by the stiff bending of it, and if it be well Ground, (that is, evenly Ground,) it will not bend in one part of it more than in another; for if it do, it is a sign that part were it bends most is, either too much Ground away, or too thin Forged in that place: But if it bend into a regular bow all the way, and be stiff, the Blade is good: It cannot be too stiff, because they are but Hammer-hardned, and therefore often bow when they fall under unskilful Hands, but never break, unless they have been often bowed in that place. The Edge whereon the Teeth are, is always made thicker than the Back, because the Back follows the Edge, and if the Edge should not make a pretty wide Kerf, if the Back do not strike in the Kerf, yet by never so little irregular bearing, or twisting of the Hand awry, it might so stop, as to bow the Saw; and (as I said before) with often bowing it will break at last. When Workmen light of a good Blade thus qualified, they matter not much whether the Teeth be sharp or deep, or set to their mind: For to make them so, is a Task they take to themselves: And thus they perform it: They wedge the Blade of the Saw hard into the Whetting-Block, marked P, in Plate 4: with the Handle towards

wards their left Hand, and the end of the *Saw* to the right, then with a three-square File they begin at the left hand end, leaning harder upon the side of the File on the right Hand, than on that side to the left Hand; so that they File the upper-side of the Tooth of the Saw a-slope towards the right Hand, and the underside of the Tooth a little a-slope towards the left, or, almost down-right. Having filed one Tooth thus, all the rest must be so filed. Then with the *Saw-wrest*, marked O, in *Plate 4.* they set the Teeth of the *Saw*: That is, they put one of the Notches marked *a a a* of the *Wrest* between the first two Teeth on the Blade of the *Saw*, and then turn the Handle Horizontally a little about upon the Notch towards the end of the *Saw*; and that at once turns the first Tooth somewhat towards you, and the second Tooth from you: Then skipping two Teeth, they again put one of the Notches of the *Wrest* between the third and fourth Teeth on the Blade of the *Saw*, and then (as before) turn the Handle a little about upon the Notch towards the end of the *Saw*, and that turns the third Tooth somewhat towards you, and the fourth somewhat from you: Thus you must skip two Teeth at a time, and turn the *Wrest* till all the Teeth of the *Saw* are set. This Setting of the Teeth of the *Saw* (as Workmen call it) is to make the Kerf wide enough for the Back to follow the Edge: And is Set *Ranker* for soft, course, cheap Stuff, than for hard, fine, and costly Stuff: For the *Ranker* the Tooth is set, the more Stuff is wasted in the Kerf: And besides, if the Stuff be hard it will require greater Labour to tear away a great deal of hard Stuff, than it will do to tear away but a little of the same Stuff.

The *Pit Saw*, is Set so Rank for course Stuff, as to make a Kerf of almost a quarter of an Inch, but for fine and costly Stuff they set it finer to save

G

Stuff,

Stuff. The *Whip-Saw* is set somewhat finer than the *Pit-Saw*; the *Hand-Saw*, and the *Compass-Saw*, finer than the *Whip-Saw*; but the *Tennant-Saw*, *Frame-Saw*, and the *Bow-Saw*, &c. are set fine, and have their Teeth but very little turned over the Sides of their Blades: So that a Kerf made by them, is seldom above half a half quarter of an Inch.

The reason why the Teeth are filed to an Angle, pointing towards the end of the *Saw*, and not towards the Handle of the *Saw*, or directly straight between the Handle and end of the *Saw*, is, Because the *Saw* is designed to cut only in its Progress forwards; Man having in that Activity more strength to rid, and Command of his Hands to guide his Work, than he can have in drawing back his *Saw*, and therefore when he draws back his *Saw*, the Work-man bears it lightly off the un-sawn *Stuff*; which is an ease to his Labour, and enables him the longer to continue his several Progressions of the *Saw*.

Master-Workmen, when they direct any of their Underlins to saw such a piece of Stuff, have several Phrases for the sawing of it: They seldom say *Saw that piece of Stuff*; But *Draw the Saw through it*; *Give that piece of Stuff a Kerf*; *Lay a Kerf in that piece of Stuff*; and sometimes, (but most unproperly,) *Cut*, or *Slit that piece of Stuff*: For the *Saw* cannot properly be said to cut, or slit the *Stuff*; but it rather breaks, or tears away such parts of the *Stuff* from the whole, as the points of the Teeth prick into, and these parts it so tears away are proportionable to the fineness, or rankness of the setting of the Teeth.

The Excellency of Sawing is, to keep the Kerf exactly in the Line marked out to be sawn, without wriggling on either, or both sides; And straight through the *Stuff*, as Work-men call it; that

that is, in a Geometrical Term, perpendicular through the upper and under side, if your Work require it, as most Work does : But if your Work be to be Sawn upon a Bevil, as some Work sometimes is, then you are to observe that Bevil all the length of the Stuff, &c.

**S. 27. The Use of the Pit-Saw, marked M, in Plate 4.**

**T**HE PIT-SAW is not only used by those Workmen that make sawing Timber and Boards their whole Busines, but is also for small matters used by Joiners, when what they have to do, may perhaps be as soon done at home, as they can carry or send it to the Sawyers. The manner of their working is both alike, for if it be a Board they would slit off a piece of Timber, or if they would take any Square, Quarter, or Batten, &c. off, they first set off their Scantlin : For Example, If it be an Inch (or more, or less) they would take off a piece of Stuff, they open the Points of their Compasses to an Inch Measure on their Rule, and so much more as they reckon the Kerf of the *Saw* will make, and from on side of their Stuff they set off at either end of the Stuff, the Distance of the points of their Compasses ; at this Distance therefore they make with the points of their Compasles a prick at either end of the Stuff ; Then with Chalk they whiten a Line, by rubbing the Chalk pretty hard upon it ; Then one holds the Line at one end upon the prick made there, and the other strains the Line pretty stiff upon the prick at the other end ; then whilst the Line is thus strain'd, one of them between his Finger and Thumb draws the middle of the Line directly upright, to a convenient height (that it may spring hard enough down) and then lets it go again, so that it swiftly applies to its first Position, and strikes so strongly against the Stuff, that the Dust, or At-

toms of the Chalk that were rubbed into the Line, shake out of it, and remain upon the Stuff. And thus also they mark the under side of their Stuff: This is called *Lining of the Stuff*: And the Stuff cut into those Lines shall be called *Inch-Stuff*, because the Compasses that prickt the Stuff, were opened wider by the width of the Kerf than an Inch Measure upon the Rule: But had the Compasses been opened but an Inch exactly, that piece Sawn off should, in Workmen's Language, have been called *Inch-pricks*, thereby giving to understand that it is half the breadth of the Kerf thinner than an Inch: And thus they call all other Scantlins *2 Inches*, *2½ Inches*, *3 Inches*, &c. *Sawn*, or *Pricked*.

When two Work-men are not at hand to hold the Line at both ends, he that Lines it, strikes one point of his Compafs, or sometimes a Pricker, or a Nail aslope towards that end into the prick set off, and putting the Noose at the end of his Line over his Compafles, &c. goes to the other end, and strains his Line on that prick, and strikes it as before.

The Stuff being thus lined is fastned with wedges over the *Pit*, (if the Joiner be accommodated with a *Pit*) if he have none, he makes shift with two high Frames a little more than Man high in its stead, (called *great Trussells*) with four Legs, these Legs stand spreading outwards, that they may stand the firmer: Over these two *Trussells* the Stuff is laid, and firmly fastned that it shake not. Its outer side from whence the Pricks were set off must be Perpendiculer, which you must try by a Plumb-line, for should the top edge of that side, hang never so little over the bottom edge, or the bottom edge not lie so far out as the top edge, the Scantlin you saw off would not be of an equal thickness on the Top or Bottom: Because

cause the *Saw* is to work exactly Perpendicular. Then with the *Pit-Saw* they enter the one end of the Stuff, the *Top-man* at the Top, and the *Pit-man* under him: The *Top-man* observing to guide the *Saw* exactly in the Line: And withal drawing the *Saw* somewhat towards him when the *Saw* goes down; and the *Pit-man* drawing it with all his strength Perpendicularly down; but not so low that the upper and lower Handles of the *Saw* sink below both their Managements: Then bearing the Teeth of the *Saw* a little off the Stuff, the *Top-man* draws the *Saw* up again, and the *Pit-man* assists, or eases him in it, and thus they continue sawing on till the *Saw* has run through the whole length upon the Stuff. But when the Kerf is made so long, that by the working of the *Saw* the pieces of Stuff on either side will shake against one another, and so more, or less, hinder the easie Progress of the *Saw*, they drive a Wedge so far in the Kerf as they dare do for fear of splitting the Stuff, and so provide the *Saw* freer and easier Passage through the Stuff: This Wedging they continue so oft as they find occasion.

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MECHA.

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## MECHANICK EXERCISES;

O R,

### The Doctrine of Handy-Works

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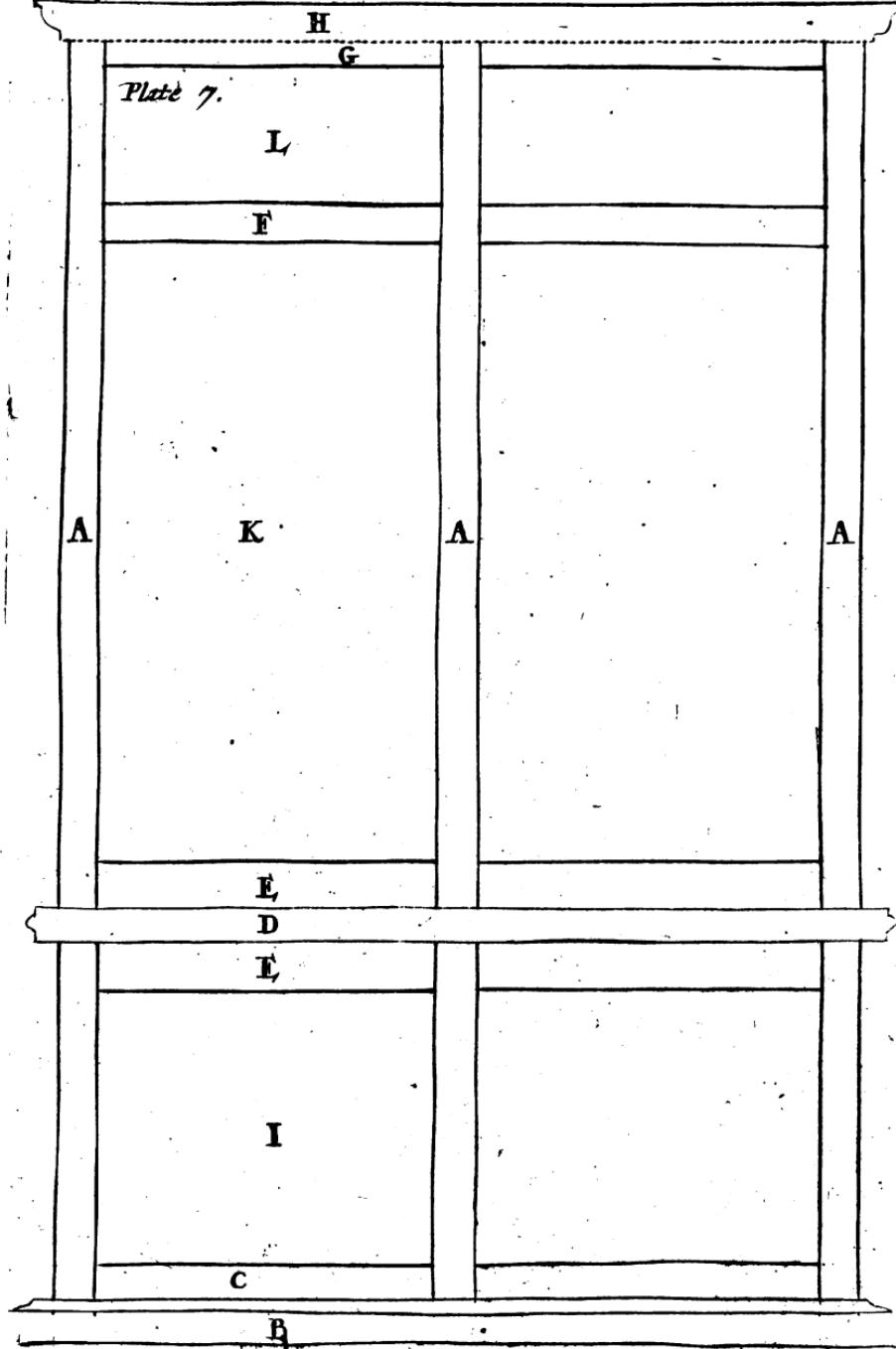
*Continued in the Art of JOINERY.*

§. 28. *The Use of the Whip-Saw, marked N in Plate 4.*

**T**HE *Whip-Saw* is used by Joiners, to saw such greater pieces of Stuff that the *Hand-Saw* will not easily reach through; when they use it, the Stuff is laid upon the *Trussel*, marked O in *Plate 5.* in the Angles of it. Then two Men takes each an Handle of the *Saw*; He to whom the Teeth of the *Saw* points, drawing to him, and the other thrusting from him: And (as before) the *Saw* having run its length, is lifted gently over the Stuff to recover another stroak of the *Saw*.

§. 29. *The Use of the Hand-Saw marked D; the Frame or Bow-Saw, the Tenant-Saw, marked O in Plate 4.*

**T**Hese *Saws* are accommodated for a single Man's Use, and cut forward as the other *Saws* do. The Office of the Cheeks made to the *Frame-Saw* is, by the twisted Cord and Tongue in the middle, to draw the upper ends of the Cheeks closer together, that the lower end of the Cheeks may





may be drawn the wider asunder, and strain the Blade of the *Saw* the straighter. The *Tennant-Saw*, being thin, hath a Back to keep it from bending.

**S. 30. The Use of the Compafs-Saw, marked Q in Plate 4.**

**T**He *Compafs-Saw* should not have its Teeth *Set*, as other *Saws* have; but the edge of it should be made so broad, and the back so thin, that it may easily follow the broad edge, without having its Teeth *Set*; for if the Teeth be *Set*, the Blade must be thin, or else the Teeth will not bow over the Blade, and if it be thin, (considering the Blade is so narrow) it will not be strong enough to abide tough Work, but at never so little an irregular thrust, will bow, and at last break; yet for cheapness, they are many times made so thin that the Teeth require a setting. Its Office is to cut a round, or any other *Compafs* kerf; and therefore the edge must be made broad, and the back thin, that the Back may have a wide kerf to turn in.

**S. 31. Of the Rule marked D in Plate 5;**

**T**He use of the *Rule* is to measure Feet, Inches, and parts of Inches, which for that Purpose, are marked upon the flat and smooth sides of the *Rule*, and numbered with Inches, and hath every Inch divided into two halves, and every half into two quarters, and every quarter into two half-quarters; so that every Inch is divided into eight equal parts; And these Inches are numbered from one end of the *Rule* to the other; which commonly is in all 24 Inches: Which is a Two-Foot *Rule*.

They have commonly both Board and Timber-measure, &c. marked upon them, for the finding both the superficial and solid Content of Board or

G 4 Tim.

**T**imber : The use of which Lines and Tables ha-  
vin been often taught by others, and being more  
Mathematical than Mechanical, is unproper for  
me to meddle with in this Place : But rather to  
refer to those Books.

But the manual Use of it is, either to measure  
length with it, or to draw a straight Line by the  
side of it, or to Try the straightnes or flatnes  
of their Work with. They Try their Work by  
applying one of its Edges to the flat of the  
wrought side of their Work, and bring their Eye  
as close as they can, to see if they can see light  
between the edge of the Rule and their Work :  
If they cannot, they conclude their Work is Try,  
and well wrought.

#### §. 32. Of the Compasles marked E in Plate 5.

**A**a **T**he Joint, **bb** the Cheeks of the Joint, **cc** the  
Shanks, **dd** the Points. Their Office is to  
describe Circles, and set off Distances from their  
Rule, or any other Measure, to their Work.

#### §. 33. Of the Glew-pot marked F in Plate 5.

**T**he Glew-pot is commonly made of good thick  
Lead, that by its Substance it may retain a  
heat the longer, that the Glew Chill not (as  
Work-men say when it cools) when it is to be  
used.

#### §. 34. Of Chusing and Boiling Glew.

**T**he clearest, driest, and most transparent  
Glew is the best : When you boil it, break  
it with your Hammer into small pieces, and put  
it into a clean Skillet, or Pipkin, by no means  
greasie, for that will spoil the Clamminefs of the  
Glew, put to it so much Water as is convenient  
to dissolve the Glew, and to make it, when it is  
hot, about the thickness of the White of an Egg ;  
The

The quantity of Water cannot be assigned, because of the different Quality there is in Glew: Keep it stirring whilst it is melting, and let it not stick to the sides or bottom of the Vessel: When it is well boiled, pour it into your Glew-pot to use, but let your Glew-pot be very clean. When it is cold, and you would heat it again in your Glew-pot, you must take great care that it burn not to the sides or bottom of the Glew-pot, for that burning either turns to a thick hard skin, or else to a burnt Cinder-like Substance, which if it mingle with the Glew, will spoil it all; because by its Substance it will bear the two Joints you are to Glew together, off each other.

When (with often heating) the Glew grows too thick, you may put more Water to it; but then you must make it very hot, lest the Glew and Water do not wholly incorporate.

Some Joiners will (when their Glew is too thick, put Small-Bear into it, thinking it strengthens it: I have tried it, and could never find it so, but think it makes the Glew weaker, especially if the Small-Bear chance to be new, and its Yeast not well settled from it, or so stale, that it be either Draggly, or any whit mingled with the Settlings of the Cask.

### §. 35. *Of using the Glew.*

YOur Glew must be very warm, for then it is thinnest, and as it chills, it thickens: With a small Brush you must smear the Glew well upon the Joint of each piece you are to Glew together; And before you set them as they are to stand, you must jostle them one upon the other, that the Glew may very well touch and take hold of the Wood; and that the Glew on each Joints may well incorporate. Then fit the two Joints as they must stand; And when you set them by to dry, let

let the one stand upright upon the other ; For if they stand a-slope, the weight of the Stuff when it leans upon two extream Edges, may make one end of the Joint Open.

### §. 36. Of the Waving Engine.

**T**He *Waving Engine* discribed in *Plate 5. Fig. 7.* Hath A B a long square Plank, of about seven Inches broad, five Foot long, and an Inch and half thick : All along the length of this Plank, on the middle between the two sides, runs a *Rabbet*, as part of it is seen at C : Upon this *Rabbet* rides a *Block* with a *Groove* in its under side : This *Block* is about three Inches square, and ten Inches long, having near the hinder end of it a wooden Handle going through it, of about one Inch Diameter, as D E : At the Fore-end of this *Block* is fastned a Vice, somewhat larger than a great Hand-Vice, as at F : The *Groove* in the *Block* is made fit to receive the *Rabbet* on the Plank.

At the farther end of the Plank is erected a spuare strong piece of Wood, about six Inches high, and five Inches square, as G. This square piece hath a square wide Mortess in it on the Top, as at H. Upon the top of this square piece is a strong square flat Iron Coller, somewhat loofly fitted on, having two Male Screws fitted into two Female Screws, to screw against that part of the wooden Piece un-mortessled at the Top, marked L, that it may draw the Iron Coller hard against the Iron marked Q, and keep it stiff against the fore-side of the un-mortessled Piece, marked L, when the piece Q, is set to its convenient heighth ; and on the other side the square wooden Piece is fitted another Iron screw, having to the end of its shank fastned a round Iron Plate which lies within the hollow of this wooden piece, and therefore cannot in Draft be seen in its proper place ;

place; But I have described it a part, as at M. (Fig. 9.) Its Nut is placed at M, on the wooden Piece. On the farther side of the wooden Piece is fitted a wooden Screw called a *Knob*, as at N. Through the farther and hither side of the square wooden Piece is fitted a flat Piece of Iron, about three quarters of an Inch broad, and one quarter of an Inch thick, standing on edge upon the Plank; but its upper edge is filed round: (the reason you will find by and by:) Its hither end comes through the wooden Piece, as at O, and its farther end on the opposite side of the wooden Piece.

Upright in the hollow square of the wooden Piece stands an *Iron*, as at Q, whose lower end is cut into the form of the Molding you intend your work shall have.

In the fore side of this wooden Piece is a square hole, as at R, called the *Mouth*.

To this Engine belongs a thin flat piece of hard Wood, about an Inch and a quarter broad, and as long as the *Rabbet*: It is disjunct from the Engine, and in Fig. 8. is marked S S, called the *Rack*: It hath its under flat cut into those fashioned Waves you intend your Work shall have: The hollow of these Waves are made to comply with the round edge of flat Plate of Iron marked O (described before) for when one end of the Riglet you wave, is, with the Vice, screwed to the plain side of the Rack, and the other end put through the Mouth of the wooden Piece, as at T T, so as the hollow of the Wave on the under side of the Rack may lie upon the round edge of the flat Iron Plate set on edge, as at O, and the Iron Q, is strong fitted down upon the Reglet: Then if you lay hold of the Handles of the *Block* D E, and strongly draw by them, the Rack and the Riglet will both together slide through the Mouth of the wooden Piece: And as the Rounds of the Rack

rid

rid over the round edge of the flat Iron, the Rack and Reglet will mount up to the Iron Q, and as the Rounds of the Waves on the under side of the Rack slides off the Iron on edge, the Rack and Reglet will sink, and so in a Progression (or more) the Riglet will on its upper side receive the Form of the several Waves on the under side of the Rack, and also the Form, or Molding, that is on the edge of the bottom of the Iron, and so at once the Riglet will be both molded and waved.

But before you draw the Rack through the Engine, you must consider the Office of the Knob N, and the Office of the Iron Screw M; For by them the Rack is screwed evenly under the Iron Q. And you must be careful that the Groove of the Block slip not off the Rabbet on the Plank: For by these Screws, and the Rabbet and Groove, your work will be evenly gaged all the way (as I said before) under the edge of the Iron Q, and keep it from sliding either to the right, or left Hand, as you draw it through the Engine.

### S. 37. Of Wainscoting Rooms.

**A** A A (in Plate 7.) The Stiles. B The Base. C The Lower Rail. D The Sur-Base. E E The Middle Rail, or Rails. F The Frieze Rail. G The Upper Rail. H The Cornice. I The Lying Pannel. K The Large Pannel. L The Frieze Pannel.

In Wainscoting of Rooms there is, for the most part, but two heights of Pannels used; unless the Room to be Wainscoting be above ten foot high, as some are eleven or twelve Foot high, and then three Heights of Pannels are used: As I The Lying Pannel, above the Base. K The Large Pannel above the Middle Rail: And L The Frieze Pannel above the Frieze Rail.

The Frieze Rail is to have the same breadth the Margent of the Stile hath; The Middle Rail hath com-

commonly two breadths of the *Margent* of the *Stile*, viz. one breadth above the *Sur-base*, and the other below the *Sur-base*. And the *Upper* and *Lower Rail* have also each the same breadth with the *Margent* of the *Stile*.

Those Moldings above the Prickt Line on the Top, as H, are called the *Cornice*.

Sometimes ( and especially in low Rooms ) there is no *Base* or *Sur-base* used, and then the *Middle* and *Lower Rail* need not be so broad : For the *Middle Rail* need not be above a third part more than the *Margent* of the *Rail*: and the *Lower Rail* you may make of what breadth you see convenient : They are commonly about three Inches and an half, or four Inches broad, yet this is no Rule : For sometimes Workmen make only a flat Plinth serve.

You may ( if you will ) adorn the outer edges of the *Stiles* and *Rails* with a small *Molding*: And you may ( if you will ) Bevil away the outer edges of the *Pannels*, and leave a Table in the middle of the Pannel.

#### *An Explanation of Terms used among Joiners*

WHEN I first began to Print these Exercises, I marked some Terms in *Joinery* with *superior Letters* ( as Printers call them ) thus <sup>a b c</sup> &c. intending, at the latter end of these Exercises, to have explained the Terms those Letters referr'd to : But upon consideration that those Terms might often be used in this Discourse, when the Superior Letter was out of sight, and perhaps its Position ( where ) forgotten ; I have changed my Mind, and left out the Superior Letters beyond fol. 66. and instead of those References give you this Alphabetical Table of Terms, by which you may always more readily find the Explanation, though you often meet with the Term.

A

## A.

*Arbitrave.* See Plate 6. *l.* is the *Arbitrave Molding.*

*Augre* § 24. Plate 4. fig. K.

## B.

*Base.* See Plate 6. *b.* And Plate 7. *B.*

*Bead.* See Plate 6. *a.*

*Bed-molding.* See Plate 6. *d.*

*Basil.* The *Basil* is an Angle the edge of a Tool is ground away to. See fol. 71.

*Batten.* Is a Scantling of Stuff either two, three or four Inches broad; and is seldom above an Inch thick: and the length unlimmited.

*Beak.* The end of the Hold-fast. See fol. 60, 61.

*Bench-screw.* See Plate 4. *A g.* and fol. 60.

*Bevil.* Any sloping Angle that is not a square, is called a Bevil. See fol. 60. 85. § 19. and Plate 4. *F.*

*Bitt.* See § 22.

*Bow saw.* Plate 4. O.

## C

*Capital.* See Plate 6. *g.*

*Cast.* Stuff is said to Cast, or Warp, when by its own Droughth or Moisture, or the Droughth or Moisture of the Air, or other Accident, it alters its flatness and straightness.

*Clamp.* When a piece of Board is fitted with the Grain to the end of another piece of Board cross the Grain the first Board is *Clamp'd*. Thus the ends of Tables are commonly *Clamp'd* to preserve them from warping.

*Compass-saw.* See fol. 9. and Plate 4. fig. R.

*Cornice.* See Plate 6. *q.* and Plate 7. *H.*

*Cross-grain'd-stuff.* Stuff is Cross-grain'd when a *Bough* or some *Branch* shoots out on that part of the

the Trunk of the Tree; For the *Bough* or *Branch* shooting forwards, the Grain of that branch shoots forwards also, and so runs a-cross the Grain of the Trunk; and if they be well grown together, it will scarce be perceived in some stuff, but in working; yet in Deal-boards, those Boughs or Branches are Knots, and easily perceiv'd, and if it grew up young with the Trunk; then instead of a Knot you will find a Curling in the *Stuff* when it is wrought.

*Curling-stuff.* If the Bough or Branch that shoots out of the Trunk of a Tree be large, and the stuff in that place sawn somewhat a-slope, when that stuff comes under the Plane you will find a Turning about or Curling on that place upon the stuff; and in a straight progress of the Plane the Iron will cut with, and suddenly *a-cross* the Grain, and that more or less as the Bough grew in the Youth of the Tree, or grew more or less upright, or else sloping to the Trunk, or was sawn so. Such stuff therefore is called *Curling-stuff*.

## D.

*Door-case.* Is the Fram'd work about the Door.  
*Double-Screw.* See fol. 60. Plate 4. fig. g. on the Work-bench A.

## F.

*Facia.* See Plate 6. b.

*Fence.* See § 8. Use of the Plow, and Plate 4. fig. B 6.

*Fine-set.* The Irons of Planes are set Fine, or Rank. They are set Fine, when they stand so shallow below the sole of the Plane, that in working they take off a thin shaving. See § 3.

*Flat Frieze.* See Plate 6. p.

*Fore-Plane.* See § 2. and Plate 4. B 1.

*Former.* See § 10. and Plate 4. C 1, C 3.

*Frame.*

**Frame.** See fol. 59, 60.

**Frame Sow.** See § 28. and Plate 4. O.

**Free-stuff.** See §. 3.

**Friese.** See Plate 6. p.

**Friese Pannel.** See Plate 7. L.

**Friese Rail.** See Plate 7. F.

**Frowy stuff.** See § 3.

## G.

**Gage.** See § 21. and Plate 4. G.

**Gimblet.** See § 23. and Plate 4. I.

**Gouge.** See § 14. C 6.

**Groove.** See fol. 69.

## H.

**Hammer-hard.** See Numb. I. fol. 58.

**Handle.** See § 15. and Plate 4. D a.

**Hard Stuff.** See § 3.

**Hatchet.** See § 25. Plate 4. L.

**Head.** See § 22. Plate 4. H a.

**Hold-fast.** See § 1. Plate 4. H d.

**Hook.** See § 1. Plate 4. A b.

**Husk.** See Plate 6. n.

## I.

**Inner-square.** See § 15. and Plate 4. D d.

**Joints.** See fol. 59.

**Jointer.** See § 4. and Plate 4. B 2.

**Iron.** See § 2. and Plate 4. B 1 d.

## K.

**Kerf.** The Sawn-away slit between two pieces of stuff is called a Kerf. See fol. 95.

**Knob.** See § 36. fol. 104. and Plate 5. fig. 7. N.

**Knot.** See Plate 6. o.

## L:

**Large Pannel.** See Plate 7. K.

*Lying*

*Lying Pannel.* See Plate 7. I.

*Lower Rail.* See Plate 7. H.

## M.

*Margent.* See Plate 7. at A A A the flat breadth of the Stiles besides the Moldings, is called the Margent of the Stiles.

*Middle Rail.* See Plate 7. E E.

*Miter.* See fol. 64.

*Miter Box.* See § 20. and Plate 5. fig. 1.

*Miter square.* See § 18. and Plate 4. E.

*Moldings.* The several wrought-work made with Planes on Wood, is called Moldings. See Plate 6.

*Molding Planes.* See § 9.

*Mortess.* Is a square hole cut in a piece of stuff, to entertain a Tennant fit to it. See § 17.

*Mortess Chissel.* See § 13. and Plate 4. C 5.

*Mouth.* See § 2. B 7. a The Mouth.

## O.

*Ogee.* See Plate 6. c.

*Oval.* See § 21. and Plate 4. G. b.

*Outer Square.* See § 15. and Plate 4. D c.

## P.

*Pad.* See § 22. and Plate 4. H b.

*Pannel.* In Plate 7. I K L are Pannels, but distinguished by their Positions.

*Pare.* The smooth cutting with the Paring-Chissel is called Paring.

*Paring-Chissel.* See § 11. and Plate 4. C 2.

*Plaister.* See Plate 6. f.

*Peirce.* See § 22. and Plate 4. H.

*Pit-man* The Sawyer that works in the Pit, is called the Pit-man.

*Pit-Saw.* The Pit-saw is a great Saw fitted into a square Frame; as in Plate 4. M is a Pit-saw.

*Planchier.* In Plate 5. between *d* and *e* is the Planchier.

*Plintb.* See Plate 6.

*Plow.* See § 8. and Plate 4. B 6.

*Pricker.* Is vulgarly called an Awl: Yet for Joiner's Use it hath most commonly a square blade, which enters the Wood better than a round blade will; because the square Angle in turning it about breaks the Grain, and so the Wood is in less danger of splitting.

## R.

*Rabbit.* See § 7.

*Rabbit Plane.* See § 7. and Plate 4. B 5,

*Rack.* See Plate 5. fig. 8. Read § 36.

*Rail.* See Plate 7. A A A.

*Rank.* The Iron of a Plane is said to be set *Rank*, when its edge stands so flat below the Sole of the Plane, that in working it will take off a thick shaving. See § 3.

*Rank-set.* See Rank.

*Range.* The side of any Work that runs straight, without breaking into Angles, is said to *run Range*: Thus the Rails and Pannels of one straight side of Wainscoting is said to *run Range*.

*Return.* The side that falls away from the fore-side of any Straight or Rank-work, is called the *Return*.

*Riglet.* Is a flat thin square piece of Wood: Thus the pieces that are intended to make the Frames for small Pictures, &c. before they are Molded are called *Riglets*.

## S.

*Scaw-work.* See § 26. fol. 97. and Plate 4. O.

*Scantlin.* The size that your stuff is intended to be cut to.

*Scriber.*

*Scribe.* When Joiners are to fit a side of a piece of Stuff against the side of some other piece of Stuff, and the side of the piece of Stuff they are to fit to is not regular; To make these two pieces of Stuff join close together all the way, they Scribe it, (as they phrase it,) thus; They lay the piece of Stuff they intend to Scribe close against the other piece of Stuff they intend to Scribe to, and open their Compasses to the widest Distance, these two pieces of Stuff bear off each other: Then (the Compasses moving stiff in their Joint) they bear the point of one of the shanks against the side they intend to Scribe to, and with the point of the other shank they draw a Line upon the Stuff to be Scribed; and then the points of the Compasses remaining unremov'd, and your Hand carried even along by the side of the piece to be Scribed to, that Line Scribed upon the piece intended to be Scribed, shall be parallel to the irregular side intended to be Scribed to: And if you work away your Stuff exactly to that Line, when these two pieces are put together, they shall seem a Joint.

*Shoot a Joint.* See fol. 63.

*Skew-former.* See § 12. and Plate 4. C 4.

*Smoothing Plane.* See § 6. and Plate 4. B 4.

*Sole.* See Plate 4. B 7. *b a b.* The under side of a Plane is called the *Sole*.

*Square.* See § 15. and Plate 4. D.

*Staff.* See § 21. and Plate 4. G c.

*Staves.* See § 8. and Plate 4. B 6. *aa.*

*Stile.* The upright Pieces AA in Pl. 7. are *Stiles*.

*Stock.* See § 22. and Plate 4. H e.

*Stops.* In Plate 6. *kk* are *Stops*.

*Stuff.* The Wood that Joiners work upon they call in general *Stuff*.

*Sur-base.* In Plate 7. D is the *Sur-base*.

*Swelling-Frieze.* In Plate 6. *r* is the *Swelling-frieze*.

## T.

*Table.* In Plate 6. *f* is the *Table*.

*Taper.* All sorts of Stuff or Work that is smaller at one end than at the other, and diminishes gradually from the biggest end, is said to be *Taper*.

*Tennant.* Is a square end fitted into a Mortise. See § 17.

*Tennant-Saw.* In Plate 4. *O*. would be a *Tennant-saw*, were the flat of the Blade turned where the edge there stands.

*Tongue.* See § 16. and Plate 4. *D b.*

*Tooth.* See § 21. and Plate 4. *G e.*

*Top-man.* Of the two Sawyers, the uppermost is called the *Top-man*.

*Tote.* See § 2. and Plate 4. *B 1 a.*

*Traverse.* See fol. 69.

*Trussel.* See fol. 100. and Plate 5. Fig. 3.

*Try.* See § 13.

## V.

*Vaws-Cornice.* See Plate 6. *e.*

*Upper Cornice.* See Plate 6. *t.*

## W.

*Warp.* The same that *Cast* is.

*Waving Engine.* See § 46. and Plate 5.

*Wedge.* See § 2. and Plate 4. *B 1 c.*

*Whetting-Block.* See Plate 4. *P.*

*Whip-Saw:* See Plate 4. *N.*

*Wrest.* See § 26. and Plate 4. *Q.*

Thus much of Joinery. The next Exercises will be of Carpentry.

## MECHA.

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## MECHANICK EXERCISES;

O R,

### The Doctrine of *Handy-Works*

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Applied to the A R T of *House-Carpentry*.

BING now come to exercise upon the *Carpenters Trade*, it may be expected, by some, that I should insist upon *Architecture*, it being so absolutely necessary for Builders to be acquainted with: But my Answer to them is, that there are so many Books of *Architecture* extant, and in them the Rules so well, so copiously, and so compleatly handled, that it is needless for me to say any thing of that Science: Nor do I think any Man that should, can do more than Collect out of their Books, and perhaps deliver their Meanings in his own Words. Besides, *Architecture* is a Mathematical Science, and therefore different from my present Undertakings, which are (as by my Title) Mechanick Exercises: yet because Books of Architecture are as necessary for a Builder to understand, as the use of Tools; and lest some Builders should not know how to enquire for them, I shall at the latter end of *Carpentry* give you the Names of some Authors, especially such as are Printed in the *English Tongue*.

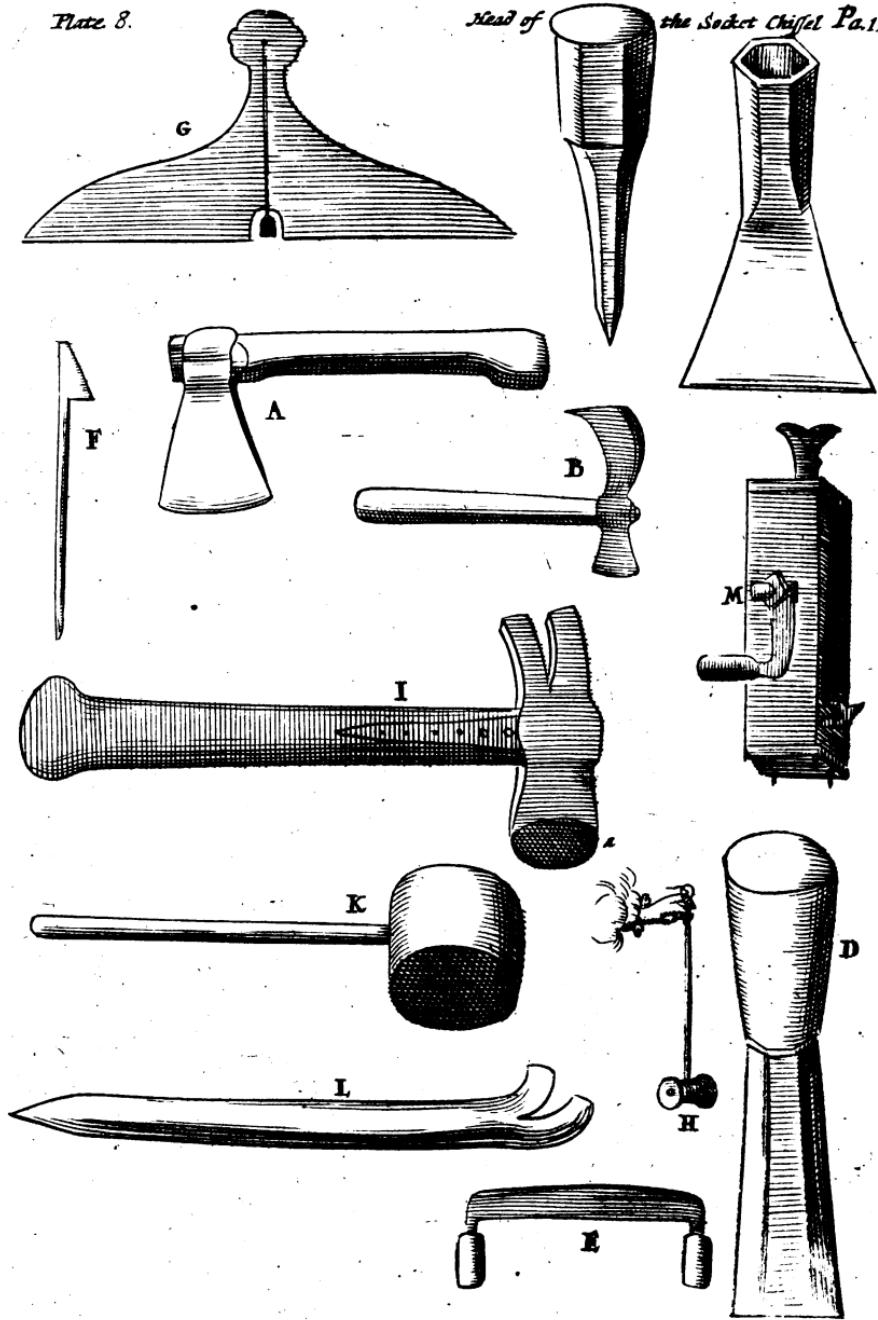
Some may perhaps also think it had been more proper for me in these Exercises to have introduced *Carpentry* before *Joinery*, because Necessity, (the Mother of Invention) did doubtless compel

our Fore-fathers in the beginning to use the convenience of the first, rather than the extravagancy of the last. I confess, I considered it my self, and had in my own Reason been persuaded to it, but that I also considered that the Rules they both work by are upon the matter in the same, in *Sawing*, *Mortessing*, *Tenanting*, *Scribing*, *Paring*, *Plaining*, *Moulding*, &c. and likewise the Tools they work with the same, though some of them somewhat stronger for Carpenter's Use than they need be for Joiner's; because Joiners work more curiously, and observe the Rules more exactly than Carpenters need do. And therefore I say it was, that I began with Joinery before Carpentry; for he that knows how to work curiously, may, when he lists, work slightly; when as they that are taught to work more roughly, do with greater difficulty perform the curious and nice work. Thus we see Joiners Work their Tables exactly flat and smooth, and shoot their Joint so true, that the whole Table shews all one piece: But the Floors Carpenters lay are also by Rule of Carpentry to be laid flat and true, and shall yet be well enough laid, though not so exactly flat and smooth as a Table.

Yet though the Rules Joiners and Carpenters work by are so near the same, and the Tools they work with, and Stuff they work upon, the same; yet there are many Requisites proper to a Carpenter, (especially a Master Carpenter) that a Joiner need take little notice of, which, after I have described the Carpenters Tools that are not express among the Joiners, I shall speak to.

**S 1.** Of several Tools used in Carpentry, that are not used in Joinery. And first of the Ax.

The Ax marked A in Plate 8. is (as you see) different from what the Joiners Hatchet is, both





both in Size and Form ; theirs being a light Hatchet, with a Basil edge on its left side, because it is to be used with one hand, and therefore hath a short Handle : But the Carpenter's Ax being to hew great Stuff, is made much deeper and heavier, and its edge tapering into the middle of its Blade. It hath a long Handle, because it is used with both their Hands, to square or bevil their Timbers.

When they use the Ax, the Timber hath commonly some Bank or Log laid under it near each end, that the edge of the Ax may be in less danger of striking into the ground, when they hew near the bottom of the Timber. And they commonly stand on that side the Timber they hew upon.

### § 2. Of the Adz, and its use.

The Adz marked *B* in Plate 8, hath its Blade made thin, and somewhat arching. As the Ax hath its edge parallel to its Handle, so the Adz hath its edge athwart the Handle, and is ground to a Basil on its inside to its outer edge : Wherefore when it is blunt they cannot well grind it, unless they take its Helve out of its Eye.

Its general Use is to take thin Chips off Timber or Boards, and to take off those Irregularities that the Ax by reason of its Form cannot well come at ; and that a Plane ( though rank set ) will not make riddance enough with.

It is most used for the taking off the Irregularities on the framed Work of a Floor, when it is framed and pin'd together, and laid on its place ; for that lying flat under them, the edge of the Ax being parallel to its Handle ( as aforesaid ) cannot come at the Irregularities to take them off ; but the Adz having its edge athwart the Handle will. Again, upon some Posts framed upright, and range with other framed Work close to it,

the edge of the Ax cannot come at the Irregularities for the reason aforesaid, but the *Ax* will. And the like for the Irregularities of framed Work on a Ceiling, &c.

When they work upon the framed Work of a Floor, they take the end of the Handle in both their Hands, placing themselves directly before the Irregularity, at a small Distance, stradling a little with both their Legs, to prevent Danger from the edge of the *Ax*, and so by degrees hew off the Irregularity. But if they hew upon an Upright, they stand directly before it.

They sometimes use the *Ax* upon small thin Stuff, to make it thinner, (but this is many times when the Ax, or some other properer Tool, lies not at hand) and then they lay their Stuff upon the Floor, and hold one end of it down with the Ball of the Foot, if the Stuff be long enough; if not, with the ends of their Toes, and so hew it lightly away to their size, form, or both.

### § 3. Of Carpenters Chisels in general.

**T**Hough Carpenters for their finer Work use all the sorts of *Chisels* described in the Art of Joinery yet are not those sorts of *Chisels* strong enough for their rougher and more common Work, and therefore they also use a stronger sort of *Chisels*; and distinguish them by the name of *Socket-Chisels*: For whereas those *Chisels* Joiners use have their wooden Heads made hollow to receive the Iron Sprig above the Shoulder of the Shank, Carpenters have their Shank made with an *hollow Socket* at its Top, to receive a strong wooden Sprig made to fit into the *Socket*, with a square Shoulder above it, the thickness of the Iron of the *Socket*, or somewhat more; which makes it much more strong, and able to endure the heavy blows of the *Mallet* they lay upon the head of the *Chisel*.

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*sel.* And the Shanks and Blades are made stronger for Carpenter's Use than they are for Joiners.

Of these *Socket-Chisels* they have of the several sorts described in Joinery, though not all severally distinguished by their Names; for they call them *Half-Inch*, *Three-quarter-Inch Chisels*, *Inch and Half*, *Two-Inch*, to *Three-Inch Chisels*, according to the breadth of the Blade. But their Uses are the same mentioned in Joinery, though the manner of using them be somewhat different too: For, as I told you in Joinery, the Joiners press the edge of the Blade into the Stuff, with the strength of their Shoulders, but the Carpenters with the force of the blows of the Mallet. And the Joiners guide their *Chisels* differently from what the Carpenters do their *Sockets-Chisels*; for the Joiners hold the Shank and Blade of their *Chisels*, as I described in Joinery, *Sect. 11.* but the Carpenters hold the Shank of their *Chisels* in their clutched left Hand, and beat upon the Head with the *Mallet* in the right. See the Figure of *Socket-Chisel* in *Plate 8. C.* with its Head *a* out of the Socket.

#### S 4. Of the Ripping-Chisel, and its Use.

The *Ripping-Chisel* described in *Plate 8. D.* is a *Socket-Chisel*, and is about an Inch broad, and hath a blunt Edge. Its Edge hath not a *Basil*, as almost all other *Chisels* have, and therefore would more properly be called a *Wedge* than a *Chisel*. But most commonly Carpenters use an old cast off *Chisel* for a *Ripping-Chisel*.

Its Office is not to cut Wood, as others do, but to *rip* or *tear* two pieces of Wood fastned together from one another, by entering the blunt Edge of it between the two pieces, and then knocking hard with the *Mallet* upon the head of the Handle, till you drive the thicker part of it between the two pieces, and so force the power that holds them

them together (be it Nails, or otherwise) to let go their hold: For its blunt Edge should be made of Steel, and well tempered, so that if you knock with strong blows of the Mallet the *Chissel* Edge upon a Nail (though of some considerable Substance) it may cut or brake it short asunder. If you cannot, at once, placing the *Ripping-Chissel*, part the two pieces, you must use two *Ripping-Chissels*, placing the second at the remotest entrance in the breach, and driving that home, will both open the breach wider, and loosen the first *Ripping-Chissel*, so that you may take it again, and place it farther in the breach: And so you must continue edging farther and farther, till you have separated your intended pieces.

It is sometimes used when Carpenters have committed Error in their Work, and must undo what they did, to mend it. But it is generally used in all Alterations, and old Work.

#### S 5. Of the Draw-knife, and its Use.

**T**HE *Draw-knife* described Plate 8. E. is seldom used about House-building, but for the making of some sorts of Household-stuff; as the Legs of Crickets, the Rounds of Ladders, the Rails to lay Cheese or Bacon on, &c.

When they use it, they set one end of their Work against their Breast, and the other end against their Work-bench, or some hollow Angle that may keep it from slipping, and so pressing the Work a little hard with their Breast against the Bench, to keep it steady in its Position, they with the Handles of the *Draw-knife* in both their Hands, enter the edge of the *Draw-knife* into the Work, and draw Chips almost the length of their Work, and so smoothen it quickly.

#### S 6. Of

## § 6. Of Hook-Pins, and their use.

**H**e Hook-Pin is described Plate 8. F. *a* the Pin, *b* the Hook, *c* the Head. Its Office is to pin the Frame of a Floor, or Frame of a Roof together, whilst it is framing, or whilst it is fitting into its Position. They have many of these Hook-Pins to drive into the several Angles of the Frame. These drive into the Pin-holes through the Mortises and Tenants, and being made Taper, do with a Hammer striking on the bottom of it knock it out again; or they most commonly strike under the Hook, and so knock it out. Then if the Frame lie in its place, they pin it up with wooden Pins.

## § 7. Of the Level, and its use.

**T**He Level described in Plate 8. G. *a a* the Level, *b* the Plumbet, *c* the Plumb-line, *d d* the Perpendicular mark'd from the top to the bottom of the Board. The Level is from two to ten Foot long, that it may reach over a considerable length of the Work. If the Plumb-line hang just upon the Perpendicular *d d*, when the Level is set flat down upon the Work, the Work is Level: But if it hang on either side the Perpendicular, the Floor, or Work, must be raised on that side, till the Plumb-line hang exactly upon the Perpendicular.

## § 8. Of the Plumb-line, and its use.

**T**He Plumb-line is described in Plate 8. H. *a* the Line-Row, *b* the Line. It is used to try the upright standing of Posts, or other Work that is to stand Perpendicular to the Ground Plot; and then they draw off so much Line as is necessary, and fasten the rest of the Line there, upon the Line-Row with a Slip-knot, that no more Line turn off. They hold the end of the Line between their

their Finger and Thumb half the Diameter of the *Line-Rowl* off one corner of the Post, or Work ; and if the *Line* and Corner of the Post be parallel to each other, the Post is upright : But if the Post be not parallel to the *Line*, but its bottom stands more than half the Diameter of the *Line-Rowl* from the *Line*, the Post hangs so much over the bottom of the Post on that side the *Line* bears off, and must be forced backwards till the side of the Post and the *Line* become parallel to each other : But if the bottom of the Corner of the Post stands out from the top of the *Line*, the Post must be forced forwards to comply with the *Line*.

### § 9. Of the Hammer, and its Use.

**H**THE Hammer is described in Plate 8. *L* is the *Face*, *b* the *Claw*, *c c* the *Pen* at the return sides of the *Claw*. This Tool was forgot to be described in *Joinery*, though they use *Hammers* too, and therefore I bring it in here. Its chief Use is for driving Nails into Work, and drawing Nails out of Work.

There is required a pretty skill in driving a Nail ; for if (when you set the point of a Nail) you be not curious in observing to strike the flat face of the *Hammer* perpendicularly down upon the perpendicular of the *Shank*, the Nail (unless it have good entrance) will start aside, or bow, or break ; and then you will be forced to draw it out again with the *Claw* of the *Hammer*. Therefore you may see a reason when you buy a *Hammer*, to chuse one with a true flat *Face*.

A little trick is sometimes used among some (that would be thought cunning Carpenters) privately to touch the Head of the Nail with a little Ear-wax, and then lay a Wager with a Stranger to the Trick, that he shall not drive that Nail up to the Head with so many blows. The stranger

stranger thinks he shall assuredly win, but does assuredly lose ; for the Hammer no sooner touches the Head of the Nail, but instead of entring the Wood it flies away, notwithstanding his utmost care in striking it down-right.

#### § 10. Of the Commander, and its Use.

**T**HE Commander is described in Plate 8. K. It is indeed but a very great wooden Mallet, with an Handle about three foot long, to use in both the Hands.

It is used to knock on the Corners of Framed Work, to set them into their position. It is also used to drive small wooden Piles into the ground, &c. or where greater Engines may be spared.

#### § 11. Of the Crow, and its Use.

**T**HE Crow is described in Plate 8. L. a the Shank, b b the Claws, c the Pike-end. It is used as a Lever to lift up the ends of great heavy Timber, when either a Bauk, or a Rowler, is to be laid under it ; and then they thrust the Claws between the Ground and the Timber, and laying a Bauk, or some such Stuff behind the Crow, they draw the other end of the Shank backwards, and so raise the Timber.

#### § 12. Of the Drug, and its Use.

**T**HE Drug described in Plate 9. A. is made somewhat like a low narrow Carr. It is used for the carriage of Timber, and then is drawn by the Handle a a, by two or more Men, according as the weight of the Timber may require.

There are also some Engines used in Carpentry, for the management of their heavy Timber, and hard Labour, viz. the Jack, the Crab, to which belongs Pulleys and Tackle, &c. Wedges, Rollers, great Screws, &c. But I shall give you an account

account of them when I come to the explanation of Terms at the latter end of *Carpentry*.

**S 13.** Of the Ten-foot Rod, and thereby to measure and describe the Ground-plot.

**W**E shall begin therefore to measure the *Ground-plot*, to which Carpenters use a *Ten-foot Rod* for Expedition, which is a Rod about an Inch square, and ten foot long; being divided into ten equal parts, each part containing one foot, and is divided into 24 equal parts, and their Sub-divisions.

With this *Rod* they measure the length and breadth of the *Ground-plot* into Feet, and if there be odd Inches, they measure them with the *Two-foot Rule*. Their measure they note down upon a piece of paper, and having considered the situation of the Sides, *East*, *West*, *North* and *South*, they draw on paper their several Sides accordingly, by a small Scale, either elected, or else made for that purpose. They may elect their *Two-foot Rule* for some plots; for an Inch and an half may conveniently serve to set off one Foot on some small *Ground-plots*, and then you have the Inches to that Foot actually divided by the Marks for the half quarters on the *Two-foot Rule*. But this large Scale will scarce serve to describe a *Ground-plot* above ten Foot in length, because a small sheet of Paper is not above 15 or 16 Inches long, and therefore one sheet of Paper will not contain it, if the *Ground-plot* be longer: Therefore if you make every half quarter of an Inch to be a Scale for two Inches, a sheet of Paper will contain 20 Foot in length: And if you make every half quarter of an Inch to be a Scale for four Inches, a sheet of Paper will contain 40 Foot. And thus by diminishing the Scale, the sheet of Paper will contain a greater number of Feet.

But

But having either elected, or else made your Scale, you are to open your Compasses to the number of Feet on your Scale your *Ground-plot* hath in length, and then transfer that Distance to your paper, and to draw a straight Line between the two points, and mark that straight Line with *East*, *West*, *North* or *South*, according to the situation of that side of the *Ground-plot* it represents. Then again open your Compasses to the number of Feet on your Scale one of the adjoining Sides contains, and transfer that Distance also to your paper, and draw a Line between the two points, and note its situation of *East*, *West*, *North* or *South*, as before. Do the like by the other Sides; and if either a Quirk, or any Addition, be added to the Building, on any side of your *Ground-plot*, you must describe it also proportionably.

Then you are to consider what Apartments, or Partitions, to make on your *Ground-plot*, or second, or third Story, and to set them off from your Scale, beginning at your intended Front. As for Example, Suppose your *Ground-plot* be a Long-square, 50 Foot in length, and 20 Foot wide: This *Ground-plot* will contain in its length two good Rooms, and a Yard behind it 10 Foot long. If you will, you may divide the 40 Foot into two equal parts, so will each Room be 20 Foot square: Or you may make the Rooms next the front deeper, or shallower, and leave the remainder for the Back-Room: As here the Front-Room is 23 Foot, and the Back-Room 15 Foot deep, and a setting off of 8 Foot broad and 10 Foot long taking out of the Yard, for a Battery below Stairs (if you will) and Closets above Stairs over it. But what width and depth soever you intend your Rooms shall have, you must open your Compasses to that number of Feet on your Scale, and set off that Distance on the *East*, *West*, *North* or *South*, Line,

Line, according to the Situation of that side it represents on your *Ground-plot*. If you set it off the *East Line*, you must also set it off on the *West*; if on the *North Line*, you must also set it off on the *South Line*: Because between the two Settings off on the *East* and *West Lines*, or *North* or *South Lines*, you must draw a straight Line of the length of your intended Partition. And in this manner you must from every Partition draw a Line in its proper place on the Paper, by measuring the Distances each Partition must have from the outside of the *Ground-plot*.

And thus you are also to describe by your Scale your Front, and several sides of the Carcase; allowing the *Principal Posts*, *Esterduces*, *Quarterings*, *Braces*, *Gables*, *Doors*, *Windows*, and *Ornaments*, their several Sizes, and true Positions by the Scale: Each side upon a Paper by it self: Unless we shall suppose our Master-Workman to understand *Perspective*; for then he may, on a single piece of Paper, describe the whole Building, as it shall appear to the Eye at any assigned Station.

#### S 14. Of Foundations.

**H**aving drawn the *Draft*, the Master-Workman is first to cause the Cellars to be dug, if the House shall have Cellars. And then to try the Ground, that it be all over of an equal firmness, that when the weight of the Building is set upon it, it may not sink in any part. But if the Ground be hollow or weaker in any place, he strengthens it, sometimes by well ramming it down, and levelling it again with good dry Earth, Lime-Core, Rubbish, &c. or sometimes with ramming in Stones, or sometimes with well Planking it; or most securely by driving in Piles. But driving in of Piles is seldom used for Timber Houses,

Houses, but for Stone, or Brick Houses, and that but in few places of *England* neither, but where the Ground proves *Fenny*, or *Moorish*. Therefore a farther account shall be given of Foundations, when I come to exercise upon *Masonry*, &c.

Then are the Celler-Walls to be brought up by a *Brick-layer* with *Brick*; for small Houses two Bricks thick, for bigger two and an half Bricks thick, or three or four Bricks thick, according to the bigness of the House, and quality of the Ground, as I shall shew when I come to Exercise on *Bricklaying*.

But if the House be designed to have no Cellars (as many Country-Houses have not) yet for the better securing the Foundation, and preserving the Timber from rotting, Master-Workmen will cause three, or four, or five course of Bricks to be laid, to lay their *Ground-plates* upon that Foundation.

The Foundation being made good, the Master-Workman appoints his Under-Workmen their several *Scantlings*, for *Ground-plates*, *Principal Posts*, *Posts*, *Bressummers*, *Girders*, *Trimmers*, *Joyfts*, &c. which they cut square, and frame their Timbers to, as has been taught in the several Exercises upon Joinery, (whither I refer you) and there set them up, each in its proper place, according to the Draft.

The Draft of a Foundation I have described in *Plate 10*, according to a Scale of eight Foot in an Inch; where you have the Front A B 20 Foot long, the sides A C and B D 50 Foot long. The Shop, or first Room, E E 25 Foot (as aforesaid) deep. I make the first Room a Shop, because I intend to describe *Shop-windows*, *Stalls*, &c. though you may Build according to any other purpose: The *Kitching*, or *Back-Room* F F 15 Foot deep. A *Buttry* or *Closet*, taken out of the *Yard*, marked G,

10 Foot deep, and 8 Foot wide: H a Setting off in the Yard, 4 Foot square for the House of Office. I Leaving way in the Shop for a Stair-Case 6 Foot, and 11 Foot. K The Yard. L The Sink-hole 1 Foot square. M Leaving way in the Kitching 6 Foot deep, and 4 Foot wide for the Chimneys.

I do not deliver this Draft of Partitions for the most Commodious for this Ground-plot, nor is the House set out designed for any particular Inhabitant; which is one main purpose to be considered of the Master-Workman, before he make his Draft; for a Gentleman's House must not be divided as a Shop-keeper's, nor all Shop-keepers House a-like; for some Trades require a deeper, others may dispence with a shallower Shop, and so an Inconvenience may arise in both. For if the Shop be shallow, the Front Rooms upwards ought to be shallow also: Because by the strict Rules of *Architecture*, all Partitions of Rooms ought to stand directly over one another: For if your Shop stands in an eminent Street, the Front Rooms are commonly more Airy than the Back Rooms; and always more Commodious for observing publick Passages in the Street, and in that respect it will be inconvenient to make the Front Rooms shallow: But if you have a fair Prospect backwards of Gardens, Feilds, &c. (which seldom happens in Cities) then it may be convenient to make your Back-Rooms the larger for Entertainment, &c. But I shall run no farther into this Argument; for I shall leave the Master-Workman to consult Books of *Architecture*, and more particularly the Builder, which, in this case, they ought all to do.

*MECHA-*

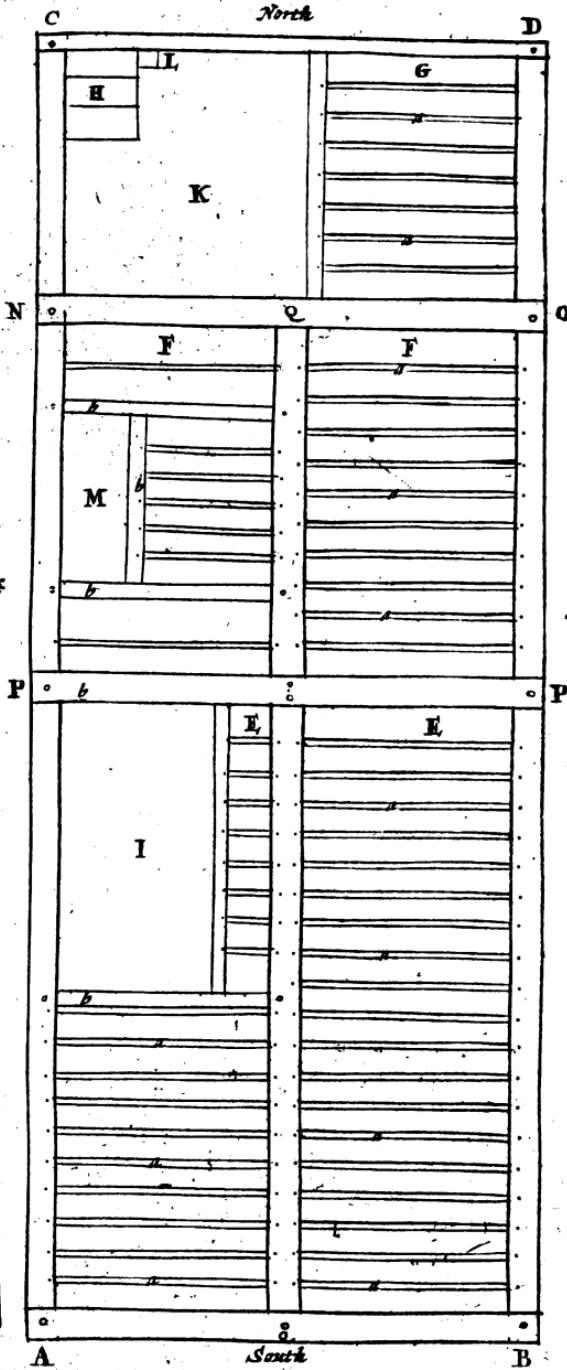
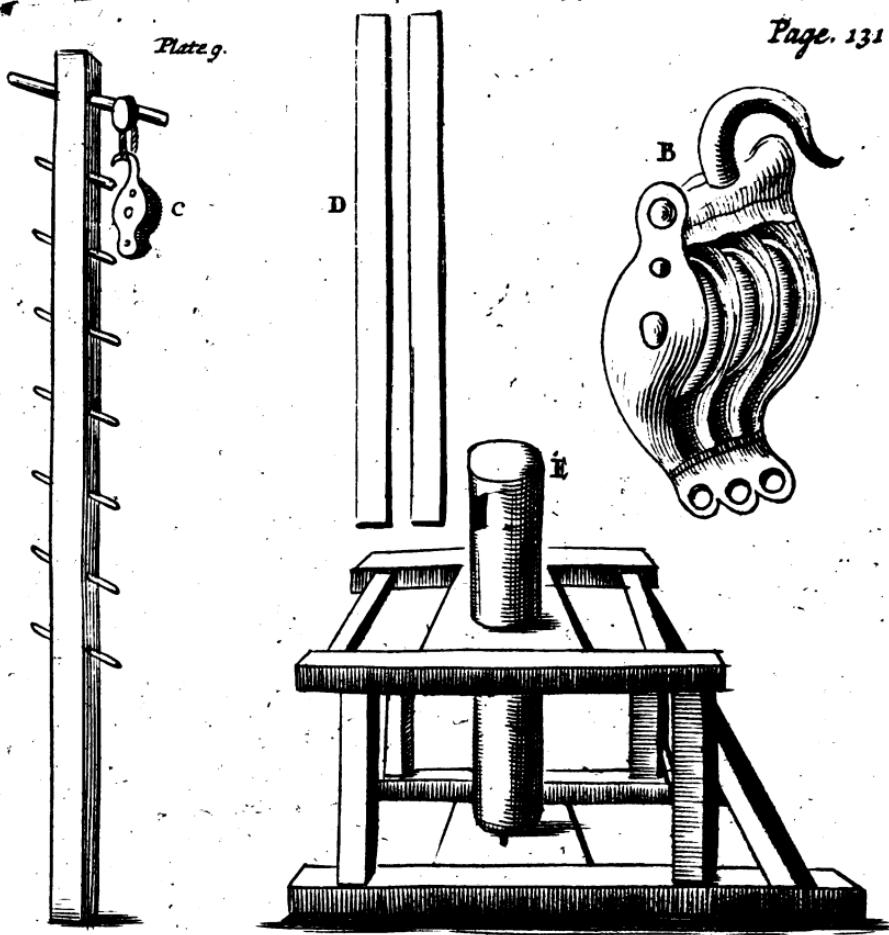
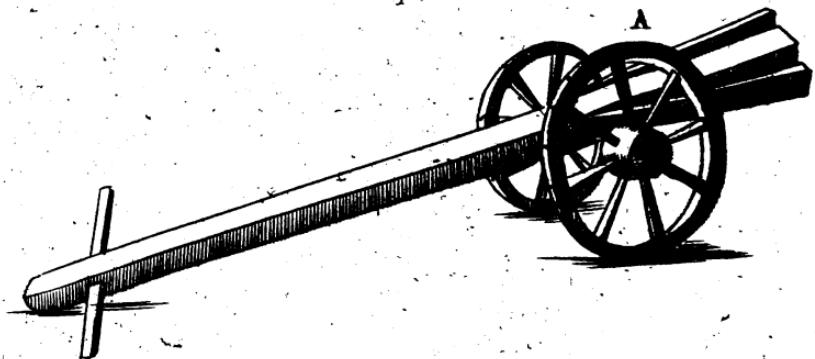




Plate 9.



A





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## MECHANICK EXERCISES;

O R,

### The Doctrine of *Handy-Works*

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Continued in the A R T of *House-Carpentry*.

A C, B D, C D, N O, *Ground-plates, Wall-plates, Bresummers, Lintels, the Thickness of the Wall.*

A B, *Also a Ground-plate, or Ground-fell.*

P P, *The Summer.*

Q Q Q, *Girders.*

I, *The Well-boule for the Stairs, and Stair-case.*

M, *Leaving a way for the Chimnies.*

b b, *Trimmers for the Chimney-way and Stair-case.*

a a a a, *Joysts.*

#### § 15. Of Framing for the Floors.

**T**H E four Plates, A B, A N, N O and B O, lying on the Foundation, are called *Ground-plates*. They are to be of good Oak, and for this size of Building about eight Inches broad, and six Inches deep. They are to be framed into one another with Tennants and Mortesses. The longer Ground-plates A N and B O are commonly tennanted into the Front and Rear Ground-plates A B and N O, and into these two side-Ground-plates are Mortelles made for the Tennants at the ends of the Joysts, to be fitted somewhat loosely in, at about ten Inches distance from one another, as in the Draft. These Ground-plates are to be bor'd with an Inch and half *Augre*, and well pinned into

I 2                      one

one another with round Oaken Pins, made tapering towards the point, and so strong, that with the hard blows of a Mallet, they may drive stiff into the *Augre-holes*, and keep the Tennant firmly in the Mortises. The manner of making a Tennant and Mortess is taught in *Jouery*, p. 85. But because the Stuff Carpenters work upon, is generally heavy Timber, and consequently not so easily managed as the light Stuff Joiners work upon ; therefore they do not at first pin their Tennants into their Mortesses with wooden Pins, lest they should lie out of square, or any other intended Position : But laying a *Block*, or some other piece of Timber, under the corner of the Frame-work to bear it hollow off the Foundation, or what ever else it lies upon, they drive *Hook-pins* (described in *Plate 8. § 6.*) into the four *Augre-holes* in the corners of the Ground-plates , and one by one fit the Plates either to a Square, or any other intended Position : And when it is so fitted, they draw out their *Hook-pins*, and drive in the wooden Pins (as aforesaid) and taking away the wooden *Blocks* one by one from under the corners of the Frame, they let it fall into its place.

But before they pin up the Frame of Ground-plates, they must fit in the *Summer* marked P P, and the *Girders* Q Q, and all the *Joists* marked a a a a, &c and the *Trimmers* for the *Stair-case*, and *Chimney-way* marked b b, and the binding *Joists* marked c c, for else you cannot get their Tennants into their respective Mortess-holes. But they do I say fit all these in, while the Frame of Ground-plates lies loose, and may, corner by corner, be opened to let the respective Tennants into their respective Mortesses, which when all is done, they Frame the *Raising-plates* just as the *Ground-plates* are Framed ; and then Frame the Roof into the *Raising-plates* with *Beams*, *Joists*, &c.

The

The *Summer* is in this Ground-plate placed at 25 Foot distance from the Front, and is to be of the same Scantlin the principal Plates are of, for Reasons as shall be shewn hereafter: And the *Girders* are also to be of the same Scantlins the *Summers* and *Ground-plates* are of, though according to the nice Rules of Architecture, the *Back-Girder* need not be so strong as the *Front-Girder*, because it Bears but at 14 Foot length, and the *Front-Girder* Bears at 24 Foot length: Yet Carpenters (for uniformity) generally make them so, unless they build an House by the Great, and are agreed for the Sum of Money, &c.

The *Foists* Bearing at 8 Foot (as here they do) are to be 7 Inches deep, and 3 Inches broad.

The *Trimmers* and *Trimming Foists* are 5 Inches broad and 7 Inches deep, and these *Foists*, *Trimmers* and *Trimming Foists*, are all to be pinned into their respective Mortesles; and then its flatness try'd with the Level, as was taught § 7.

#### § 16. Of setting up the Carcass.

**T**Hough the *Ground-plates*, *Girders*, &c. be part of the Carcass, yet I thought fit in the last Section they should be laid, before I treated of the Superstructure, which I shall now handle. The four Corner Posts called the *Principal Posts* marked A A, should be each of one piece, so long as to reach up to the *Beam* of the *Roof*, or *Raising-plate*, and of the same Scantlin the *Ground-plates* are of, viz. 8 Inches broad, and 6 Inches thick, and set with one of its narrowest sides towards the Front. Its lower end is to be Tennanted, and let into a Mortess made near the corner of the *Ground-plate Frame*; and its upper end hath also a Tenant on it to fit into a Mortess made in the Beam of the Roof, or *Raising-piece*.

At the heighth of the first Story in this Principal Post, must be made two Mortesles, one to receive the Tennant at the end of the Bressummer that lies in the Front, and the other to entertain the Tennant at the end of the Bressummer that lies in the Return-side.

Two such Mortesles must also be made in this Principal Post at the height of the second Story, to receive the Tennant at the ends of the Bressummers for that Story.

Though I have spoken singularly of one Principal Post, yet as you work this, you must work all four Principal Posts ; and then set them plumb upright, which you must try with a Plumb-line described in *Plate 8* §. 8.

Having erected the Principal Posts upright, you must enter the Tennants of the Bressummers into their proper Mortesles, and with a Nail or two ( about a single Ten or a double Ten ) tack one end of a deal Board, or some other like piece of Stuff to the Bressummer, and the other end to the Fram'd Work of the Floor, to keep the Principal Posts upright, and in their places. Then set up the several Posts between the Principal Posts ; but these Posts must be Tennanted at each end, because they are to be no longer than to reach from Story to Story, or from Entertise to Entertise, and are to be framed into the upper and under Bressummer. If the Entertises be not long enough, they set up a Principal Post between two or three Lengths, to reach from the Ground-plate up to the Raising-plates.

It is to be remembred, that the Bressummers and Girders are laid flat upon one of their broadest sides, with their two narrowest sides Perpendicular to the Ground-plot ; but the Joysts are to be laid contrary : For they  
are

are Framed so as to lie with one of their narrowest sides upwards, with their two broadest sides Perpendicular to the Ground-plot. The reason is, because the Stuff of the Bressummers and Girders are less weakned by cutting the Mortesses in them in this Position, than in the other Position; for as the Tennants for those Mortesses are cut between the top and bottom sides, and the flat of the Tennants are no broader than the flat of the narrowest side of the Joysts; so the Mortesses they are to fit into, need be no broader than the breadth of the Tenant, and the Tennants are not to be above an Inch thick, and consequently the Mortesses are to be made with an Inch Mortess-Chissel, as was shewn in *Joinery*, p. 86. for great care must be taken that the Bressummers and Girders be not weakned more than needs, lest the whole Floor dance,

These Tennants are cut through the two narrowest sides, rather than between the two broadest sides, because the Stuff of the Girders retains more strength when least of the Grain of the Stuff is cut: And the Tennants being made between the narrowest sides of the Joyces, requires their Mortess-holes no longer than the breadth of that Tenant: And that Tenant being but an Inch thick, requires its Mortess but an Inch wide to receive it; so that you Mortess into the Girder no more than three Inches wide with the Grain of the Stuff, and one Inch broad contrary to the Grain of the Stuff. But should the Tenant be cut between the two broad sides of the Joysts, the Mortess would be three Inches long, and but one Inch broad, and consequently, you must cut into the Girder three Inches cross the Grain of the Stuff, which would weaken it more than cutting six Inches with the Grain, and one Inch cross.

But it may be objected that the Tennants of the Joists being so small, and bearing at an Inch thickness must needs be too weak.

Answer, First, Though the Tennants be indeed but an Inch thick, and three Inches broad; yet the whole Bearing of the Joyces do not solely depend upon their Tennants; because the Girders they are framed into, prove commonly somewhat Wainny upon their upper sides, and the Joists are always scribed to project over that Waynniness, and so strengthen their Bearing by so much as they project over the Roundness or Waynniness of the upper side of the Girder.

Secondly, The Floor is boarded with the length of the Boards athwart the Joists, and these Boards firmly railed down to the Joists, which also adds a great strength to them.

Thirdly, The Joists are seldom made to Bear at above ten Foot in length, and should by the Rule of good Workmanship, not lie above ten Inches asunder at the most: So that this short Bearing and close discharging of one another, renders the whole Floor firm enough for all common Occupation. But if the Joyces do Bear at above ten Foot in length, it ought to be the care of the Master-workman to provide stronger Stuff for them, viz. Thicker and Broader. If not, they cut a Tusk on the upper side of the Tenant, and let that Tusk into the upper side of the Girders.

Having erected the Principal Post, and other Posts, and fitted in the Bressummers, Girders, Joists, &c upon the first Floor, they pin up all the Frame of Carcass-work. But though the Girders and Joists described for this first Floor, lie proper enough for it; yet for the second Story, and in this particular Case, the Joists lie not proper for the second Story; because in

in the second Story we have described a *Balcony*.

Therefore in this Case you must frame the Front-Bressummer about seven Inches lower into the Principal Posts : Because the Joists for the second Floor are not to be Mortised into the Bressummer to lie even at the top with it, but must lie upon the Bressummer, and project over it so far as you design the *Balcony* to project beyond the Upright of the Front : And thus laying the Joists upon the Bressummer renders them much stronger to bear the *Balcony*, than if Joists were Tennanted into the Front of the Bressummer, and so project out into the Street from it.

But the Truth is, Though I have given you a Draft of the Joists lying athwart the Front and Rear for the first Floor, you may as well lay them Range with the two sides on the first Floor. But then the Bressummer that reaches from Front to Rear in the middle of the Floor must be stronger : And Girders must then be Tennanted into the Bressummer, and the Ground-plates at such a Distance, that the Joists may not Bear at above ten Foot in length. And the Tennants of the Joists must be Tennanted into the Girders, so that they will then lie Range with the two Sides.

But, a word more of the Bressummer : I say (as before) the Bressummer to Bear at so great Length must be stronger, though it should be discharged at the Length of the Shop, (*viz.* at 25 Foot) with a Brick Wall, or a Foundation brought up of Brick. But if it should have no Discharge of Brick-work, but Bear at the whole 40 Foot in Length, your Bressummer must be yet considerably stronger than it need be, were it to Bear but 25 Foot in Length ; because the shorter all the Bearings of Timbers are, the firmer they Bear. But then the Framing Work will take up more Labour : And in many

many Cases it is cheaper to put in stronger Stuff for long Bearings, than to put a Girder between, to Discharge the Length of the Joysts to be framed into the Girders.

But to make short of this Argument, I shall give you the Scheme of Scantlins of Timber at several Bearings for *Summers, Girders, Joysts, Rafters, &c.* as they are set down in the Act of Parlia. for the Re-building the City of *London*, after the late dreadful Fire: Which Scantlins were well consulted by able Workmen before they were reduced into an Act.

*Scantlins of Timber for the first Sorts of Houses*

	Foot	Inches	Foot	Inches
For the Floor	Summers under	15—12—and—8		
	Wall-plates	7—and—5		
			Foot	at foot—8
				6 Inch.
For the Roof	Principal Rafters under	15	at top—5	
	Single Rafters	4—and—3	Inches.	
			Length	Foot
	Joysts to	10—3	Thickness	Inches
	Garret Floors	3	Depth	7 Inches

*Scantlins of Timber for the other two Sorts of Houses.*

	Breadth	Depth	Thickness	Depth
	Foot	Foot	Inches	Inches
For the Floor:	Summers or Girders which bear in length from	10—15—18—21—21—24—24	11—11—13—14—16—17	and—8—9—10—12—14
				3—3—7—3—8—3
				6—7—7—8—8
	Principal Discharges upon Peers in the first Story in the Fronts	13	12	6
		15	13	7
	Binding Joysts with their Trimming Joysts	5	depth equal to their own Floors	
			10	8
	Wall-plates, or Raising Pieces and Beams	8	6	6
		7	5	5
	Lintels of Oak in the 1st. and 2d; Story	8	6	6
	3d. Story	4	4	4
			Length	

	Length		Thickness	
	Foot	Foot	Inches	Inches
Principal Rafters from	15 to 18	at foot	9	7
		at top	7	7
	18 - 21	at foot	10	8
		at top	8	8
	21 - 24	at foot	12	8½
		at top	9	9
	24 - 26	at foot	13	9
		at top	9	9

	Length			
	Foot	Foot	Inches	Inches
Purlins from	14 to 18	—	9	8
		—	12	9

		Foot	Inches	Foot	Inches
Single Rafters	not exceeding in length	—	9	5	4
	not exceeding in length	—	6	4	3½

Scantlings for Sawed Timber and Laths, usually brought out of the West Country, not less than

	Breadth		Thickness	
	Foot	Inches	Foot	Inches
Single Quarters in length	8	3½	1	¾
Double Quart. in length	8	4	3	½
Sawed Joists in length	8	6	4	
Laths in length	—	5	1	¼
	—	4	quarter and 1/2 Inch	

	Foot		Thickness	
	Inches			
Stone	Corner Peers		18 square	
	First sort of Houses	Middle or Single Peers	14 and 12	
Where Stone is used, to keep to these Scantlings		Double Peers between House and House	14 and 18	
2d & 3d sorts	Door-Jambs and Heads	12 and 8		
			Corner Peers	2 - 5 square
			Middle or Single Peers	18 square
			Double Peers between House and House	24 and 18
			Door Jambs and Heads	14 and 10

	Foot	
	Thickness	
Scantlings for Sewers	3 wide	1 Brick
	5 high	Bottom paved plain, and then 1 Brick on edge circular.
Arch	1 Brick on end	

Gene-

## General RULES.

**I**N every Foundation within the Ground add one Brick in thickness to the thickness of the Wall (as in the Scheme) next above the Foundation, to be set off in three Courses equally on both sides.

That no Timber be laid within twelve Inches of the fore-side of the Chimney Jambs : And that all Joists on the back of any Chimney be laid with a Trimmer at six Inches distance from the Back.

That no Timber be laid within the Tunnel of any Chimney, upon Penalty to the Workman for every Default ten Shillings, and ten Shillings every Week it continuues un-reformed.

That no Joists or Rafters be laid at greater distances from one to the other, than twelve Inches ; and no Quarters at greater distance than fourteen Inches.

That no Joists bear at longer length than ten Foot ; and no single Rafters at more in length than nine Foot.

That all Roofs, Window-frames, and Cellar-floors be made of Oak.

The Tile-pins of Oak.

No Summers or Girders to lie over the Head of Doors and Windows.

No Summer or Girder to lie less than ten Inches into the Wall, no Joists than eight Inches, and to be laid in Lome.

But

But yet the *Carcass* is not compleated, till the *Quarters* and *Braces* between the *principal Posts* and *Posts* are fitted in; the *Window-frames* made and set up, and the *principal Rafters*, *Purlins*, *Gables*, &c. are also fram'd and set up. The manner of their Pitch and Scantlins you will see in *Plate XI.* And the Reasons for several *Pitches* you may find among Books of *Architecture*. But the Names of every Member you will find in the *Alphabetical Table* at the latter end of these Exercises on *Carpentry*, referred unto by Letters and Arithmetical Figures in the Plate aforesaid.

But now we will suppose the Carcass is thus finished. The Bricklayer is then to bring up the Chimnies, and afterwards to *Tile* the House. And then the next Work the Carpenter has to do, is to bring up the *Stairs*, and *Stair-cases*, and afterwards to *Floor* the Rooms, and *Hang* the *Doors*, &c. For should he either bring up the Stairs and Stair-cases, or Floor the Rooms before the House is Tiled, or otherwise covered, if wet Weather should happen it might injure the Stairs, Flooring, &c.

A, *The Ground-plate, or Ground-sell.*

BB, BB, *The Principal Posts.*

CC, *The Binding Intertises, or indeed, more properly Interduces, Bressummers, Girders.*

D, *Beam of the Roof, Bressummer, or Girder to the Garret Floor.*

E E, *Principal Rafters. F F, Bressummers.*

G, *Plate or Raising-piece, also a Beam.*

a a, *Jaums or Door-posts. b b, Braces. c c, Jaums. d, Top-rail of the Balcony.*

e e, *Bottom-rail of the Balcony.*

f f f, *Posts of the Balcony.*

g g g, *Banisters.*

b b, *Bressummers for the Shop-windows;*

H, *King-*

H, King-piece or Joggle-piece.

i, Struts.

k k, Top-beam, Coller-beam, Wind-beam, Strut-beam.

l l l, Door-head.

II, The Feet of the principal Rafters.

K, The Top of the Rafters.

KK, The Gable-end.

LL, Knees of the principal Rafters, to be made all of one piece with the principal Rafters.

M, The Fust of the House.

NN, Purlins.

OO, Shop-windows.

PP, Flaps or Falls.

mm m<sub>2</sub>, Quarters.

nn, Jaums of the Window.

oo, Back and Head of the Window.

pp, Transums.

qq, Munnions.

rr, Furrings, or Sbreadings.

V, Single light Windows or Lateons.

ss, Rafters.

### § 16. Of Window-Frames.

**I**N Brick Buildings the *Window-Frames* are so framed, that the *Tennants* of the *Head-sell*, *Ground-sell*, and *Transum*, run though the outer *Jaums* about four Inches beyond them : And so they are set in a Lay of Morter upon the *Brick-wall* before the *Peers* on either side is brought up, at about three Inches within the Front ; So that the *Brick-work* over the *Head* and about the *Jaums* defend it from the Weather. Then the *Bricklayer* brings up the *Peers* on both sides, so that the four *Ends* or *Tennants* that project through the outer *Jaums* being buried and trimmed into the *Brick-work* become a Fastning to the *Window-Frame*.

But

But if the Window-Frame stands on a Timber-house, the Head and Ground-fell are sometimes Tennanted into Posts of the Carcass; and then the Posts do the Office of the outer Jaums of the Window-Frame; and the Head and Ground-fell are then called *Entertises*, and therefore both Head and Ground-fell, and Posts or Jaums, are rabbeted about half an Inch on the outside of the Front, to receive the Pane of Glass that is fitted to it. And thus (as I said) the Posts become part of the Window-Frame.

But the better way is to frame a Window as the Brick-work Window, and to project it an Inch and a half beyond the side of the Building, and to Plaister against its sides, for the better securing the rest of the Carcass from the Weather.

The Window-Frame hath every one of its Lights Rabbetted on its outside about half an Inch into the Frame, and all these Rabbets, but that on the Ground-fell, are grooved square, but the Rabbets on the Ground-fell is bevell'd downwards, that Rain or Snow, &c. may the freelier fall off it. Into these Rabbets the several Panes of Glass-work is set, and fastned by the Glasier.

The square Corners of the Frame next the Glass is Bevell'd away both on the out and inside of the Building, that the Light may the freelier play upon the Glass. And upon that Bevel is commonly Stuck a Molding (for Ornament sake) according to the Fancy of the Workman, but more generally according to the various Mode of the Times.

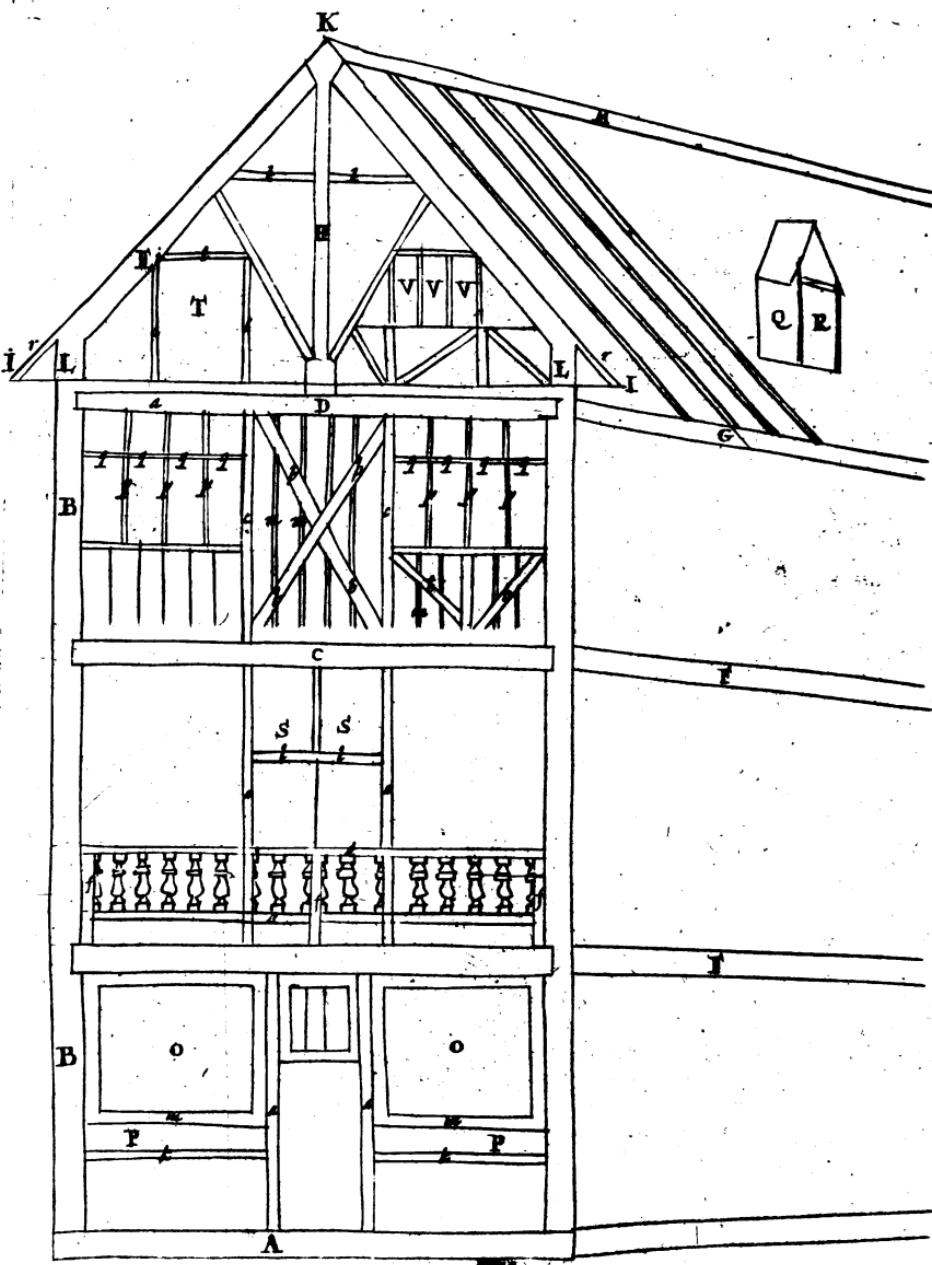
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## § 17. Of Stairs, and Stair-Cases.

**S**everal Writers of *Architecture* have delivered different Rules for the Height and Breadth of *Steps*, and that according to the several Capacities of the *Stair-Cases*. They forbid more than six, and less than four Inches for the Height of each Step, and more than sixteen, and less than twelve, for the Breadth of each Step. But here we must understand they mean these Measures should be observed in large and sumptuous Buildings: But we have here proposed an ordinary private House, which will admit of no such Measures, for want of room. Therefore to our present purpose.

The first and second Pair of Stairs the Steps shall be about  $7\frac{1}{3}$  Inches high, and 10 Inches broad. The third Pair of Stairs each Step may be about  $6\frac{1}{2}$  Inches high, and  $9\frac{1}{2}$  Inches broad. And for the fourth Pair of Stairs, each Step may be about 6 Inches high, and 9 Inches broad. But this Rule they do, or should follow, *viz.* to make all the Steps belonging to the same pair of Stairs of an equal height; which to do, they first consider the height of the Room in Feet and odd Inches, if any odd be, and multiply the Feet by 12, whose Product, with the number of odd Inches, gives the sum of the whole Height in Inches; which sum they divide by the number of Steps they intend to have in that Height, and the Quotient shall be the number of Inches and parts that each Step shall be high. Or, if they first design the Height of each Step in Inches, they try by Arithmetick how many times the Height of a Step they can have out of the whole Height of the Story, and so know the number of Steps.

M E C H A -





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## MECHANICK EXERCISES:

O R,

The Doctrine of Handy-Works.

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Continued in the A R T of House-Carpentry.

**S**TAIRS are either made about a *Solid Newel*, or an *Open Newel*, and sometimes mixt, *viz.* with a Solid Newel for some few Steps; then a straight or Foreright Ascent, with *Flyers* upon the side of the square Open Newel, and afterwards a Solid Newel again. Than reiterate, &c.

The last, *viz.* the *Mixt Newel'd Stairs*, are commonly made in our *Party-walled Houscs* in *London*, where no Light can be placed in the Stair-Cafe, because of the Party-walls; so that there is a necessity to let in a *Sky-light* through the Hollow Newel: But this sort of Stair-Cafes take up more room than those with a single solid Newel; because the Stairs of a solid Newel spread only upon one small Newel, as the several Foulds of the Fans Woman use spread about their Center: But these because they sometimes wind, and sometimes fly off from that winding, take therefore the more room up in the Stair-Cafe.

The manner of projecting them, is copiously taught in many Books of *Architeture*, whether I refer you: Yet not to leave you wholly in the dark,

L

dark,

dark, I shall give you a small light into it. And first of the *Solid Newel*.

Winding Stairs are projected on a round *Profile*, whose Diameter is equal to the Base the Stair-Case is to stand on, suppose six foot square. This *Profile* hath its Circumference divided into 16 equal parts. The Semi-diameter of the *Profile* is divided into four equal parts, and one of them used for the Newel, and the rest for the length of the Steps: If you draw Lines from the Center through every one of the equal parts into the Circumference, the space between every two Lines will be the true Figure of a *Winding-Step*. And if they were all cut out and placed one above another, over the true place on the Profile round about the Newel, whose Diameter is one quarter the length of a Step, you would by supporting each Step with a *Raiser* have the middle of a true pair of *Winding-Stairs*. See Plate 10. Fig. 2.

*Hollow Newel'd* Stairs are made about a square Hollow Newel. We will suppose the *Well-hole* to be eleven foot long, and six foot wide; and we would bring up a pair of Stairs from the first *Floor* eleven Foot high; it being intended that a Skie-light shall fall through the Hollow Newel upon the Stairs: We must therefore consider the width and breadth of the Hollow Newel; and in this example admit it to be two foot and a half wide, and two foot broad: By the width I mean the sides that range with the Front and Rear of the Building, and by the breadth I mean the sides that range with the Party-walls.

I find (by the Rule aforesaid) that if I assign 18 Steps up, each Step will be seven Inches and one third of an Inch high.

You

You must Note, that the flying off, or else winding of these Steps will vary their places according as you design the first Ascent. For if you make the first Ascent as you come straight out of the Street (as in Plate 10.) on the *South-side*, you will first ascend upon a Pitch of *Flyers*, which Pitch (making an Angle of 38 deg. with the Floor) with ten Steps raise you six Foot high above the Floor, and bring you eight Foot towards the *North-end* of the *Well-hole*, by making each Step ten Inches broad.

But now you must leave *Flyers*, and make four Winding Steps. These Winding Steps are made about a solid *Newel* (as hath been taught) and this *Newel* serves also for a *Post* to *Trim* the *Stair-case* too. This Post stands upon the Floor, and is prolonged upwards so high, that Mortesfes made in it may receive the Tennants of the *Top* and *Bottom Rails* of the whole Stair-case for that Floor: These four Winding steps aforesaid, rounding one quarter about the *Newel*, turns your Face in your Ascent now towards the *East*; these four steps are raised 2 foot,  $5\frac{1}{2}$  Inches above the *Flyers*, so that (in all) your Stairs are now raised 8 foot  $6\frac{1}{2}$  Inches. Here remains now only 2 foot  $5\frac{1}{2}$  Inches to the *Landing place*, and these take up just four *Flyers*, which must be made as was taught before.

But now in your second pair of Stairs, it will be proper to begin your Ascent with your Face towards the *West*: For landing by the first pair of Stairs with your Face towards the *East*, you turn by the side of the Rail on the second Floor from the *East* towards the *North*, and at the further end of that Rail, you turn your Face again from the *North* towards the *West*, and begin your Ascent on the second pair of Stairs.

Between the Skie-light and the Ascent is a Post set upright to fasten Rails into : ( to bound the Stair-caſe ) from the bottom of which, *viz.* on the ſecond Floor you trim up three Flyers, and then turn off a quarter of a Circle, with Winding Steps : Then again, Flyers to your deſigned pitch : And then again another quarter of a Circle with Winding Steps, &c.

The Rail theſe Steps are built upon, being at the beginning or bottom of the Ascent framed or otherwife faſtned to the firſt upright Post, muſt at its higher end be framed into the next Post alſo, with a Bevel Tennant, as you were taught to frame *Quarters* into one another, *Numb.* 5. § 17. Only with this diſference, that there you were taught to frame Square; but here you muſt frame upon the *Bevel*, as you were taught, *Numb* 5. § 19. This Post aforesaid bears upon the Floor, to make its Bearing the stronger; and this Post muſt be continued to ſuch an heighth, as it may also ſerve to receive the Tennanted end of an upper and lower Rail framed into it. And between theſe *Bevelling Rails*, *Bannifers* make good the outside of the *Stair-Cafe*.

Though I have here deſcribed this Contrivance of a pair of Stairs, yet do I not deliver it as the best Patern for this Building, or for theſe ſorts of Stairs, nor matters it to our purpoſe whether it be or no; for (as I told you before) my undertaking is the *Doctrine of Handy-works*, not *Architecture*; but it's *Architecture* confiders the best forming of all Members in a Building for the capacity of the Ground-Plot, and the Conveniēnce of the intended Inhabitant; but Carpenters (as Carpenters) only work by direcions preſcribed by the Architect.

These therefore are the common Rules that theſe ſorts of Stairs, and indeed all others with carving

carving according to the Profile or Ground-plot of the Stairs are made by. But those that will see many Inventions may consult Books of *Architecture*, &c.

### § 18. Of Flooring of Rooms.

**T**Hough Carpenters never Floor the Rooms till the Carcass is set up, and also inclosed by the Plaisterer, lest weather should wrong the Flooring; yet they generally *Rough-plane* their *Boards* for Flooring before they begin any thing else about the Building, that they may set them by to season: Which thus they do, they lean them one by one on end aslant with the edge of the Board against a Bauk, somewhat above the height of half the length of the Board, and set another Board in the same posture on the other side the Bauk, so that above the Bauk they cross one another: Then on the first side they set another Board in that posture, and on the second side another, till the whole number of Boards are set an end: Being set in this posture, there remains the thickness of a Board between every Board all the length, but just where they cross one another, for the Air to pass through to dry and shrink them, against they have occasion to use them: But they set them under some covered Shed, that the Rain or Sun comes not at them; for if the Rain wet them, instead of shrinking them, it will swell them; or if the Sun shine fiercely upon them, it will dry them so fast, that the Boards will *Tear* or *Shake*, which is in vulgar English, *Split* or *Crack*,

They have another way to dry and season them, by laying them flat upon three or four Bauks, each Board about the breadth of a Board asunder, the whole length of the Bauks. Then they lay another Lay of Boards athwart upon

them, each Board also the breadth of a Board asunder; then another Lay athwart the last, till all are thus laid: So that in this position they also lye hollow for the Air to play between them.

Thus then, the Boards being Rough-plain'd and Season'd. They try one side flat, as by Numb. 6. § 31. and both the edges straight, as if they were to shoot a Joint; as by Numb. 4. § 4. and cut the Boards to an exact length, because if the Boards are not long enough to reach athwart the whole Room, the ends may all lye in a straight Line, that the straight ends of other Boards laid against them may make the truer Joint, and this they call a *Beaking Joint*. But before they lay them upon the Floor, they try with the *Level* (described § 7.) the flatness of the whole Frame of Flooring again, lest any part of it should be *Cant* since it was first framed together; and if any part of the Floor lye too high, they with the *Axe* (if the eminency be large) take it off, as was shewed § 2. Or if it be small, with the *Jack-Plain* in Numb. 4 § 2. till it lye level with the rest of the Floor. But if any part of the Floor prove hollow, they lay a Chip, or some such thing, upon that hollow place, to bare up the Board, before they nail it down.

All this being done, they chuse a Board of the commonest thickness of the whole Pile for the first Board, and lay it close again one side of the Room athwart the Joysts, and so nail it firmly down with two Brads into every Joyst it crosses, each Brad about an Inch, or an Inch and a half within the edge of the Board.

If they should lay more than an ordinary thick or thin Board at the first, they would have a greater number of Boards to work to a Level than

than they need, because all the rest of the Boards must be equalized in thickness to the first.

Then they lay a second Board close to the first. But before they nail it down they again try how its sides agrees with the side of the first, and also how its thickness agrees with the first Board. If any part of its edge lye hollow off the edge of the first Board, they shoot off so much of the length of the Board from that hollowness towards either end, till it comply and make a close Joint with the first. But if the edge swell in any place, they plain off that swelling till it comply as aforesaid.

If the second Board prove thicker than the first, then with the *Axe* (as aforesaid) they hew away the under side of that Board (most commonly cross the Grain, left with the Grain the edge of the *Axe* should slip too deep into the Board) in every part of it that shall bare upon a Joyst, and so sink it to a flat superficies to comply with the first Board. If the Board be too thin, they underlay that Board upon every Joyst with a Cap, &c.

And as this second Board is laid, so are the other Boards laid, if they be well assured the Boards are dry, and will not shrink; but if they doubt the driness of the Boards, they (sometimes do, or should) take a little more pains, for after they have nailed down the first Board, they will measure the breadth of two other Boards, laying them by the side of the first. But yet they will not allow them their full Room to lye in, but after there edges are true shot in a straight line, they will pinch them off about half a quarter of an Inch room more or less, according as they guess at the well-seasonedness of the Boards; by nailing down the fourth Board nearer to the first Board by half a quarter

of an Inch ( more or less ) then the breadth of both Boards are. And though it be afterwards somewhat hard to get these two Boards into that narrow room, *viz.* between the first and fourth Board, yet they help themselves thus : The under-edge of these Boards that are to join to each other, they Bevel somewhat away, and then the first and fourth Board being fast nailed down ( as aforesaid ) they set the outer edges of these two Boards again the two nailed Boards, letting the inner edges of the two loose Boards meet, and make an Angle perpendicular to the Floor. Then with two or three Men jumping all at once upon that Angle, these two Boards with this force and reiterated jumps by degrees press flat down into the superficies of the Floor, or else with forcing Pins and Wedges, force them together : And then with Brads they nail them down, as they did the first Board. Thus afterwards they nail down a seventh Board, as they did the fourth, and then fit in the fifth and sixth Boards, as they did the second and third Boards. And so on, nailing down every third Board, and forcing two others between it and the last nailed Board, till the whole Floor be boarded.

But if these Boards are not long enough ( as I hinted before ) to reach through the whole Room, they examine how true the ends lye in a straight line with one another, by applying the edge of the Two-foot Rule to the ends, and where the ends of any Boards keep of the edge of the Two-foot Rule from complying with the whole range of ends, they with the *Chissel* and *Mallet* cut off that irregularity, holding and guiding the Chissel, so that it may rather cut away more of the bottom then top of the Board, that so the Boards joined to the ends of the first laid

laid Boards, may make on the Superficies of the Floor the finer and truer Joint.

Having thus Boarded the whole Room, notwithstanding they used their best diligence to do it exactly, yet may the edges of some Boards lye somewhat higher than the Board it lies next to; therefore they peruse the whole Floor, and where they find any irregularities they plane them off with the Plane, &c.

### § 19. *The Hanging of Doors, Windows, &c.*

THE Floors being Boarded, the next work is to *Hang the Doors*, in which tho' there be little difficulty, yet is there much care to be taking, that the *Door* open and shut well.

If the *Door* have a *Door-Case* (as Chamber-Doors, and Closet-Doors commonly have) the *Jams* of the *Door-Case* must stand exactly perpendicular, which you must try by the Plumb-line, as by § 8. and the Head of the *Door-Case* or Entertise must be fitted exactly square to the *Jams*, as you where taught Numb. 3. § 17, 18, 19. and the Angles of the *Door* must be made exactly square, and the *Rabbets* of the *Door* to fit axactly into the *Rabbets* of the *Door-Case*. But yet they commonly make the *Door* about one quarter of an Inch shorter than the insides of the *Jams* of the *Door-Case*, least if the Boards of the Floor chance to fwell within the sweep of the *Door*, the bottom of the *Door* should drag upon the *Floor*.

They consider what sort of *Hinges* are properst for the *Door* they are to *Hang*. When they have a *Street-door* (which commonly is to take off and lift on) they use *Hooks* and *Hinges*. In a *Battend-door*, *Back-door*, or other *Battend-door*, or *Shop-windows*, they use *Cross-Garnets*. If a *Framed Door*, *Side Hinges*: And for *Cup-board*

*boards Doors*, and such like, *Duf-tails*. (See the description of these Hindges in *Numb. I. Fig. 1. 5, 6.*) But what sort of Hindges soever they use, they have care to provide them of a strength proportionable to the size and weight of the *Door* they hang with them. Well-made Hindges I have described *Numb. I. fol. 20.* whither to avoid repetition I refer you.

If they hang a *Street-door* (which is commonly about six foot high) they first drive the *Hooks* into the *Door-post*, by entring the Post first with an *Augure*: But the *Bit* of the *Augure*, must be les than the *Shank* of the *Hook*, and the hole boared not so long, because the *Shank* of the *Hook*, must be strongly forced into the *Augure-hole*, and should the *Augure-hole* be too wide, the *Shank* would be loose in it, and not stick strong enough in it. Therefore if the *Shank* be an Inch square, an half Inch-*Augure* is big enough to bore that hole with, because it will then endure the heavier blows of an *Hammer*, to drive it so far as it must go; and the stronger it is forced in, the faster the *Hook* sticks; but yet they are careful not to split the *Door-post*.

These *Hooks* are commonly drove in about Fifteen Inches and an half above the *Ground-sell*, and as much below the top of the *Door*. It is, or should be, their care to chuse the *Pin* of the lower *Hook* about a quarter of an Inch longer than that they use for the upper *Hook* (or else to make it so) because these *Doors* are commonly unweildy to lift off and on, especially to lift both the Hindges on both the *Hooks* at once. Therefore when the lower Hindge is lifted on the lower *Hook*, if the *Door* be then lifted perpendicularly upright, so high as the under side of the upper Hindge may just reach the top  
of

of the upper *Hook*, you may the easier slip the Eye of the upper Hindge upon the *Hook*; whereas, if the lower *Hook* be either shorter, or just no longer than the other, instead of lifting it readily upon the upper *Hook*, you may lift it off the lower *Hook*, and so begin the labour again.

Having drove in the *Hooks*, they set the *Rabbets* of the *Door* within the *Rabbets* of the *Door-post*, and underlay the bottom of the *Door*, with a Chip or two about half a quarter of an Inch thick, to raise the *Door* that it drag not. Then they put the Eyes of the Hindges over the Pins of the *Hooks*, and placing the Tail piece of the Hindges parallel to the bottom and top of the *Door*, they so nail them upon.

This is the Rule they generally observe for Hanging *Doors*, *Shop-windows*, &c. Only, sometimes instead of Nailing the Hindges upon the *Door*, they *Rivet* them on, for more strength. And then, after they have fitted the *Door*, or *Window*, into its *Rabbets*, and laid the Hindges in there proper place and position (as aforesaid) they make marks in the Nail-holes of the Hindge with the point of their *Compasses* upon the *Door*, and at those marks they Pierce holes, with a *Piercer-Bit*, that fits the shank of the *Rivet*; then they put the shank of the *Rivet* thro' the holes made in the *Door*; yet so that the Head of the *Rivet* be on the outside of the *Door*; and they also put the end of the Shank into the Nail-hole of the Hinge, and so whilst another Man holds the head of the Hatchet against the Head of the *Rivet*, they with the *Pen* of their *Hammer* batter and spread the flat end of the Shank over the Hole, as was shewn *Numb. 2.*  
*fol. 24. 25.*

The

The Titles of some Books of Architecture.

**S**ebastion Seirle, in Folio.

*Hans Bloom's Five Columns*, Folio.

*Vignola*, in Folio.

*Vignola*, Or the *Compleat Architect*, in Octvo.

*Scamotzi*, Quarto.

*Palladio*, Quarto.

Sir Henry Wotton's Elements of Architecture,  
Quarto.

These Books are all Printed in English: But there are many others extant in several other Languages, of which *Vitruvius* is the chief: For from his Book the rest are generally derived; as *Philip Le Orm*, *Ditterlin*; *Marlois*, and many others, which being difficult to be had among Book-sellers, and these sufficient for information, I shall omit till another opportunity.

### An Explanation of Terms used in Carpentry.

#### A

**A**dz, Plate 8. B § 2.

**A**rch, Any work wrought Circular, as the top part of some Window-frames, the top of some great Gates, the Roof of Vaults, &c.

**Architrave**, See Numb. 6. Plate 6. 1. and Plate 6. A. § 1.

**Ax**, Numb. 7. Plate 8. A.

#### B

**B**ack or *Hip-molding*. The backward Hips or *Valley-Rafters* in the way of an Angle for the back part of a Building.

**Bannister**, Numb. 8. Plate 11. ggg.

**Base**, is commonly the Bottom of a Cullumn, See Numb. 6. Plate 6. b. and Plate 7. B.

**Batt**

*Batement*, To abate or waste a piece of Stuff, by forming of it to a designed purpose. Thus instead of asking how much was cut off such a piece of Stuff, Carpenters ask what *Batement* that piece of Stuff had.

*Batter*, The side, or part of the side of a Wall, or any Timber that bulges from its bottom or Foundation, is said to *Batter*, or *hang over* the Foundation.

*Battlement*, A flat Roof or Platform to walk on. But Battlements are more properly Walls built about the Platform to inclose it, as is seen upon Towers for defence; part of the Battlement being Breast high that Musqueters may shoot over it, the other part Man high, to secure Men from the shot of their Enemies.

*Bauk*, A piece of Fir unslit, from four to ten Inches square, and of many lengths.

*Bear*, Timber is said to *Bear* at its whole length, when neither a Brick-wall, or Posts, &c. stand between the ends of it. But if either a Brick-wall or Posts, &c. be Trimmed up to that Timber, than it is said to Bear only at the distance between the Brick-wall or Post, and either end of the Timber. Thus Carpenters ask what

*Bearing* such a piece of Timber has? The answer is 10, 12, 15, &c. Foot, according to the length of the whole Timber, or else according to the distance between either end of the Timber, and a

*Bearer*, viz. a Post or Brick-wall that is Trimmed up between the two ends of a piece of Timber, to shorten its *Bearing*.

*Bond*, When Workmen say make good Bond, they mean fasten the two or more pieces of Timber well together, either with Tennanting and Mortessing, or Duff-tailing, &c.

*Binding*

*Binding Joists*, See Trimmers, or Plate 10.  
*bbb.*

*Brace*, See Plate 11. *bbb.*

*Brad*, is a Nail to *Floor Rooms* with, they are about the size of a Ten-penny Nail, but have not their heads made with a shoulder over their shank, as other Nails, but are made pretty thick towards the upper end, that the very top of it may be driven into, and buried in the Board they nail down, so that the tops of these Brads will not catch (as the Heads of Nails would) the Thrums of the Mops when the *Floor* is washing. You may see them at most Ironmongers.

*Break in*, Carpenters with their Ripping Chisel do often *Break in* to Brick-walls; that is, they cut holes, but indeed more properly break the Bricks by force, and make their hole to their size and form.

*Bressummer*, See Plate 11. CC, D, FF, *bb.*

*Bring up*, A Term most used amongst Carpenters, when they discourse *Bricklayers*; and then they say, *Bring up* the Foundation so high, *Bring up* such a Wall, *Bring up* the Chimnies, &c. which is as much as to say, Build the Foundation so high, Build the Wall, Build the Chimnies, &c.

*Butment*, The piece of Ground in the Yard marked G, in Plate 10. is a *Butment* from the rest of the Ground-plot.

*Butress*, That stands on the outside a Wall to support it.

### C.

**C***amber*, A piece of Timber cut Arching, so as when a weight considerable, shall be set upon it, it may in length of time be reduced to a straight.

*Can-*

*Cantilevers*, Pieces of Wood framed into the Front or other sides of an House to sustain the Molding and Eaves over it.

*Carcass*, is (as it were) the Skeleton of an House, before it is Lath'd and Plastered.

*Cartouches*. Ornamented *Corbels*.

*Cleer Story Window*, Windows that have no Transum in them.

*Commander*, See Numb. 7. Plate 8. K. and § 10.

*Coping over*, is a sort of hanging over, but not square to its upright, but Bevelling on its under side, till it end in an edge.

*Corbel*, A piece of Timber set under another piece of Timber, to discharge its Bearing.

*Crab*, The Engine described Plate 9. E. and BCD several of its Appurtenances, *viz.* BCC *Snatch Blocks*. D *Levers*. Its Office is to draw heavy Timber to a considerable height.

*Crow*, See Plate 8. L. its Office is to remove heavy Timber, and therefore for strength is made of Iron.

*Crown Post*, See Plate 11. H. Also the *King-Piece*, or *Joggle-Piece*.

## D

**D**ischarge, A Brick-wall or a Post trim'd up to a piece of Timber over charg'd for its Bearing, is a Discharge to that Bearing.

*Dormer*, Plate 11. Q R.

*Double Quarters*, See *Quarter*.

*Draft*, The Picture of an intended Building discribed on Paper, whereon is laid down the devised Divisions and Partitions of every Room in its due proportion to the whole Building, See Numb. 7. § 13.

*Drag*, A *Door* is said to *Drag* when either by its ill Hanging on its Hinges, or by the ill boarding of the Room, the bottom edge of the *Door* rides

rides (in its sweep) upon the *Floor*. See § 19:

*Dragon-beams*, are two strong Braces or Struts that stands under a Bressummer, meeting in a  
an angle upon the shoulder of the *King-piece*. In  
Plate 11, 22 are *Dragon beams*.

*Draw knife*, described Plate 8. E and § 5.

*Draw Pins*, described Plate 8. F and § 6.

*Drug*, described Plate 9. E and § 12.

## E

**E**nter, When Tennants are put into Mortef-  
ses, they are said to Enter the Mortesses.

*Enterduce*, or *Entertise*, described Plate 11. CC.

## F.

**F**eather-edge, Boards, or Planks, that have one  
edge thinner than another are called *Feather-*  
*edge stuff*.

*Fir-Pole*, A sort of stuff cut off of the Fir-  
tree, small and long, commonly from 10 to 16  
Foot. They are sometimes used in flight Buil-  
dings, to serve instead of Bauks and Quarters.

*Fliers*, are Stairs made of an Oblong square  
Figure, whose fore and backsides are parallel to  
each other, and so are their ends; the second of  
these *Fliers* stands parallel behind the first, the  
third behind the second, and so are said to fly  
off from one another.

*Floor*, in *Carpentry*, it is as well taken for the  
Fram'd work of Timber, as the Boarding over  
it.

*Foot-pace*, is a part of a pair of Stairs, where-  
on after four or six steps you arrive to a broad  
place, where you make two or three paces be-  
fore you ascend another step; thereby to ease  
the legs in ascending the rest of the steps.

*Furrings*, The making good of the Rafters  
Feet in the Cornice:

*Cable*,

## G

**G**able, or Gable-end, in Plate 11. II K.

**Gain**, The bevelling shoulder of a Joyst; or other Stuff: It is used for the Lapping of the end of a Joyst, &c. upon a Trimmer or Girder, and then the thickness of the shoulder is cut into the Trimmer also Bevilling upwards, that it may just receive that Gain, and so the Joyst and Timber lye even and level upon their superficies. This way of working is used in a Floor or Hearth.

**Girder**, described Plate 10 Q.Q.

**Ground Plate**, described Plate 11 A.

**Ground Plate**, The piece of Ground a Building is to be erected upon.

## H.

**H**ang over, See Batter.

**Hips**, described Plate 11. EE, They are also called Principal Rafters, and Sleepers.

**Hook-pin**, described Plate 8. F.

## I.

**J**ack, described Plate 8. M. An Engine used for the removing and commodious placing of great Timber.

**Jack-Plane**, called so by Carpenters, but is indeed the same that Joiners call the *Fore-Plane*, See Numb. 4. § 2. and Plate 4. B. I.

**Jambs**, Door Posts are so called: So are the upright outer Posts of a Window frame, See Plate 11. *a a a a, cc, nn*.

**Joggle-piece**, See Plate 11. H;

**Joyst**, See Plate 10. *a a a a*.

## M

## Timmers;

**Tuffers**, Stuff, about 4 or 5 inches square, and of several Lengths.

## K.

**K**ing-piece, See *Joggle-piece*.

**Kerf**, See *Explanation of Terms* in Numb. 6.

**Knee**, A piece of Timber growing angularly, or crooked, that is, a great Branch shooting out near the top of the Trunk of the Tree, and is so cut that the Trunk and the Branch make an angle; as in Plate 11. E L, being made out of one piece of stuff: It is called a *Knee-piece*, or *Knee-rafter*.

## L.

**L**anding-place, is the uppermost Step of a pair of Stairs, viz. The Floor of the Room you ascend upon.

**Skirts**, Projecting of the Eaves.

**Level**, See Plate 8. G and § 7.

**Lever**, See Plate 9. D.

**Lintel**, In Brick-buildings Carpenters lay a long piece of Timber over the Peers, to Trim with the Window-Frame; as well to bear the thickness of the Brick-wall above it, as to make Bond with the sides of the Walls.

**Long-plane**, The same that Joiners call a *Joyn-*  
*ter*. See Numb. 4. B. 2. § 4.

**Lutheen**, See *Dormer*.

## M.

**M**odillon, See *Cantilever*.

**Molding**, Moldings are stuck upon the edges of stuff to Ornament it: As on Chimney-pieces, the inner edges of Window-frames, Shelves, &c. See Numb. 4. §. 9.

*Munnion*,

*Munnion*, the upright Post that divide the several Lights in a Window-frame, are called *Munnions*. See Plate II. *qqq.*

N.

**N***Ewel*, the upright post that a pair of Winding-stairs are turned about.

P.

**P***itch*, The Angle a Gable-end is set to, is called the *Pitch* of the Gable-end.

*Planchier*, An Ornament to which the Cornice is fastned.

*Plate*. A piece of Timber upon which some considerable weight is framed, is called a *Plate*: Hence *Ground-Plate*, *Plate* II. A. *Window-plate*, &c.

*Plumb-line*, described *Plate* 8. H §. 8.

*Posts*, See *Principal-Posts*.

*Prick-Posts*, Posts that are framed into *Breſsummers*, between *Principal-Posts*, for the strengthening of the Carcass.

*Principal-Posts*, The corner Posts of a Carcass, See *Plate* II. B. B.

*Profile*, The same with *Ground-Plot*.

*Projecture*, is a jetting over the upright of a Building: Thus *Balconies* project into the Street.

*Puncheons*, Short pieces of Timber placed under some considerable weight to support it.

*Pudlaies*, Pieces of Stuff to do the Office of Hand-Spikes.

*Purlins*, See *Plate* II. NN.

Q.

**Q**uarters are *single* and *double*. *Single Quarters* are Sawen stuff, two Inches thick, and four Inches broad. The *Double Quarters* are sawen to Four Inches square.

M 2

*Quar-*

*Quartering*, In the Front of the third Story in Plate 11. All the Work, except the Principal Posts, Jaums, and Window-frames, *viz.* the upright Trimming, and the Braces is called *Quartering*.

*Quirk*, A piece taken out of any regular Ground-plot, or Floor: For example, the whole Ground-plot A B C D. in Plate 10. is a regular Ground-plot. But if the piece K be taking out of it, K shall be a *Quirk*.

## R.

**R** *After*, See Plate 11. *cccc.*

*Rail*, Rails stand over and under Bannisters of Balconies, Stair-Cases, &c.

*Raiser*, is a Board set on edge under the Fore-side of a step.

*Raising-piece*, Pieces that lye under the Beams upon Brick or Timber by the side of the House.

*Rellish*, See *Projecture*.

*Return*, Either of the adjoining sides of the Front of an House, or Ground-plot, is called a *Return-side*, as in Plate 10. the Front is A B, the *Return-sides* to this Front is A C and B D.

*Ridge*, the meeting of the Rafters on both sides the House is called the *Ridge*.

*Ripping-Chissel*, See Plate 8. D § 4.

*Roof*, The Covering of a House: But the word is used in Carpentry for the Trimming work of the Covering.

## S.

**S** *Cribe*, See Number 6. in *Explanation of Terms*.

*Shake*, Such stuff as is crackt either with the heat of the Sun, or the droughth of the wind, is called *Shaken Stuff*.

*Shingles*,

*Shingles*, Small pieces of Wood used to cover Houses with, instead of Tiles or Slates.

*Sbreadings*, See Plate 11. the lower end of the Principal Rafters markt *rr* are called *Sbreadings*, or *Furrings*.

*Sleepers*, The same with *Purlins*.

*Snatch-blocks*, See Plate 9. B.C.C.

*Socket-Chisel*, Described Plate 8. and § 3.

*Soils*, or *Sells*, are either *Ground-Sells* described Plate 11. A. or *Window Sells*, which are the bottom Pieces of Window Frames.

*Stair-Case*, The inclosure of a pair of Stairs, whether it be with Walls, or with Walls and Railes and Bannisters, &c.

*Stancheons*, See *Puncheons*.

*Strut*, See *Dragon-beam*.

*Summer*, In Plate 10. P.P. is a *Summer*, where into the Girders are Tennanted.

### T.

**T**en-Foot-Rod, See § 13.

*Transom*, The Piece that is fram'd a-cross a double Light-window. See Plate 11. P.P.

*Trim*, When workmen fit a piece into other Work, they say they *Trim* in a piece.

*Trimmers*, See Plate 10. b b b.

*Truss*, See *King-piece*, or *Foggle-piece*.

*Tusk*, A Bevel shoulder, made to strengthen the Tenant of Joyst, which is let into the Girder.

### V.

**V**alley Rafter, See *Back*, or *Hip-molding*.

W.

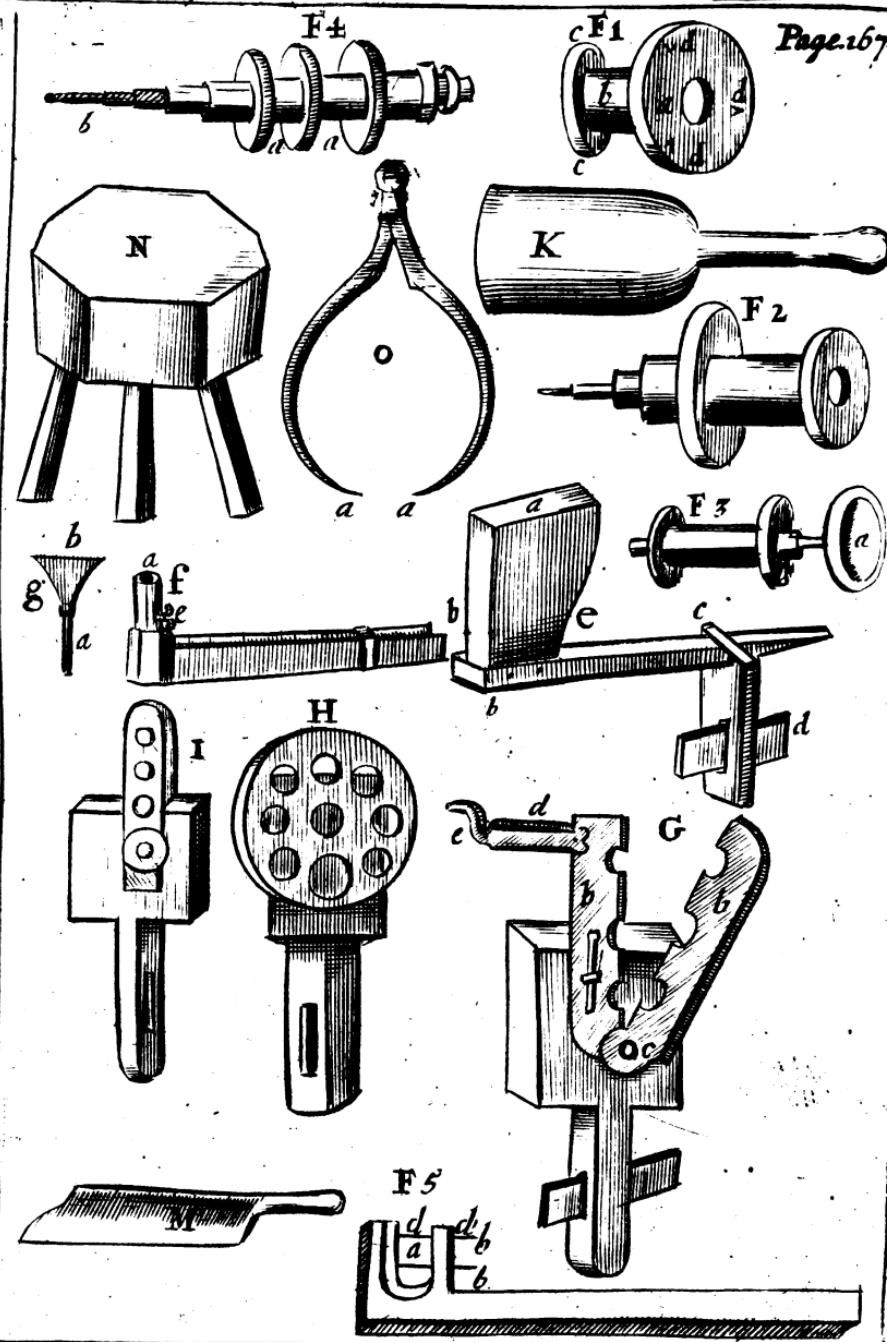
**W**ELL-hole, See Plate 10. I.  
*Wall-Plate*, In Plate 10. A C, BD and  
NO are *Wall-Plates*.

Thus much of *Carpentry*. The next *Exercises* will (God willing) be upon the Art of *Turning*, *Soft Wood*, *Hard Wood*, *Ivory*, *Brass*, *Iron*, &c. With several Inventions of *Oval-work*, *Rose-work*, *Rake-work*, *Angular-work*, &c.

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**MECHA**

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## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

---

Applied to the A R T of *TURNING.*

Of Turning.

AS by placing one Foot of a pair of Compasses on a Plane, and moving about the other Foot or point, describes on that Plane a Circle with the moving point; so any Substance, be it *Wood*, *Ivory*, *Brafs*, &c. pitcht steddy upon two points (as on an *Axis*) and moved about on that *Axis*, also describes a Circle Concentrick to the *Axis*: And an Edge-Tool set steddy to that part of the outside of the aforesaid Substance that is nearest the *Axis*, will in a Circumvolution of that Substance, cut off all the parts of Substance that lies farther off the *Axis*, and make the outside of that Substance also Concentrick to the *Axis*. This is a brief Collection, and indeed the whole Sum of *Turning*.

Now, as there is different Matter, or Substance, to be *Turned*, so there is also different Ways, and different Tools to be used in *Turning* each different Matter.

M 4

The

The different Matters are *Soft Wood*, *Hard Wood*, *Ivory*, *Brass*, *Iron*, &c. each of which (when I have described the Turners Tools for soft Wood) I shall discourse upon. But,

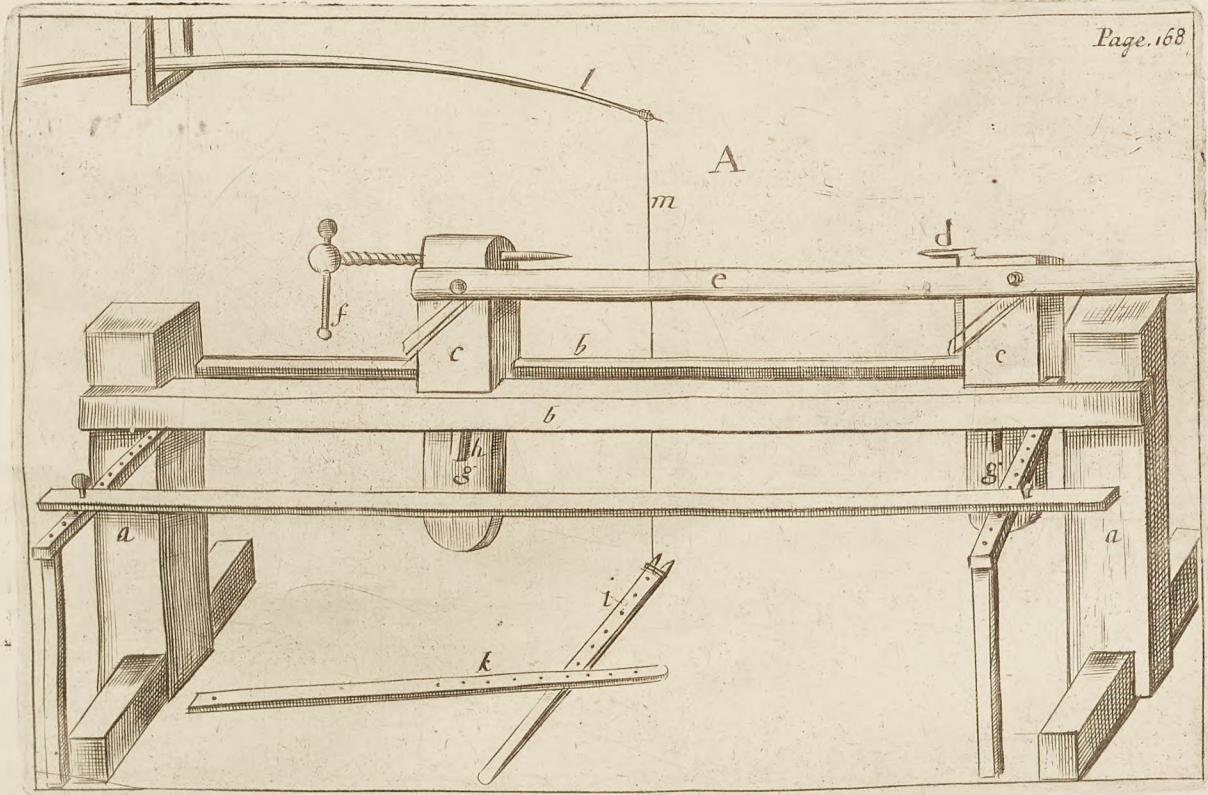
### § I. Of the Lathe.

**T**He *Lathe* is described in *Plate 12. A.* This Machine is so vulgarly known, that tho' it cannot be described in Draft, so as all its parts shall appear at one single View, yet enough of it to give you the Names of its several Members, and their Uses are represented, *viz.*,

- a a a a* The *Legs or Stiles.*
- b b* The *Cheeks or Sides.*
- c c* The *Puppets.*
- d* The *Screw.*
- d* The *Pike.*
- e* The *Reft.*
- f* The Handle of the *Screw.*
- g* The *Tennants of the Puppets,*
- h* The *Wedge.*
- i* The *Treddle.*
- k* The *Cross-Treddle.*
- l* The *Pole.*
- m* The *String.*
- n* The *Horn.*

### § i. Of the Legs, or Stiles.

**T**He *Legs, or Stiles*, are commonly about two Foot and ten Inches high, and are set perpendicularly upright; having each of them a *Tenant* on its upperend, of the thickness the two *Cheeks* are to stand assunder: And on either side the Shoulder of these two *Tennants*, is laid one of the *Cheeks* close to the sides of the *Tennants*, and so pinned close to the *Tenant*, as was



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comparatively upright; having each of them a  
Tennant on its upperend, of the thickness the  
two *Cheeks* are to stand assunder: And on ei-  
ther side the Shoulder of these two *Tennants*, is  
laid one of the *Cheeks* close to the fides of the  
*Tennants*, and so pinned close to the *Tennant*, as  
was

was taught *Numb.* 5. § 17. But a stedderier and more secure way, is to have a strong Iron Screw made with a square Shank near the Head, that when it enters into a square hole made fit to it in the hithermost *Cheek*, it may not twist about, but by the Turning about of an Iron Nut, upon the fore-end of the Screw, the Nut shall draw the two Cheeks close to the two sides of the *Tennants*, or the upper ends of the *Legs*.

### ¶ 2. Of the Cheeks.

**A**S I told you, the Legs are to be set up directly perpendicular, so the *Cheeks* are to be fastned directly Horizontally upon them: And the *Legs* and *Cheeks* are to be fastned with *Braces* to the Floor, and other parts of the Room the *Lathe* stands in, according to the convenience of the Room for fastning, that the whole *Lathe* may stand as steady and solid as may be. For if with *Turning* large Work the strength of the Tread should make the *Lathe* tremble, you will not be able to make true and neat Work; but the Tool will job into softer parts of the Stuff, and fly off where a Knot or other harder parts of the Stuff comes to the Tool.

### ¶ 3. Of the Puppets.

**T**He *Puppets* are square pieces of Wood, of a Substance convenient to the light or heavy work they intend to *Turn*: And *Turners* will rather have their *Puppets* too strong than too weak; because, though the *Puppets* be very strong, yet they can turn light work with them; whereas if they be weak they cannot turn Heavy work with them: For the weight of heavy unequal tempered Stuff running about, will be apt both to shake the *Puppets*, and loosen the small

small hole of the *Wedge* in the *Tennant*; by either of which Inconveniences the Work in the *Lathe* may tremble, as aforesaid.

And though no size for the height of the *Puppets* can be well asserted, because of the several Diameters of Work to be *Turned*, yet Workmen generally covet to have their *Puppets* as short as they well can, to bear their Work off the *Cheeks* of the *Lathe*, because these *Puppets* stand in the firmer, and are less subject to loosen. But then, if the Diameters of the work be large, the *Puppets* may be too short to *Turn* that work in: For the *Pikes* of the *Puppets* must stand somewhat more than half the Diameter of the Work above the superficies of the *Cheeks*. Therefore *Turners* have commonly two or three pair of *Puppets* to fit one *Lathe*, and always strive to use the shortest they can to serve their Work, unless the shortness of the *Legs* of the *Lathe*, makes the work fall too low for the pitch of the Work-man that is to work at the *Lathe*. Therefore in the making of the *Lathe*, the height of the *Legs* with relation to the intended Work, and height of the Work-man, are to be well considered.

At the lower end of these *Puppets* are made two *Tennants*, of such a thickness, that they may easily slide in the *Grove* between the two *Cheeks*, and so long, that a *Mortes* through it of the length of the *Cheeks* depth, and a sufficient strength of Wood below it may be contained. Into this *Mortes* is fitted a Tapering *Wedge*, somewhat less at the fore end, and bigger at the hinder end than the *Mortes*, that as it is forced into the *Mortes* with a *Mallet*, or a *Maul*, it may draw the bottom Shoulder of the *Puppet* close and firmly down upon the *Cheeks*, that they may neither joggle or tremble in working.

¶ 4. Of

## ¶ 4. Of the Horn.

**U**pon the Right Hand *Puppet* on the out fide near the top of it, is hung the Tip-end of an *Horn* with its Tip downwards, to hold Oyl in, and ought to have a Wooden round *Cover* to fit into it, that neither Chips or Dirt get in to spoil the Oyl; and in the handle of the *Cover* should be fitted a wooden *Butten*, which may serve for an *Handle* to the *Cover*: And through this *Butten* should be fastned an Iron *Wyer*, to reach almost to the bottom of the *Horn*: This *Wyer* stands always in the Oyl, that so oft as the Workman has occasion to oyl the Centers of the Work, to make his Work slip about the easier, he takes the wooden *Cover* by the *Button*, *Wyer* and all, and with the end of the *Wyer*, oyls his *Center-holes*, and pops his *Wyer* and *Cover* again into the *Horn* against he has occasion to use it the next time.

## ¶ 5. Of the Pikes and Screw.

**N**ear the upper end of one of these *Puppets* is fastned a strong Iron *Pike*, but its point is made of tempered Steel: And near the upper end of the other *Puppet* is fitted an Iron *Screw* quite through a *Nut* in the *Puppet*, whose point is also made of Temper'd Steel. This Iron *Pike* in one *Puppet*, and the *Screw* in the other *Puppet* are so fitted into the *Puppets*, that their Shanks lye in a straight Line with one another, and both their points lie also in that straight Line pointing to one another: And in the Head of the Iron *Screw* is a Hole where into is fitted an Iron *Handle* about seven or eight Inches long, with a round *Knob* at each end of it that it slip  
not

not through the hole in the Head. This Iron *Handle* is to turn about the *Screw* forward or backward as your purpose shall require.

Upon the points of this *Screw* and *Pike* the Centers of the Work are pitcht, and afterwards screwed with the *Screw* hard, and so far into the Stuff, that it may not slip off the points in working, especially if it be soft Wood, and the work large and heavy.

Also, near the upper end of these *Puppets*, upon that side the Workman stands when he works, the Wood of the *Puppets* is wrought a-way to square flat shoulders somewhat below the *Pikes*, that the *Reft* may (if occasion be) lye near the *Pikes*, and bear steddy upon the *Shoulders*.

#### ¶ 6. Of the *Reft*.

**T**He *Reft* is a square piece of Stuff about an Inch, or an Inch and half thick, and two Inches, or two and an half broad, and somewhat longer than the distance between the *Puppets*. Its Office is to rest the Tool upon, that it may lie in a steddy position while the Workman uses it.

#### ¶ 7. Of the Side-*Reft*.

**B**ut besides this *Reft*, *Turnners* have another *Reft*, called the *Side-reft*. This they use when they *Turn* the flat sides of Boards; because the flat sides of Boards standing athwart the *Pikes*, and this *Reft* standing also athwart the *Pikes*, they can the more conveniently rest their Tool upon it. It is marked *e* in plate 13, and is in the *Plate* disjunct from the *Lathe*; as well because it and the Common *Reft* cannot both together be exprest in Picture, as also because it is made to take off and put on as occasion requires.

The

The *Reſt* is marked *a*, and is a piece of an Oaken plank, or Elm plank, about two Inches think, and stands so high above the *Cheeks* of the *Lathe* as the *points* of the *Pikes* do, or sometimes a little higher: Its Breadth is about a Foot, or more, or less, as the Work requires, or the Workman fancies. The Bottom of it is firmly nailed to one fide of a Quarter of Oak, or Elm, of about three Inches square, and two Foot, or two Foot and an half long, close to one end, as you see in the Figure at *b*, so as the *Reſt* stand upright to the piece of Quarter. This piece of Quarter is as a *Tennant* to slide into a square Iron Collar marked *c*; this square Iron Collar is made so long as to reach through the depth of the *Cheeks* of the *Lathe*, and to receive the Quarter or *Tennant* thrust through it above the *Cheeks*, and a *Wedge* under the *Cheeks* marked *d*, which *Wedge* (when stiff knock'd up) draws the *Tennant* strong and firmly down to the *Cheeks*, and consequently keeps the *Side-reſt* steady on any part of the *Cheeks*, according as you slide the *Collar* forwards or backwards towards either *Pike*, or as you thrust the *Reſt* nearer or farther to and from the *Pikes*.

Some *Turners* for some Work, instead of a plank for this *Reſt*, fasten to one end of the Quarter or *Tennant*, a long Iron with a round Cilindrick *Socket* in it, as at the Figure marked *f* in Plate 13, *a* is the *Socket* of about an Inch, or an Inch and an half Diameter, to reach within two or three Inches as high as the *Pikes*, and into this *Socket* they put a long round Iron *Shank*, as in Figure *g* of the same *Plate*, *a* is the *Shank*, and at the top of this *Shank* is made the *Reſt*, marked *b*. This *Shank* (I say) slips easily into the *Socket*, that it may be raised, or let down, as occasion requires, and by the help

help of a *Screw* through the *Socket* at *e*, may be fastned at that length.

The *Reft*, (by reason of its Round *Shank*) may be also turned with its upper edge more or less oblique or athwart the Work, or else parallel to the Work, according as the purpose may require.

Near one end of the *Reft* is fitted and fastned a piece of Wood about an Inch square, and ten or twelve Inches long: This piece of wood is fitted stiff into a square Hole or Mortels made in the *Puppet*, a little above the *Shoulder* for the *Reft*, to set the *Reft* to any distance from the *Pikes*, which, with the ends of wooden *Screws* entred into wooden *Nuts* on the further side of the *Puppet*, and coming through against the *Reft*, keeps the *Reft* from being thrust nearer to the work when the Workman is working.

#### ¶ 8. Of the Treddle and Cross-Treddle.

**A**bout the middle between the ends, is placed a wooden *Treddle* about two Inches and an half broad, an Inch thick, and three Foot long, and sometimes three and an half, to four Foot long. The hinder end of it is fastned to the Floor, with a piece of Leather (sometimes a piece of the Upper-leather of an old Shoe, which piece of Leather is nailed to the under-side of the hinder end of the *Treddle*, so as to leave Leather enough beyond the end of the *Treddle* to nail down upon the Floor; which *Treddle* being thus nailed down, will move upwards, as the Spring of the *Pole* draws up the *String*; the *String* being also fastned to the fore-end of the *Treddle*,

The

The hinder end of the *Treddle* is nailed down about a foot, or a Foot and an half behind the *Latbe*, and about the middle between both the *Legs*, so that the fore-end of the *Treddle* reaches beyond the fore-side of the *Latbe*, about a Foot and an half, or two Foot. And Note, that the farther the Fore-end of the *Treddle* reaches out beyond the Fore-side of the *Latbe*, the greater will the sweep of the Fore-end of the *Treddle* be, and consequently it will draw the more *String* down; and the more *String* comes down at one *Tread*, the more Revolutions of the Work is made at one *Tread*, and therefore it makes the greater riddance of the Work.

But then again, if the Fore-end of the *Treddle* reach too far before the Fore-side of the *Latbe*, it may draw the end of the *Pole* so low as to ~~make it~~; And it will also be the harder to *Tread* down, because the power commanding (which is the weight of the *Tread*) lies so far from the weight to be commanded, which is the strength of the *Pole*, augmented by the distance that the end of the *Treddle* hath from the Work in the *Latbe*; so that you may see, that the nearer the Fore-end of the *Treddle* lies to the Perpendicular of the Work in the *Latbe*, the easier the *Tread* will be: And some *Turners* that *Turn* altogether small Work, have the Fore-end of the *Treddle* placed just under their work; so that their *String* works between the *Cheeks* of the *Latbe*: But then the Sweep of the *Treddle* being so small, the *Pole* draws up but a small length of *String*, and consequently makes the fewer Revolutions of the Work in one *Tread*, which hinders the riddance of the Work; unless with every Spring of the *Pole*, they should lift their Treading Leg so high, as to tire it quickly

quickly with bringing it down again, after it is raised to so uncommodious a position.

This *Treddle* hath a square Notch in the middle of the further end, about an Inch and an half wide, and two Inches long, that the end of the *String* may be wound either off or on the Wood on either side the Notch, to lengthen or shorten the *String*, as the different Diameters of the Work shall require.

About the midde of the *Treddle* is fixed a round Iron *Pin* about half an Inch in Diameter; so as to stand upright about an Inch and an half, or two Inches long above the *Treddle*. And under the *Cheeks* is also fixed down the *Cross-Treddle*, which is such another piece of Wood as the *Treddle* is, but longer or shorter, according to the length of the *Lathe*: And in the middle of the Breadth of the *Cross-Treddle*, is made several holes all a-row to receive the Iron *Pin* set upright in the *Treddle*. These holes are commonly boared about two or three Inches assunder, that the *Pin* or the *Treddle* may be put into any one of them, according as the *String* is to be placed nearer to or further off either end of the *Lathe*.

## ¶ 9. Of the Pole.

**T**He *Pole* is commonly made of a *Fir-pole*, and is longer or shorter, or bigger or smaller, according to the weight of the Work the Workman designs to *Turn*: For the thicker the *Pole* is, the harder must the *Tread* be to bring it down; and for this reason, if the *Pole* prove too strong for their common or continued Work, they will weaken it by cutting away (with a Draw-knife, described Numb. 7. Plate 8. E, and § 5.) part of the substance off the upper and under sides of the *Pole*.

The thick end of this *Pole* is nailed (or indeed rather pinned) up to some Girder, or other Timber in the Ceiling of the Room, with one single Nail or a Pin, that the *Pole* may move upon that Nail, or Pin, as on a Center, and its thin end pass from one *Puppet* to the other, as the Work may require. And at about a distance or more, is also nailed up to some Joists, or other Timbers of the Ceiling, two *Cheeks* of a convenient strength, and at the lower end of these two *Cheeks* is nailed a Quarter or Batten to bear the *Pole*, though the weight of a *Tread* be added to it, as you may see at *nn* in Plate 12.

## ¶ 10. Of the Side-Reft.

**B**UT it sometimes happens that the Ceiling of the Work-room is not high enough for the *Pole* to play upwards and downwards; therefore in such case, they place the thin end of the *Pole* at some considerable distance off the *Lathe*, either before or behind it, and so make the Spring of the *Pole* Horizontal towards the *Lathe*, conveying and guiding the *String* from the *Pole* to the Work by throwing it over a

N

Rowles

*Rowler*, moving on two Iron *Center-pins* fastned at both ends, and placed parallel to the *Cheeks* of the *Lathe*, above the Work as high as they can; and thus every *Tread* draws the *Rowler* about: But should the *Rowler* not move about upon these Irons Pins, the *String* every *Tread* would both cut a Groove in the *Ruler*, and fret it self more or less upon the *Rowler*.

#### ¶ 11. Of the Bow.

Some *Turners* that work light Work, such as *Care-heads*, *Ink-horns*, &c. for which they need scarce remove the *Puppets* off their *Lathe*, use a common *Bow*, such as Archers use. The middle of this *Bow* they fasten over Head, with its *String* Horizontally downwards, and in the middle of that *String* they fasten another *String* perpendicularly downwards, whose other end they fasten to the *Treddle*, and the *String* wound round their Work brings it about.

#### ¶ 12. Of the Great Wheel.

But when *Turners* work heavy Work, such as the Pole and *Tread* will not Command, they use the *Great Wheel*. This Wheel is so commonly known, that I shall need give you no other Description of it than the Figure it self, which you may see in *Plate 14. a.* It is turned about with one, and sometimes with two Iron *Handles*, according as the weight of the Work may require.

Its *String* hath both its ends strong and neatly fastned together, not with a Knot, but lapt over one another about three Inches in length, and so is firmly whipt about with small Gut, that it may the easier pass over the narrow *Groove* in the edge of the *Rowler*. This *String* is laid in the *Groove* made on the edge of the *Wheel*,

Wheel, and also in the *Groove* of the Work. But before it is laid upon both, one part of the *String* is lapt over and crosses the other, and the *String* receives the Form of a Figure of Eight (only one of its Bows or Circles becomes no bigger than the *Groove* in the Work, and the other as big as the *Groove* in the *Wheel*.)

Then the whole Frame wherein the *Wheel* is fixed is removed farther off the *Lathe*, that the *String* may draw tight upon the Work.

The reason why the *String* thus crosses it self, is, because it will touch and gird more upon the *Groove* of the Work, and consequently (as was said before ¶ 14.) will the better command the Work about.

The manner of Turning this *Wheel*, is as the manner of Turning other *Wheels* with *Handles*.

Besides the commanding heavy Work about, the *Wheel* rids Work faster off than the Pole can do; because the springing up of the Pole makes an intermission in the running about of the Work, but with the *Wheel* the Work runs always the same way; so that the Tool need never be off it, unless it be to examine the work as it is doing.

When the *Wheel* is used, its Edge stands athwart the *Cheeks* of the *Lathe*.

#### ¶ 13. Of the Treddle-Wheel.

This is a *Wheel* made of a round Board of about two Foot and an half Diameter, conveniently to stand under the *Cheeks* of the *Lathe*. It also hath a *Groove* on its Edge for the *String* to run in; it hath an Iron *Axle* with a *Crook* or *Crank* at one end: And on this *Crook* is flipt the Noose of a *Leather Thong*, which having its other end fastned to a *Treddle*, does, by keep-

ing exact time in *Treads*, carry it swiftly about without intermission.

But the length of the *Thong* must be so fitted, that when the *Wheel* stands still, and the *Crook* at the end of the *Axis* hangs downwards, the end of the *Treddle* to which the *Thong* is fastned may hang about two or three Inches off the Ground : For then, giving the *Wheel* a small turn with the Hand, till the *Crook* rises to the highest, and passes a little beyond it ; if just then ( I say ) the Workman gives a quick *Tread* upon the *Treddle* to bring the *Crook* down again with a jerk, that *Tread* will set it in a motion for several revolutions ; and then if he observes to make his next *Tread* just when the *Crook* comes about again to the same position, it will continue the motion, and cause of the motion, and keep the *Wheel* always running the same way, if he punctually times his *Treads*.

The *Treddel Wheel* is used for small work only, as not having strength enough to carry heavy Work about, such as *Cane-heads*, *Small Boxes*, &c. and it is fitted below the *Cheeks* between the *Puppets*, as the *Bow* is above.

Besides these Inventions to carry about the Work in the *Lathe*, there are many more ; as with a great *Iron Wheel*, having Teeth on its edge, which Teeth are to fall into an *Iron Nut* upon an *Iron Axis*, pitcht upon the *Pikes* of the *Puppets* of the *Lathe*, or fitted into *Collars*, &c.

Also, for very heavy Work, as *Guns*, great *Mortars*, &c. *Wheels* turn'd with *Wind*, *Water*, or *Horses*, to carry the Work about. Of which more in their proper places.

## ¶ 14. Of the String.

**U**PON the thin end of the *Pole* is wound a considerable Bundle of *String*, that as a *Mandrel* requires to be bigger than ordinary, or the Work heavier, they may unwind so much of the *String* as will compass the *Mandrel* twice, or (if the Work be heavy) thrice; the easier to carry it about.

This *String* is made of the Guts of Beasts (most commonly of Sheep, and spun round of several thickneses, of which the Workman chuses such sizes as are aptest for his Work; for large and heavy Work, very thick, but for small and light work, thin: And there are several reasons for his Choice; for a thin *String* will be too weak for heavy Work; but if it were not too weak for heavy work, it would be apt to mark soft wood more than a thick *String* would, when they are forc'd to shift the *String*, and let it run upon the Work. Besides, a thin *String* (though it were strong enough) would not so well bring heavy Work about; because being small, but little of the *String* touches the wood to command it, unless they wind it the oftner about the Work, which both takes up time, and hazards the breaking of the *String*, by the fretting of the several twists against one another.

Now a thick *String* is uncommodious for small work; because having a strength and stubbornness proportionable to its size, it will not comply closely to a piece of Work of small Diameter, but will be apt to slip about it, unless both *Pole* and *Tread* be very strong; and then, if the Center-holes be not very deep, and the *Pikes* fill them not very tight, and the *Puppets* also not very well fixt, the strength of the

String will alter the Center-holes; especially, when the work is upon soft Wood, or else it will endanger the breaking the work in its weakest place.

### § 15. Of the Seat.

Parallel to the *Cheeks* on the inside the *Lathe* is fitted a *Seat*, about two and an half Inches square, and the whole length of the *Lathe*; having an Iron Pin fastned on either end the under-side of it: It lies upon two *Bearers* of Wood, that are fastned athwart the outer sides the *Legs*, (or else to set it higher) the outer ends of the *Cheeks*, according to the height of the person that works at the *Lathe*. These *Bearers* reach in length so far inwards, as that they may be capable to bear the *Seat* so far off from the *Lathe*, as in the Diameter of the *Work* they intend to *Turn* in the *Lathe*, and also the bulk of the Workman that stands between the *Lathe* and it, may be contained.

It is not called a *Seat*, because it is so; but because the *Workman* places the upper part of his *Buttocks* against it, that he may stand the steddieer to his *Work*, and consequently guide his Foot the firmer and exacter.

The two *Bearers* have several Holes made in them, from within sixteen Inches off the *Lathe*, to the ends of them, that the Iron Pins fastned in the ends of the *Seat*, may be removed nearer or farther off the *Lathe*, according to the greatness or smallness of the Diameter of their *Work*.

Having thus described the parts of a Common *Lathe*, I shall now follow with their other Tools also.

§ II. Of

## § II. Of Gouges.

**G**ouges are marked B B in *Plate 15*. They do the Office of *Fore-plains* in *Joynery*, and the *Jack-plains* in *Carpentry*, and serve only to take off the Irregularities the *Hatchet*, or sometimes the *Draw-knife* leaves, after the work is hewed or drawn pretty near a Round with either of them: And therefore as the *Fore-plain* is made with a Corner-edge, only to take off the Irregularities of a Board, so the *Gouge* that it may also take off the Irregularities or Extuberancies that lye farthest from the *Axis* of the Work, and also frame pretty near the hollow Moldings required in the *Work*, precede the *Smoothing-Chisels*. And that the *Gouge* may the more commodiously and effectually do it, the Blade of this Tool is formed about half round to an edge, and the two extream ends of this half round a little sloped off towards the middle of it, that a small part about the middle may the easier cut off the prominencies that are not concentrick to the *Axis*, and so bring the *Work* into a Method of Formation.

The hollow edge is ground upon the Corner of a *Grind-stone*, which in short time wears the outside of that Corner to comply and form with the hollow of the *Gouge*. It is afterwards set upon a round *Whet-stone*, that fits the hollow of the edge, or is somewhat less. But they do not set their *Gouges* or *Chisels* as (I told you in *Numb. 4. § 10.*) the Joyners do; for *Turners* Tools being somewhat unweldy, by reason of their size, and long Handles, they lay the *Blade* of the *Gouge* with its convex side upon the *Rest* of the *Lathe*; and so with the *Whet-stone* in their right hand they rub upon the *Bafil* the *Grind-stone* made, and as they rub, they often turn

another part of the hollow of the edge to bear upon the round of the *Whet-stone*, till they have with the *Whet-stone* taken off the roughness of the *Grind-stone*.

Of these *Gouges* there are several sizes, *viz.* from a quarter of an Inch, to an whole Inch, and sometimes for very large *Work*, two Inches over.

The *Handles* to these *Gouges* (and indeed to all other *Turning Tools*) are not made as the *Handles* of *Joyners* or *Carpenters Tools* are, but tapering towards the end, and so long that the *Handle* may reach (when they use it) under the Arm-pit of the *Work-man*, that he may have more stay and stiddy management of the *Tool*.

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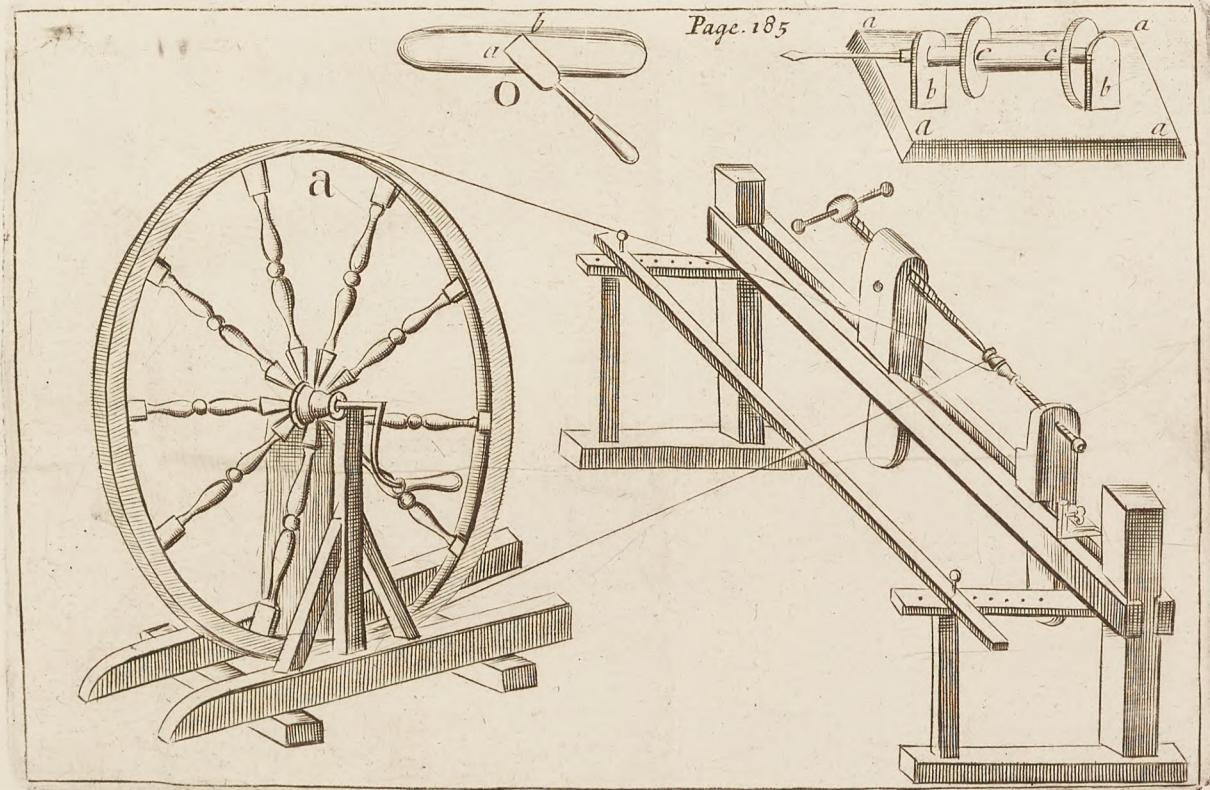
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## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

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Applied to the ART of TURNING.

### § III. Of Flat Chisels.

**T**H E *Flat Chisels* are marked CC in Plate 15. These do the Office of *Smoothing Plains* in *Joyning* and *Carpentry*; for coming after the *Gouges* they cut off the prominent Risings that the *Gouges* leaves above the hollow.

The edges of these *Flat Chisels* are not ground to such a *Basil* as the *Joyners Chisels* are, which are made on one of the Flat sides of the *Chisels*, but are *Basil'd* away on both the flat sides; so that the edge lies between both the sides in the middle of the *Tool*: And therefore either sides of the *Tool* may indifferently be applied to the Work; which could not well be, should the edge lye on one of the sides of the *Tool*: Because, if they should apply the *Basil* side of the *Tool* to the Work, the thickness of the *Basil* would bear the edge of the *Tool* off: And should they apply that side of the *Tool* the edge lies on to the *Work*, the swift coming about of the *Work* would (where a small irregularity of

Stuff

Stuff should happen) draw or jobb the fuddain edge into the Stuff, and so dawk it; which if the Stuff be already small enough, would now be too small, because in *Turnings*, all Irregularities must be wrought smooth down.

Of those *Flat Chiffels* there are several sizes, viz. from a quarter of an Inch, one Inch, two Inches, to three Inches broad, according to the largeness of the *Work*.

These are Set with the *Whet-stone* as the *Gonges* are, only they often turn the *Gouges* upon the round fide, because they would smoothen all the hollow edge; but these are laid flat upon the Rest, and with a flat *Whet-stone* rubbed on the *Basil*, as the *Gouge* was with the Round.

#### § IV. Of Hooks.

The *Hook* is marked D in *Plate 15*. As the *Gouge* is used when the *Work* lies before the *Workman*, viz. parallel to its *Axis*, and cuts right forwards, so the *Hook* is used when the *Work* stands on the right or left fide the *Workman*, as the flat sides of Boards to be Turned do; and therefore this *Work* may be said to lye athwart its *Axis*. And the *Hook* is made so as to cut on the right or left fide a Board, and to take off the extuberances from the plain of the Board. But though this *Tool* does the Office of a *Gouge*, yet it is more difficult for a *Workman* to use than a *Gouge*, because it is made thinner and slenderer than a *Gouge*, that its edge cutting at a greater Bearing from the *Rest*, may the easier come at the Stuff it works upon, and the farther the edge that cuts lies from the *Rest*, the more difficult it is for a *Workman* to guide it, because it is then more subject to tremble; especially since (as aforesaid) the edge of the *Hook* is and must be thinner than the edge of the *Gouge*. These

These *Tools*, as also the *Gouges*, and *Flat-Chisels*, are all about ten or twelve Inches long without the Handles.

The *Hooks* when they want sharpening cannot be *ground* as the *Gouges* and *Chisels* are ; but they must be first softned in the Fire and turned straight, and then brought to an edge, and by heating again red hot turned into its form : Then must it be hardned and tempered as you were taught, *Numb. 3. fol. 57, 58.* Yet do not *Workmen* proceed thus with their *Hook* every time it grows bluntnish, but only when the edge is either by long use, or bad Temper, grown so thick, that this following way will not help them : For they *Whet* the outer edge with a *Whet-stone* as they do other *Tools*. But because ~~they cannot come at the inner edge~~ of the *Hook* with a *Whet-stone*, unless the *Hook* be very wide, and the *Whet-stone* very thin, they make use of a piece of *Temper'd Steel*, as sometimes the thin side of a *Chissel*, or the back of a *Knife*, and so with the edge of the Square, scrape along the hollow edge of the *Hook*, and force the edge as much to the outside of the *Hook* as they can, Thus *Butchers* wear at their Girdles small round Rods of Steel well tempered and polisht, that they may with quick dispatch whet their *Knives* upon it, by forcing the edge forwards upon the Blade, or pressing down the Shoulder that hinders the edge Entrance ; for their Steels being so well polisht, cannot properly be said to wear away any part of the Shoulder that should hinder the edge from doing its Office.

§ V. Of

**§ V. Of Grooving Hooks, and Grooving Tools.**

The *Grooving Hook* is marked E in *Plate 15*, and hath its Tooth of different forms, according to the Fashion of the *Groove* to be made on the Plain of the Board; for sometime its Tooth hath a flat Edge, sometimes a round Edge, sometimes a point only, and sometimes two points, or other Forms as aforesaid.

Its whole Blade is made much stronger than the *Gouge* and *Chisels*, and hath the sides of its Edge more obtuse to make it the stronger.

The *Flat Tools* work the Boards Flat either to the Plain of the Board, or to a Flat Groove in the Board.

The *Round Edge* cuts an half-round hollow in the Board.

The *Point* cuts a fine Hollow Circle or *Swage* in the Flat of the Board; and being made Triangular, hath three Edges each, of which cuts the Ridges smooth down that the *Hook* left upon the Board.

The *Two-point Grooving-Hook* cuts two fine hollow Circles or *Swages* on the Plain of the Board.

The *Grooving-Hooks* do not work as the *Hooks* do, for the *Hooks* cut the Wood; but these do but indeed scrape off the Extuberancies, or fret into the Wood, and therefore they are very seldom used to soft Wood, because its being loose, will not endure scraping without leaving a roughness upon the Work; but hard Wood, or Ivory (for the Reason converted) will.

**§ VI. Of**

### § VI. Of Mandrels. And ¶ 1. Of Flat Mandrels.

**M**andrels are marked F 1. F 2. F 3. F 4. in Plate 15. There are different sorts of *Mandrels*, and the fizes of them also different, according to the fizes of the Work.

1. *Broad Flat Mandrels* marked F 1. in *Plate 15.* with three or more little Iron Pegs, or Points near the Verge of its Flat: And these are used for the *Turning* Flat Boards upon. For the back-side of a Board placed Flat upon it, will when screwed up tight between the Pikes, by help of the Iron Pegs, remain in its place and position, whilst the Flat side of the Work is working upon.

Behind the Backside of this *Mandrel* (and indeed all other *Mandrels*) is fitted a long *Shank*, or ~~Rowler, for the String to be wound about while the Work is Turning.~~ This *Rowler* must be so large in Diameter, that the *String* wound about it may command the *Work* about. If the *Work* be large and heavy, the *Rowler* must be bigger than if the *Work* be light; for else the *String* will not command it about: But if the Diameter of the *Rowler* be smaller, the work comes so much swifter about. The *Rowler* must also be so long between its *Shoulders*, that it may conveniently contain so many Diameters of the *String* as shall be necessary to wind about it.

This whole *Mandrel* is marked F 1. in *Plate 15.* a. The *Round Flat*, or *Face*, of the *Mandrel*. b. The *Rowler*. c c The *Shoulders* of the *Rowler*. d d d The *Pegs*.

### ¶ 2. Of Pin-Mandrels.

2. **M**andrels are made with a long *Wooden Shank*, to fit stiff into a round hole that is made in the *Work* that is to be *Turned*. This *Mandrel*

*Mandrel* is called a *Shank*, or *Pin-Mandrel*, and is marked F 2. in Plate 15. And if the hole the *Shank* is to fit into be very small, and the Work to be fastned on it pretty heavy, then *Turners* fasten a round Iron *Shank*, or *Pin*, of the size of the Hole it is to be fitted into, and fasten their Work upon it. These *Mandrels* with Iron *Shanks* are used by *Turners* that *Turn* Bobbins, or such like Work: Because a *Wooden Shank* to fit the small Hole though the work would not be strong enough to carry the work about.

### ¶ 3. Of Hollow-Mandrels.

3. **T**HERE is another sort of *Mandrels* called *Hollow Mandrels*, described F 3. Plate 15. It is both a *Hollow-Mandrel*, and also used to *Turn* hollow *Work* in it. This *Mandrel* hath but one Center-hole belonging to it, viz. at the *Rowler* end or Neck; but it hath a *Shank*, which supplies the Office of another Center-hole, *a* the hollow, *b* the *Shank*, or *Neck*. The *Hollow* is made so wide, that the *Work* intended to be *Turned* hollow in it may fit very stiff into it, and so deep that it may contain the intended *Work*.

When it is used, it is pitcht upon the Center at the farther end of the *Rowler*, and hath its *Shank* put into one of the Holes of the *Joynt-Coller* described in Plate 13. fig. G. that will best fit it; which Hole standing directly against the *Pike* in the hinder *Puppet*, and receiving the *Shank* into it, guides the *Mandrel* about, as if it were pitcht upon two Centers: And the *Work* being forced stiff into the Hollow of this *Mandrel*, will be carried about with it, exposing the Fore-side of the work bare and free from the *Joynt-Coller*, and not impeded by *Spikes* from coming at the *work*; so that with the *Hook*,  
*Grooving-*

*Grooving-Hook, Gouge, or Flat-Chiffel*, according as your work requires, you may come at it to Turn your intended Form.

*Hollow Mandrels* are also used in Collers that open not with a Jynt ; but then the Spindle is made of Iron, and hath a Screw just at its end, upon which is screwed a Block with an hollow, in it, made fit to receive the work stiff into it.

#### ¶ 4. Of the Screw-Mandrel.

4. A Nother sort of *Mandrel* is called the *Screw-Mandrel*, and is marked F 4. in Plate 15. *a* the Rowler of the *Mandrel*, *b*. the *Shank*, or *Screw*, is made of Iron, having its two ends Round, and in the middle between the Round ends a Square the length of the *Rowler*, and this Square is fitted stiff into a Square-hole made through the middle of the *Rowler* that it turn not about in the Square-hole. In each Flat-end of this Iron *Shank*, or *Spindle*, is made a Center-hole, wherein the Pikes of the Puppets are pitcht when this *Mandrel* is used. This Iron *Shank*, or *Axis*, must be made very straight, and ought to be turned upon the two Center-holes for exactnes ; because on one of the round ends, or sometimes on both, a Screw, or indeed several Screws of several Diameters is made. That Screw next the end of the *Shank* is the smalleſt, viz. about three quarters of an Inch over, and takes up in length towards the middle of the *Shank*, about an Inch, or an Inch and an half ; and ſo far from the end of the *Shank* it is of an equal Diameter all the way ; and on this portion of the *Shank* is made a *Male-screw* of the finest Thread. The next Inch and half (wrought as before) hath another *Male-screw* ; but about half a quarter of an Inch more in Diameter than the former, and hath its Threads courſer. Another

ther Inch and half hath its Diameter still greater, and its Threads yet courser. And thus you may make the *Shank* as long as you will, that you may have the more variety of sizes for *Screws*.

These sorts of *Mandrels* are made for the making of *Screws* to *Boxes*, and their *Lids*, as shall be shewed in the next Paragraph.

**¶ Of Sockets, or Chocks, belonging to the Screw-Mandrel.**

**T**O this *Screw-Mandrel* belongs so many *Sockets* as there are several sizes of *Screws* on the *Shank*. They are marked F 5. in *Plate 15.* a the *Socket* or *Chock*: b b, the *Wooden Pin*, c the *Stay*, d d the *Notch* to slip over the *Male-screw*.

These *Hollow Sockets* have *Female-Screws* in them, made before the *Notch* to slip over the *Male-screw* of the *Screw-Mandrel* is cut. The manner of making *Female-screws* is taught *Numb. 2. fol. 29, 30, 31.* only instead of a *Tap* ( used there ) you use the several and different sizes of *Screws* made on the *Screws-Mandrel* to do the Office of a *Tap* into each respective *Socket*; which *Sockets* being only made of hard Wood, it will easily perform, though the *Shank*, or *Axis* be but Iron.

Therefore ( as aforesaid ) to each of the *Male-screws* on the *Screw-Mandrel* is fitted such a *Socket*, that you may chuse a *Thread Courser* or *Finer* as you please; but this *Female-screw* is open, or hath a *Notch* on one side of it, that it may slip over the *Male-screw*, and the Threads of each other fit into each others *Grooves*; and when they are thus fitted to one another, the further or open side of the *Male-screw* is gaged in, or pin'd on the *Female-screw* with a wooden *Pin* thrust through two opposite Holes, made for

for that purpose in the *Cheeks* of the wooden Sockets, that it shake not.

When the *Treddle* comes down in working, and the *Socket* is fitted on its proper *Screw*, and pinn'd stiff upon it, and the *Stay* held down to the *Rest* of the *Lathe*, then will the *Socket*, and consequently the *Stay* slide farwards upon the *Male-screws*; so that a Tool held steady on any part of the *Stay*, and applied to the out or in-side of your *Work*, that Tools point will describe and cut a *Screw*, whose Thread shall be of the same fineness that the *Screw* and the *Shank* is of.

### § VII. Of Collars.

There are several fashion'd *Collars*; As the *Foynt-Coller* marked G, the *Round-Coller* marked H, and the *Collar* marked I, in Plate 13.

The *Foynt-Coller* is made of two Iron *Cheeks* marked b b, which moving upon a Joint c at the Bottom, may be set close together, or else opened as the two insides of the *Foynt-Rule* Carpenters use to do. On the inner Edge of each *Cheek* is formed as many half-round holes or Semi-circles as you please, or the length of the *Cheeks* will conveniently admit: These Semicircles are made of different Diameters, that they may fit the *Shanks* or *Necks*, of different siz'd *Mandrels*: And these Semi-circles must be made so exactly against each other on the edges of the *Cheeks*, that when the two *Cheeks* moving upon their *Foynt* are clapt close together, the Semi-circles on both the *Cheeks* shall become a perfect round hole, or circumference.

Near the top of one of these *Cheeks* is fastned with a *Center-pin*, a square Iron Coller marked d, with a small *Handle* to it marked e. This square Coller is made to contain the breadth of



both

both the *Cheeks* when they are shut together, and to hold them so fast together, that they shall not start assunder; and yet is made so fit, that it may slip off and on both the *Cheeks*.

This *Foynt-Coller* may serve to do the Office of the other two *Collers*, and its one particular Office too: Yet to save the Charge of the price of this Tool, *Turners* seldom use them, but make shift with either of the other, or sometimes with a hole made in a Board only: But its particular Office is to hold a *Mandrel*, whose Neck is fitted to one of its Holes, and the work they are to *Turn* is required to stand out free from the outer Flat of the *Cheeks* of the *Coller*, the better to come at it with the *Tool*; such as are deep Boxes, or deep Cups, &c.

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## **MECHANICK EXERCISES:**

O R,

### **The Doctrine of Handy-Works.**

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Applied to the ART of TURNING.

#### **§ VIII. Of the Mawl.**

**T**H E *Mawl* is marked K in Plate 13. The Figure of it there is Description sufficient: Its Office is to knock and unknock the Wedge in the *Puppets*; and to knock upon the back of the *Cleaving Knife*, when they split their Wood for their Work. The *Foyner's Mallet* would supply the Office of this Tool; but use has made the *Mawl* more handy for them: Besides when one is batter'd to shivers, they can quickly, of a Chump of Wood, accommodate themselves with another.

#### **§ IX. Of the Hatchet, Draw-knife and Cleaving-knife.**

**T**HE *Hatchet* is marked L in Plate 4. It is of the same sort that *Foyners* use; which I described Numb. 5. § 25. and therefore refer you thither. And the *Draw-knife* is described in Numb. 7. § 5. Plate 8. marked E. The *Cleaving-knife* marked M in Plate 13. needs no other Description than that Figure.

O 2

§ 10. Of

## § X. Of the Chopping-Block.

**T**He *Chopping-Block* is marked N in Plate 13. It is made of a piece of *Elm-Tree* placed with its Grain upwards and downwards as it grew. It hath three Leges in it, that stand stradling out from the underside of the *Block* to the Floor, and of such an height, as the Workman may have most Command of the Work. See the Figure. Sometimes *Turners* use instead of it, a piece of the Trunk of a Tree, of about a Foot and an half, or two Foot, in length from the Ground, or more or less.

## § XI. Of the Callippers.

**T**He *Callippers* is marked O in Plate 13. As common Compasses (described Numb. 6. § 32.) are for measuring Distances upon a plain Superficies; so *Callippers* measure the distance of any round *Cilindrick Conical Body*, either in their Extremity, or any part less than the Extream: So that when Workmen use them, they open the two points *a a* to their described width, and *Turn* so much stuff off the intended place, till the two points of the *Callippers* fit just over their Work; so shall their Work have just the Diameter in that place, as is the distance between the two points of the *Callippers*, be it either Feet or Inches, &c.

## § XII. Of the Drill-Bench.

**T**here is yet another Tool, or rather a *Machin* used by some *Turners*, called a *Drill-Bench*. It is described in Plate 14. *a a a a* a thick Board, about three Inches thick, five Inches broad, and eighteen Inches long, *b b* two Stiles placed towards either end, and fastned upright. In the hithermost Stile is a *Collar* described § 7. and Plate

Plate 13. H. or any of the other *Collers*: And in the further *Stile* is fitted a square flat temper'd piece of Steel having a Center-hole in the middle of it, and is placed just against the Center or middle point of the Hole of the *Coller*, & the *Rowler*, whose hither end is Turned away, so as it just fit into the *Coller*, and at the further end of it, it hath a temper'd Steel *Pir*, to be placed in the Center-hole: And in the middle of the hither end of it, it hath a *Piercer-Bit* fastned straight in, so that it lie in a true straight Line, with the *Axis* of the *Rowler*. Of these *Rowlers* they have several, and *Bits* of different sizes fitted into them, that upon all occasions they may chuse one to fit their purpose.

On the under-side, about the middle of the *Bench*, is fitted and fastned athwart it a square Iron *Coller*, deep enough to reach through the *Cheeks* of the *Latbe*, and so much deeper as it may receive a Wooden *Wedge*, such a one as belongs to one of the *Puppets*: And by the force and strength of the *Wedge*, the whole *Drill-bench* is drawn down and fastned athwart the *Cheeks* of the *Latbe*.

When it is used, it stands athwart the *Cheeks* of the *Latbe* (as aforesaid) with the point or end of the *Bit* towards you; and then the *String* being turned twice or thrice about the *Rowler*, will (with *Treading* on the *Treddle*) turn the *Rowler* and its *Bit* forcibly about, and cause it to enter swiftly into a piece of Wood that shall be prest forwards upon the *Bit*.

When they use it, they hold the piece of Wood they intend to *Drill*, or *Pierce*, fast in both their Hands, right before them, and press it forwards upon the *Piercer-Bit*; so that by its running about, it cuts a straight round hole into the Wood, of what length they please.

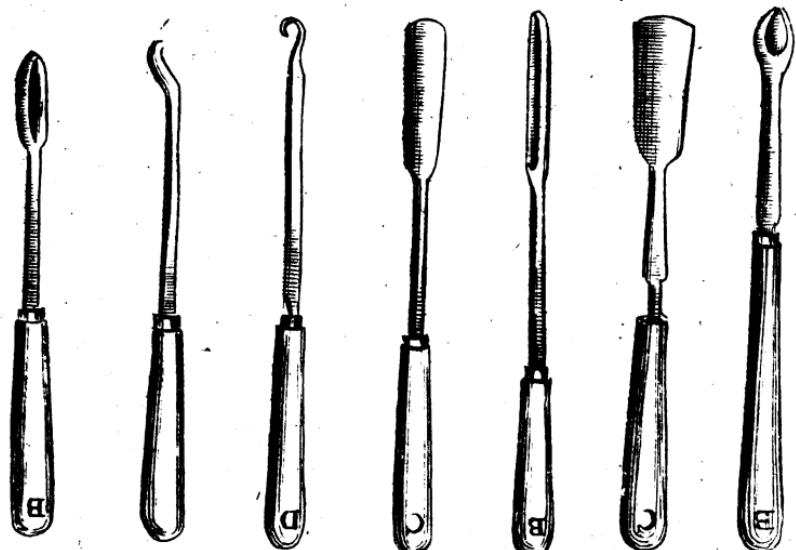
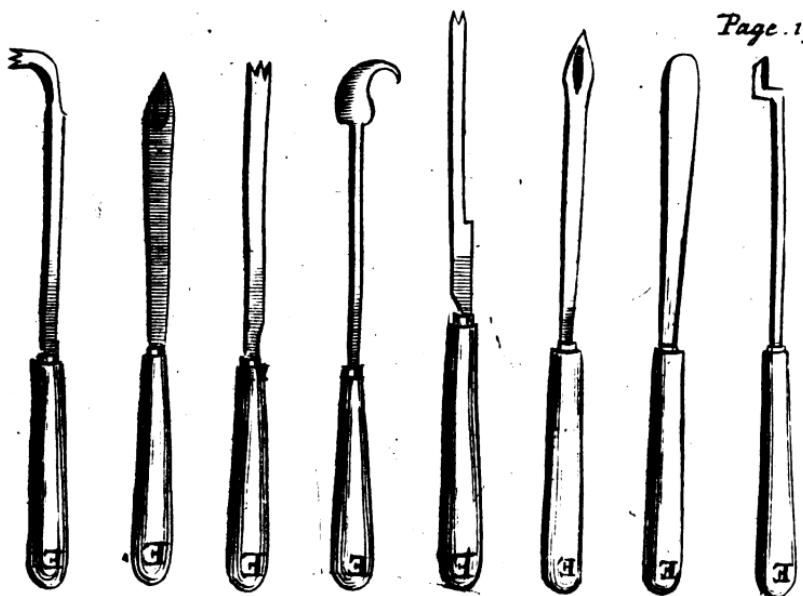
But while the *Pole* is rising after every *Tread*, they press not against the *Piercer-Bit*, so that it is disengaged from doing its Office in the Wood; but in that while, they nimbly give the Wood a turn in their hands, of about one third part of its Circumference; which makes the *Bit* very successive *Tread*, go the straighter through the middle of the Wood: And thus they reiterate *Treads*, and keep the Wood turning in their Hands, till the *Bit* is enter'd deep enough.

Thus much of the *Tools* used in common *Turning*: I shall proceed to the Working a Pattern or two in soft Wood; which being well understood, may render a Practicer capable of most common Work.

### § XIII. Of Turning a Cilinder in soft Wood.

The soft Wood Turners Use is commonly either *Maple*, *Alder*, *Birch*, *Beech*, *Elm*, *Oak*, *Fir*, &c. and for some particular purposes each of these sorts are best.

The first Pattern we purpose shall be a *Cilinder* two Inches over, and eight Inches long: Therefore you must chuse a piece of Wood at least two Inches and a quarter over, lest you want Stuff to work upon: Nay, if your Stuff prove shaken, or otherwise unsound, or your Center be not very exactly pitcht, you may want yet more Stuff; and that according as it proves more or less faulty, or as the Centers are more unequally pitcht. But supposing the Stuff good, you may take a piece of two Inches and a quarter over, as I said before, and about ten or eleven Inches long. For though the length of the *Cilinder* be but eight Inches, yet you must cut your Stuff long enough to make a Groove at one end of it besides, for the *String* to run in. If your Stuff be somewhat too big for your Scantlin,





Scantlin, and not round enough to go into the *Lathe*, you must *Hew* it pretty near with the *Hatchet* to make it fizable, and afterwards smoothen it nearer with a *Draw-knife*, as you were taught, *Numb.* 7. § 5.

But if you have not Stuff at hand near your size, then you must Saw off your length from a Billet, or some other piece of Stuff, and with the *Cleaving-knife* and the *Mawl*, split it into a square piece near the size, and with the *Draw-knife* round off the Edges to make it fit for the *Lathe*.

Then set your *Puppets*, and wedge them right up, so as the *Points* of your *Spikes* stand pretty near the length of your Work assunder, and move the *Pole*, so as the end of it may hang over between the *Pikes*, and also fit the Iron *Pin* in the *Treddle* into a proper *Hole* in the *Cross-Treddle*, so as the end of the *Treddle* may draw the *String* below the Work into pretty near a straight Line with the string above the Work: And take the Work in your Right Hand, and put it beyond the *String* before you, and with your Left Hand wind the *String* below the Work, but once about the Work, lest it should be too strong for your shallow Centers, as you shall understand by and by, and then with a pretty strength press the middle of one end of your Work over the Point of one of the *Pikes*, and so make a hole in your Work for one of the Center holes: Then screw your Pike wider or closer, according as the length of your Work requires, and pitch the other end of your Work upon the other Pike also, and screw your Work a little lightly up: Then try how the Centers are pitcht, by Treading the *Treddle* lightly down; and if you find the Centers are well pitcht, you may without more ado screw up your Work tight:

O 4

But

But if your Centers, or either of them be not well pitcht, you must alter them. You may know when they are well pitcht, by treading softly upon your *Treddle*, and holding your Finger steddy on the *Reft*, direct the point of it pretty close to the Work: For if in a Revolution of your Work, its Out-side keeps it an equal distance from the end of your Finger, you may conclude your Work is well pitcht. But if you find one side of your Work comes nearer your Finger than the other side, you must with your *Flat Chissel*, or *Gouge*, (or what is nearest at hand) knock softly, or hard, upon that side that comes nearest to your Finger, till you have forc'd the *Pikes* into the true Centers at the end of your Work; and then you may boldly screw it hard up: But you must be sure to screw it hard up; because it is soft Wood you purpose to work upon, and the strength of the *Pole* may endanger the drawing or removing the Centers, if the *Pikes* have not good hold of them.

Haying found your Centers, take your Work again off the *Pikes*, and wind the *String* once or twice more about your Work, that your *String* (as I said in *Numb.* 10. § 1. when I wrote of the *String*) may the better command it, and then wind off or no more *String* at the end of your *Pole*, or end of your *Treddle*, or both, if your Work require it, till the *Pole* draws the *Treddle* up a little above half the length of the *Legs* of the *Lathe*. For about the height your Leg may without sudden trying, command the *Pole* down again.

But before you begin to work upon the Stuff, I shall inform you how to *Tread* the *Treddle*, in which you may observe this General Rule; That the nearer the Fore-end of the *Treddle* you *Tread*, the easier you bring down the *Pole*; but then

the *Pole* in its Spring raises your Leg the higher, and may draw the upper side of the your Thigh against the underside of the *Cheek* of the *Lathe*, and with reiterated Risings Gawl, and also tire your Thigh.

Place therefore your Foot steddy upon the *Treddle*, so far forward as you can, to avoid the *Poles* rising from drawing your Thigh against the underside of the *Lathe*; and Tread the *Treadle* nimbly down, but not quite so low as to knock against the Floor: Then abate the weight of your Tread, and let the *Pole* draw the *Treddle* up, but still keep your Foot steddy, and lightly Bearing upon the *Treddle*: For then your succeeding *Treads* will prove easier to your Leg and Thigh, and you will with your Foot the better and quicker command the *Treddle*. Then *Tread* again nimbly down as before, and keep this train of Treading till your Work be finish'd, or that you may have occasion to stop and exaime how rightly you proceed.

In all small Work the *Tread* is lightly and nimbly performed, but in large and heavy work the *Tread* comes slow and heavily down.

This being premised, you may begin with your *Gouge*; lay the round side of it upon the *Rest*, and take the Handle of it in your Right Hand, and lay the Fore and Middle Fingers of your Left Hand upon the Hollow of the *Gouge* near the Work, mounting the Edge about a quarter of an Inch above the *Axis* of your Work, and sinking your Right Hand a little; for in this position the *Gouge* cuts best: And thus cut down on your Work near one end, a *Groove* for your *String* to run in: The *Groove* may be about an Inch, or an Inch and an half long; but it matters not much what depth. Then slip your *String* into the *Groove*, and if you find the *String* will

will not slip easily, you may put your Foot under the *Treddle* and lift it a little up, that the *String* when no weight is hanged to it, may slide the easier into the *Groove*.

And by the way you may take notice, that the deeper you cut down the *Groove*, the oftner will your Work come about every Tread; because the *String* that comes down every Tread, measure a small Circumference oftener than it does a greater Circumference: But then the work is not so strongly carried about; because it hath a less portion of the *String* to command it. This I hint, not that in this our small proposed Pattern it is very considerable: For if you only cut the *Groove* down but so low as there may be a Shoulder at the end, and another against the Work, to keep the *String* from slipping out of the *Groove*, it will be sufficient: But in heavy Work this *Groove* ought to be cut with discretion.

Now come to the Forming of your Work, and hold your *Gouge*, as you were taught before, but somewhat lightly against your Work, beginning at one end, and sliding your *Gouge* gradually to the other, cutting with its Edge all the way you go, and bearing somewhat stiff against the Work every Tread you make on the *Treddle*: And withdrawing it again a little lightly from the *work* every Spring of the Pole. And thus by Use you must habituate your self to let the edge of your *Tool* bear upon the Work when the Pole and *Treddle* comes down, and to draw it back just off the Work, as the Pole and *Treddle* goes up. And thus you must continue till you have rough-wrought all your work from end to end.

If you have not at first brought your Work clean; that is, if you have not gone deep enough with your *Gouge* to take off all the *Rings*

sings of the Stuff the *Draw-knife* left, even with the smallest part of your Work, you must in like manner (as before) work it over again. But you must have a special Care you take not too much Stuff away on any part of the whole Work : For this proposed Pattern being a *Cilinder*, if you take but a small matter to much away from any part, and make it smaller than your given measure there, the whole Work will be spoiled, as being smaller than the proposed Diameter ; which to know, you may by opening the Points of your *Callipers* to two Inches on your *Rule* (the proposed Diameter of your *Cilinder*) try if the Points at that distance will just slip over the deepest *Grooves* of your Work (for we will not suppose that the *Grooves* are of an equal depth with the Rough-working of the *Gouge*) without straining the Joint, for then your Work is just sizeable : If not, work over again as before, &c. But we will now suppose you have not taken too much away, but have made a due process with your *Gouge*. Therefore now proceed, and use a *Flat Chissel*, about an Inch and an half broad, to take off the Irregularities the *Gouge* left.

Take the Handle of it in your Right Hand, as you did the *Gouge*, and claspsing the *Blade* of it in your Left Hand, lean it steady upon the *Rest*, holding the Edge a little aslant over the Work, so as a Corner of the thin side of the *Chissel* may bear upon the *Rest*, and that the Flat side of the *Chissel* may make a small Angle with the *Rest*, and consequently with the Work ; (which is parallel to the *Rest*) for should you set the edge of the *Chissel* parallel to the Work, it might run too fast into the Work, and dawk it. Therefore you must set the *Chissel* in such a position, that the lower, Corner, or near the lower Corner of the edge,

edge, may cut lightly upon the Work : But this position is best described by a Figure, which to that purpose I have inserted in *Plate 14.* at O, where you may perceive in, or near, what position the *Chiffel* must be set to cut the Work ; and how the edge of the *Chiffel a b* lying *aslant* the Work, and the further Corner of the edge of the *Chiffel b* being somewhat mounted, as the Work comes about, the Bottom, or near the Bottom, of the edge of the *Chiffel* is only capable to cut a narrow Shaving off the Work : And just in this manner you must keep the *Chiffel* steady bearing upon the Work, as the *Pole* comes down, and withdrawing it from the Work as the *Pole* springs up ( as you were taught to use the *Gouge* ) and at the same time sliding it forwards from one end of the Work to the other, till it be wrought down all the way to its true Diameter between the points of the *Callipers* : For then a straight *Ruler* applied to your Work, the outside of your purposes *Cilinder* will be formed.

Only the ends must be cut down square to the length : Therefore open the points of your *Compasses* to the distance of eight Inches on your *Rule*, and prick that distance hard off upon your Work, that the points of your *Compasses* may leave visible marks, by placing one point as near one end as you can, to leave Stuff enough to cut straight down all the way ; that is, to cut it square down at right Angles with the outside of the Work. Which to do, you must hold the Handle of the *Flat Chiffel* in your Right Hand ( as before ) and clasp the Blade of it in your Left, and lay one of the thin sides of it upon the *Reft*, so that the edge may stand upright, or very near upright against the Work. Then sink your Right Hand somewhat below the Level of the *Reft*, that the lower Corner of the edge of the

the *Chiffel* may mount, and being thrust steddy against the Work, just in the mark one Point of the *Compasses* made, Tread the *Treddele*, and cut a pretty deep Circle into the Stuff. But you must have a care you do not direct the cutting Corner of the *Chiffel* inwards, but rather outwards, lest you make the end hollow instead of Flat: For if you do take off too little at first, you may by degrees cut it down to a Flat afterwards. As you cut deeper into the Stuff, you must turn the Flat of the *Chiffel*, and with it cut down the Shoulder just at the end on the outside the mark, for else that may hinder the Corner of the edge of the *Chiffel* for coming at the Work.

Note, That if you hold not the edge of the *Chiffel* truly before the Work, but direct it inwards, and if you hold it not very steddy, and have a good guidance of it, the quick coming about of the Work, may draw the edge of the *Chiffel* into it inwards and run a dawk on *Cilinder*, like the *Grooves of a Screw*, and so spoil your Work: For being once wrought to the true size, you cannot afterwards take any more off to cleanse it, &c.

The other end must be cut down as this.

§ 14. Of

## § 14. Of Turning Flat Boards.

**I**F your Board be thick enough, you may boar a round Hole in the middle of it; and turn a *Mandrel* with a *Pin* a very little Tapering, to fit hard and stiff into the round Hole: And if the *Hole* and *Pin* be proportionable in size to the weight of the Board, the *Pin* will carry it about. But you must be very careful the *Hole* be board-ed exactly straight through the middle, and not inclining on either fide the Board, more to any part of the Verge than to another; but that the middle of the *Hole* be exaclty the Center of the Board the whole thickness through. This *Pin-Mandrel* is described *Numb.* 11. § 6. and *Plate* 13.

If your Board be not thick enough to be fastened upon a *Pin-Mandrel*, or that your Work will not admit of an Hole to be bored through the middle of it, you may use the *Flat-Mandrel* de-scribed *Plate* 13. F 2. And then you must with your *Compasses* find the Center on the backside of the Round Board (with several proffers if need require) till you have found it, and prick there an Hole for a mark: Then open the points of your *Compasses* to about the thickness of a Shilling wider than the Semidiameter of the *Flat-Mandrel*; and with the points of your *Compasses* at that distance describe a Circle on the back-fide of the Board to be turned, by placing one Foot in the prick-mark, and turning about the other Foot. By this Circle you may pitch the Center of the Board exactly upon the Center of the *Flat-Mandrel*: For the points of the *Compasses* being opened about the thickness of a Shilling wider than the Semidiameter of the *Flat-Mandrel*: will

(when

( when you have pitcht the Center of the Board on the Center of the *Mandrel* ) place the outer Verge of the *Mandrel* the thickness of a Shilling round about within the Circle described on the backside of the Board: And when it is thus pitcht, you may, by laying the Board flat down, knock upon the *Rowler* end of the *Mandrel*, and drive the *Pegs* in the flat of the *Mandrel* into the Board, and so hold it steddy upon the *Mandrel*: Then find the Center on the Fore-side of the Board also, as you were taught to find the Center on the backside, and put your Board and *Mandrel* upon the *Pikes* of the *Puppets*, and screw them hard up, as you have been taught before.

Sometimes *Turners* use this *Flat-Mandrel* without *Pegs*, and then they chalk the Flat side of it very well, and clap the backside of the Board to it, which will ( if the Board to be *Turned* be not too heavy, but be well screwed up between the *Pikes* ) keep the Board steddy from slipping from its set-position, till you work it.

If in going about of your Work you find it *Wabble*, that is, that one side of the Flat incline either to the Right or Left Hand, you must with soft Blows of an Hammer, or other Tool at hand, set it to right, and then again screw it hard up: For so often as you thus strike upon the Verge to set the Board true, you force the Steel point of the *Pike* more or less ( according to the softness of the Wood ) towards that side of the Verge you strike upon; and therefore you may perceive a reason for screwing up the *Pike* so oft as you knock upon the outer Verge of the Board.

But we will now suppose the Board well pitcht and fastned on the *Mandrel* and Center; therefore take the *Side-Rest* described in § 1. *Numb.*

10. ¶ 7. and *Plate 83.* at the Figure *e*, and *f g*; and fit it so into the *Lathe*, as the upper edge of it may stand range, or parallel to the side of the Board you are to work upon, and so wedge it hard up.

Now you must come to use the *Hook*, described *Numb. 12. § 5.* and *Plate 15.* For this Tool is most commodious to serve you instead of the *Gouge*, when the Work stands athwart the *Pikes*; because the end of the Blade of this Tool being on its Flat side turned into a Circular Figure, and that Circular Figure turned a little backwards, one of the Edges of this Circular Figure will conveniently (though the Tool be not held straight before the Work) come at any part of the Flat of the Board, and so by the Circulation of the Board against the Edge of the *Hook*, cut off its irregular Extuberances.

In the using of this Tool, you must place the end of the *Handle* under your Arm-pit, and hold your Left Hand on the upper side of the Blade of the Tool close to the *Reft*, and your Right Hand close besides your Left Hand under the Tool, and with both your hands clasp the Tool hard, and press it steddy upon the *Reft*, and at the same time hold it also steddy, and yet lightly bearing against the Work, that by the swift coming about of the Work it draw not the Edge of the thin and tender Blade of the *Hook* into it.

You must not hold the Blade of this Tool perpendicularly before the Work, *viz.* parallel to the *Pikes*, but aflat, so as somewhat above the middle of the Convex of the *Hook* may touch against the Work. You may begin at the *Verge*, and so lay several Grooves close by one another  
till

till you come to the Center : But you must observe ( as was said before in the *Cilinder* ) that you lay all your *Grooves* of an equal depth into the Board : For if you lay one deeper than the rest, and an Hollow may not properly be in that place, you must again go over your work with your *Hook*, to work that dawk out : And then perhaps your Board may be made too thin for its intended purpose. But this Craft of the Hand must be acquired with some continued Use and Practice, which will better inform your Judgment what Errors you may be subject to commit, than many words ( though significant ) upon this Doctrine. And this I'm sure I found, when I first practised upon *Turning*.

Having thus with the *Hook* rough-plain'd the Board ( for this *Hook* does in *Turning* the Office of a *Fore-plain* in *Foynery* ) you must use the *Triangular Grooving Tool*, described in *Turning* § 5, Plate 15. and with one of its Edges smoothen down the ridges the *Hook* left on the Board.

But if your Work require any Molding near the Verge, or any other part of it, you must work that Molding as near as you can with the *Hook*, especially where Hollows are required ; for that cuts farter and smoother than any other Tool, and most artificially forms an Hollow.

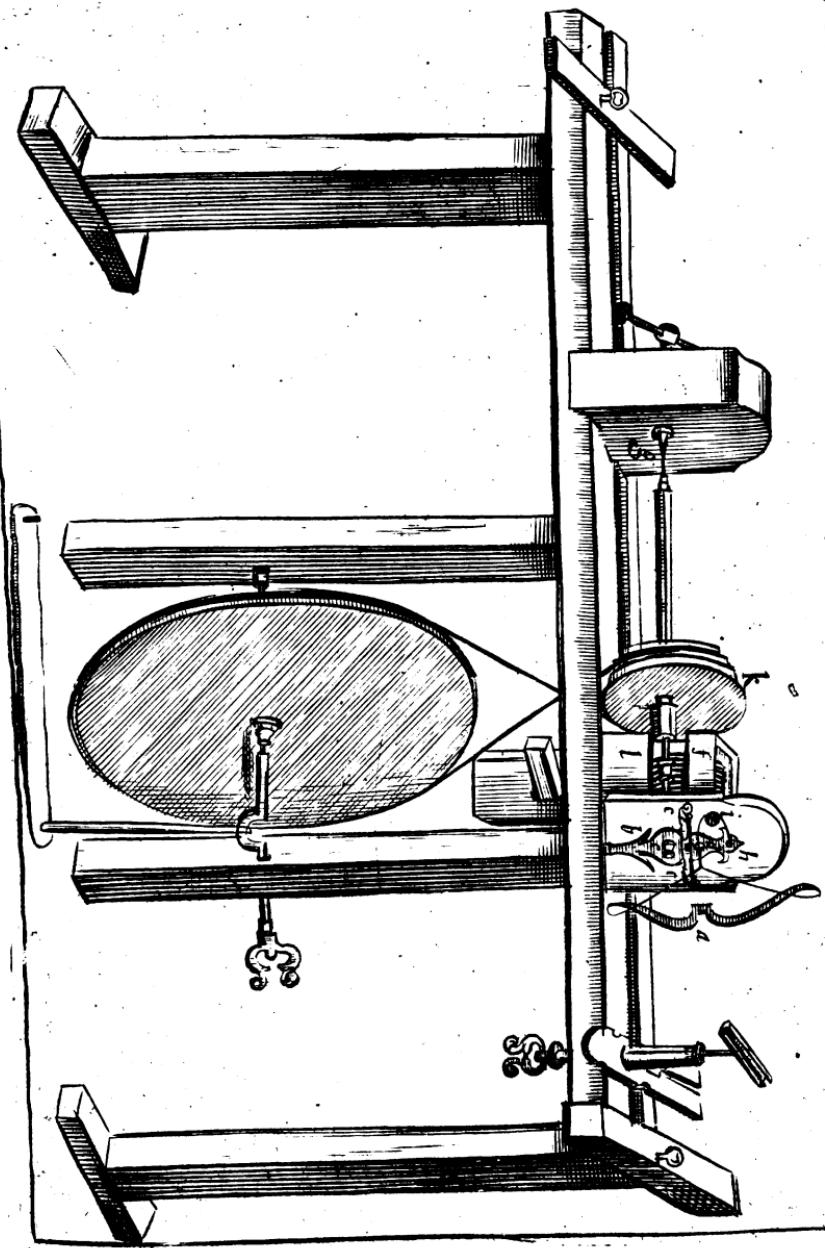
If a Flat be to be laid in the Board, you must first use the *Triangular Point Tool*, and with it strike so many Threds as the breadth of the Flat requires, and lay each Thred almost so deep into the Board as you intend the Flat shall be : And afterwards to smoothen it down, you must use the *Flat Grooving Tool*, or a *Flat Chiffel*, and with either of them finish the Flat to its intended Depth and Breadth. And where a fine Thred, or Circle, is to be laid in the Board,

you must use the *Triangular Point Tool*. And thus as you see occasion, you must accommodate your self with a Tool apt and proper for your purpose, *viz.* such a Tool as will most conveniently come at, and from the intended Work.

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**MECHA-**

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## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

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Applied to the A R T of T U R N I N G.

§ XV. Of Turning Hard Wood, and Ivory.

**I**F the Wood be very hard, as *Ebony*, *Lignum Vitæ*; or if it be *Ivory*, *Bone*, or *Horn* they are to Turn; they neither use the same Tools they do for soft Wood; because their edge is to tender: Nor do they use their other Tools as they do soft Wood. For the Tools made for Hard Wood are made with a stronger Point, Edge, &c. than they are for soft, as was said in Turning § 5. And they use them differently, because for Turning Soft Wood, they hold the Edge of the *Gouge* and *Flat Chisel*, at some considerable Distance from the *Rest*, mounting the Edge at such an Angle as will best cut off from the Work, as a great Chip as they can, or desire. And as they Turn the Work smaller, they guide the *Chisel* to follow the Work: But for Hard Wood, they raise the *Rest* near the Horizontal Plain of the *Axis* of the Work, setting it as close as conveniently they can to their Work, and lay their Tool flat and

stiddy upon the *Rest*; which being hard held in this position, does by the comming about of the Work, cut or tear off all the Extuberances the Tool touches in the sweep of the Work. So that (as I said before) as in *Turning soft Wood* the Tool does somewhat follow the Work; in *Turning hard Wood* the Work comes to the *Tool*: And therefore you may perceive a great reason they have to keep the *Tool* stiddy: For should it in one sweep of the Work be thrust nearer the *Axis* in any place, it would there take off more than it should.

Having prepared the Work fit for the *Lathe*, either with Hewing, or as some Hard Woods and Ivory may require, with Rasping, they pitch it between the *Pikes*, as before has been shewn, or such Work as it may be, as Boxes, and generally all Hollow Work, they fit into *Collers*, either by screwing the *Mandrel* on an Iron *Axis*; or fitting it with some other of the *Mandrels* described in Turning § 6. as is proper for it: As sometimes they fit the Work tight into an *Hollow Mandrel*, and the tight fitting in holds it whilst it is working upon: And sometimes, if the Work be very thin, they fix it on a *Flat Mandrel* with Cement; But they are always either to chuse one of the *Mandrels* described already in Turning § 6. or else contrive (as they often do) some other *Mandrel* convenient to the opportunity that accidentally their Busines may require. For the Work (whether it be pitcht on the *Pikes*, or fitted into *Hollow Mandrels*, or otherwise) must run very stiddy and tight.

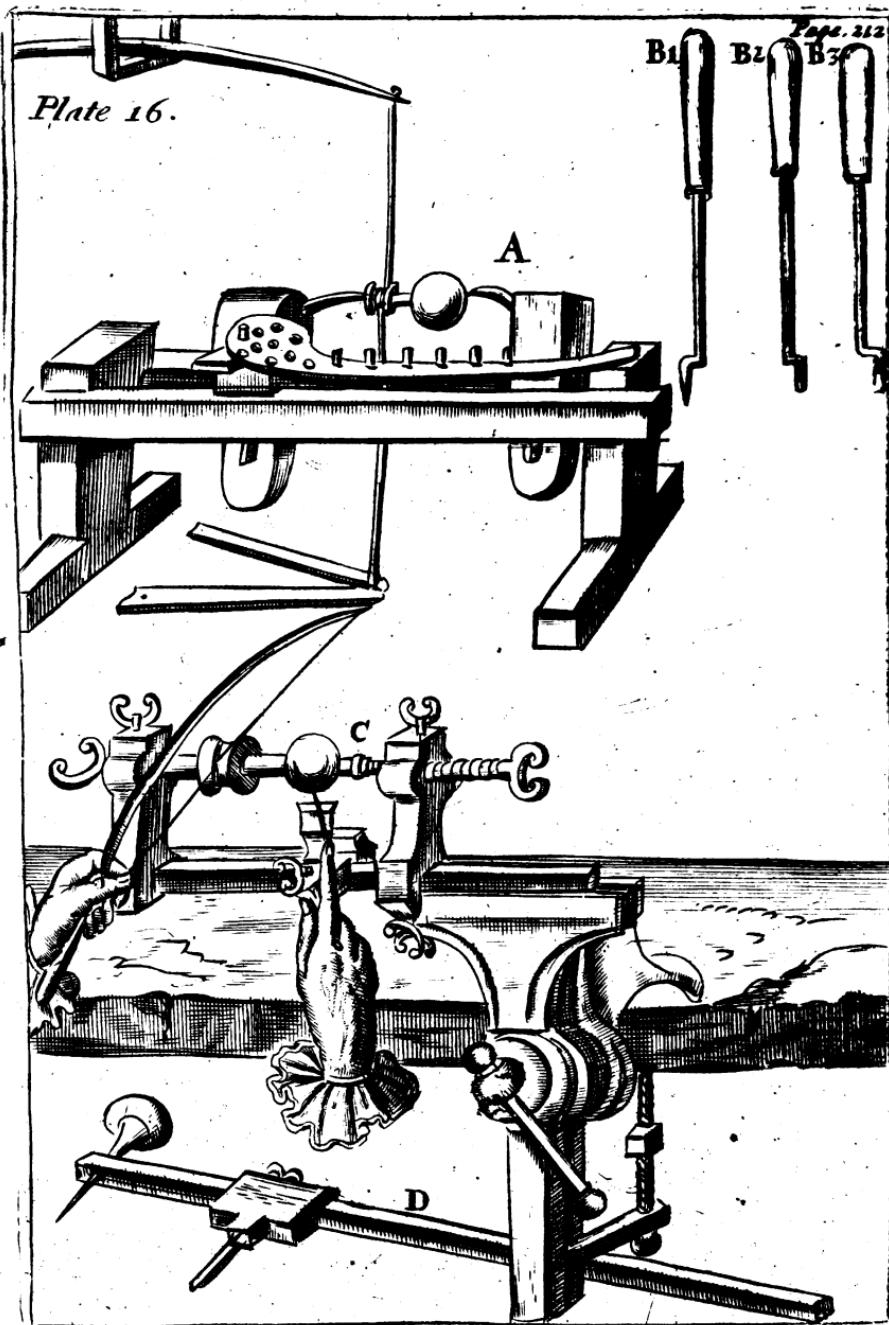
But having thus fitted it into the *Lathe*, they begin to work with the *Sharp-pointed Grooving Tool*, or else with the *Triangular Grooving Tool*, and

B1

B2

B3

Plate 16.





and with the point of either of these Tools break the Grain of the Wood, by laying small Grooves upon its Surface, till they have pretty well wrought away Extuberances, and brought the Work tollerably near an intended shape, by streightning, hollowing, and leaving Risings in their several proper places.

Afterwards with edg'd *Grooving Tools* of a proper Breadth, they cut down and smoothen away the Extuberances left by the *Sharp-pointed Grooving Tool*, or the *Triangular Grooving Tool*, and bring the Work into a perfect shape. Which done, they smoothen the work with the Edge of a piece of a Blade of a broken Knife, bafil'd away, by following the Work with it: That is, holding the bafil'd Edge of the Knife close against the Work while it comes about: For then its sharp Edge scrapes or shaves off the little roughness the grosser Tools left upon the Work.

Lastly, they hold either a piece of Seal-skin or *Dutch Reeds* (whose outer Skin or Filme somewhat finely cuts) pretty hard against the Work, and so make it smooth enough to polish.

Hard Wood they polish with *Bees-wax*, viz. by holding *Bees-wax* against it, till it have sufficiently toucht it all over; and press it hard into it by holding hard the edge of a Flat piece of hard Wood made sizable and suitable to the Work they work upon, as the Work is going about. Then they set a Gloss on it with a very dry Woollen Rag, lightly smear'd with *Sallad Oyl*.

But *Ivory* they polish with Chalk and Water, and afterwards dry it with a Woollen Rag, and a light touch of *Sallad Oyl*; which at laft they rub off again with a dry Woollen Rag, and so set a Gloss on it.

If there be a Screw to be made upon the thin Edge of an *Ivory*, or *Hard Wood*, or *Brass Box*, they use the *Screw-Mandrel*, and its *Socket*, described in Turning § 6. ¶ 4. and 5. as is shewn at the latter end of that Section.

§ XVI. Of Turning long and slender Work  
of Ivory.

Some Turners to shew their Dexterity in *Turning*, and make others that know not the way how it is done admire their Skill, Turn long and slender Sprigs of *Ivory*, as small as an Hay-stalk, and perhaps a Foot or more long : Which perform they cut a piece of *Ivory* to its intended length, but strong enough to bear working till they bring it to as small a *Cilinder* as they can ; which being thus forwarded, they place a *Joint Coller* (as is described in Turning § 7.) made small and fit for their purpose, just in the middle of their Work : Only that their Work may *Bear* at a smaller length, and consequently be stronger for being thus supported while it is *Turned* yet smaller. Then they place other *Collers* between the *Pikes*, and the middle *Coller*, and Turn the whole *Cilinder* slender yet. And thus by placing *Collers* where ever they find the Work buckle, they (as aforesaid) with *Sharp Tools*, tender touches, somewhat a loose and fine *String*, weak *Bow*, and great care and diligence work the whole *Cilinder* down as small as they list, either with *Moldings*, or other Work upon it, as best likes them.

The properest *Lathe* to Turn this slender Work in, is the *Turn-Bench* described § 18. Plate 16.

§ XVII. Of

§ XVII. Of the Brasiers Lathe and Turning Tools; and their manner of using them.

**B**rasiers that Turn Andirons, Pots, Kettles, &c. have their *Lathe* made different from the Common *Turners Lathe*, as you may see in *Plate 16.* at A, where the *Cheeks*, *Puppets* and *Rests*, &c. are much stronger and the *Pikes* stronger and longer than those the common *Turners* use. Their *Edge Tools* which they call *Hooks*, are also of a different shape, as the Figures of them described at B 1, B 2, B 3. in the said *Plate* shew, as being bent backwards and forwards towards the cutting end, somewhat like an z. And as the common *Turners* work with a round *String* made of *Gut*, as hath been described in *Turning* § 1. ¶ 14. The *Brasiers* work with a *Flat Leather Thong*, which wrapping close and tight about the *Rowler* of their *Mandrel*, commands it the easier and more forcibly about. Their *Thong* runs between the *Cheeks* of the *Lathe*.

The whole *Lathe*, and its parts, are made so strong, because the Matter they *Turn* being Metal, is much heavier than Wood, and consequently with forcible coming about, would (if the *Lathe* were flight) make it tremble, and so spoil the Work; as hath been said before.

The reason why the *Hook* is so turned backwards, and again forwards, towards the end, is, that they may the better direct the Edge of it as much below the Horizontal Plain of the *Pikes* as they list, the better (in many cases) to come at the Work: For contrary to Soft Wood, Hard Wood and Ivory *Turners*, they always dip the end of their *Hook* below the *Rest*, that so the *Hook* resting very steddy upon the *Rest*, and also against one of the Iron *Pins* standing upright in

the *Reft*, and held very steddy forwards to the Work, the strong coming about of the Work against the strong Edge of the *Hook*, scrapes off the extuberant Mettle lying in that Sweep.

I need no further describe the *Latbe*, and other Tools that belong to *Braffers* Turning; or more of the manner of using them; because, by the whole proceeding Discourse, these Arguments are largely and sufficently handled; especially considering I have given you the Figures of them in *Plate 16.* as aforesaid.

Only, their way of *Whetting* their Tools being different from the *Whetting* of other Turning Tools, I shall say somewhat to: For they *Whet* their *Hooks* upon a broad Flat *Slate*, holding the *Hook* almost perpendicular, that the *Basil* of its Edge may comply with the Flat of the *Slate*; with clasping the upper end of the *Handle* in their left hand to lo lean the heavier on it, and clutching the *Spank* of the *Blade* near the *Hook-end* in the right hand, to guide it: And thus with Spittle, or Water, rub forwards and backwards on the *Slate*, till they have sharpened the Edge of the *Hook*. But if it be a round end *Hook* they *whet*, they chuse a *Groove* in the *Slate* fit to comply with the round edge of the *Hook* (for they have different sized *Grooves* in the *Slate* for that purpose) and so in it rub forwards and backwards as aforesaid.

### § XVIII. Of Turning Small Work of Brafs, or other Mettle.

**S**mall Work in Mettal is *Turned* in an *Iron Latbe* called a *Turn-bench*. The Figure of it is described in *Plate 16.* at C. when they use it they screw it in the *Chaps* of a *Vise*, and having fitted their Work upon a small *Iron Axis*, with a *Drill-Barrel* fitted upon a square *Shank* at the end of the

the *Axis* next the left hand, they with a *Drill-bow* and *Drill-string* carry it about, as was shewn in Smithing fol. 6. with this difference, that when a Hole is drill'd in a piece of Mettal, they hold the *Drill-bow* in their Right Hand; but when they *Turn* Small Work, they hold the *Drill-bow* in their Left Hand, and with their Right Hand use the *Tool*, which is commonly a *Graver*, or sometimes a *Sculpter*, fit to such Moldings as are to be made on the *Mettal*.

They begin to work first with the sharp point of a *Graver*, laying the Blade of it firm upon the *Reft*, and directing the point to the Work, and lay Circles upon it close to one another, till they have wrought it pretty true: Then with one of the broad Edges of the *Graver* they smoothen down what the Point left, and afterwards with *Sculpters*, *Round* or *Flat*, or great or small, they work their intended Moldings.

The Circumstances and Considerations in the choice of a *Drill-bow* and *Drill-string* for *Turning*, are the same with what you find in Smithing fol. 6, 7. for Drilling.

#### § XIX. Of laying Moldings either upon Mettal, or Wood, without fitting the Work in a Lathe.

I Had, soon after the Fire of London, occasion to lay Moldings upon the Verges of several round and weighty flat pieces of *Brafs*: And being at that time, by reason of the said Fire, unaccommodated of a *Lathe* of my own, I intended to put them out to be *Turned*: But then *Turners* were all full of Employment, which made them so unreasonable in their Prizes, that I was forc'd to contrive this following way to lay Moldings on their Verges.

I provided a strong Iron *Bar* for the *Beam* of a *Sweep*: (For the whole *Tool* marked in *Plate 16*, is

is by Mathematical *Instrument-makers* called a *Sweep*.) To this Tool is filed a *Tooth* of Steel with such *Roundings* and *Hollows* in the bottom of it, as I intended to have *Hollows* and *Roundings* upon my Work: For an *Hollow* on the *Tooth*, makes a *Round* upon the Work; and a *Round* upon the *Tooth*, makes an *Hollow* on the Work; even as they do in the *Molding-plains Joiners* use. Then I placed the *Center-point* of the *Sweep* in a *Center-hole* made in a square *Stud* of *Mettal*, and fixed in the *Center* of the Plain of the Work; and removed the *Socket* that rides on the *Beam* of the *Sweep*, till the *Tooth* stood just upon its intended place on the *Verge* of the Work, and there screw'd the *Socket* fast to the *Beam*.

To work it out, I employ'd a Labourer, directing him in his Left Hand to hold the *Head* of the *Center-pin*, and with his Right Hand to draw about the *Beam* and *Tooth*, which (according to the strength) he us'd, cut and tore away great Flakes of the *Mettal*, till it receiv'd the whole and perfect Form the *Tooth* would make; which was as compleat a *Molding* as any Skillful *Turner* could have laid upon it.

Having such good Success upon *Brafs*, I improv'd the invention so, as to make it serve for *Wood* also. And make a *Plain-Stock* with my intended *Molding* on the *Sole* of it, and fitted an *Iron* to that *Stock* with the same *Molding* the *Sole* had.

Through the sides of this *Stock* I fitted an *Iron Beam*, to do the Office of the *Beam* I used for the *Sweep*, viz. to keep the Plain always at what position I lifted from the *Center* (for thus the *Iron* in the Plain wrought about the *Center*, even as the *Tooth* in the *Sweep* (before rehearsed) and to that purpose I made a round *Hole* of about half

half an Inch Diameter near the end of the Iron : Then in the Center of the Work I fixed a round Iron *Pin*, exactly to fit the said round Hole, putting the round Hole over the *Pin*, and fitting the *Iron* into the *Stock* commodious to work with. I used this Plain with both Hands, even as *Joyners* do other *Plains* : For the *Iron Pin* in the Hole of the *Beam* kept it to its due distance from the Center; so that neither hand was ingaged to guide it.

But note, The *Stock* of this *Plain* was not straight (as the Stocks of other *Plains* are) but by Hand cut Circular pretty near the size of the Diameter of the intended Molding : And yet was made to slide upon the *Beam*, farther from or nearer to the Center, as different Diameters of Verges might require.

**§ XX. To Turn several Globes or Balls of Ivory within one another, with a Solid Ball in the middle.**

**Y**OU must first Turn your *Ivory Ball* or *Globe* truly round, of your intended Diameter : Then describe a Circle exactly through the middle, or Equinoctial of the *Globe* : Divide that Circle into four equal parts, and pitch one point of a pair of Compasses in one of those Divisions, and extend the other point to either of the next Divisions, and describe with it a Circle round about the *Globe*. Then remove the standing point of the Compasses to either of the next Divisions in the Equinoctial, and in like manner describe another Circle round about the *Globe*.

But Note, That the moving point of your Compasses must be somewhat bended inwards ; for else its point will not describe a Circle on the greatest Exuberances of the *Globe*, but will slide off it.

Thus

Thus shall the Ball or Globe be divided into eight Spherical Quadrants : Describe as great a Circle as you can in each of these Quadrants, and each two Centers of every two opposite Circles shall have an imaginary *Axix* passing between them : And if the *Globe* be successively pitcht upon all the rest of the Centers, so as the imagined *Axix* passing between it and its opposite Center, lye in a straight line with the *Pike* and the Center of the *Coller* it is *Turned* in, the working out of all the *Hollows* on the *Ball* will be but common *Turners* Work, as you will find hereafter. This is in brief the Theory : But to the Practice.

You must use an *Hollow-Mandrel*, made fit stiffly to receive the convexity of the *Globe* in its concavity, so as it may stick firmly in the *Mandrel*, in its position : And you must take care that in pitching the *Globe* into the *Mandrel*, that the imaginary *Axix* of the *Globe* (which is the Line passing between the two Centers of the two opposite Circles as aforesaid) lye in a straight Line with the *Axix* of the *Mandrel*, which you may know by examining whether the Circle described with your *Compasses* (as aforesaid) on the Center (aforesaid) wabble not in a whole Revolution of the *Globe*, from the point of a Tool applied steady to it.

Having thus pitcht the *Globe* true, and fixt it fast into the *Mandrel*, you must begin to work with the *Triangular Grooving Point* (described in Turning § 5. and Plate 15.) placing the point of it pretty near the Center of the Circle, and work into the *Ball* with the *Grooving Point*, and so by degrees make a Hollow in the *Ball* so deep, and so wide, as you think convenient, I mean so deep from the Superficies of the *Globe* towards the Center of the *Globe*, and so wide from the Center of the Circle described on the Superficies of the *Globe*

*Globe* towards that Circle, as it may have a convenient Substance between this Hole, and the next intended to be *Turned*.

Thus must every one of the eight Circles described on the *Globe*, be successively by the same Rule, and after the same manner be pitcht outwards, and fixt into the *Mandrel*, and then Hollowed out as the first was. Where Note, That every Hollow is to be *Turned* to the same depth and width exactly as the first was : Which to do, you must use a *Gage* made of a thin Plate of Iron or Brass, as is described in *Plate 17. Fig. D.* whose two fides from *a* the Bottom of the *Gage*, to *b* the *Shoulder* are the depth of the *Hollow* from the Superficies of the *Globe* towards the Center : *b b.* is the width of the *Hollow* at the Superficies of the *Globe*; and *aa* is the bottom width of the *Hollow*; and the concave Arch between *aa* is an Arch that the Convexity of the little solid *Ball* to be *Turned* within all the *Spheres* must comply with. So that when each *Hollow* is *Turned*, the *Gage* must be put into it to try how the fides of the *Hollow* complies with the fides of the *Gage*, and also how the Arch in the bottom of the *Gage*, complies with the surface of the Solid *Ball* in the middle.

Having thus *Turned* all the *Hallows* in the *Globe*, you must provide several thin and narrow Arching *Grooving Tools*, whose convex and concave Arches comply both with the Convexity and Concavity of each *Globe*, or *Sphere*, to be *Turned* within the outermost : So that begining at the bottom of the *Hollow*, you Turn just half way of the Solid *Ball* loose from the *Sphere* it is contained in, *viz.* as far as the Equinoctial of the *Globe*; and in thus Turning it, you must take great care, that the Solid *Ball* on its Convexity and the Concavity of the *Sphere* it is contained in, be both at the same time Turned exactly Spherical. Thus

Thus one half of the Solid *Ball* being *Turned* loose, you may in like manner *Turn* the next Sphere it is included in half loose also : And so successively as many Spheres as you list.

Having thus *Turned* one half of all the *Spheres* loose, you must take the whole *Globe* out of the *Hollow-Mandrel*, and pitcht and fix the *Globe* again into the *Mandrel*, so as the imagined *Axis* of the *Hollow* opposite to the last loosed *Hollow* lye in a straight line ( as before was taught ) with the *Pike* and *Center* of the *Coller* the *Mandrel* runs in, and then *Turn* the other half of the Solid *Ball* and *Spheres* also loose, as the first half was *Turned*.

§ XXI. *To Turn a Globe with several loose Spheres in it, and a Solid Cube, or Dy, in the middle of it.*

This is *Turned* after the same manner the former *Ball* was *Turned*; only instead of dividing the Equinoctial of that *Globe* into four equal parts, the Equinoctial of this must be divided but into three equal parts, and their Semi-Circle draw through the divitions into either Pole of the *Globe*: So shall the *Globe* be divided into six equal parts, or Segments; in each of which parts must be described a Circle, as was described before in the *Globes* of eight equal parts; and in these six Circles must be made six Hollows, as before there was eight: But instead of working the Bottom of each hollow Spherical, now the Bottom must be wrought Flat: So shall the *Cube* when these six Hollows are thus made, be formed: And the Hollows being exactly of the same depth, and flat in the Bottom, the *Cube* or *Dy* will loosen, and each of the six Flats in the Bottom will become the six fides or Faces of the *Cube*.

The

The manner of loosing all the other inward Spheres, is as the Former: Only, that was loosed with twice pitching the Ball in the Mandrel, because the Centers of the *Hollows* lay opposite to one another; but to loosen this Ball will require three Pitchings into the Mandrel; because the Centers lye not opposite to one another.

§ XXII. To Turn a Cube, or Dy, *in an Hollow Globe, that shall have but one Hole on the outside to work at.*

The Outside of this *Globe* must be Turned Round, *viz.* Spherical, as the former, and fixed in an Hollow *Socket* (as before hath been taught.) Then must an Hole be Turned in the *Globe* so deep and so wide as you please, as in the former *Globes*, and the Bottom of that Hole Turned flat, for one side, or Face of the *Cube*, or *Dy*: Then with a Semi-circular Tool loosen the whole Core, or middle of the Ball, and pitch the Core with the point opposite to the Center of the already flatted face of the *Dy*, outwards against the Hole in the *Globe*, and so fasten it in this position, by powring in some melted hard Wax, or other Cement; and then with a flat Tool Turn the foreside, (*viz.* the side opposite to the first side) flat also: Which done, loosen it out of the Wax, and successively pitch the other fides to be Turned flat carefully against the Hole, so as all the fides have right Angles to each other, and fastning them with Wax, or Cement (as before) Turn them by the same Rule flat also.

Now

Now to make this Thing more admirable to the ignorant Spectator, you may make the *Dy* as big as you can, and the Hole you Turn it at as little as you can; that it may the more puzzle the Wit of the Enquirer to find how so great a *Dy* should have Entrance at a small Hole, unless the hollow Ball were turned in two Halves, &c.

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**MECHA-**

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## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

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Applied to the A R T of *T U R N I N G.*

§ XXIII. Of *Turning Oval Work.*

**T**HIS Work may be perform'd in the Common *Lathe* that goes either with the *Tredle-Wheel*, or the great Wheel, because the Work must run always one way, if the *Puppet* be made to it with the Machination described in *Plate 17.* and an Iron *Axis* be made to carry the Work about, and to its end be fitted and fastned a *Brass Coller*, with a Female Screw in it, to screw on the *Mandrel* that the Work you intend to Turn is fixt upon.

To the Foreside of this *Puppet* is fastned at *b*, as on a Center-pin, a strong Iron *Coller* marked *b b*, and this Coller is called the *Moving Coller*; because it moves between the Iron *Shackles c c*, and the Foreside of the *Puppet*. Into this *Moving Coller* is fitted the *Hollow Axis* marked *c*, so as to turn round in it as if it were in any of the other *Collors* formerly described; but the *Moving Coller* moving between the *Shackles*, and the Foreside of the *Puppet*, carries the *Hollow Axis* with it athwart the *Puppet*, even so far as is the width

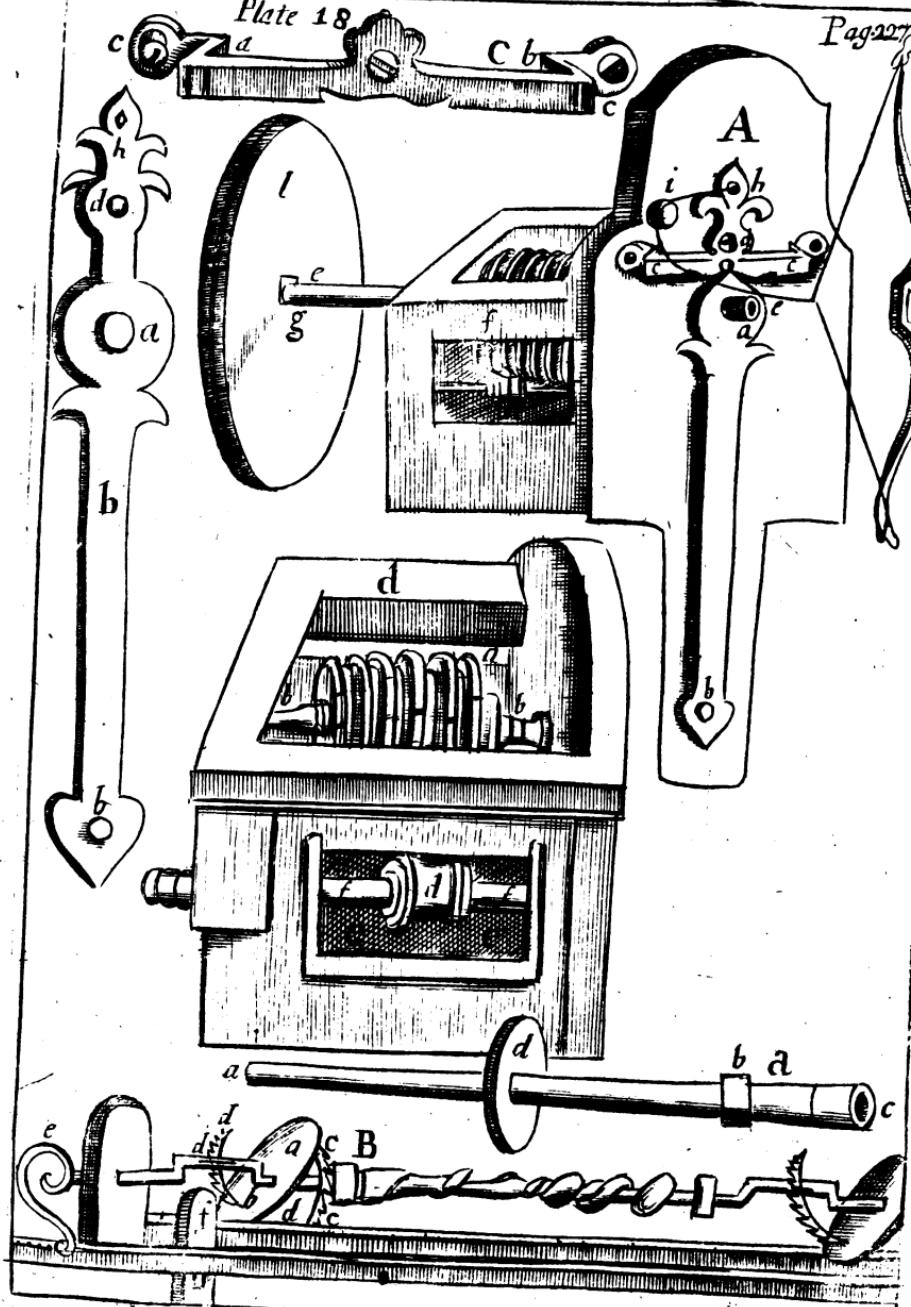
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width of the *Hollow* between the *Shackle*, and the Foreside of the *Puppet*. And thus by the moving of the *Hollow Axis* backwards and forwards the Work screwed in it, having an *Edg'd*, or a *Pointed-Tool* applied to it, receives that *Oval* Form which is made upon the *Guide*.

But to make it move thus to and from you, there are required several Machinal Helps: For there is a strong *Steel Bow* as at *a*, fastned about its middle part to the further side of the *Puppet*, which stands about an Inch forwarder than the Foreside of the *Puppet* with its hollow fide to the Workman. And to the ends of this *Steel Bow* is fastned a strong *String* of Gut, and to the middle of that *String* in a *Noos* is fastned another strong *Gut-string*, with a *Noos* at its end. This last mentioned *String* is made exactly of that length, that when the nearest fide of the *Guide*, viz. its least Diameter is set into the *Groove* of the *Guide-pulley*, and the *Bow* is strained, and this *String* laid in the *Groove* of the *String-pulley*, the *Noos* at the end of it may be put over the Iron *Button* fixed in the top of the *Moving-Coller*. For then as the *Tredle-Wheel* carries the *Axis* about, the *Guide* being firmly fastned upon the *Axis*, comes also about; and having the *Groove* of the *Guide-pulley* set against the outer edge of the *Guide*, as the great Diameter of the *Guide* is turned against the *Guide-pulley*, the *Moving-Coller* being drawn by the strength of the *Bow*, draws the *Hollow Axis* along with it, as also the Work screwed in the *Hollow Axis*: And thus as the small Diameter of the *Guide* comes to the *Guide-pulley*, the small Diameter of the Work is Formed; and as the great Diameter of the *Guide* comes to the *Guide-pulley*, the great Diameter of the Work is formed.

This is the sum of *Oval Turning*.

But





But that the whole Machine may be yet better understood, I shall more particularly give you the names of all its parts, together with a Description upon its most material parts, where the *Fore-puppet* is more largely delineated in *Plate 18*, at A, where also some of the Members most difficult to be described, are drawn more at large by themselves.

- a The *Bow*.
- b The *Moving Coller*.
- c c The *Socket* in which the *Coller* is moved.
- d The *Stop-screw*, to take out when the *Hollow Axis* moves in the *Moving-Coller*.
- e The *Hollow Axis*.
- f The *Head*, in which is contained the several *Guides*.
- g The *Center Head*.
- h The *Button*.
- i The *String-pulley*.
- k The *Wheel-pulley*.
- l The *Guide-pulley*.

¶ i. Of the *Hollow Axis*, and its *Shank*, marked a in *Plate 18*.

The *Shank* is a Bar of Iron about an Inch thick, and two Foot long, having in its further end a *Center-hole* to pitch upon the *Pike* in the further *Puppet*; but its hither end is made square to fit tight into a square *Socket*, in the Brass *Hollow Axis*: And when it is thus fitted into the hither end of the Brass, it is Turned true Cilindrically round, so as to fit into the round Hole in the *Moving Coller*. The Diameter of the Round is about two Inches, and the length about two Inches straight; but then a Shoulder is Turned to the Brass Cilinder, to stop it from slipping thro' the *Moving Center*. In the Fore-end

of this *Hollow Axis* ( viz. in the Brads Cilinder ) is Turned a wide Hole about an Inch and a quarter Diameter, and an Inch deep : And in this wide Hole is Turned a Female Screw with a course Thred, to receive a Male Screw made behind the *Mandrel* that the Work is fixed upon.

About the middle of this Iron *Shank* is placed a *Pulley* made of Wainscot Board, about eight Inches Diameter, and an Inch thick, with a *Groove* on its outer edge about half an Inch wide, and half an Inch deep, for the *String* of the *Tredle Wheel* that carries the *Axis* about to run in : And between this *Pulley* you may ( if you will ) have several lengths of such *Male-screws* as was described in Turning § 6. ¶ 4. and Plate 15. to make Screws with, if you please.

See the Figure *adcb*, disjunct from the rest of the Work.

*a* The hinder end.

*d* The Pulley of the *Axis*, or *Wheel-pulley*.

*c* The Hollow, or Hole in the Fore-end of the *Hollow Axis*.

*b* The Shoulder of the *Hollow Axis*.

### ¶ 2. Of the Moving Coller marked *b*, in Plate 18.

This whole Member is called the *Moving Coller*, tho' the *Coller* strictly is only the round Hole at *a*, into which the *Hollow Axis* is fitted. It is made of Iron to reach from its top at *b* (the *Button*) down to the bottom of the *Cheeks* of the *Lathe*, as at *b*; upon which Pin ( as on a *Center* ) the whole *Moving Coller* moves backwards and forwards; its extream Breadth is about three Inches, and its thickness above a quarter of an Inch. Its Neck at *c* is clasped, but not fixed down to the Foreside of the *Puppet*; for this Neck is only gaged in the *Shackle* marked *c*, so as the Neck, ( and consequently the whole *Moving Coller* )

*ter*) may slide from end to end of the *Shackle* forwards and backwards. *d* A small *Female Screw*, into which through a Hole in the *Shackles* is fitted a *Male Screw* to hold the *Moving Coller* and the *Shackle* together, that the *Moving Coller* may not move when only round Work is Turned in the *Coller*.

¶ 3. Of the Foreside of the Puppet, and the Shackle marked *c*.

**U**Nder this *Shackle* (viz. between it and the Foreside of the *Puppet*) moves the *Neck* of the *Sliding-Coller* from *a* to *b*, when the ends at *c c* are fixed down to the Foreside of the *Puppet* with two Iron Screws.

¶ 4. Of the Hollow in the Puppet marked *d*.

**I**N the middle of the *Puppet* is hollowed out a Hole about three Inches between the Fore and Back-side of the *Puppet*, and four Inches athwart the *Cheeks* in the *Puppet*, and four Inches deep: So that about an Inch of Substance remains on each of the four upright sides. But the Top is quite open, (as at *a*) through the middle of this square *Hole* runs the Iron *Axis* marked *b b*, on which is fixed the several *Guides* that are to be used in this sort of Working.

It is open at the Top, that Light may be let in to set the *Guide-pulley* to which *Guide* you please, and it is open on the hither side as at *e e*, about an Inch and an half above and below the *Axis*, that the *Guide-pulley* may be slid on its *Axis* to any of the *Guides*.

The *Guide-pulley* marked *d*, is a brass Pulley of about an Inch Diameter, and a little above a quarter of an Inch thick, having a *Groove* in the Edge of it to receive the Edge of the *Guide*. It hath in its middle a round Hole about half an

Inch Diameter, which round Hole slips over a round Iron *Pin* of the same Diameter, marked *f f*, so as it may slide from one end of the said Iron *Pin* to the other, according as the *Guides* may be fixed towards either end.

When it is used, the Groove in the Edge of this *Guide-pulley* is set against the Edge of the *Guide*, and being fitted tight on the round Iron *Pin* aforesaid, and the two ends of the Iron *Pin* fast fixed into the Wood of the *Puppet*, the *Guide-pulley* may indeed move round on the Iron *Pin*; but the strength of the Iron *Pin*, and *Guide-pulley* will resist the extuberick parts of the Edge of the *Guide*; and so with the assistance of the strength of the *Steel Bow* force the *Guide* and *Hollow Axis* to move backwards; and then an Edge-Tool held to the Work in the *Mandrel* screwed in the *Hollow Axis*, will describe the same Figure on the Work, as is on the out Edge of the *Guide*.

Note, that when you are at Work, you must keep the Hole in the middle of the *Guide-pulley* well oyld', as also the round Iron *Pin* it slides and turns round upon; because this *Guide-pulley* ought to run round: For then the *Axis* will have and easier and swifter motion, tho' it may indeed perform the Work if it run not round upon the Iron *Pin*.

#### § XXIV. Of Rose-work, &c.

**R**ose-Work Turning, or Works of any other Figure, are performed by the same Rule, and after the same manner as Oval Work is made; only by changing the *Guides*, and using one whose outer Edge is made with the Figure, or several Figures you intend to have on your Work,

#### § XXV.

## § XXV. Of Turning Swash-Work.

TO the Turning of *Swash-work* you must have two such *Puppets*, as the *Fore-puppet* described in § 22. And also a round *Swash-board*, about ten Inches Diameter, and an Inch and a half thick, as is *a* in Fig. B. Plate 18. Upon both the flat sides of this *Swash-board*, in a diametrical Line, is fastned upright an Arch of a Quadrant made of a Steel Plate, about half a quarter of an Inch thick, and an Inch and a quarter broad, as at *b b, c c*. The Convex edges of these Quadrants are cut into Notches, like the Teeth of an Hand-saw; that according as you may have occasion to set the *Swash-board* more or less a-flope, you may be accommodated with a Notch or Tooth to set it at. This *Swash-board* hath an Hole made about its Center, to slip over the *Iron Axis*, and being thus slipt over the *Iron Axis*, you set it to that Slope you intend the *Swash* on your Work shall have. And to fix it fast in this position, you must put the Blades of the Quadrants into two *Slits*, made in the *Iron Axis* as at *d d*, and fit the two opposite Teeth against the two outer Shoulders of the *Slits*.

You must moreover make two strong Steel *Springs* as at *c c*, to reach from the bottom of the outer sides of the *Puppets*, being strong nailed, or rather screwed down there, which must reach up so high as the *Axis*. And in the inner sides of these *Springs* must be made two Center holes for the points of the *Axis* to be fitted in: For the *Oval-Guide* being fitted to one end of the *Axis*, and a Low-Puppet, as at *f*, wedged close to one side of the *Swash-board*, when the *Swash-board* stands in its greatest declirity; then in a Revolution of the *Axis*, as the farther part of the

the circumference of the *Swash-board* comes to the *Low-Puppet*, one *Spring* will be forced backwards, and the other will spring forwards; and an Edg'd-Tool held against the Work fixed on the *Axis*, will make on the Work the Form of a *Swash*, &c.

These *Oval-Engines*, *Swash-Engines*, and all other *Engines*, are excellently well made by Mr. *Thomas Oldfield*, at the sign of the *Flower-de-luce*, near the *Savoy* in the *Strand, Londen*.

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*An Explanation of Terms used in these Exercises of Turning, Alphabetically digested.*

## A.

**A**XIS. The imagined straight Line that passes through the two Center-points that Turned Work is Turned upon. Thus the imagined Line that passes between the two Pikes through the Work in the Lathe is the Axis.

## B.

**B**OW. The Bow that common Turners use is described § 1. ¶ 11. And the Bow that Oval Turners use is described § 23. and Plate 17, 18. at a.

**Button.** The Button is described § 23. and Plate 17. at b.

## C.

**C**allipers. Compasses with bowed shanks to measure the Diameter of any round Body. See § 11. and Plate 14. at O.

**Center-head.** See § 23. and Plate 17. at g.

**Cheeks.** See § 1. ¶ 2. and Plate 12. b b.

**Chock.** See § 6. ¶ 5. and Plate 13. at F. 5. a.

**Cleaving-knife.** See § 9. and Plate 13. at M.

**Crank.** The end of an Iron Axis turned Square down, and again turned Square to the first turning down, so that on the last turning down a Leather Thong is slipt, to Tread the Treddle-wheel about.

**Coller.** See § 7. and Plate 13. at G H I.

**Crook.** See Crank.

**Cross-Treddle.** See § 1. ¶ 8. and Plate 12. at k.

**Drill-**

## D.

**D**ill-Barrel. See Smithing Fol. 6. Plate 1.  
and Fig. 8. at C.

Drill-Bench. See § 12. Plate 14. at a a a a,

Drill-Bow. See Smithing Fol. 6, 7.

## F

**F**emale Screw. The Screw made in the round  
Hole of a Nut.

Flat-Chisel. See § 3. and Plate 15. at C C.

Flat-Mandrel. See § 6. and Plate 13. at F 1.

## G

**G**ouge. See § 2. ¶ 1. and Plate 15. at B. B.

Great Wheel. See § 1. ¶ 12. and Plate  
14. at 2.

Grooving Hooks. See § 5. and Plate 15. at E.

Grooving Tools. See Grooving Hooks.

Guide. See § 23. ¶ 4. and Plate 18.

Guide-Pulley. See § 23. ¶ 4. and Plate 18. at d.

## H.

**H**ead. See § 23. and Plate 17.

Hook. See § 17. and Plate 16. at B. 1.  
B 2. B 3.

Hollow Axis. See § 17. and Plate 17. at e.

Hollow Mandrels. See § 6. ¶ 3. and Plate 13.  
at F 3.

## I.

**J**oint Collar. See § 7. and Plate 13. at G.

## L.

**L**athe. See § 1. and Plate 12.

Legs. See § 1. and Plate 12. at a a a a,

Man-

## M.

**M**andrel. See § 6. ¶ 1. and Plate 13. at F 1. F 2. F 3. F 4.

*Marl.* See § 8. and Plate 13. at K.

*Male-Screw.* The Screw made upon a Shank, or Pin.

*Moving-Collar.* See § 23. ¶ 2. and Plate 18. at b.

## N.

**N**ut. A piece of Iron that a Female Screw is made in.

## P.

**P**ike. See § 1. ¶ 5. and Plate 12.

*Pin Mandrel.* See § 6. ¶ 2. and Plate 13. at F 2.

*Pole.* See § 1. ¶ 9. and Plate 12 at l.

*Puppet.* See § 1. ¶ 3. and Plate 12. at c.

## R.

**R**ef. See § 1. ¶ 6. and Plate 12. at e.

*Rowler.* See § 6. and Plate 13. F 1. at b.

## S.

**S**crew-Mandrel. See § 6. ¶ 4. and Plate 13. at F 4.

*Seat.* See § 1. ¶ 15.

*Shackles.* See § 23. ¶ 2. and Plate 18. V at c.

*Side-Reft.* See § 1. ¶ 7. and Plate 13. at e.

*Socket.* See *Chock.*

*Steel-bow.* See § 23. and Plate 18. at a.

*Stop-Screw.* See § 23. and Plate 17. at d.

*String.* See § 1. and Plate 12. at m.

*String-Pulley.* See § 23. and Plate 17. at i.

*Swash.* A *Swash* is a Figure whose Circumference is not Round but Oval; and whose Moldings lie

lye not at Right Angles, but Oblique to the *Axis* of the Work. See § 25. and Plate 18. at Fig. B.

*Swallow-Board.* See § 25. and Plate 18. at *a* in Fig. B.

*Sweep.* See § 19. and Plate 16. at D.

### T.

**T***Read.* See § 13. Fol. 209.

*Treddle.* See § 1. and Plate 12. at *i*.

*Treddle Wheel.* See § 1. § 13.

*Turn-Bench.* See § 18. and Plate 16. at C.

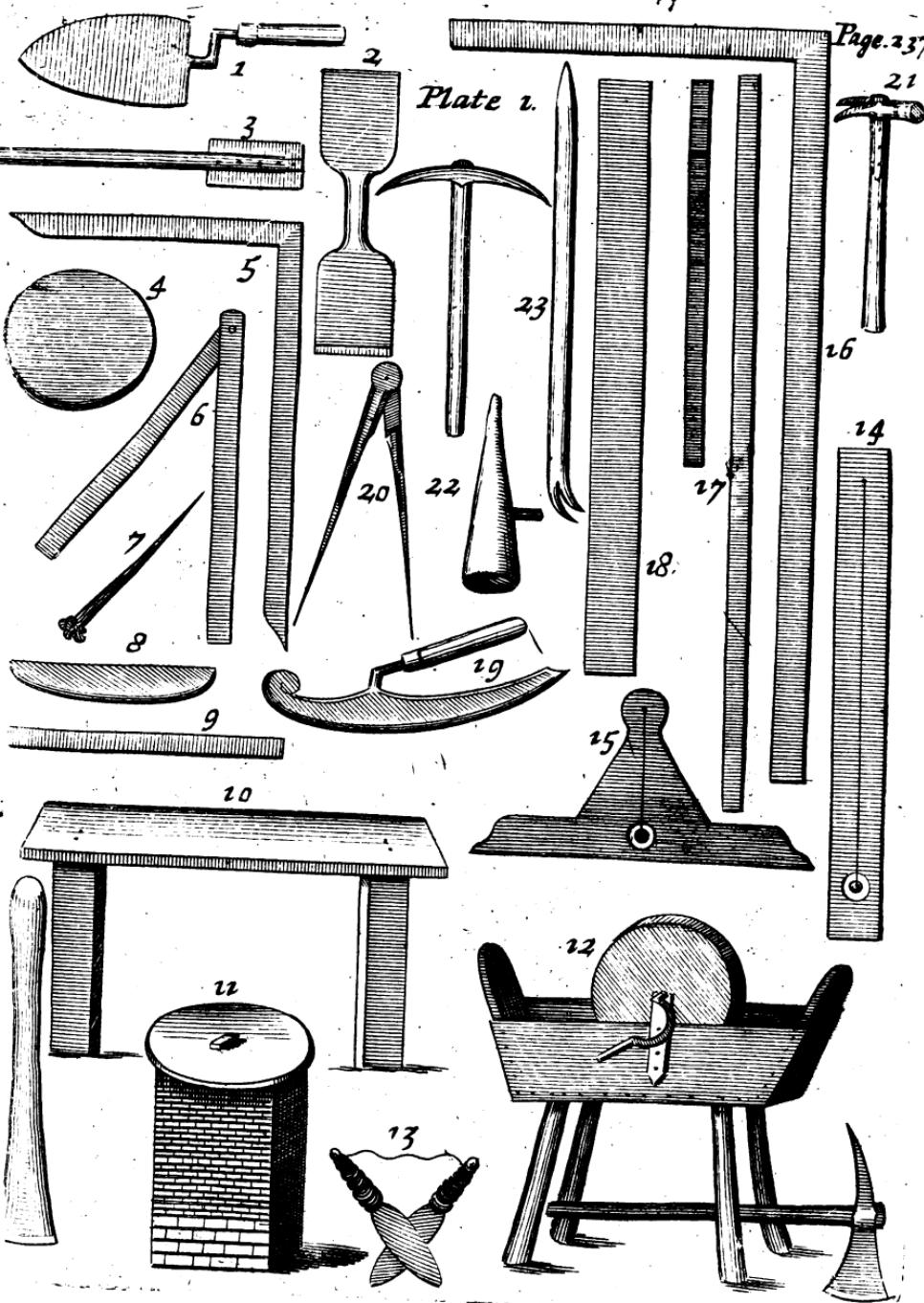
### W.

**W***abble.* When a piece of Work is not pitcht true upon its Centers, it will in a Revolution incline more on one side of its Circumference than on its opposite side. See § 23. and Plate 17. at *k*.

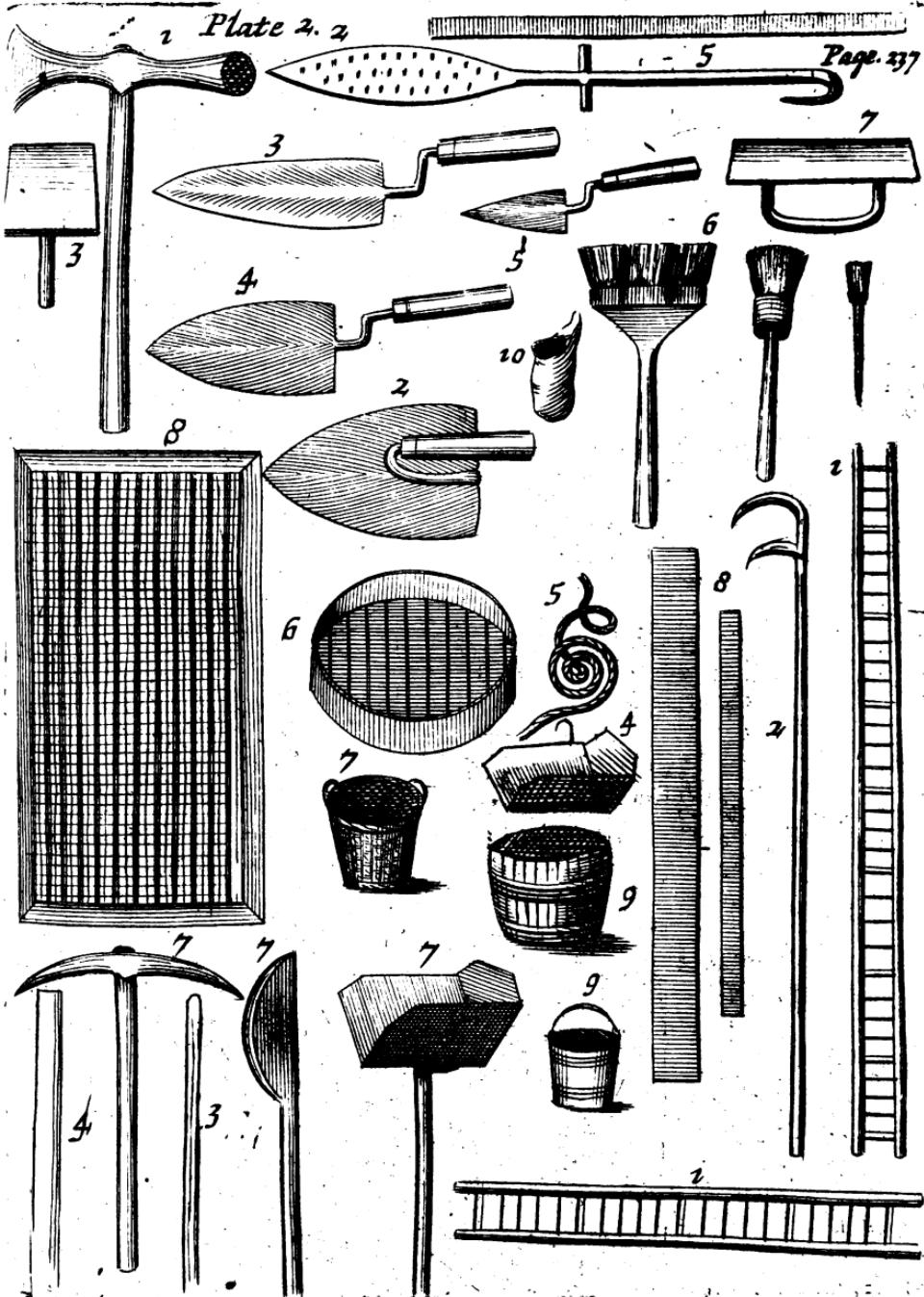
There are several other Terms used in these *Exercises of Turning*, not explain'd here: But because they are used in some of the former *Exercises*, and there explain'd, I shall referr you to them.

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MECHA.









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## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

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Applied to the A R T of *Bricklayers Work.*

*Definition.*

**B**ricklayers-Work is an Art Manual, which Joins several Bodies so together, that they adhære like one entire Body.

Whether the *White Mason*, which is the Hewer of Stone, or the *Red Mason*, which is the Hewer of Brick, be the most Ancient, I know not: but in Holy Writ, we read of making of Bricks, before we read of Digging or Hewing of Stones; therefore we may suppose the *Red Mason* (or *Bricklayer*) to be the most Ancient.

The method that I shall use in Treating of this Art shall be this.

*First*, I will shew what Materials they use, and their Composition.

*Secondly*, I will treat of their Tools, and describe their Names and Uses.

*Thirdly*, I will declare their Method of Working, both in *Bricks*, *Tiles*, &c.

And

*And first of Materials.*

**W**HICH are comprised under fix Heads, viz.  
 1. Bricks, 2. Tiles, 3. Morter, 4. Latbs,  
 5. Nails, 6. Tile-pins.

*Of Bricks.*

**T**HEY are made of Earth, of which the white-  
 iish Chalky sort of Earth, and the Redish  
 are the best.

At *Lauenburg* in *Saxony*, they make them of a  
 fat Earth full of *Allom*. Also there are good  
 Bricks made at *Pitane* in *Asia*, of a Pumice sort  
 of Earth, which being dried, will swim in Wa-  
 ter and not Sink.

Likewise the Antients made them of Earth  
 which was Sandy.

But here in *England* they are made for the  
 most part of a yellowish coloured fat Earth some-  
 what Redish.

*And they are made of several sorts and sizes.*

**I**N *Holland* they make small ones, being about  
 six Inches long, three Inches broad, and one  
 Inch in thickness.

Which sort of Bricks, is commonly used here  
 in *England*, to pave Yards or Stables withal; and  
 they make a good Pavement, and are very Du-  
 rable, and being laid edge-ways looks handsomly,  
 especially if laid Herring-bone fashion.

*They are also used in Soap-boilers Fats, and in ma-*  
*king of Cisterns.*

**T**HE common Bricks that are made here in *Eng-*  
*land*, are nine Inches in length, four Inches  
 and  $\frac{1}{4}$  in Breadth, and two and an half in thick-  
 ness; and sometimes three Inches thick.

Ms. B. 1. 1. v. 1. p. 238

*Most Counties in England afford Earth for the making of Bricks.*

But the best Earth that we have in *England* for *making of Bricks*, is in the County of *Kent*, from whence we have most of the *Bricks* which are Rubbed and Hewed for the Ornaments of the chief Fronts in the City of *London*: The Ornamental part of which Fronts, are done with the reddest *Bricks* they can pick from among them; and the Rough or Plain Work, is done with the *Grey Kentish Bricks*; also those *Gray Kentish Bricks* are used in making of Cisterns to hold Water, and Horse-Ponds, and also Fats for Soap-Boilers; and I am of the Opinion, that no time will impair or decay those *Grey Kentish Bricks*: But, as *Pliny* says, (speaking of *Bricks*.) that they will last to Eternity.

There are also in most Counties of *England*, *Bricks* made for the Paving of *Floors of Rooms, Cellars, Dairy-houses, &c.* which are made of a stronger sort of Earth, than the common *Bricks* for Building, the *Earth* being a kind of *Clay*, and in some Countries are called *Clay Bricks*, which are dearer than the *Ordinary Bricks* by about six Shillings in a Thousand.

Likewise in several Counties, but chiefly in *Surrey*, are made Paving *Tiles* of three several Magnitudes; the largest sort being twelve Inches long, and twelve broad, and one Inch and an half in Thickness.

The second sort are ten Inches long, and ten Inches broad, and one Inch and a quarter thick.

The third sort are eight Inches long, eight broad, and one Inch thick.

Either of which sorts being Polished or rubbed with sharp Sand on the Surface, and the joints made exactly square, and the sides equal, by hewing

hewing them with a *Brick Ax*, and rubbing them on a rubbing Stone with sharp Sand, makes an excellent Pavement and pleasing to the Eye, especially when laid *Arris ways*.

Having thus described the several sorts of *Bricks*; and also paving *Tiles*, we come in the next place to treat of *Tiles*, made and used in the Covering of *Roofs* of *Houses*, both Publick and Particular, of which are four sorts or kinds.

The first sort are called *Plains Tiles*, being made of a strong sort of Earth like *Clay*; and are, or should be ten Inches and an half in length, in breadth six Inches and a Quarter, and in thickness three quarters of an Inch.

The second sort are *Gutter* or *Hip Tiles*, which are used sometimes for *Vallies* and *Hips* of *Rooffs*, altho' here at *London*, the *Vallies* are commonly tiled with *Plain Tiles*, and the *Hips* with *Ridge*, or (as some call them) *Roof Toiles*: These *Gutter Tiles* are in length ten Inches and an half, with convenient breadth and thicknes accordingly, and are made Circular or hollow, and wider at one end than at the other.

The third sort are *Ridge* or *Roof Tiles*, being in length thirteen Inches, and made Circular breadthways like an half Cylinder, whose Diameter is about ten Inches, or more, and about half an Inch and half a quarter in thickness; These are laid upon the upper parr, or ridge of the Roof, and also on the *Hips*.

The fourth sort are *Pan-Tiles*, being about thirteen Inches long, with a *Nob* or *Button* to hang on the *Laths*, and are made hollow of circular breadthways, being eight Inches in breadth, and about half an Inch in thickness, or somewhat more. The best sort of these are brought from *Holland* into *England*, and are called *Flemish Pan-Tiles*, we having such *Tiles* made here in

in *England*, but not so good: Which *Flemmish Tiles* are sometimes glazed, and are of a Lead, or Blewish colour, and being glazed they are very durable and handsom.

Having done with the Description of *Tiles*, for the Covering of Roofs, we come in the next place to treat of *Morter*, and first of *Lime*, being the chief Material of which the *Mortar* is made, for the Cementing or joining of *Tiles*, as well as *Bricks* together, we will Treat of it in the first place.

### *Of Lime.*

There are two sorts, one made of Stone, which is the strongest, and the other of Chalk, both sorts being burnt in a *Kilne*.

The Lime that is made of soft Stone or Chalk is useful for Plastering of Seelings and Walls within Doors, or on the insides of Houses; and that made of hard Stone, is fit for Structures or Buildings, and Plastering without Doors, or on the out side of Buildings that lies in the Weather; and that which is made of greasy clammy Stone, is stronger than that made of lean poor Stone; and that which is made of spongy Stone, is lighter than that made of firm and close stone; that is again more Commodious for Plastering, this for Building.

Also very good *Lime* may be made of *Millstone*, not course and Sandy, but fine and Greasy;

Likewise of all kinds of Flints (but they are hard to burn except in a *Reverbratory Kilne*) except those that are roled in the Water, because a great part of its increase goes away by a kind of Glass.

But the shells of Fish, as of Cockles, Oysters, &c. are good to burn for *Lime*.

R

And

And the Fire in *Lime* burnt, Asswages not, but lies hid, so that it appears to be cold, but Water excites it again, whereby it Slacks and crumbles into fine Powder.

*Lime* also is useful in divers things, for 'tis useful in Oyles and Wines, and good to Manure Land with ; some season new Wine with it, mitigating the unpleasantness of the Wine therewith.

Moreover *quick Lime* being cast into an arch'd Vault, and Water thrown upon it, consumes dead Bodies put therein.

Also *Diers* and *Tanners*, and likewise *Physicians* use it, but they choose the newest, to wit, that which is newly drawn out of the *Kiln*, and not slack'd with Water or Air.

It will burn so vehemently, that it makes crusts, and will fire Boards or Timber against which it lies ; but being slackt for sometime, it burns no more, yet it warms and dries, and dissolves Flesh ; and being washed three or four times, it Bites or Eats not, but dries quickly.

*Lime* mixt with Sand is much used in Buildings ; and *Vitruvius* says, That you may put three parts of Sand that is digged (or pit Sand) and one part of *Lime* to make Morter ; but if the Sand be taken out of a *River*, or out of the *Sea*, then two parts thereof, and one of *Lime* ; as also to *River* to *Sea-Sand*, if you put a third part of Powder of *Tiles* or *Bricks*, (to wit, *Tile*, or *Brick* dust ) it works the better.

But *Vitruvius* his Proportion of Sand seems too much, altho' he should mean the *Lime* before it is slack'd ; for one Bushel of *Lime* before it is slack'd, will be five Pecks after 'tis slack'd.

Here at *London*, where for the most part our *Lime* is made of *Chalk*, we put about thirty six Bushels of Pit-Sand, to twenty five Bushels of *Quick-*

Quick-Lime, that is about one Bushel and half of Sand, to one Bushel of *Lime*.

And *Lime* mixt with *Sand*, and made into *Morter*, if it lye in an heap two or three Years before 'tis used, it will be the stronger and better, and the reason of so many insufficient Buildings, is the using of the *Morter*, as soon as 'tis made, as *Agricola* faith.

Moreover there is other *Morter* used in making of Water-courses, Cisterns, Fish-ponds, &c. which is very hard and durable, as may be seen at *Rome*, at this day, which is called *Maltha*, from a kind of *Bitumen* Dug there; for as they build most firm Walls thereof naturally, so they use it in making of Cisterns to hold Water, and all manner of Water-works; and also in finishing or Plastering of Fronts to represent Stone.

And I find two kinds of Artifices used by the Antients, both of which is compounded of *Lime* and *Hogs-grease*, but to one is added the Juice of Figs, and to the other *Liquid Pitch*; and the Lumps of *Lime* are first wet or flack'd with Wine, then pounded or beat with *Hogs-grease*, and juice of *Figs*, or with the same *Pitch*; that which hath *Pitch* in it, is blacker and easily distinguished from the other by its Colour, and that which is Plastered with this *Tarrace*, is done over with *Linseed Oil*.

*Metalists* use a kind of *Tarrace* in their Vessels for fining of *Metalls*, that the melted Mettle run not out; for as the Moderns restrain *Water*, and contain it, so the Antients, this liquid Mettal, and 'tis compounded or made of *Quick-Lime* and *Ox Blood*, the *Lime* being beat to Powder and sifted, and then mixt with the *Blood* and beat with a *Beater*.

But their *Cement* differs from both the *Malthas* in Composition and use, for 'tis made of Dust

or Powder of *Marble*, and *Glew* made of *Bull* or *Ox* Leather, and with this they glew pieces of *Marble* or *Stones* together.

In latter times, two kinds of *Cement* are in use, in both which they use the Powder of *Marble*, or other *Stone*, to one is added the Whites of Eggs, to the other is added *Pitch*; to these some add other things, as the Gravers of *Gems*, they make it of *Tile Dust* and *Pitch*.

Another Material which *Bricklayers* use are *Laths*, which are made of heart of *Oak*, for outside Work, as *Tiling* and *Plastering*; and of *Fir* for inside *Plastering* and *Pantile Lathing*; their usual lengths being 5 Foot, and 4 Foot, and sometimes longer or shorter; their Breadth sometimes 2 Inches, and one Inch and an half, the thickness about  $\frac{1}{4}$  of an Inch or thicker: But for *Pantiling*, the *Laths*, are about ten Foot long, one Inch and half Broad, and half an Inch or more thick.

Another Material is *Nails*, of which they use three sorts, one is called, *Reparation* or *Lath Nails*, which are used for plain *Tile Lathing*, and outside and inside *Lathing* for *Plastring*; another sort are four Penny, and six Penny Nails, used for *Pantile Lathing*; and a third sort are great Nails for *Scaffolding*.

Moreover they use *Tile-Pins*, which are sometimes made of *Oak*, and sometimes of *Fir*, which they drive into holes that are made in the *Plain Tiles* to hang them upon their *Lathing*.

They also put *Ox* or *Cow* Hair into the *Mortar* which they use for *Plastering*, being called *Lime* and *Hair*, which Hair keeps the *Mortar* from Cracking or Chaping, and makes it hold or bind together.

And whereas they make use of the sharpest, Sand they can get (that being best) for *Morter*,

to

to lay *Bricks* and *Tiles* in; so they chose a fat *Loamy* or Greasy Sand for inside Plastering, by reason it sticks together, and is not so subject to fall assunder when they lay it on Seelings or Walls.

Having given you an account of the several Materials that are used in *Bricklayers Work*, we shall in the next place Treat of their Tools and their uses, which are as follows.

*Tools used in Brick Work.*

1. **A** *Brick Trowel* to take up the Morter with, and to spread it on the *Bricks*, with which also they cut the *Bricks* to such lengths as they have occasion, and also stop the joints.

2. A *Brick Ax*, with which they cut *Bricks* to what shape they please, as some for Arches both streight and Circular, others for the mouldings of Architecture, as Architrave Friez and Cornice.

3. A *Saw* made of Tinn, to saw the *Bricks* which they cut.

4. A *Rub-stone*, which is round, and is about fourteen Inches Diameter, and sometimes more or less at pleasure, on which they rub the *Bricks* which they cut into several shapes, and also others which they cut not, being call'd *Rubbed Returns*, and *Rubbed Headers* and *Stretchers*.

5. A *Square*, to try the bed of the *Brick*, ( *viz.* that side which lies in the Morter ) with the superficies or face of the *Brick*, to make the *Brick* square, or at Rect-angles one side with the other, which is done by rubbing it on the *Rub-stone* till it exactly answers, or fits to the *Square*.

6. A *Bevel*, by which they cut the undersides of the *Bricks*, of Arches streight or circular, to such oblique Angles as the Arches require, and also for other Uses.

7. *A small Trannel of Iron*, or a large Nail ground'd to a sharp point, with which they mark the Brick, either from a Square or Bevel, or a Mould made of thin Wainscot, or Past-board to direct them in the cutting thereof.

8. Some use a *Float Stone*, with which they rub the moulding of the Brick, after they have cut it with the *Ax*, pretty near to the Pattern described on the Brick, by the *Trannel* from the Wainscot, or Pastboard Mould, that so they may make the Brick exactly to answer to the Pattern or Mould. Others use no Stone at all, but cut the Brick exactly to the Pattern with their Brick-Ax, leaving the Ax stroaks to be seen on the Brick, which, if they be streight and parallel one to another, look very prettily, and is the truest way of Working; but then they must take care, to Ax the Brick off, with an Ax that is exaclty streight on the edge, that the moulding in the Brick be neither round nor hollow, from side to side of a Header, or from end to end of a Stretcher.

9. *A Little Ruler*, about 12 Inches in length, and 1 Inch and  $\frac{1}{2}$  broad, which they lay on the Brick to draw streight Lines by, with the *Trannel* or *Nail*.

10. *A Banker*, to cut the Bricks upon, which is a piece of Timber about six foot long, or more, according to the number of those who are to work at it, and 9 or 10 Inches square, which must be laid on two Piers of Brick, or fixt on Bearers of Timber about three foot high from the Floor, on which they stand to work.

11. They work up a Pier of Brick-work, about the same height to lay their *Rubbing-Stone* upon, which must be laid in Morter that it may lye fast.

12. A *Grinding-stone*, to sharpen their Axes, Hammers, Trowels, &c. upon.

13. A *Pair of Line Pins of Iron*, with a length of Line on them about sixty feet in length, to lay each Row, or Course of *Bricks*, level on the Bed, and streight on the Surface by, a Line seldom holding to stren, or draw streight in length, above 50 or 60 feet.

14. A *Plumb Rule* about 4 foot long, with a Line and Plummet of Lead, to carry their Work upright, or perpendicular withal.

15. A *Level*, about 10 or 12 foot long, to set out their Foundations level, or parallel to the Horizon, and also to try whether the Walls of the Building, or Jambs of Chimneys, be carried level, as they raise the Work, that so they may bring up all their *Brick-work* to an exact horizontal height, at the laying on of ever floor of Carpentry.

16. A *Large Square*, to set their Walls at rectangles, which may also be done without a *Square*, by setting 6 foot from the angle one way, and 8 foot the other way, then if the Diagonal line, or Hypotenuse, be exactly 10 feet, the angle is a rectangle: If not, you must set the Wall that is to be at rectangles to the other, either this or that way, till the two measures of 6 and 8 feet answer exactly to 10 feet.

17. A *Ten Foot* and a *Five Foot Rod*, as also a *Two Foot Rule*, to take and lay down Lengths, and Breadths, and Heights.

18. A *Jointing Rule*, about 10 foot long, and about 4 Inches broad, whereby to run the long Joints of the *Brick-work*.

19. A *Jointer of Iron*, with which, and the foresaid Rule, they joint the long *Joints*, and also the *Cross Joints*, these being done with the *Jointer* without the *Rule*.

20. *Compasses*, to describe the several Mouldings on Wainicot or Pastboard.
21. A *Hammer*, to cut Holes in *Brick-work*, and drive Nails for Scarfolding.
22. A *Rammer*, to Ram the Foundations.
23. A *Crow of Iron*, to dig through a Wall, and also a *Pick-Ax*.

The *Manner* and *Shapes* of the aforesaid *Tools*, you may see in Plate 1. and the *Name* of each *Tool* in the Page next the Plate wherein they are delineated.

*The Names and Uses of Tools relating to Tyl ing.*

1. A *Lathing Hammer*, to nail on the Laths withal, with two *Gauge Stroaks* (for Lathing for *Tyl ing*) cut upon the handle of it, one at 7 Inches from the head, and the other at 7 Inches and an half; some indeed Lath at 8 Inches, but that is too wide, occasioning Rainings in.
2. A *Lathing Staff of Iron*, in the form of a Cross, to stay the croſs Laths while they are nailed to the long Laths, and also to clinch the Nails.
3. A *Tyl ing Trowel*, to take up the Morter and lay it on the Tiles, it being longer and narrower than a *Brick-Trowel*, altho' for a ſhift many times they uſe a *Brick-Trowel* to Tyle withal, when they have not a *Tyl ing-Trowel*.
4. A *Boffe*, made of Wood, with an Iron Hook, to hang on the Laths, or on a Ladder, in which the Labourer puts the Morter which the Tyler uſes.
5. A *Striker*, which is only a piece of Lath about 10 Inches long, with which they strike, or cut off the Morter at the britches of the Tiles,
6. A *Broome*, to sweep the Tyl ing after 'tis strooke,

*Of the Names and Uses of Tools relating to  
Plastering.*

1. **A Latbing Hammer** being the same as before in Tylng, with which the Laths are nailed on with its head, and with its Edge they cut them to any length, and likewise cut off any part of a Qurter, or Joyst, that sticks further out than the rest.

2. A **Laying Trowel**, to lay the Lime and Hair withall upon the Laths, it being larger than a **Brick Trowel**, and fastned its handle in a different manner from the **Brick Trowel**.

3. A **Hawke**, made of Wood about the bigness of a square Trencher, with a handle to hold it by, whereon the Lime and Hair being put, they take from it more or less as they please.

4. A **Setting Trowel**, being les than the **Laying Trowel**, with which they finish the Plastering when it is almost dry, either by Trowelling and brishing it over with fair Water, or else by laying a thin Coat of fine stuff made of clean Lime, and mixt with Hair without any Sand, and setting it, that is to say, Trowelling and brishing it.

5. A small **Pointing Trowel**, to go into sharp Angles.

6. **Briſhes**, of three sorts, viz. A **Stock Briſh**, a **Round Briſh**, and a **Pencil**. With these **Briſhes**, they wet old Walls before they mend them, and also brish over their new Plastering when they set, or finish it, and moreover white and size their Plastering with them. The **Pencil**, or **Drawing Tool**, is used in blacking the bottoms, or lower ports of Rooms, &c.

7. **Floats**, made of Wood, with handles to them, which they sometimes use to float Seelings or Walls with, when they are minded to make their Plastering very streight and even,  
these

these *Floats* being some larger, and some lesser, than the *Laying Trowels*: Likewise they use *Floats* made to fit to Mouldings, for the finishing of several sorts of Mouldings with finishing Morter to represent Stone, such as *Cornices*, *Facias*, *Architraves*, &c.

The finishing Morter to represent Stone, should be made of the strongest Lime, and the sharpest Sand you can get, which Sand must be washed in a large Tub, very well, till no Scum or Filth arise in the Water, when you stir it about, which sometimes will require to have Water 5 or 6 times, when the Sand is somewhat foul; and it requires a greater Proportion of Sand than the ordinary Morter, because it must be extreamly beaten, which will break all the knots of *Lime*, and by that means it will require more Sand.

8. *Streight Rules* of several lengths, to lay Quines streight by, and also to try whether the Plastering be laid true and streight, by applying the Rules to their Work.

9. A *Pale*, to hold *Water* or *Whitewash*, or *White* and *Size*.

10. Some use a *Budget* or *Pocket* to hang by their sides, to put their *Nails* in when they *Lath*, and others Tuck and tye up their *Aprons*, and put the *Nails* therein.

Having given you a Description of the several *Tools* and uses, there are some things yet remaining, which tho' they cannot be properly called *Tools*, yet they are *Utensils*, without which they cannot well perform their Work.

*And*

*And they are.*

1. *Ladders*, of several lengths, as *Standard Ladders*, two Story, and one Story *Ladders*, &c.

2. *Fir Poles*, of several lengths for *Standards* and *Ledgers* for *Scaffolding*.

3. *Putlogs*, which are pieces of Timber, or short Poles, about 7 Foot long, which lies from the *Leggers* into their *Brickwork*, to bear the boards they stand on to Work, and to lay *Bricks* and *Morter* upon.

4. *Fir Boards*, about 10 Foot long, and any Breadth, but commonly about a Foot broad, because for the most part, four of them in breadth, makes the breadth of the Scaffold : Which boards ought to be one Inch and or two Inches in thickness, altho' commonly they make use of some, which are not above one Inch thick, which are sometimes subject to break, especially when the *Putlogs* lye far asunder from one another.

5. *Chords*, which should be well Pitched to preserve them from the Weather, and rotting, with which they fasten the *Ledgers* to the *Standards*, or upright *Poles*.

6. *Sieves*, of several sorts, some larger, others lesser, some finer, others courser, to sift the *Lime* and *Sand* withal, before they wet it into *Morter* or *Lime* and *Hair*.

7. A *Loame-book*, *Beater*, *Shovel*, *Pick-Ax*, *Basket* and *Hod*, which commonly belong to *Bricklayers*, *Labourers*, and may be called the *Labourers Tools*.

8. A *Skreen* made of Boards and Wyer, which performs the Office of a *Sieve*, and with which one Man will Skreen as much *Lime*, mixt with *Sand* or *Rubish*, as two Men can with a *Sieve*.

9. *Boards*

9. *Boards or Tubs*, to put the *Morter* in.

And except my memory fails me, these are all, or the most usual Tools and Utensils, which they make use of.

Having now given you an account of their several Materials, together with their necessary Tools and Utensils; we shall proceed in the next place to treat of the Method of working, which is various, some working after a better Method, and more concisely than others.

#### *And first of Foundations.*

It is usual, and also very convenient, for any person before he begins to Erect a Building, to have Designs or Draughts drawn upon Paper or Vellum, and also if it be a large Building, to have a Model of it made in Wainscot; in which Designs and Model, the Ground Plat or Ichnography of each Floor or Story, is delineated and represented: As also the fashion and form of each Front, together with the Windows, Doors, and Ornaments, if they intend any, to wit, *Facias*, *Rustick Quines*, *Architraves*, *Friezes* and *Cornices*, are to be shewn in the Draughts or Designs of the Uprights or *Orthographies*.

If more Fronts than one be shewn *Perspectively* in one Draught, then 'tis called *Scenography*, which is not easily understood, except by those who understand the Rules of *Perspective*.

Therefore it will be more Intelligible to the several Workmen, to have a Draught of each Front in a Paper by it self, and also to have a Draught of the Ground-Plat or *Ichnography* of every story, in a Paper by it self; because many times the Conveniences, or Contrivances in one Story, differs from those in another, either in bigness of Chimneys, or division of the Rooms, some being larger in one Story than another, and some,

sometimes having more Chimnies in one Story than in another, &c.

All which things being well considered, and drawn on Papers, or a Model made thereof, before the Building is begun, there will be no need of Alterations, or Tearing and pulling the Building to pieces after it is begun; for besides the hindrance of the Procedure of the Work, it makes the Building lame and Deficient, nothing being so well done, when 'tis put up, and pulled down, and set up again, as if it were well done at first.

Besides it makes the Workmen uneasy, to see their Work, in which they have taken a great deal of pains, and used a great deal of Art, to be pull'd to pieces.

The drawing of Draughts is most commonly the work of a Surveyor, although there be many Master Workmen that will contrive a Building, and draw the Designs thereof, as well, and as curiouly, as most Surveyors: Yea, some of them will do it better than some Surveyors; especially those Workmen who understand the Theorick part of Building, as well as the Practick.

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**M E C H A**

## MECHANICK EXERCISES:

O R,

The Doctrine of *Handy-Works.*

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*And now concerning the Foundations.*

After the Cellars are dug, if there are to be any, or if none, after the Trenches are dug, in which the Walls are to stand; the Master-Bricklayer, or else his Foreman (which ought to be an ingenious Workman) must in the first place try all the Foundations, in several places, with an Iron Croe, and Rammer, or, indeed, with a Borer (such as Well-Diggers use, to try what Ground they have to produce Water) to see whether the *Foundations* are all sound, and fit to bear the Weight which is to be set upon them. If he find any part of the *Foundations* defective, he ought to dig it deeper till he comes to firm ground; or if it proves to be loose, or made Ground to a great depth, then he must take care to make it good and sufficient to carry its Weight by Art, which may be done several ways.

*First,* If the *Foundation* be not very loose, and insufficient, it may be made good, by ramming in

in great Stones with a heavy Rammer, the Stones being placed close together, and about a foot wider on each side of the Trench than the width of the Wall is to be; because all Walls ought to have a Basis, or Footing, at least 4 Inches on a side broader than the thickness of the Wall; which Stones being well rammed, and the Basis being 8 Inches more in breadth than the thickness of the Wall, and this 8 Inches being set off, about one Inch, or one Inch and an half at a time on both sides (that so the middle of the Wall may stand on the middle of the Basis) may make the Foundation good, and able to bear its Burden.

But if the *Foundation* be somewhat worse than as aforesaid, then he must get good pieces of Oak, whose length must be the breadth of the Trench, or about two foot longer than the breadth of the Wall, which must be laid cross the *Foundation* about foot asunder, and being well rammed down, lay long Planks upon them, which planking need not be the length of the cross pieces, but only 4 Inches of a side wider than the Basis, or footing of the Wall is to be, and pin'd or spiked down to the pieces of Oak on which they lye.

But if the *Foundations* be so bad that this will not do, then he must provide good Piles made of Heart of Oak, of such a length as will reach ground, whose Diameter must be about  $\frac{1}{3}$  part of their length, which must be drove or forced down with a Commander, or an Engin for that purpose, and then lay long Planks upon them, and spike or pin the Planks to them, and the closer together that these Piles are drove the better it will be.

More-

Moreover, if the *Foundation* be faulty but in here and there a place, and there be good Ground in the other parts of it, you may turn Arches over those insufficient places, which will discharge and take off the weight from the loose places.

And when you make these Arches to shun the difficulty of the Earth, and to save the charge of Expence, they must be made of Bricks and Morter that are very good, and be well wrought, that they do neither settle nor give way.

You may observe for the greater strength of these Arches, or Discharges, to make them higher than a Semicircle, or half round, if the Work will admit of it, and to make the same, of Portions of Arches : As in *Plate 3. Fig. 4.* you may see, they are described from an Equilateral Triangle ; that is to say, supposing the breadth of the Arch between the Piers to be *A B* ; with this width, and from the points *A* and *B*, make the two Portions of the Arches *A C* and *B C* ; this rising so high, adds great strength to the Arches to resist, or carry the Weight which they are to bear.

The ancient Architect *Leon Baptista Albert* advises, when the Earth on which we would make Pillars or Piers is of equal resistance, that is to say, not good, to turn Arches inverted, or upside down, and says, by this means one Pillar shall bear no more weight than another, when the Earth that is underneath is not so strong, or that it bears more than another part ; which he doth thus.

Having wrought up the Pillars, or Piers, as high as is necessary from the *Foundation*, make from these Piers inverse Arches, as *A B C* in *Plate 3. Fig. 5.* whose Joints tend to the Center *D*.

By

Plate 3.

Pag. 256.

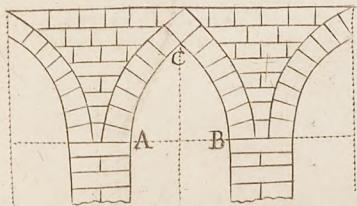


Fig. 4.

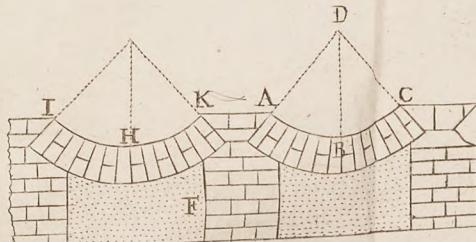


Fig. 5.

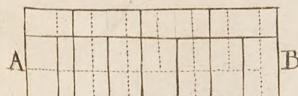


Fig. 2.

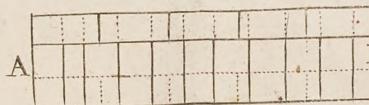


Fig. 1.

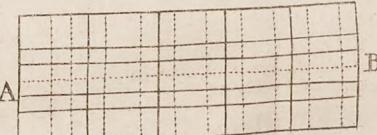


Fig. 3.

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Moreover, if the *Foundation* be faulty but in here and there a place, and there be good Ground in the other parts of it, you may turn Arches over those insufficient places, which will discharge and take off the weight from the ~~the~~ places.

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Plate 3. F  
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By this construction he pretends for Example, that if the Pier *F* hath a worse *Foundation*, or hath a greater Weight, that is to say, is more charged than the other Piers, this charge, or weight, will be stopped, or stayed by the Inverse Arches *ABC, IHK*, because the Earth which is under these Arches keeps the Piers in the same height, that is to say, that they shall not fink.

But he must also suppose that this Earth is as firm as that of the *Foundation* of the Piers, or at least it must be made so.

The Ingenious Surveyor Mr. *Hook*, made use of this Artifice, as I am informed, in building the Lord *Montague's* brave House in *Bloomsbury*, in the County of *Middlesex*, and where he was then Surveyor.

The *Foundation* being all made firm, and levelled, the Master-Bricklayer, or his Foreman, must take care to see all the *Foundations* set truly out, according to the design of the Ground-plat, or Cellar-floor, and that all his Walls be made of the same thickness as they are in the Design; which is very difficult to do, to wit, to take the true thickness of the Walls from a Design that is drawn to a small Scale, because the breadth of the Points of the Compasses will vary somewhat; therefore 'tis advisable for him that draws the Draught, to set the Dimensions in Figures to each Wall, Chimney, Window, &c. and then the Workman cannot so easily make a Mistake.

And because the well-working and bonding of Brick-walls conduces very much to their strength, I will here add some necessary Rules to be observed in the laying of Bricks, to make the Walls strong and durable.

*First.* That the Morter be made of well burnt good Lime, and sharp Sand, and that it have a due proportion of Sand, that is to say, if it be very sharp, a Load of Sand, being about 36 Bushels, is sufficient for an Hundred of Lime, being 25 Bushels, or an hundred Pecks, (for I imagine that the word *Hundred of Lime* is used, because it contains an Hundred Pecks, and that in Old Time they used to sell it by the Peck, but now by the Bushel) to wit, to one Bushel of Quick Lime, a Bushel and half of Sand.

But if the Sand be not very sharp, then you may put a greater quantity of Sand, for Morter which hath its due proportion of Sand, is stronger than that which hath less Sand in it, altho' some think otherwise.

*Secondly,* When you slack the Lime, take care to wet it every where a little, but do not over-wet it, and cover with Sand every laying, or bed of Lime, being about a Bushel at a time as you slack it up, that so the Stream, or Spirit of the Lime, may be kept in, and not flee away, but mix it self with the Sand, which will make the Morter much stronger, than if you slack all your Lime first, and throw on your Sand altogether at last, as some use to do.

*Thirdly,* That you beat all your Morter with a Beater three or four times over before you use it, for thereby you break all the Knots of Lime that go through the Sieve, and incorporate the Sand and Lime well together, and the Air which the Beater forces into the Morter at every stroak, conduces very much to the strength thereof.

lf

If I might advise any one that is minded to build well, or use strong Morter for Repairs, I would have them beat the Morter well, and let it lie 2 or 3 Days, and then beat it well again when 'tis to be used.

*Fourthly*, If you lay bricks in hot dry Weather, and be it some small piece of Work that you would have very strong, dip every Brick you lay, all over in a Pale of Water, which will make the Wall much stronger than if the Bricks were laid dry: The reason why I mention a small piece of Work is, because 'tis a great deal of trouble to wet them for much Work, or a whole Building, and besides it makes the Workmen's Fingers sore; to prevent which, they may throw Pales of Water on the Wall after the Bricks are lay'd, as was done at the building of *Physicians College* in *Warwick-Lane*, by order of the Surveyor, which was the afore-said Ingenious Mr. *Hook*, if I mistake not.

*Fifthly*, Cover all your Walls in the Summer-time to keep them from drying too hastily, for the Morter doth not Cement so strongly to the Bricks when it dries hastily, as when slowly.

*Sixthly*, Be sure to cover them *very well* in the Winter-time, to preserve them from Rain, Snow and Frost, which last is a great Enemy to all kinds of Morter, especially to that which hath taken wet just before the Frost.

*Seventhly*, In working up the Walls of a Building, do not work any Wall above 3 foot high before you work up the next adjoining Wall, that so you may join them together, and make good

good Bond in the Work : For 'tis an ill Custom among some *Bricklayers*, to carry, or work up a whole Story of the Party-walls, before they work up the Fronts, or other Work adjoining, that should be bonded or worked up together with them, which occasions Cracks and Setlings in the Walls.

*Eightly,* Take care that you do not lay Joint on Joint, in the middle of the Walls as seldom as may be, but make bond there as well as on the outsides ; for I have seen some, who in working of a Brick and half Wall, have laid the Header on one side of the Wall, upright upon the Header on the other side of the Wall, and so all along through the whole course, which indeed necessarily follows from the inconsiderate setting up of the Quine at a Tooothing ; for 'tis common to Tooth in the stretching course two Inches with the Stretcher only, and the Header on the other side, to be set upright upon the Header on this side, which causes the Headers to lye Joint in Joint in the middle of the Wall, as in *Plate 3. Fig. 1.* you may see.

Whereas if the Header of one side of the Wall, toothed as much as the Stretcher on the other side, it would be a stronger Tooothing, and the Joints of the Headers of one side, would be in the middle of the Headers of the course they lye upon of the other side, as in *Plate 3. Fig. 2.*

All that can be said for this ill Custom of working, is this, that the Header will not well hang two Inches over the Bricks underneath it, I grant it will not, but then it may be made, by having a piece of Fir, or any other Wood of the thickness of a Course of Bricks, and two Inches

Inches broad, and lay it on the last Tooothing Course to bear it; or a *Bat*, put upon the last Tooothing, will bear it till the next *Quine* is set upon it, and then the *Bat* may be taken away.

**Ninthly,** The same Inconveniency happens at an upright *Quine* in a *Brick* and half Wall, where 'tis usual to lay a *Closier* next the Header on both sides of the Wall, and in so doing 'tis Joint in Joint all the length of the Wall, except by chance a three quarten *Bat* happen to be laid.

To prevent which Inconveniency, and to make the Wall much stronger, lay a *Closure* on one side, and none on the other; but lay a three quarter *Bat* at the *Quine* in the stretching course, and in the Heading course adjoin an Header next to the Header at the *Quine*, as you may see it done in Plate 3. Fig. 1. and 2.

Where A and B in both Figures or Diagrams, represents a *Brick* and half Wall, having an upright *Quine* at A, and a *Tooothing* at B, and the *Prick Lines* represents the Course of Bricks laid upon the other course; so in Fig. 1. the black Lines next you are an heading course, and the *Prick-lines* next you, shew a Stretching course: And on the further side from you, the black Lines shew a stretching course, and the *Prick-Lines* an Heading course.

In which Fig. 1. is shewn the usual way of bad Working, but in Fig. 2. is shewn the true way it should be wrought, to be made firm and strong.

Also in working a two *Brick* Wall, I would advise in the Stretching courses, wherein you lay stretching on both sides the Wall next the Line, so also to lay stretching in the middle of the Wall, and *Closiers* next to each stretching Course that lies next the Line, as in Fig. 3. of Plate 3. you may see.

Where the Diagram or Fig. A B, signifies a two Brick Wall, A being an upright Quine, and B the Toothing, in which, the black lines represent the stretching course, and the Prickt Lines the Heading course, that lies upon the stretching course : In a two brick Wall if you lay a clofier next the upright Quine on both sides of the Wall, it makes good Bond,

Tenthly, In Summer time use your Morter as soft as you can, but in the Winter time pretty stiff or hard.

Elevently, If you build in the City of London, you must make all your Walls of such thickneses as the Act of Parliament for rebuilding of the said City enjoyns, but in other places you may use your Discretion.

And because the Act of Parliament may not be in every Builders hands, I will therefore Insert so much of it as relates to *Bricklayers Work*, to wit, the Heights and number of Stories, and the Thickness of Walls of the four several sorts of Buildings, which is as follows.

And be it further Enacted, That the said Houses of the First and least sort of Building Fronting by Streets or Lanes, as aforesaid, shall be of two Stories high, besides Cellars and Garrats; That the Cellars thereof 6 Foot and an half high, if the Springs of Water hinder not; and the First Story be 9 Foot high from the Floor to the Seeling; and the second Story 9 Foot high from the Floor to the Seeling; that all Walls in Front and Reer as high as the first Story, be of the full thickness of the length of two Bricks, and thence upwards to the Garrats of the thick-

ness

ness of one Brick and an half; and that the thickness of the Garrat Walls on the back part, be left to the Discretion of the Builder, so that the same be not less than the length of one Brick; and also that the thickness of the party Walls between these Houses of the First and lesser sort of Building, be one Brick and  $\frac{1}{2}$  as high as the said Garrats, and that the thickness of the party Wall in the Garrat, be of the thickness of the length of one Brick at the least.

And be further Enacted, That the Houses of the second sort of Building fronting Streets and Lanes of Note, and the River of *Thames*, shall consist of three Stories high, besides Cellars and Garrats as aforesaid; that the Cellars thereof be 6 Foot and  $\frac{1}{2}$  high, (if the Springs hinder not) that the first Story contain full 10 Foot in height from the Floor to the Seeling: The second full 10 Foot, the third 9 Foot; that all the said Walls in Front and Reer, as high as the first Story, be two Bricks and  $\frac{1}{2}$  thick, and from thence upwards to the Garrat Floor, of one Brink and  $\frac{1}{2}$  thick; and the thickness of the Garrat Walls on the back part be left to the dis-  
cretion of the Builder, so that the same be not less than one Brick thick: And also that the thickness of the party-walls between every House of this second, and larger sort of Building, be two Bricks thick as high as the first Story, and thence upwards to the Garrats, of the thickness of one Brick and  $\frac{1}{2}$ .

Also, that the Houses of the third sort of Buildings, fronting the high and principle Streets, shall consist of 4 Stories high, besides Cellars and Garrats as aforesaid: That the first Story contain full 10 foot in height from the Floor to the Seeling; the second 10 foot and  $\frac{1}{2}$ ; the third

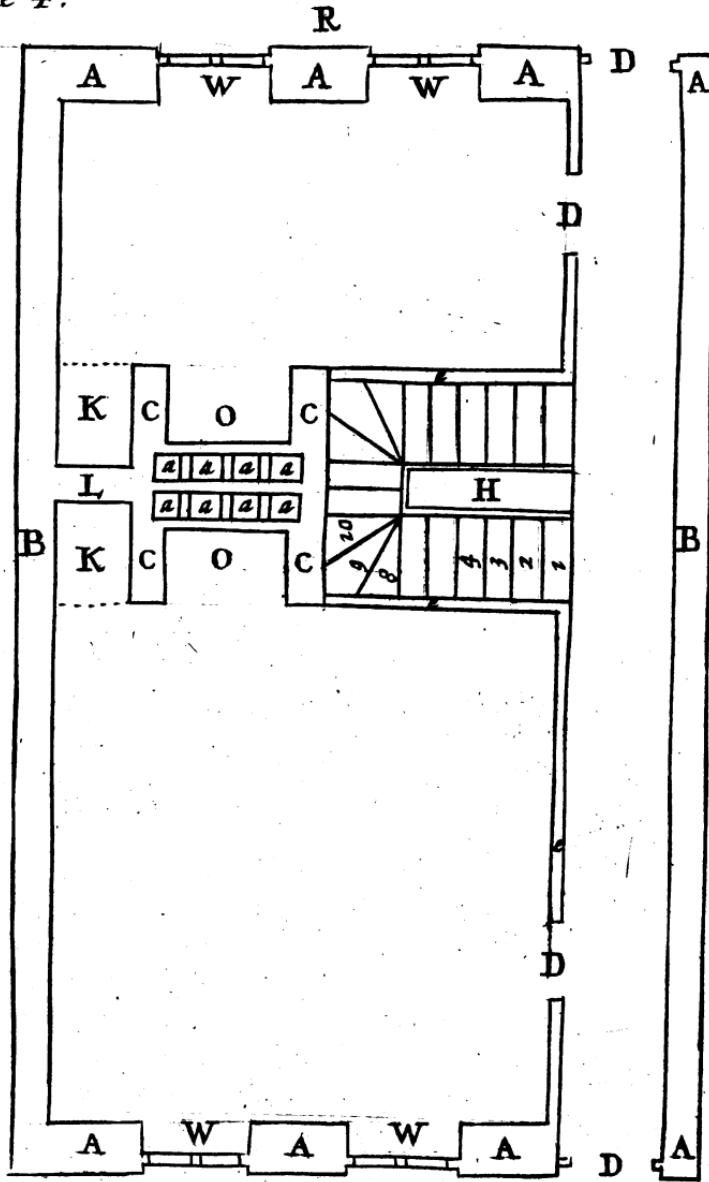
S 4 9 foot;

9 foot; the fourth 8 foot and  $\frac{1}{2}$ : That all the said Walls in Front and Rear, as high as the first Story, be of two Bricks and  $\frac{1}{2}$  in thickness, and from thence upwards to the Garret Floor, of the thickness of one Brick  $\frac{1}{2}$ : That the thickness of the Garret Walls on the back part be left to the discretion of the Builder, so as the same be not less than one Brick: And also that the Party-walls between every House, of this third and larger sort of Building, be two Bricks thick as high as the first Floor, and thence upwards to Garret Floor, the  $1\frac{1}{2}$  Brick in thickness.

*And, Be it further Enacted, That all Houses of the fourth sort of Building, being Mansion Houses, and of the greatest bigness, not fronting upon any of the Streets or Lanes as aforesaid; the number of Stories, and the Height thereof, shall be left to the discretion of the Builder, so as he exceeds not four Stories.*

Also, the same Act enjoins, That no Timber be laid within 12 Inches of the foreside of the Chimney Jambs; and that all Joists on the back of any Chimney be laid with a Trimmer, at six Inches distant from the back: Also, that no Timber be laid within the Tunnel of any Chimney, upon penalty to the Workman for every Default ten Shillings, and ten Shillings every week it continues unreform'd.

*Twelftly,* When you lay any Timber on Brick-work, as Torsels for Mantle-Trees to lye on, or Lintols over Windows, or Templets under Girders, or any other Timbers, lay them in Loam, which is a great preserver of Timber, for Mortar eats and corrodes the Timber: Likewise the Joist ends, and Girders which lye in the Walls, must be Loamed all over, to preserve them from the



Scale of Feet and Inches. 20

1 2 3 4 5 6 7 8 9 10 11 12

20



the corroding of the Morter. Some Workmen pitch the ends of the Timber that lye in the Walls to preserve them from the Morter.

*In the next place you shall have the Ground Plat of a Building, and its Explanation.*

**I**N Plate 4, you have the Draught of a Ground Plat of a Building, which is 25 Feet, both in the Front and Reer Front; and 40 Feet in the Flank or Depth: The Front and Reer Front Walls, are 2 Bricks and  $\frac{1}{2}$  in thickness; the Flank Walls are 2 Bricks in thickness, as you may prove by the Scale of Feet and Inches annexed to the Design.

You may imagine this Design to be the Ground Floor, having no Cellar beneath it: And the height of the Story between the Floor and the Seeling to be 10 Foot; and because we do suppose this Building to have Houses adjoining it on each side, therefore we have drawn the Stair-case with an open Nuel to give light to the Stairs; but if the House had stood by it self, without other Houses adjoyning, then we might have had light to the Stairs from the Flank Wall.

*Explanation of the Design.*

- F. The Front.
- R. Reer Front.
- B. Flank Walls.
- A. Piers of Brick.
- W. Windows of Timber.
- D. Door-cases of Timber.
- O. Chimneys.
- C. Jambs of Chimneys.

H. Open

- H. Open Nuel to give light to the Stairs.
- K. Closets.
- L. A Brick and half Wall between the Closets.
- a. Funnels or Tunnels of Chimneys.
- I. 2. 3. 4, &c. Steps of Stairs called Fliers.
- 8. 9. 10, &c. Steps of Stairs called Winders.
- e. Timber Partitions.

The Scale contains 32 Feet, with a Diagonal Line to shew the Inches in a Foot: For Example, if you would take of 8 Inches, take the Interval from 8 in the Horizontal Line to the Diagonal Line, and that is 8 Inches: From 3 in the Horizontal Line to the Diagonal Line, is 3 Inches, and so of the rest.

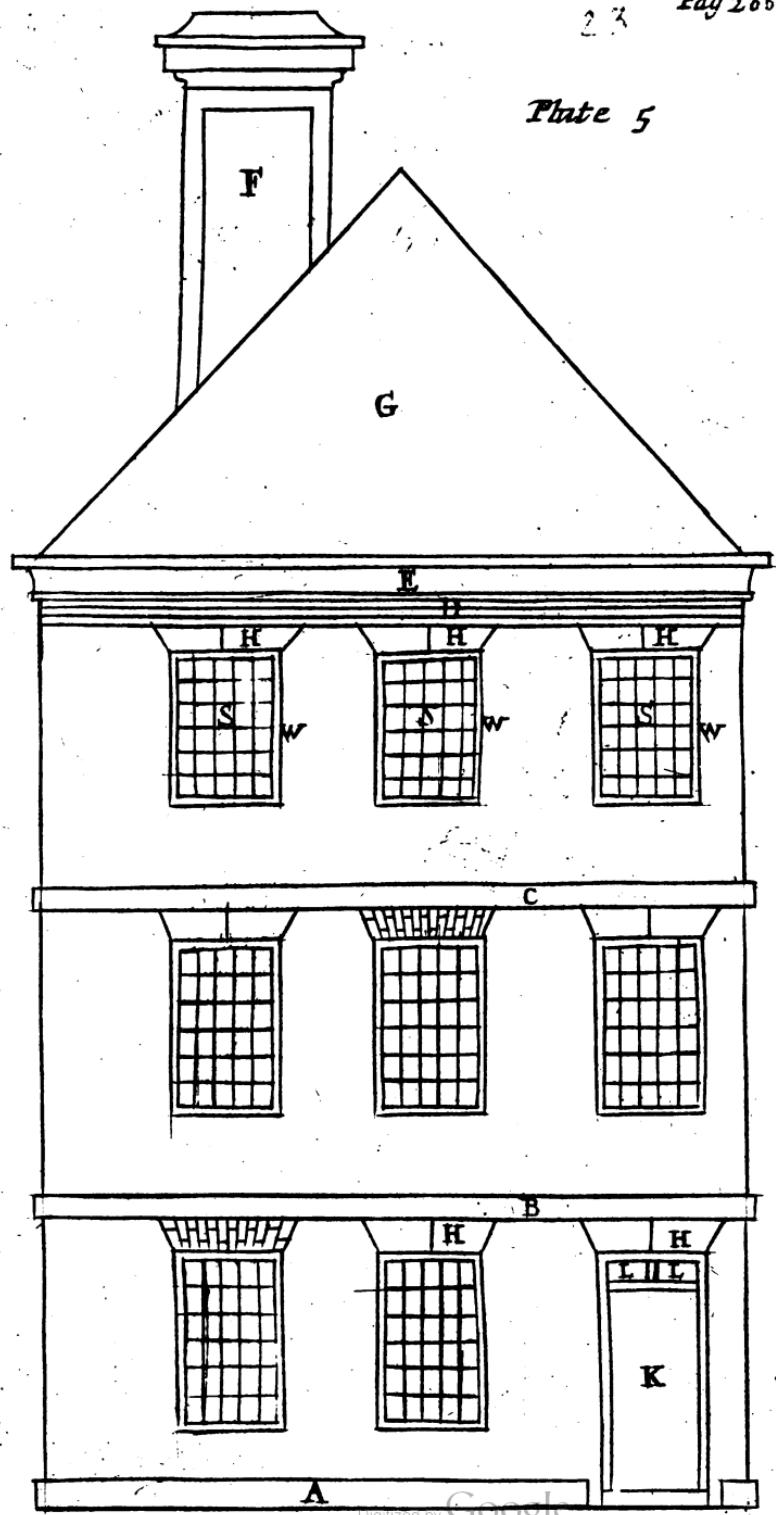
In the next *Plate* you have the Orthography, or upright of this Ground Plat, and this the Explanation thereof, with a Scale of Feet and Inches annexed thereto,

#### *Explanation of Plate 5.*

- A. The Water-Table.
- B. First Fascia.
- C. Second Fascia.
- D. Three plain Courses of Bricks over the Arches.
- E. Cornice.
- F. Chimnies.
- G. Gable-end.
- H. Streight Arches.
- W. Shas Frames.
- S. Shas lights.
- K. Door-caſe.
- L. Window-Lighte over the Door.

The

Plate 5





## Plate 6.

A

B

C

C

D

E

Fig. 2.

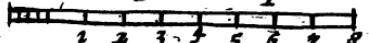
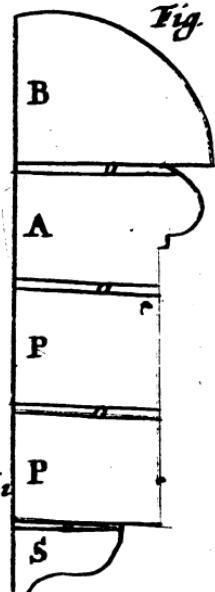
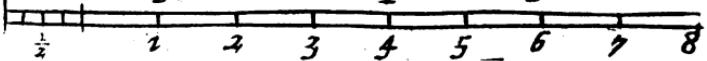
*A Scale of Inc. and quart. to F.t.*

Fig. 1.

*A Scale of Inches and quarters of an inch to Ft.*

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The Scale of Feet and Inches being the same, as in the Ground Plat of *Plate 4.* I need not say any thing concerning it, because I have there shewn the use of it.

And although I have in this Design, drawn the Fasias plain without any Mouldings, yet sometimes they are made with Mouldings, which shew very neat and handsome, I have therefore in *Plate 6.* given you a Design of a Brick Fasia, wrought with Mouldings, in which Design

- S. Is Scima reversa.
- O. Joints of Morter.
- P. Plain Courses.
- A. Astragal.
- B. Ovolo, or Boltel, reversed.

In the same *Plate,* you have the design of a Brick Cornice, and the Names of the Mouldings, are

- A. Scima recta, or Ogee;
- O. Joint of Morter.
- B. Scima reversa, or Scimatium.
- C. Corona, or Plancheer.
- D. Ovolo, or Boltel.
- E. Cavetto, or Casement.

In which Cornice, the Corona, or Plancheer, ought ( according to the Rules of Architecture ) to Sail over, or project more ; but the length of a Brick being but about 8 Inches when its head is rubbed for hewing, it will not hang, if it sail over, more than is shewn in the Draught, which is about 3 Inches and an half. But if you would make it to project more, then you must Cement pieces to the ends of your bricks for tailing

ing, or to make them longer: Of which Cement there is two sorts, one is called cold Cement, and the other is hot, the making and use whereof, we will shew towards the latter end.

*To describe Mouldings on Wainscot, or Panelboard, for Patterns, to cut Bricks by.*

There are two ways to describe the Hollows, and rounds of Moulding in Fasias, or Cornices; one from the *oxi*, or *oxigonium*, the other from the *half round*, or *Semicircle*, that makes the Moulding flatter, this more circular; I will shew both ways, and then you may make use of which you please.

*First*, We will describe a Cavetto, or Casement, both ways.

In Plate 7. the Fig. 1. is described from the *oxi*, in this manner, having allowed the projection of the Moulding at the bottom, and the Fillet at top, draw the Line *a b*, then with the Compasses taking the interval *a b*, place one point of the Compasses in *a*, and with the other describe the Arch *d d*; then with one Foot in *b*, with the other describe the Arch *c c*, and where these two Arches intersect each other, there is the Center to describe the Cavetto; then fixing one Foot in the Center, extend the other to *a* or *b*, and describe the Arch *a g b*.

You may describe it from a Semicircle thus: In Fig. 2. having allowed the Projection at bottom, and the Fillet at top, as before, draw the Line *a b*, bisect, or middle it, as at *c*, then upon *c* as a center, with the Interval *c a*, or *c b*, describe the Semicircle *a d b*, and bisect it in *d*, which is the Center to describe the Cavetto, or Casement by; then fixing one point of the Compasses

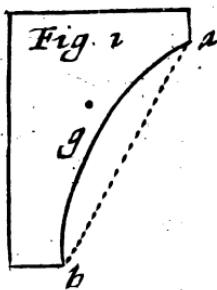


Plate 7.

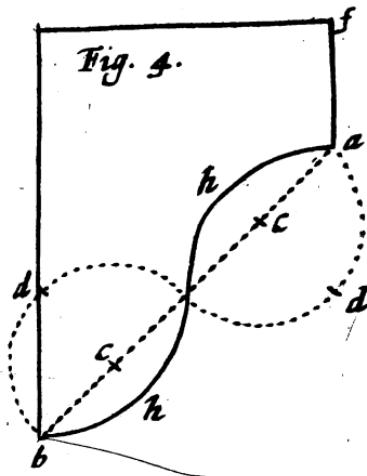
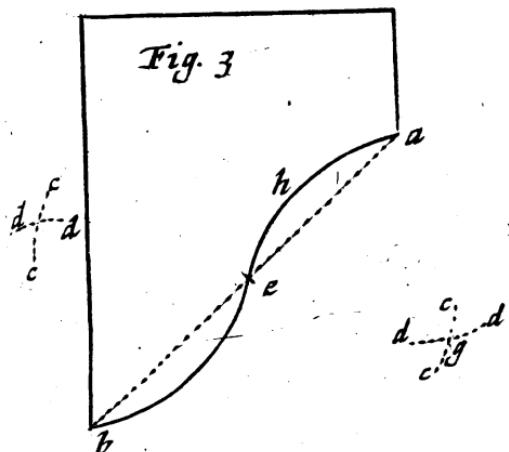
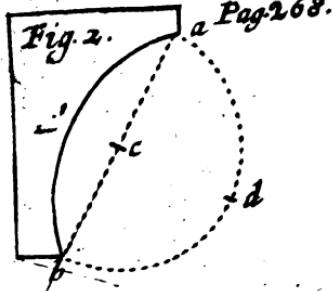


Fig. 5.

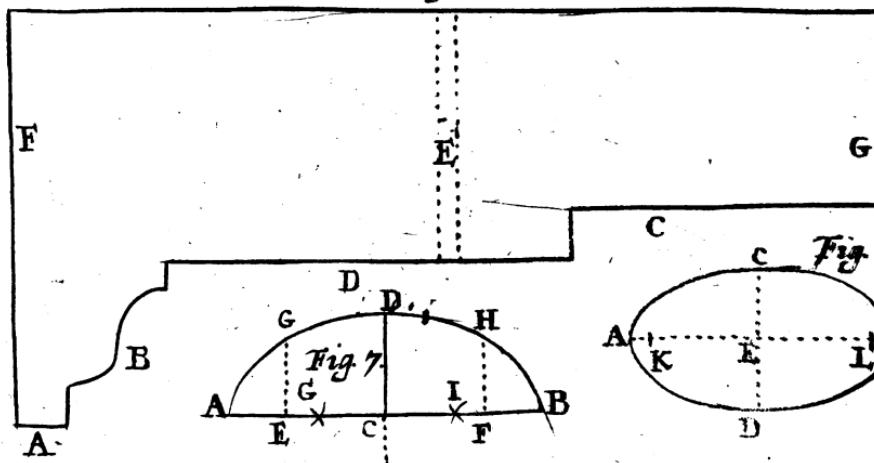


Fig. 7.



passes in *d*, extend the other to *a* or *b*, and describe the Arch *a g b*.

*To describe the Scima Recta, or Ogee,  
both ways.*

*Fig. 3.* is described by the *Oxi* in this manner; having allowed the Fillet at top *a f*, draw the Line *a b*, and bisect it, that is, part it in the middle in *e*; then with your Compasses take the Interval *e b*, and fixing one point in *e*, with the other describe the Arch *c c*, then with the same Interval, or distance, fixing one point in *b*, with the other, describe the Arch *d d*, and where these two Arches Intersect, or cut each other, there is the Center to describe the round, or lower part of the *Ogee*, to wit, *e b b*: Then fixing one point of the Compasses on the Intersection by *d*, extend the other to *b*, or *e*, and describe the Arch *e b b*: Then to describe the Hollow, or upper part of the *Ogee*, take with your Compasses the Distance, or Interval *e a*, and fixing one point in *e*, with the other describe the Arch *c c*, then keeping the Compasses, at the same distance, fix one foot in *a*, and with the other describe the Arch *d d*, intersecting the other Arch in *g*: Then fixing one Foot in *g*, extend the other to *e* or *a*, and describe the Arch *e b a*, which compleats the *Scima recta*, or *Ogee*.

T.

*To describe the same Ogee by a Semicircle.*  
Fig. 4.

1. After you have allowed the Fillet *a f*, draw the Line *a b*.
2. Biseect the Line in *s*.
3. Biseect *e b* and *s a*, as at *c c*.
4. On the Center *c*, with the Interval *c a*, describe the Semicircle *s d a*.
5. Middle it, as at *d*.
6. Fixing one point in *d*, extend the other to *a* or *s*, and describe the Arch *a b s*.
7. On the Center *c*, with the distance *c b*, describe the Semicircle *b d s*.
8. Middle it, as at *d*.
9. Fix one Foot in *d*, and extend the other to *b* or *s*.
10. Describe the Arch *b b s*, which compleats the *Scima Recta*, or *Ogee*; and after either of these ways, which you like best, you may describe any other Moulding.

And because many times *Bricklayers* make Archytrave Jambs and Arches, about Windows and Door-cafes in a Front, I will therefore delineat an Archytrave to be cut in the length of a Brick; which is most usual, although you may make your Archytrave larger, and cut it in the length of one Brick and an half.

In *Plate 7. Fig. 5.* you have Delineated the Ground Plat of an Archytrave Jamb, to be cut in the length of a Brick, which suppose to be *F G*, and also Imagine *F E G* to be a Stretcher, or a Stretching Archytrave: Also you may understand the design to be divided in the middle by the two Prick Lines on each side *E*, which represents a Joint of Morter, and imagining it

to

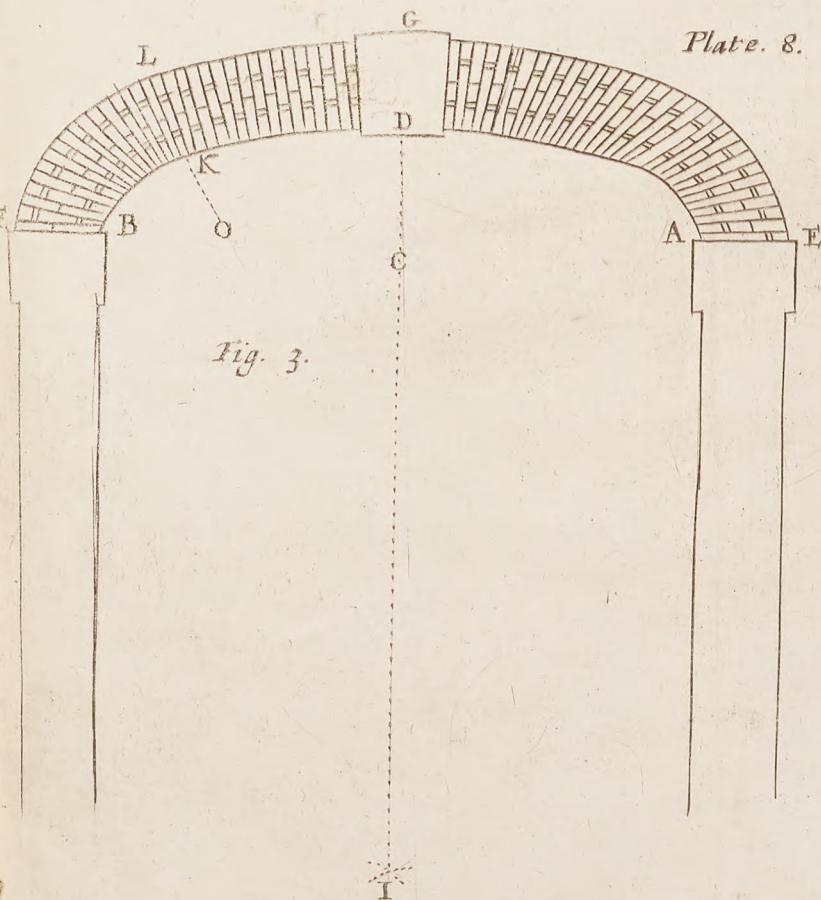
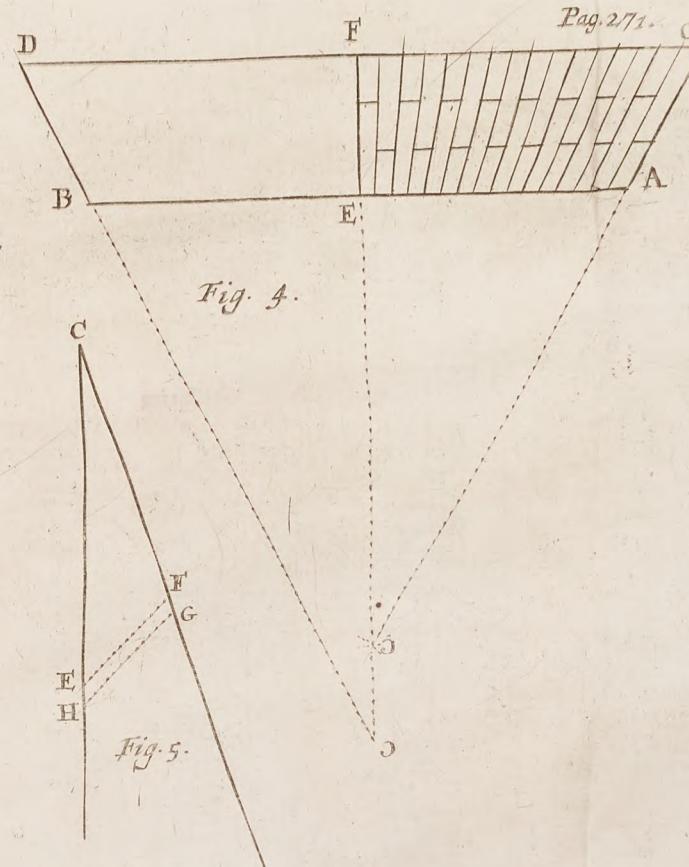
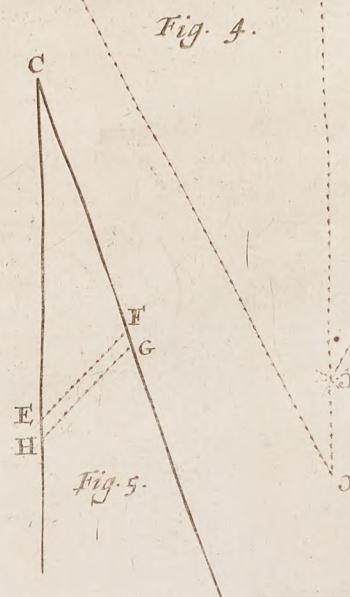


Plate. 8.



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*To describe the same Ogres by a Seminole*

to be thus divided; then E F is called a Header; or a heading Architrave, and E G is called a Jak.

*Here follows the Names of the several parts of the Architrave.*

- A. Fillet.
- B. Scima.
- C. Upper Fascia.
- D. Lower Fascia.

I did intend here to have added something about the Arching of Vaults, but intending, God willing, to treat largely of the Description of all manner of Arches, and making of Moulds, or Patterns, to cut them by, when I come to exercise in *Masonry*, which will succeed this: I shall therefore omit speaking of Vaults in this Exercise.

I shall now in the next place shew how to describe any Ellipsis Arch in Brick; and make the Moulds, as also to describe straight Arches, and make the Moulds for the same.

*To describe an Oval to any Length and Breadth given.*

An *Ellipsis Arch* is an half Oval: Therefore in Plate 8. Fig. 1. let the length given be A B, and the Breadth C D.

Apply the two given Lines together, so that they may cut each other into two equal parts, and at right angles in the point E, then take half the line A B, between your Compasses, and setting one point of the Compasses in C, extend the other till it touch the line A B, in K and L, which

which two points are called the *Focasses*, or burning points, in which points drive two Nails, if you describe it on Boards, but upon Paper, as here two Pins will do; the Pins being stuck fast in the points K and L, stick also another Pin in the Point C, then take a Thread, and Encompass these 3 Pins in form of a Triangle, pulling the Thread tight, tye the two ends of the Thread together, by a knot at C, then taking out the Pin at C, take a Pencil of Black-Lead, holding it close to the inside of the Thread, and carrying the Pencil round upon the Paper, about the Pins, with the Thread always straight, the *Ellipsis* or *Oval A C B D*, will be thereby described.

*Another way to describe the same.*

*Here I shall only describe a Semi-Oval, being an Ellipsis Arch.*

In Fig. 2. let the length given be A B, and the Semidiameter or height of the Arch C D; Divide A B into seven equal parts, then upon one seventh part from A as at E, raise a Perpendicular from the Line A B, (viz. E G.) also at one seventh part from B, as at F, raise another Perpendicular F H; then divide the Semidiameter given C D, into 15 equal Parts, and take Eleven of those Parts, and set upon the Perpendicular from E to G, and likewise from F to H; then taking the space between A and G, setting one point of the Compasses in A, describe the Arch G i, keeping the Compasses at the same distance, set one point in G, and describe another Arch, which will cut the former in the point by i; from which point, with the Radius A i,

us A *i*, describe the *Hanse AG*; this being done, take between your Compasses the space B H, and setting one point in B, describe the arch I *i*, then remove your Compasses to H, and intersect that Arch in the point by *i*, then setting your Compasses on the point *i*, with the same distance, describe a part of the *Ellipsis BH*, which is called the *Hanse*: The other part to be described from G to H, is called the *Scheam*, which to describe, continue or draw longer the Semi-diameter D C, and in that line find a Center, whereon setting one point of the Compasses, the other point may touch the three points G D H, as on the Center I; whereby describe the *Scheam GDH*, which was to be done.

These *Ellipsis*, or *Semi-Oval* Arches, being neatly wrought in Brick, shew very pleasant, and are sometimes made over Gate-ways, and also over Kitchin-Chimnies, instead of Mantle-trees.

We will suppose an *Ellipsis* Arch to be made over a Chimny, whose Diameter between the Jambs is eight feet, and the under side of the Arch at the Key to rise in height 18 Inches from the level of the place, whence you begin to spring the Arch; the height or depth of the Arch we will suppose to be made of the length of two Bricks, which when they are cut to the sweep of the Arch, will not contain above 14 Inches, and perhaps you must Cement pieces to many of the Courses in the *Hanse* to make them long enough to contain, or hold 14 Inches, especially if you intend to make the Courses of the *Hanse*, and the Courses of the *Scheam* to seem alike in greatness, on the under side of the Arch: For if you make the *Hanse* to come to a true Sommering for the *Scheam*, by that time that

T you

you have ended the Hanse, and are ready to set the first Courses of the Scheam: The Mould, and so likewise each Course in the Hanse, will be much less at the lower part, or under side of the Arch, than the Mould, or Courses of the Scheam, as you may perceive by the Hanse B K, in the 3d. Fig. which way of working these kind of Arches is stronger, than to make the Courses seem alike in bigness in Hanse and Scheam, although it be not so pleasing to the eye. In the 3d. Fig. I will shew how to make one half of the Arch this way, and in the other half shew how to make the Courses in Hanse and Scheam of a bigness.

*First*, Describe the under side of the Arch, (viz. the Ellipsis A D B, whose Diameter A B is eight feet, and the height C D 18 Inches) upon some smooth Floor, or streight plaistered Wall, or such like; then continue (viz. draw longer) both the lines A B, C D, cutting each other at right Angles, then from A to E, also from B to F, likewise from D to G, set 14 Inches, the intended height of your Arch. Then describe another Ellipsis to that length and height, after this manner; lay a streight Ruler on the Centre by I, and on the joining of the Hanse, and the Scheam together, as at K, and draw the line K L, then set one point of your Compasses in the centre of the Hanse at M, and open the other point of the Compasses to F, and describe the upper Hanse F L, likewise setting one point of the Compasses in the centre by I, with the other extended to G, describe the Scheam G L, (although I speak here of Compasses, yet when you describe an Arch to its full bigness, you must make use of centre Lines or Rues;

Rules ; the last are best, because Lines are subject to stretch) then taking between your Compasses the thickness of a Brick, abating some small matter which will be rub'd off from both beds of the Brick ; with the Compasses at this distance divide the upper Hanse from L to F into equal parts, and if they happen not to divide it into equal parts, then open them a small matter wider, or shut them a small matter closer, till it doth divide it into equal parts, and look how many equal parts you divide the upper Hanse into, so many equal parts you must divide the lower Hanse from K to B into likewisewise ( or you may divide the upper Hanse from the centre O, making a right Angle from each sommering Line to the Ellipsis, as is shewn in describing the st freight Arches following ; and from the centre O, and the Divisions in the upper Hanse being thus divided, you may draw the st freight Lines to the lower Hanse, and not divide it with the Compasses ) through each of which divisons with a Rule, and Pencil, draw st freight lines, then get a piece of thin Wainscot, and make it to fit between two of these Lines, allowing what thicknes for Morter you intend, this will be the Sommering Mould for the Hanse ; then divide the upper Scheam likewis, with the Compasses at the same distance into equal parts, and laying a Ruler on the centre I, from each Divisfon in the Scheam G L, draw st freight Lines to the lower Scheam D K, then make another Sommering Mould to fit between two of these Lines, abating so much as you intend the thickness of your Joints of Morter to be, which if you set very close Morters, the breadth of the Line will be enough to allow ; then laying the inner Edge of

a Bevil streight on the line K L, bring the Tongue to touch the under side of the first Course of the Scheam, then take up the Bevil, and set that Bevil line upon the Sommering Mould of the Scheam; which Bevil line serves for each Course in the Scheam; but you must take the Bevil of each Course in the Hanse, and set them upon your Sommering Mould by themselves, and Number them with 1, 2, 3, 4, &c. because each Course varies.

Thus having made your Sommering Moulds, in the next place you must make the Moulds for the length of your Stretchers, and for the breadth of the Headers and the Closiers; a piece of Wainscot seven Inches long, and three Inches and an half broad will serve for the length of the Stretchers, and the breadth of the Headers, the Closiers will be 1 Inch and  $\frac{3}{4}$ . broad. So the Closier will be half the breadth of the Header, and the Header half the length of the Stretcher, which will look well.

It remains now to speak something to the other part of the Arch, to wit, A D, whose Courses both in *Hanse* and *Scheam*, run alike upon the *Ellipsis* Lines, and seem of one bigness, although perhaps there may be some small matter of difference, by reason I have not divided the Courses to this Figure, from a right Angle, but every Course from the Angle, which it makes with the *Ellipsis*, which I chose rather to do, that so the *Bevil* of one Course, might not seem to run more upon the *Ellipsis* than the *Bevil* of another, and the difference of the thicknesses being so inconsiderate, is not discerned.

Having

Having described both the *Ellipsis* lines A D, E G, divide each of them into a like number of equal parts, always rememberring to make each Division on the upper *Ellipsis* line, no greater than the thickness of the Brick will contain, when it is wrought; then through each Division in both the *Ellipses* draw streight lines; continuing them four or five Inches above the upper *Ellipsis* Line, and as much below the lower *Ellipsis* Line; then having provided some thin Sheets of fine Pastboard about 20 Inches square, cutting one edge streight, take one sheet and lay the streight edge even upon the line A E, so that it may cover both the *Ellipsis* lines, and being cut to advantage, it may cover eight courses (or nine of the streight Lines) having laid it thus upon the figure of the Arch, stick a Pin, or two, through it, to keep it in its place; then lay a Ruler upon the Past-board true to the 7, 8, or 9th. streight Line of the Arch, according as the Past-board is in bigness to cover them, and take a sharp Pen-knife, laying the Ruler upon the Past-board true to the streight Line (whose ends being continued longer than the Arch is deep, as I directed before, will be seen beyond the Past-board) and cut the Past-board true to the Line, then take another sheet, and join to it, and cut it as you did the first, so continue till you have covered the Arch from A E, just to the line D G, sticking Pins in each Sheet to keep them in the places where you lay them: Then describe both the *Ellipsis* Lines upon the Past-board, from the same Centres and Radii that you described the *Ellipsis's* under the Past-board, and either divide the *Ellipsis* Lines with the Compasses on the Past-board, or else draw lines

upon the Past-board from or by the streight lines underneath them whose ends you see; but the surer way is to divide the Ellipsis's on the Past-board, and draw Lines through those Divisions, as you did beneath the Past-board; then set seven Inches, being the length of each Stretcher, from A towards E, and from D towards G, and describe from the former Centres, the Ellipsis o o through each other course on the Past-board, as you may see in the Fig. also set three Inches and an half, being the breadth of the Header, from A towards E, and and likewise from D towards G: Also set the same three Inches and an ha'f from E towards A, and from G towards D, and describe these two Ellipsis lines from the same Centres thro' each Course, which the Ellipsis line of the Stretchers miss'd; likewise draw in the same Courses, two other Ellipsis lines, one Inch and  $\frac{1}{2}$  from each of thoie two Lines you drew last, which is the breadth of the Closiers; thus one Course of the Arch will be divided into two Stretchers, and the next to it into three Headers and two Closiers through the whole Arch; this being done, cut the Past-board according to the lines into several Courses, and each other Course into two Stretchers, and the Heading-courses into three Headers, and two Closiers, exactly according to the Sweep of the Black-lead lines, and mark each Course with Figures, marking the first Course of the Hanse with 1, the next with 2, the third with 3, and so continue till you have marked all the Courses to the Key, or middle, for every Course differs; you were best to mark the lower Closier in each course with a Cipher on the left hand of its own number, that you may know it readily from the upper

upper Closer, and make no mistakes when you come to set them; also the middle Headers in each Course should be marked besides its own number; the thickness of the upper Header being easily discerned from the lower Header needs no marking besides its own number; the cross Joints, and likewise the under side and upper side of each Course must be cut circular, as the Past-boards which are your Moulds direct you.

If you will add a Keystone, and Chaptrels to the Arch, as in the *Figure*, let the breadth of the upper part of the Keystone be the height of the Arch, *viz.* 14 Inches, and Sommer, from the Centre at I, then make your Chaptrels the same thickness that your lower part of the Keystone is, and let the Keystone break without the Arch, so much as you project or Sale over the Jauns with the Chaptrels.

Other kind of *Circular Arches*, as half Rounds and Scheams, being described from one Centre, are so plain and easy, that I need say nothing concerning them: But since *Streight Arches* are much used, and many Workmen know not the true way of describing them, I shall write something briefly concerning them. *Streight Arches* are used generally over Windows and Doors, according to the breadth of the Piers between the Windows, so ought the Skew-back or Sommering of the Arch to be; for if the Piers be of a good breadth, as three or four Bricks in length, then the *Streight Arch* may be described (as its vulgarly said) from the *Oxi*, which being but part of a Word, is taken from the word *Oxigonum*, signifying an Equilateral Triangle,

with three sharp Angles; but if the Piers are small, as sometimes they are but the length of two Bricks, and sometimes but one Brick and an half, then the breadth of the Window, or more, may be set down upon the middle Line for the Centre, which will give a less Skew-back, or Sommering, than the centre from an *Oxi*. I will shew how to describe them both ways, and first from the *Oxi*.

Suppose a *Streight Arch*, one Brick and an half in height, to be made over a Window, 4 feet in width. [ See Fig. 4. ] wherein one half of the Arch is described from the *Oxi*, and the other half from the width of the Window, let the width of the Window be A B, taking the width between the Compasses, from A and B as two Centres, describe the two Arches, intersecting each other at P, ( though I speak here of Compasses, yet when you describe the Arch to its full bigness, you must use a Ruler, or a Line, scarce any Compasses being to be got large enough.) Then draw another Line above the line A B, as the line C D, being parallel to it, at such a height as you intend your Arch to be, as in this Fig. at 12 Inches; but most commonly these sort of Arches are but 11 Inches in the height, or thereabouts, which answers to four Courses of Bricks, but you may make them more or less in height according as occasion requires; then laying a Ruler on the centre P, and on the end of the line A, draw the line A C, which is vulgarly called the *Skew-back* for the Arch.

The next thing to be done, is to divide those two lines A B and C D into so many Courses

as the Arch will contain; the thickness of a Brick being one of them, which some do by dividing the upper line into so many equal parts, and from those parts, and from the Centre P, draw the Sommering Lines or Courses; others divide both the upper and lower line into so many equal parts, and make no use of a Centre, but draw the Courses by a Ruler, being laid from the Divisions on the upper line, to the Divisions on the lower line, both which ways are false and erroneous; [but this by way of caution.]

Having drawn the *Skew-back A C*, take between your Compasses the thickness that a Brick will contain, which I suppose to be two Inches when it is rub'd, and setting one point of the Compasses on the line C D. So that when you turn the other Point about, it may just touch the line A C in one place, and there make a Prick in the line C D, but do not draw the Sommering lines until you have gone over half the Arch, to see how you come to the Key, or middle; and if you happen to come just to the middle line, or want an Inch of it, then you may draw the lines, but if not, then you must open, or shut the Compasses a little till you do.

Then keeping one end of the Rule close to the Centre at P. (the surest way is to strike a small Nail in the Centre P. and keep the Rule close to the Nail) lay the other end of the Rule close to the Prick that you made on the line C D, keeping the Compasses at the same width (*viz.* two Inches) set one point of the Compasses on the line C D, as before, so that the

the other Point being turned about, may just pass by the Rule; and as it were touch it in one place; ( you must remove the point of the Compasses upon the line C D, farther or nearer to the Rule, until it just touch the Rule in one place,) and so continue with the Rule and Compasses, until you come to the middle line, and if it happen, that your last space want an Inch of the middle, then the middle of the Key-course will be the middle of the Arch, and the number of the Courses in the whole Arch will be odd, but if the last space happen to fall just upon the middle line E F, as it doth in the *Fig.* then the Joint is the middle of the Arch, ( but if it should happen neither to come even to the line, nor want an Inch of it, then you must open or shut the Compasses a small matter, and begin again till it doth come right ) and the number of the Courses in the whole Arch, is an even Number.

*Note,* When the number of all the Courses in the Arch, is an even Number, then you must begin the two sides contrary, *viz.* A Header to be the lower Brick of the first Course on one side ( or half ) of the Arch, and a Stretcher the lower Brick of the first Course on the other side ( or half ) of the Arch: And contrariwise, if it happen that the Number of the Courses be an odd Number, as 25 or 27, or such like, then the first Courses of each half of the Arch, must be alike, that is, either both Headers, or both Stretchers, at the bottom.

Thus having described the Arch, the next thing to be done, is to make the Sommering Mould, which to do, get a piece of thin Wainscot

scot ( being streight on one edge, and having one side plained smooth, to set the Bevil strokes upon ) about 14 Inches long, and any breadth above two Inches, then laying your Ruler, one end at the Centre P, and the other end even in the Skew-back line, clap the streight edge of the Wainscot close to the Rule, so that the lower end of the Wainscot may lye a little below the line A B, then take away the Centre Rule, but stir not the Wainscot ; and laying a Ruler upon the Wainscot just over the line C D, strike a line upon the Wainscot, then set one Point of the Compasses being at the width of a Course ( viz. two Inches ) upon that line, so that the other Point being turned about, may just touch the streight edge of the Wainscot ; ( as you did before in dividing the Courses ) then make a Prick on the line on the Wainscot, and laying your Centre Rule upon it, and on the Centre P, draw a line upon the Wainscot by the Ruler, with a Pencil, or the Point of a Compass, and cut the Wainscot to that line, and make it streight by shooting it with a Plain, then your Wainscot will fit exactly between any two lines of the Arch ; you may let it want the thickness of one of the lines, or some small matter more, which is enough for the thickness of a Mortar ; the length of your Stretcher in this Arch, may be 8 Inches and  $\frac{1}{4}$ , and the Header 3 Inches and  $\frac{3}{4}$ , but if your Arch be but 11 Inches in height, then make your Stretcher 7 Inches and  $\frac{1}{2}$  long, and the Header 3 Inches  $\frac{1}{2}$  ; one piece of Wainscot will serve both for the length of the Stretcher, and the length of the Header, making it like a long square or Oblong, whose sides are 8 Inches  $\frac{1}{4}$ , and 3 Inches and  $\frac{3}{4}$ . Then take a Bevil, and laying

ing the inner edge of it streight with the line A B, and the Angle of the Bevil just over the Angle at A, take off the Angle that the Skew-back line A C makes with the line A B, and set it upon the smoothed side of your Sommering Mould, for the Bevil stroke of your first Course; then drawing your Bevil towards E, streight in the line, until the Angle of the Bevil be just over the Angle, that the second Sommering line makes with the line A B; when it is so, draw the Tongue of the Bevil to lye even upon the second Sommering line; (in brief, cause the Bevil to lye exactly on the line A B, and on the second Sommering line) then take up your Bevil and lay it on the Mould; and strike that Bevil line on the Mould, with the Point of the Compasses, about half a quarter of an Inch distant from the first, and that is the Bevil of the underside of the second Course; proceed thus until you come to the middle line E F, but after you have set three Bevil lines upon your Sommering Mould, leave about  $\frac{1}{4}$  of an Inch between the third and the fourth, and so likewise between the 6th and 7th, and the 9th, and 10th, which will be a great help to you, in knowing the Number of each line on the Mould.

The Moulds for the other half of the Arch, namely E B, are made after the same manner, but but the Arch is described from a Centre beneath P, as Q which causeth a less Skew-back (*viz.* B. D.)

The diminishing of the Sommering Mould to any Skew-back may be found by the Rule of Three, by dividing a foot into 10 equal parts, and

and each of these into 10 parts, so that the whole foot may contain 100 parts, then proceed thus. The upper line C F, will be 309, that is three Feet and almost one Inch, and the lower line A E will be 252, that is two Feet and an half an  $\frac{2}{100}$ , and the upper part of the Sommering Mould will be 17 almost, that is, two Inches of such whereof there are 12 in a foot line measure; having these three Numbers (viz. 309, 252, 17.) work according to the Rule of Three, and you will find 13 and  $\frac{6}{100}$  of 100 parts, that is almost 14 (such parts whereof there are 100 in a Foot line measure) for the breadth of the lower part of the Mould.

*You may likewise find it Geometrically thus.*

**H**aving drawn the upper line and under line of the Arch, as C F, and A E, and drawn any Skew-back, as suppose A C in [Fig. 4.] make at discretion the Angle G C H in [Fig. 5.] then take the upper line C F, and set it from C. to F; also take the lower line A E, and set it from C to E, and draw the line E F; then take the thickness of your Brick, which suppose to be two Inches, and set it from F to G, and draw G H, parallel to F E, I say F G is the breadth of the upper part of the Sommering Mould, and E H the breadth of the lower part; Then make your Sommering Mould true to those two lines, and beginning in the middle line F E, describe the freight lines by the Mould from the Key F E, until you come to the Skew-back A C, and then take of the Bevil lines, and set them on your Sommering Mould.

I shall

**I** shall conclude this Exercise with the Art of making two sorts of Cements, for the Cementing Bricks.

**T**here are two sorts of Cement, which some Bricklayers use in Cementing of Bricks for some kind of Mouldings, or in Cementing a block of Bricks, as they call it, for the Carving of Scroles or Capitals or such like, &c. One is called cold Cement, the other is called hot Cement, because the former is made and used without Fire, but the latter is both made and used with Fire; the cold Cement being accounted a Secret, is known but to few Bricklayers, but the hot Cement is common.

*To make the cold Cement.*

**T**ake  $\frac{1}{2}$  a Pound of Old Cheshire-Cheese, pair of the Rine, and throw it away, cut or grate the Cheese very small, and put it into a Pot, put to it about a Pint of Cows-milk, let it stand all Night, the next Morning get the Whites of 12 or 14 Eggs, then take  $\frac{1}{2}$  a Pound of the best Unlackt or Quick Lime that you can get, and beat it to Powder in a Morter, then sift it through a fine Hair Sieve into a Tray or Bole of Wood, or into an Earthen Dish, to which put the Cheese and Milk, and stir them well together with a Trowel, or such like thing, breaking the Knots of Cheese, if there be any, then add the Whites of the Eggs, and Temper all well together, and so use it; this Cement will be a White Colour, but if you would have it of the Colour of the Brick, put into it either some very fine Brick-Duft, or Almegram, not too much, but only just to colour it.

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*To make the hot Cement.*

**T**ake one Pound of Rozin, one Quarter of a Pound of Bees-Wax, half an Ounce of fine Brick-Duft, half an Ounce of Chalk-Duft, or Powder of Chalk, sift both the Brick-Duft and Chalk-Duft through a fine Hair Sieve, (you may beat the Brick and the Chalk in a Morter, before you sift it) boil altogether in a Pipkin, or other Vessel, about a quarter of an hour, stirring it all the while with an Iron or a piece of Lath or such like, then take it of, and let it stand 4 or 5 Minutes, and 'tis fit for use.

**Note,** That the Bricks that are to be Cemented with this kind of Cement, must be made hot by the Fire, before you spread the Cement on them, and then rub them to and fro on one another, as Joiners do, when they Glew two Boards together.

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E I N I S.

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# *Mechanick Dyalling:*

TEACHING

Any Man, tho' of an Ordinary Capacity and unlearned in the Mathematicks,

To Draw a True

# SUN-DYAL ON ANY GIVEN PLANE, However Scituated :

Only with the help of a straight *Rule* and a pair of *Compasses*; and without any Arithmetical Calculation.

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The Fourth Edition.

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By JOSEPH MOXON, Fellow of the Royal Society, and Hydrographer to the late King Charles.

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L O N D O N:

Printed for Tbo. Leigh and Dan. Midwinter, at the Rose and Crown in St. Paul's Church-Yard. 1703.



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# Mechanick Dyalling.

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*Description of Dyalling.*

**D**yalling originally is a *Mathematical Science*, attained by the Philosophical contemplation of the Motion of the Sun, the Motion of the Shadow, the Constitution of the Sphere, the Scituation of Planes, and the Consideration of Lines.

*Explanation.*

THE Motion of the Sun is reguler, it moving in equal Space in equal Time ; But the Motion of the Shadow irregular, in all parts of the Earth, unless under the two Poles, and that more or less according to the Constitution of the *Sphere* and Scituation of the *Plane*. And therefore Scientifick Dyalists by the Geometrick Considerations of Lines, have found out Rules, to mark out the irregular Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to Comply with the regular Motion of the Sun. And these Rules of adjusting the Motion of the Shadow to the Motion of the Sun, may be called *Scientifick Dyalling*.

But though we may justly account *Dyalling* originally a *Science*, yet such have been the Generosity of many of its studious Contemplators, that they have communicated their acquired Rules ; whereby it is now become to many of the Ingenious no more difficult than an *Art*, and by many late Authors

thors so Intituled : Nay more, by this small Treatise it will scarce be accounted more than a *Manual Operation*; for, though (hitherto) all the Authors I have met with seem to pre-suppose their Reader to understand *Geomettry*, and the *Projecting of the Spbere* already, or else endeavour in their Works to make him understand them, as if they were absolutely necessary to be known by every one that would make a Dyal; when as in truth, (the Contemplative pains of others aforesaid of considered) they are not; but indeed are only useful to those that would know the reason of *Dyalling*. Thus they do not only discourage young beginners, but also disappoint many Gentlemen and others, that would willingly either make them themselves, or set their Workmen about them, if they knew how to make them.

This little Piece I have therefore composed for the help of those who understand neither the *Projection of the Spbere*, or *Geometrical Operations*: Only, if they know how to draw a straight Line between two points by the side of a Ruler, describe a Circle with a pair of Compasses, erect a Perpendicular and draw one Line parallel to another, they may know how to draw a *Dyal* for any given *Plane*, however scituated in any Latitude.

But perhaps these two last little Tricks are not known to all new beginners, therefore I shall shew them. First,

*How to erect a Perpendicular. For Example, in Fig. 1.*

Upon the Line A B, you would erect a Perpendicular to the Point C: Place one Foot of your Compasses upon the point C, and open the other to what distance you please: For Example, to the point A, make there a mark; then keeping the first Foot still in C, turn the other Foot towards B, and make there another mark; then open your Com-

Compasses wider, suppose to the length A B, and placing one Foot in the point A, with the other Foot describe a small Arch over the point C, and removing the Foot of your Compasses to the point B, with the other Foot describe another small Arch, to cut the first Arch, as at D. Then lay your straight Ruler to the point where the two small Arches cut each other, and upon the point C, and by the side of the Ruler draw the Line C D, which shall be a Perpendicular to the Line A B.

Fig. 1.

A C E

Fig. 2. D

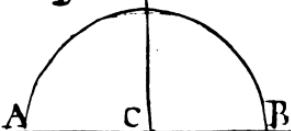


Fig. 3.

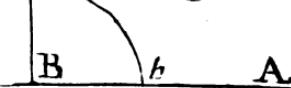


Fig. 4



*Another way with once opening the Compasses, as by Fig. 2.*

Draw the Line A B, and place one Foot of your Compasses upon the point you would have the Perpendicular erected, as at the Point C, and with the other Foot describe the Semi-circle A ab B, then placing one foot in B, extend the other foot to b, in the Semi-circle ; and keeping that Foot in b, extend the other Foot to D, and make there a small Arch : Then remove one Foot of your Compasses to A, and extend the other Foot to a in the Semi-circle, and keeping that Foot in a, extend the other to D, and make there another small Arch, to cut the first small Arch ; and laying a straight Ruler to the point where these two small Arches cut each other, and upon the point C, draw

U 3

by

by the side of the Ruler the Line C D, which shall be perpendicular to the Line A B.

*To erect a Perpendicular upon the end of a Line, as by Fig. 3.*

On the point B, at one end of the Line A B, place one Foot of your Compasses in the point B, and extend the other on the Line towards A, as to b, and with it describe the Arch *b a C*; then placing one Foot in *b*, extend the other to *a* in the Arch, and make there a mark; Divide with your Compasses the Arch *b a* into two equal parts, and keeping the Feet of your Compasses at that distance, measure in the Arch from *a* to C, then draw a straight Line from the point C to the end of the Line B, and that straight Line shall be Perpendicular to the end of the Line A B.

*To draw a Line Parallel to another Line, as by Fig. 4.*

*Example.* If you would draw a Line parallel to the Line A B, open your Compasses to the distance you intend the Lines shall stand off each other, and placing one Foot successively near each end, describe with other Foot the small Arches C D; lay a straight Ruler to the top of these Arches, and draw a Line by the side of it, and that Line shall be parallel to the Line A B.

#### *Definitions.*

A *Dyal Plane* is that Flat whereon a *Dyal* is intended to be projected.

Of *Dyal Planes* some be *Direct*, others *Decliners*, others *Oblique*.

Of *Direct Planes* there are five sorts.

1. The *Horizontal* whose Plane lies flat, and is parallel to the *Horizon*, beholding the *Zenith*.

2. The *South Erect*, whose Plane stands upright, and directly beholds the *South*.

3. The

3. The *North Erect*, whose Plane stands upright, and directly beholds the *North*.

4. The *East Erect*, whose Plane stands upright, and directly beholds the *East*.

5. The *West Erect*, whose Plane stands upright and directly beholds the *West*.

Of *Decliners* there are infinite ; and yet may be reduced into these two *Kinds*.

1. The *South Erect* Plane, declining more or less towards the *East* or *West*.

2. The *North Erect* Plane, declining more or less towards the *East* or *West*.

Of *Obligate Planes* some are *Direct* other *Declining*; and are of four sorts.

1. *Direct Inclining Planes*, which lean towards you, and lie directly in the *East*, *West*, *North*, or *South* quarters of Heaven.

2. *Direct Reclining Planes*, which lean from you, and lie directly in the *East*, *West*, *North* or *South* quarters of Heaven.

3. *Inclining Declining Planes*, which lean towards you, but lie not directly in the *East*, *West*, *North*, or *South* quarters of Heaven ; But decline more or less from the *North* or *South*, towards the *East* or *West*.

4. *Reclining Declining Planes*, which lean from you, but lie not directly in the *East*, *West*, *North* or *South* quarters of Heaven ; But Decline more or less from the *North* or *South*, towards the *East* or *West*.

If the Scituuation of the *Plane* be not given, you must seek it : For, there are several ways how to know these several kinds of *Planes* used among *Artists* ; But the readiest and easiest is by an Instrument called a *Declinatory*, fitted to the variation of your Place: And if it be truly made, you may as safely rely upon it as any other.

## OPERATIONS I.

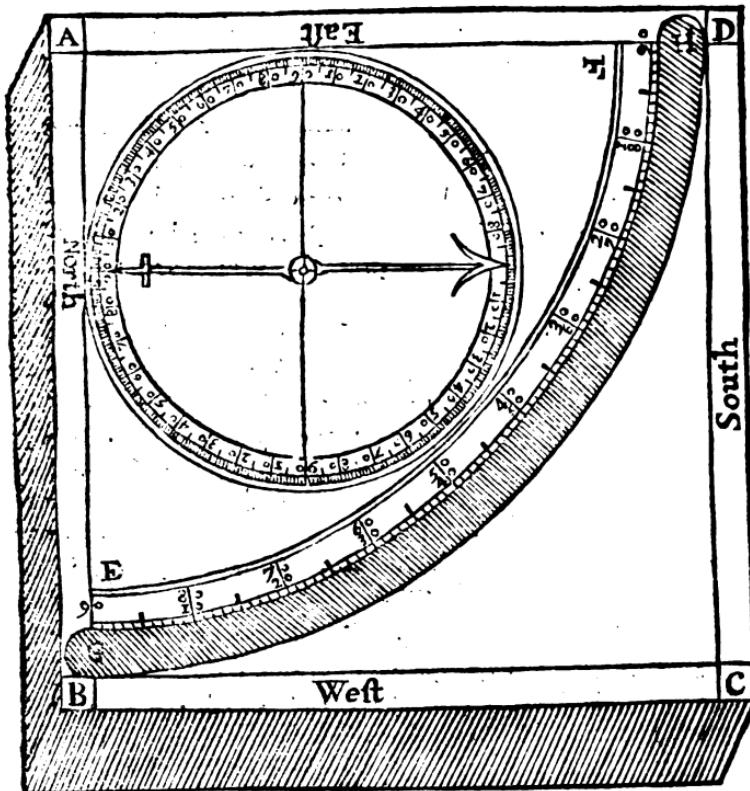
*The Description of the Clinatory.*

**T**H E Clinatory is made of a square Board, ABCD, of a good thickness, and the larger the better; between two of the sides is described on the Center A, a Quadrant as EF divided into 90 equal parts or degrees, which are figured with 10, 20, 30 to 90; and then back again with the Complements of the same Numbers to 90: Between the Limb and the two Semi-diameters is made a round Box, into which a Magnetical Needle is fitted; and a Card of the Nautical Compass, divided into four nineties, beginning their Numbers at the *East West North* and *South* points of the Compass, from which points the opposite sides of the Clinatory receives their Names of *East, West, North* and *South*.

But Note, That the North point of the Card must be placed so many degrees towards the *East* or *West* sides of the Clinatory, as the Needle varies from the true *North* point of the World, in the place where you make your Dyal; which your Workman that makes your Clinatory will know how to fit.

Upon the Center A, whereon the Quadrant was described, is fastned a Plumb-line, having a Plummet of Lead or Brads fastned to the end of it, which Plumb-line is of such length that the Plummet may fall just into the Groove GH, below the Quadrant, which is for that purpose made of such a depth, that the Plummet may ride freely within it, without stopping at the sides of it, See the Figure annexed.

With



With this Clinatory you may examine the situation of Planes. As if your Plane be Horizontal, it is direct: and then for the true situating your Dyal, you have only the true North and South Line to find: which is done only by setting the Clinatory flat down upon the Plane, and turning it towards the right or left hand, till you can bring the North point of the Needle to hang just over the Flower-de-luce; for then if you draw a Line by either of the sides parallel to the Needle, that Line shall be a North and South Line.

If your Plane either Recline or Incline, apply one of the sides of your Clinatory parallel to one of

of the Semi-diameters of the Quadrant to the Plane, in such sort that the Plumb-line hanging at liberty, may fall upon the Circumference of the Quadrant, for then the number of degrees of the Quadrant comprehended between the side of the Quadrant parallel to the Plane, and the Plumb-line shall be the number of degrees for Reclination, if the Center of the Quadrant points upwards ; or Inclination, if the Center points downwards.

If your Reclining or Inclining Plane decline, draw upon it a Line parallel to the Horizon, which you may do by applying the Back-side of the Clinatory, and raising or depressing the Center of the Quadrant, till the Plumb-line hang just upon one of the Semi-diameters, for then you may by the upper-side of the Clinatory draw an Horizontal Line if the Plane Incline, or by the under-side, if it Recline. If it neither Incline or Recline, you may draw a Horizontal Line both by the upper and under sides of the Clinatory. Having drawn the Horizontal Line, apply the North side of the Clinatory to it, and if the North end of the Needle points directly towards the Plane, it is then a South Plane. If the North point of the Needle points directly from the Plane, it is a *North* Plane : But if it points towards the *East*, it is an *East* Plane : If towards the *West*, a *West* Plane. If it do not point directly either *East*, *West*, *North*, or *South*, then so many degrees as the Needle declines from any of these four points, to any of the other of these four points, so many degrees is the Declination of the Plane.

You may find a Meridian Line another way ; thus, If the Sun shine just at Noon, hold up a Plumb-line so as the shadow of it may fall upon your Plane, and that shadow shall be a *Meridian Line*.

D P E

## O P E R A T. II.

*To describe a Dyal upon a Horizontal Plane.*

FIRST draw a North and South Line (which is called a *Meridian Line*) through the middle of the Plane ; Thus Set your *Declinatory* flat upon the Plane, and turn it to and fro till the Needle hang precisely over the *Meridian Line* of the *Declinatory* ; then by the side of the *Declinatory* parallel to its *Meridian Line*, draw a straight Line on the Plane, and if that straight Line be in the middle of the Plane, it shall be the *Meridian Line*, without more ado : But if it be not in the middle of the Plane, you must draw a Line parallel to it, through the middle of the Plane for the *Meridian Line*, or twelve a Clock Line : And it shall be the *Meridian Line*, and also be the *Subtilar Line* ; then draw another straight Line through the middle of this Line, to cut it at right Angles for the VI a Clock Lines ; and where these two Lines cut one another make your Center, whereon you describe a Circle on your Plane as large as you can, which by the *Meridian Line*, and the Line drawn at right Angles with it will be divided into four *Quadrants* ; one of the *Quadrants* divide into 90 degrees thus, keeping your Compasses at the same width they were at when you described the *Quadrant*, place one Foot in the twelve a Clock Line, and extend the other in the *Quadrant*, and make in the *Quadrant* a mark with it, so shall you have the sixtieth degree marked out : Then place one Foot of your Compasses in the six a Clock Line, and extend the other in the *Quadrant*, and make in the *Quadrant* another mark with it ; so shall that *Quadrant* be divided into three equal parts, each of these three equal parts contains 30 Degrees : Then with your Compasses divide one of these three equal

equal parts into three parts, and transfer that distance to the other two third parts of the *Quadrant*, so shall the whole *Quadrant* be divided into nine equal parts. Then divide one of these nine equal parts into two equal parts, and transfer that distance to the other eight equal parts, so shall the *Quadrant* be divided into Eighteen equal parts. Then divide one of these Eighteen equal parts into five equal parts, and transfer that distance to the other Seventeen equal parts, so shall the whole *Quadrant* be divided into 90 equal parts, Each of these 90 equal parts are called Degrees.

*Note*, That you may in small *Quadrants* divide truer and with less trouble with Steel Dividers, (which open or close with a Screw for that purpose,) then you can with Compasses.

In this *Quadrant* (thus divided) count from the *Substilar* or *Meridian Line* the Elevation of the *Pole*, that is, the number of Degrees that the *Pole* of the World is elevated above the *Horizon* of your Place, and draw a Line from the Center through that number of Degrees for the *Stilar Line*. Then on the *Substilar Line* chose a point (where you please) and through that point draw a Line at right Angles to the *Substilar Line* as long as you can, for the *Line of Contingence*, and from that point in the *Substilar Line* measure the nearest distance any part of the *Stilar Line* hath to that point ; and keeping one Foot of your Compasses still in that point, set of that distance in the *Substilar Line*, and at that distance describe against the *Line of Contingence* a Semi-circle, which divide from either side the *Meridian* or *Substilar Line* into six equal parts thus ; Draw a line through the Center of this Semi-circle parallel to the *Line of Contingence*, which shall be the *Diametral Line*, and shall devide this Semi-circle into two *Quadrants*; one on one side the *Substilar Line*, and the

Qua-

*Quadrant* on the other side the *Subſilar Line*: then keeping your Compasses at the same distance they were at when you described the Semi-circle, place one Foot first on one side the *Diametral Line* at the Intersection of it and the Semi-circle, and then on the other side, at the Intersection of it and the Semi-circle, and extend the other in the Semi-circle, and make marks in the Semi-circle on either side the *Subſilar Line*; then place one Foot of your Compasses at the Intersection of the Semi-circle and the *Subſilar Line*, and turn the other Foot about on either side the Semi-circle and make marks in the Semi-circle, so shall the Semi-circle be divided into six equal parts; Divide one of these equal parts into two equal parts, and transfer that distance to the other five equal parts, so shall the whole Semi-circle be divided into twelve equal parts. These twelve Divisions are to describe the twelve Hours of the Day, between six a Clock in the Morning, and six a Clock at Night.

If you will have half Hours, you may divide each of these twelve into two equal parts, as before: If you will have Quarters you may divide each of these twenty four into two equal parts more, as before.

For thus proportioning the Divisions in the Semi-circle, you may proportion the Divisions and Sub-divi-sions of Hours upon the *Dyal Plane*; for a straight Ruler laid upon each of these Divisions, and on the Center of this Semi-circle, shall shew on the *Line of Contingence* the several Distances of all the Hours and parts of Hours on the *Dyal Plane*. And straight Lines drawn from the Center of the *Dyal Plane*, through the several Divisions on the *Line of Contingence* shall be the several Hour Lines and parts on the *Dyal Plane*.

But

But an *Horizontal Dyal* in our Latitude will admit of four Hours more, *viz.* V, IV, in the Morning, and VII, VIII, in the Evening. Therefore in the Circle described on the Center of the *Dyal Plane* transfer the distance between VI and V, and VI and IV, on the other side the six a Clock Line; and transfer the Distances between VI and VII, and VI and VIII on the other side the opposite six a Clock Hour Line, and from the Center of the *Dyal Plane* draw Lines through those transferred Distances for the Hour Lines before and after VI.

Then mark your Hour Lines with their respective numbers. The *Substilar Line* in this Dyal (as aforesaid) is XII, from thence towards the right hand mark every successive Hour Line with I, II, III, &c. and from XII towards the left hand with XI, X, IX, &c.

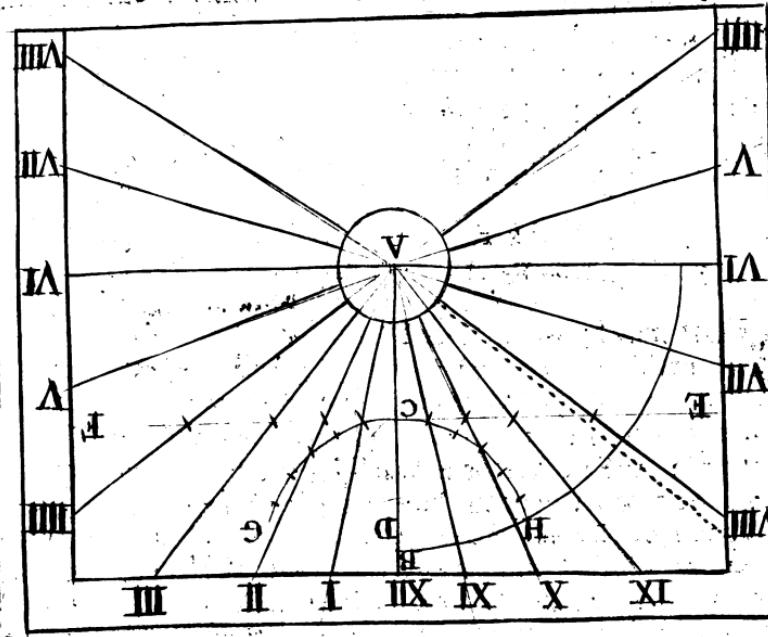
The Stile must be erected perpendicularly over the *Substilar Line*, so as to make an Angle with the *Dyal Plane* equal to the *Elevation* of the *Pole* of your Place.

#### Example.

You would draw a Dyal upon a *Horizontal Plane* here at *London*; First draw the *Meridian* (or North and South Line) as XII B, and cross it in the middle with another Line at right Angles, as VI, VI, which is an East and West Line; where these two Lines cut each other as at A, make the Center, whereon describe the Semi-circle B, VI, VI; but one of the Quadrants, *viz.* the *Quadrant* from XII to VI, towards the right hand you must divide into  $90^{\circ}$  equal parts (as you were taught in Fol. 12.) and at  $51\frac{1}{2}$  degrees (which is *Londons Latitude*) make a mark, and laying a straight Ruler to the Center of the Plane, and to this mark draw a Line by the side of it for the *Stilar Line*. Then on the Substilar

Substilar Line chuse a point as at C, and thro' that point draw a Line as long as you can perpendicular to the East and West Line VI, VI, as E F, (which is called the *Contingent Line*) where this *Contingent Line* cuts the *Substilar Line* place one Foot of your Compasses, and from thence measure the shortest Distance between the point C and the *Stilar Line*. And keeping one Foot of your Compasses still in the point C, set off the shortest distance between the point C, and the *Stilar Line* on the *Substilar Line*, as at D; which point D shall be a Center, whereon with your Compasses at the same width you must describe a Semi-circle to represent a Semi-circle of the *Equinoctial*. This Semi-circle divide into six equal parts (as you were taught Fol. 13.) to each of which equal parts, and to the Center the *Equinoctial* Semi-circle lay a straight Ruler, and where the straight Ruler cuts the *Line of Contingence* make marks in the *Line of Contingence*. Then lay the straight Ruler to the Semi-circle of the *Dyal Plane*, and to each of the marks in the *Line of Contingence*, and by the side of it draw twelve straight Lines for the twelve Fore and Afternoon Hour Lines, *viz.* from VI in the Morning to VI in the Evening. Then in the *Quadrant VI B*, measure the distance between the VI a Clock Hour Line, and the V a Clock Hour Line, and transfer the same distances from the VI a Clock Line to VII, and V on both fides the VI a Clock Hour Lines, and through those distances draw from the Center of the Plane the VII and V a Clock Hour Lines, and measure the distance between the VI a Clock Hour Line and the IV a Clock Hour Line, and transfer the same distance from the VI a Clock Line to VIII and IV, and through those distances draw from the Center of the Plane the VIII and IV a Clock Hour Lines.

If



If you will have the half Hours and quarter Hours, or any other division of Hours, you must divide each six Divisions of the *Equinoctial* into so many parts as you intend, and by a straight Ruler laid to the Center of the *Equinoctial*, and those divisions in the *Equinoctial* Circle make marks in the *Line of Contingence*, as you did before for the whole Hour Lines: and Lines drawn from the Center of the Plane through those marks shall be the Sub-divisions of the Hours: But you must remember to make all Sub-divisions short Lines, and near the verge of the *Dyal Plane*, that you may the easier distinguish between the whole Hours and the parts of Hours; as you may see in the Figure.

Having drawn the Hour-Lines, set the Number of each Hour-Line under it, as you see in the Figure. Last of all fit a Triangular Iron, whose angular Point being laid to the Centre of the *Dyal Plane*

*Plane*, one side must agree with the *Substilar Line*, and its other side with the *Stilar Line*; so is the *Style* made. And this *Style* you must erect Perpendicular over the *Substilar Line* on the *Dyal Plane*, and there fix it. Then is your *Dyal* finished.

## OPERAT. III.

*To describe an Erect Direct South-Dyal.*

YOU may know an *Erect Direct South-Plane*, by applying the North-side of the *Declinatory* to it; For then, if the North-end of the Needle hang directly over the North-point of the Card in the bottom of the Box, it is a *South-Plane*; but if it hang not directly over the North-point of the Card it is not a *Direct South-Plane*, but *Declines* either East or West and that contrary to the Pointing of the Needle Easterly or Westerly, from the North-point of the Card: For, if the North-point of the Needle points Easterly, the *Plane Declines* from the South towards the West: if it point Westerly the *Plane Declines* from the South towards the East.

You may know, if the *Plane* be truly *Erect* or upright, by applying one of the sides *AD* or *AB* to it; for then by holding the Center *A* upwards, so as the *Plumb-line* play free in the *Groove*, if the *Line* falls upon *o*, or *90*, the *Plane* is upright; but, if it hang upon any of the intermediate Degrees, it is not upright, but *Inclines* or *Reclines*.

If you find it incline, apply the side *AB* to it; and see what number of Degrees the *Plumb-line* falls on, for that number of Degrees, counted from the said *AB*, is the number of Degrees of *Inclination*.

If you find the *Plane Reclines*, apply the side *AD* to it, and see what number of Degrees the *Plumb-line* falls on, for that number of Degrees counted from the side *AD*, is the number of Degrees of *Reclination*.

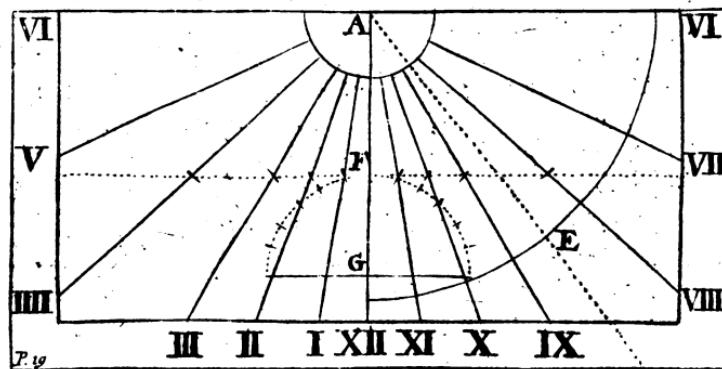
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## 322 MECHANICK DYALLING.

These Rules being well understood, may serve you to find the scituuation of all other sort of *Planes*.

But for the making a *Dyal* on this *Plane*, you must first draw a *Meridian Line* through the middle of the *Plane*, by applying a Plumb-line to the middle of it, till the Plumbet hang quietly before it: for then, if the Plumb-line be blacked (for a white Ground, or chalked for a dark Ground) and strained as Carpenters do their Lines, you may with one stroke of the string on the *Plane*, describe the *Meridian Line*, as A XII. This *Meridian* is also the *Substilar line*.



Then on the top of this *Meridian Line*, as at A draw another Line athwart it, to cut it at right Angles, as VI, VI. for an East and West Line. At the meeting of these two Lines at the top, make your Center, whereon describe a Semi-Circle on your *Plane*, as large as you can, which by the *Meridian Line* and the East and West Line, will be divided into two *Quadrants*. One of these *Quadrants* divide into 90 Degrees (as you were taught Fol. 12.) and from the *Substilar Line* count the Complement of the *Poles Elevation*, which (here at London where the *Pole* is elevated  $51\frac{1}{2}$  Degrees, its Complement to 90) is  $38\frac{1}{2}$  Degrees, and make there

there a mark, as at E. Then on the *Substilar line* chuse a point (where you please) as at F, for the *line of Contingence* to pass through ; which *Line of Contingence* draw as long as you can, so as it may cut the *Substilar Line* at right Angles, and from the point F in the *Substilar line*, measure the shortest distance between it and the *Stilar Line*, and keeping one Foot of your Compasses still in the point F, transfer that distance into the *Substilar Line*. as at G; then on the point G describe a Semi-Circle of the *Equinoctial* against the *Line of Contingence*, which Semi-Circle divide into twelve equal parts, (as you were taught by the *Example* in the *Horizontal Dyal*, Fol. 13.) and by a straight Ruler laid to each of these Divisions, and to the Center of the Semi-Circle make marks in the *Line of Contingence* by the side of the Ruler ; For straight Lines drawn from the Center of the *Dyal plane* through these marks in the *Contingent line* shall be the 12 Hour Lines before and after Noon.

Then mark your Hour Lines with their respective Numbers ; the *Substilar* or *Meridian Line* is XII, from thence towards the right hand with I, II, III, &c. and from thence towards the left hand with a XI, X, IX, &c.

The *Stile* must be erected perpendicular over the *Substilar Line*, so as to make an Angle with the *Dyal Plane* equal to the Complement of the *Poles Elevation*, viz.  $38\frac{1}{2}$  Degrees.

#### O P E R A T. IV.

*To make an Erect Direct North Dyal.*

**T**H E *Erect Direct North Dyal*, Stile and all, is made by the same Rules, changing upwards for downwards, and the left side for the right, the *Erect Direct South Dyal* is made ; for if the *Erect Direct South Dyal* be drawn on any transparent

Plane, as on Glafs, Horn, or an oyled Paper, and the *Horizontal Line VI*, VI, turned downwards, and the Line VII mark't with V, the Line VIII with IIII. the Line V with VII, and the Line IIII with VIII, then have you of it a *North Erect Direct Dyal*.

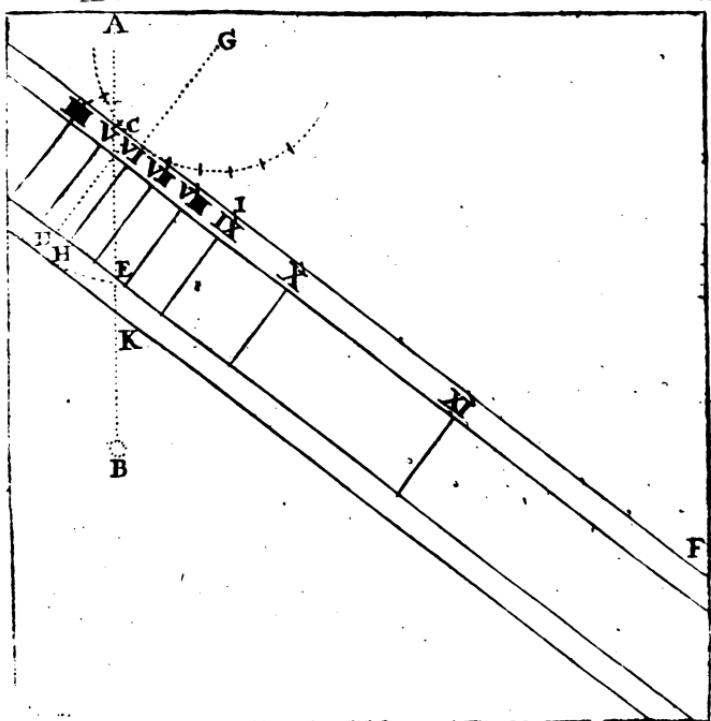
All the other Hour Lines in this Dyal are useless, because the Sun in our Latitude shines on a North Face the longest Day only before VI in the Morning, and after VI at Night.

### O P E R A T. V.

*To describe an Erect Direct East Dyal.*

**H**aving a Plumb-line a little above the Place on the Wall where you intend to make your Dyal, and wait till it hang quietly before the wall: Then if the Line be rubbed with Chalk (like a Carpenters Line) you may by holding the Plumbet end close to the wall, and straining it pretty stiff, strike with it a straight Line, as Carpenters do: This Line shall be a perpendicular, as A B. Then chuse a convenient point in this Perpendicular, as at C, for a Center, whereon describe an occult Arch, as D E; This Arch must contain the number of Degrees of the *Elevation of the Equino $\ddot{\text{t}}$ ial*, counted between D and E, which in our *Latitude* is  $38\frac{1}{2}$ , or (which is all one) the Complement of the *Poles Elevation*. Therefore in a *Quadrant* of the same *Radius*, with the occult Arch measure  $38\frac{1}{2}$  Degrees, and set them off in the Plane from E to D: Then from D to the Center C in the Perpendicular, draw the prick't Line D C; this prick't Line shall represent the *Axis of the World*. Then cross this Line at right Angles with the Line C F, and draw it from C to F, so long as possibly you can: This Line shall be the *Contingent Line*. Then chuse a point in this *Contingent Line*, as at VI, draw a Line through that point at right Angles for the *Substi-*  
*lar*

*lar Line*, as G VI H for the *Substilar Line*; then open your Compasles to a convenient width, (as to VIG) and pitching one foot in the point G, with the other Foot describe a Semi-Circle of the *Equinoctial* against the *Line of Contingence*, which Semi-Circle divide from VI both ways into six equal parts, as you were taught by the *Example* in the *Horizontal Dyal*; and laying a straight Ruler on the Center of this Semi-Circle of the *Equinoctial*, and to each of those equal parts mark on the *Contingent Line* where the Ruler cuts it, for those marks shall be the several points from whence Lines drawn parallel to the Line CD shall be the respective Hour Lines.



The reason why the *Contingent Line* is drawn from VI to F, so much longer than from VI to C is; because the Hour Lines from VI towards XII are more in Number towards Noon, than they are from VI backwrd towards IIII, for this Dyal will only shew the Hours from a little before IV in the Morning to almost Noon. For just at Noon the Shadow goes off the Plane; as you may see, if you apply a straight Ruler to the Center of the equinoctial Semi-Circle G, and lay it to the point 12 in the Semi-Circle; for the straight Ruler will then never cut the *Line of Contingence*, because the *Line of Contingence* is parallel to the line G XII on the Equinoctial Circle, and Lines parallel, though continued to never so great a length, never meet.

To these *Hour Lines*, set Figures as may be seen in the Scheme.

The *Stile IK* of this Dyal, as well as of all others, must stand parallel to the *Axis of the World*; and also parallel to the *Face of the Plane*, and parallel to all the *Hour lines*, and stand directly over the *Substilar* or VI a *Clock Hour line*, and that so high as is the distance of the Center of the Equinoctial Semi-Circle from the *Contingent Line*.

#### O P E R A T. VI.

*To describe a Dyal on an Erect Direct West Plane.*

**A**N *Erect Direct West-Dyal*, is the same in all respects with an *Erect Direct East-Dyal*; only as the *East-Dyal* shews the Forenoon Hours, so the *West* shews the Afternoon Hours.

Thus, if you should draw the *East-Dyal* on any transparent *Plane*, as on Glass, Horn, or oyled Paper, on the one side will appear an *East Dyal*, on the other side a *West*; only the numbers to the *Hour Lines* (as was said before in the *North-Dyal*,) must be

be changed ; for that which in the *East-Dyal* is XI, in the *West* must be I ; that which in the *East-Dyal* is X, in the *West* must be II ; that which in the *East-Dyal* is IX, in the *West* must be III, &c. The Stile is the same.

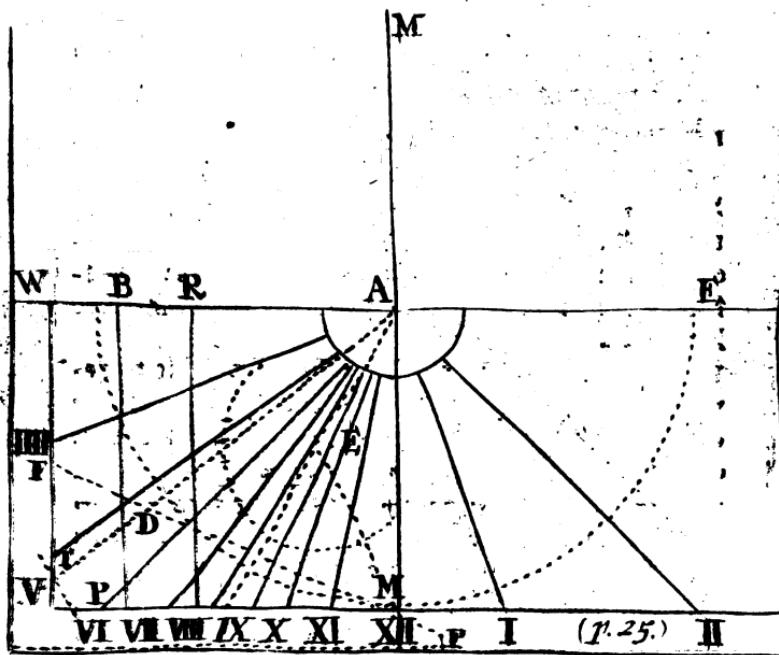
## O P E R A T. VII.

*To Describe a Dyal on an Erect North, or Erect South Plane Declining Eastwards or Westwards.*

**T**Hese four Dyals, viz. the *Erect North Declining Eastwards*, the *Erect North Declining Westwards*, the *Erect South Declining Eastwards*, and the *Erect South Declining Westwards*, are all projected by the same Rules ; and therefore are in effect but one Dyal differently placed, as you shall see hereafter.

First draw on your *Plane* a straight Line to represent the *Horizon* of your place, and mark one end of it W for *West*, and the other end E for *East*, Chuse a point in this *Horizontal Line* for a Center, as at A, whereon you may describe a Circle to comprehend all these four *Dyals* : Draw a Line as MAM perpendicular to the *Horizontal Line* WE, through the Center A for a *Meridian Line* and on that Center describe a Circle, which by the two Lines WA E, and M A M will be divided into four *Quadrants*, which will comprehend the four *Dyals* aforesaid ; for if it be a *North Declining West* you are to draw, the upper *Quadrant* to the left hand serves your purpose ; If a *South declining West*, the same Lines continued through the Center A into the lower *Quadrant* to the right Hand serves your turn ; if a *North Declining East*, the upper *Quadrant* to the right hand serves your turn ; or if a *South declining East*, the same Lines continued through the Center A into the lower *Quadrant* to the left hand serves your turn ; and you must draw the *Declination, Complement*

plement of the Poles Altitude ; Subtile Stile and Hour Lines in it ; but the Hour Lines must be differently marked as you shall see hereafter. I shall only give you an Example of one of these Dials, viz. A South Declining East.



We will suppose you are to draw a Dial that declines from the South 50 Degrees towards the East ; here being but one Dial, you need describe but one Quadrant of a Circle. Set off in the lower Quadrant W A M 50 degrees from the Meridian Line M towards W, and from the Center A draw a straight Line through that mark in the Quadrant as D A, which may be called the *Line of Declination* ; then set off from the Meridian Line the *Complement of the Poles Elevation*, which in our Latitude is  $38\frac{1}{2}$  degrees, and there draw another Line from the Center as AP, which we will call the *Polar Line*. Then

Then take in the *Horizontal Line* a convenient portion of the *Quadrant*, as A B, and from the point B draw a Line parallel to the *Meridian Line* A M, and continue that Line till it intersect the *Polar Line*, as at P, from which Point P draw a Line parallel to W A, as P C: Then measure the distance of A B in the *Horizontal Line*, and set off that distance in the *Line of Declination*, as from A to D, and from that point of distance draw a Line parallel to the *Meridian A M* through the *Horizontal Line* at R, and through the Point D, and continue it through the Line P C, as at S; then laying a straight Ruler to the Center A and the Intersection of the line P C, at S draw the Line A S for the *Subſtie*: Then upon the point S erect a Line perpendicularly as S T; Then measure the distance between R and D, and set that distance off from S to T, and from the Center to the point T draw the Line AT for the *Stile* or *Gnomon*; and the *Triangle S AT* made of Iron or Brass, and erected perpendicularly over the *Subſtie S A*, shall by its upper side TA, cast a shadow upon the Hour of the day. But you will say, the Hour Lines must be drawn first: It is true; Therefore to draw them you must chuse a point in the *Subſtie Line* where you think good, and through it draw the Line F F as long as you can for the *Line of Contingence*; then with your *Compasses* take the distance between this point and the *Stile*, and transfer that distance below the *Line of Contingence* on the *Subſtie* as at E, and with your *Compasses* at that distance describe on the Center E a Circle to represent the *Equinoctial*; then (as you were taught in the Example of the *Horizontal Dyal*) divide the Semi-Circle of the *Equinoctial* into twelve equal parts, beginning at the point in the *Equinoctial Circle*, where a straight Line drawn from the Center of it to the Intersection of the *Line of Contingence* with the *Meridian Line* cuts the *Equinoctial*

*nodal* Line, as here at the Point G; then lay a straight Ruler to the Center of the *Equinoctial Circle* and to every one of the Divisions in the Semicle, and mark where the straight Ruler cuts the *Contingent Line*; for straight Lines drawn from the Center A of the Dyal to those several marks on the *Contingent Line*, shall be the *Hour Lines*; and must be numbered from the Noon Line or *Meridian A M* backwards, as XII, XI, X, IX, &c. towards the left hand. So is your Dyal finished.

This Dyal drawn on any transparent matter, as Horn, Glafs, or an oyled Paper, shall on the other side the transparent matter become a *South Declining West (Stile and all)* but then the I a Clock Hour Line must be marked II. the XII, XII, the XI a Clock Hour Line, I, X, II, IX, III, &c.

If you project it anew, you must describe the *Quadrant M W* on the other side the *Meridian Line*, on the Center A from M to E, and then count, (as before) the *Declination, Altitude of the Pole, Substile, and Stile* in the *Quadrant*, beginning at M towards E, and work in all respects as with the *South Declining East*; only number this *South Declining West* as in the foregoing Paragraph.

If you project a *North Declining East*, you must describe the *Quadrant* above the *Horizontal Line* from M upwards, towards E on your right hand and count (as before) the *Declination, Altitude, Complement of the Pole, Substile and Stile* from the *meridian Line*, and work as with the *South Declining East*: It must be numbered from the *Meridian Line* M towards the right hand with XI, X, IX, VIII, &c.

If this Dyal were drawn on transparent matter, the other side would shew a *North Declining West*: But if you will project it anew, you must describe the *Quadrant* above the *Horizontal Line*, from M upwards towards W, and count from the *Meridian Line A M* the *Declination, Complement, Altitude of the*

*the Pole, Substile and Stile, and work with them (in all respects) as with the South Declining East; but then the XI a Clock Hour Line must be marked I; the X, II; the IX, III, &c.*

## O P E R A T . VIII.

*To draw a Dyal on an East or West Plane Reclining or Inclining.*

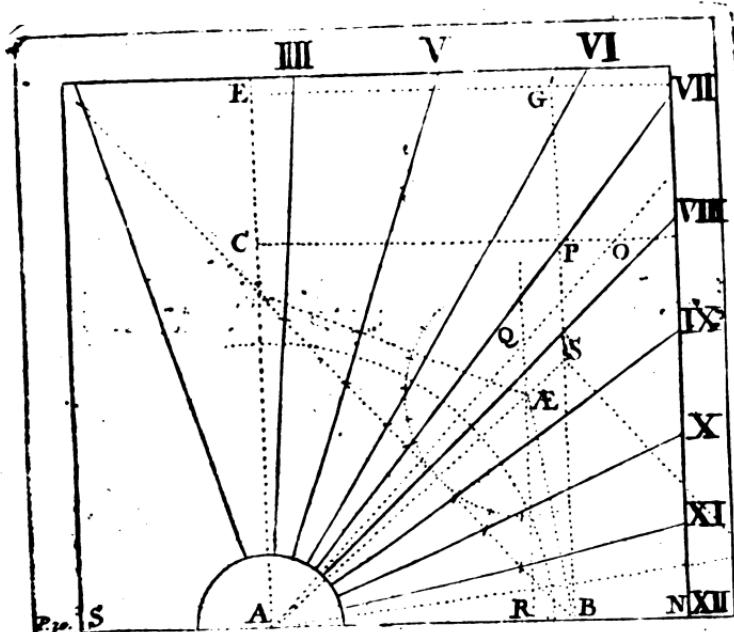
**D**raw a straight Line parallel to the *Horizon*, to represent the *Meridian*, or XII a Clock Line and mark one end N, the other S; chuse a point in this Line, as at A for a Center: Then if Your Plane be an *East*, or a *West Incliner*, let fall a Perpendicular upon this Center, (that is, the Perpendicular must stand above the Meridian Line NS) as AE, and upon the Center A describe a Semi-Circle above the Meridian Line NS; But if your Plane be an *East Incliner*, or a *West Recliner*, let fall a Perpendicular from the Center A under the Meridian Line, and upon the Center A describe a Semi-Circle under the *Meridian Line*. If your Plane be a *West Incliner*; work (as shall be taught) in the *Quadrant* on the left hand above the *Meridian Line*. If an *East Recliner*, in the *Quadrant* on the right hand above the *Meridian Line*. If it be a *West Recliner*, work in the *Quadrant* on the left hand under the *Meridian*. If an *East Incliner*, in the *Quadrant* under the *Meridian Line* the right hand.

*For Example, An East Dyal Reclining 45 Degrees.*

You would draw a *Dyal* on an *East Plane Reclining 45 Degrees*: Therefore in the *Quadrant* on the right hand above the *Meridian Line*, set off from the Perpendicular AE 45 Degrees on the *Quadrant* for the Reclination of the *Plane*; and set off

off also in the *Quadrant*  $38\frac{1}{2}$  Degrees from the Perpendicular for the Complement of the Poles Elevation, and at these settings off make marks in the *Quadrant*; Then lay a straight Ruler to the Center A, and to the marks in the *Quadrant*, and draw straight Lines through them from the Center. Then chuse in the *Meridian Line N S* a convenient point as at B, and through that point draw a Line parallel to the perpendicular A E, which will Intersect the Line drawn for the Complement of the *Poles Elevation* A P in P; from which point P, draw a Line parallel to the *Meridian Line N S*, to cut the Perpendicular A E in C, and also the Line of Obliquity A O in O. Then measure the length A O, and set off that length in the Perpendicular A C E from A to E, and draw the Line E G parallel to the *Meridian Line N S* which will cut the Line B P prolonged in G. Measure also the length of C O, and set that length off from A to Q on the Line of Obliquity A O, and draw the Line Q R parallel to the Perpendicular A C E. Then measure the distance of A R, and upon the Line G P B, set it off from G to S; and laying a straight Ruler to the point S and the Center A, draw by the side of it the Line A S, for the *Subfile Line*. Then measure the length of Q R, and from S raise a Perpendicular, and in that Perpendicular, set that length off from S to T; and laying a straight Ruler to the Center A and the point T, draw the Line A T for the *Stilar Line*, which *Stilar Line* being Perpendicular erected over the *Substilar Line A S*, will stand parallel to the *Axis of the World*, and cast its shadow on the Hour of the Day.

To



To draw the Hour Lines on this Plane, you must (as you have several times before been directed) chuse a point in the *Substilar* Line and through that point draw at right Angles with the *Substilar* Line, the Line of *Contingence* so long as you can : Then measure the shortest distance between that Point and the *Stilar* Line, and transfer that distance below the Line of *Contingence* in the *Substilar* Line, as at  $\text{Æ}$ , and with your Compasses at that distance, describe against the Line of *Contingence* the *Equinoctial* Circle ; then divide the Semi-circle of the *Equinoctial* next the Line of *Contingence* into twelve equal parts, as you have formerly been taught, beginning at the Point in the *Equinoctial* Circle, where a straight Line drawn from the Center of it to the Interfection of the Line of *Contingence* with

with the *Meridian* Line NS cuts the *Equinoctial Circle* as here at the point D; Then lay a straight Ruler to the Center of the *Equinoctial Circle*, and to every one of the Divisions in the *Equinoctial Semi-Circle*, and mark where the straight Ruler cuts the *Contingent Line*; for straight Lines drawn from the Center A of the Dyal, through these several marks in the *Contingent Line* shall be the Hour Lines and must be numbered from the *Meridian or Noon-Line* N S, which is the XII a Clock Line upwards, with XI, X, IX, VIII, &c. The Center of this Dyal must stand downward.

If this Dyal were turned with its Center upwards, it would shew a *West Inclining* 45 degrees, only the numbers to the Hour Lines must be changed; for to XI you must set I, to X, II, to IX, III, &c. and the *Substile* over which the Stile must stand, must be placed in the Semi-circle (at first described) as much to the right hand the perpendicular A E, as it doth on the left hand.

If this Dyal were drawn on Glass, or Horn, or an oyled Paper, and you turn the *Meridian Line* N S upwards the back side shall be an *East Inclining* 45 degrees, and the Hour Lines must be numbered as they are on the *East Reclining*; But the *Substile* over which the Stile must stand must be placed in the Semi-circle (at first described) as much to the left hand the perpendicular A E, as it is on the oyled Paper to the right hand.

If you turn the *Meridian Line* N S downwards, the backside shall be a *West Recliner* 45 Degrees, and the Hour Lines must be numbered from the XII a Clock line upwads, with I, II, III, &c.

You must Note that all the Hour-Lines of the Day will nor be described in this single *Quadrant*, nor does the *Quadrant* at all relate to the Hour Lines; but is described only for setting off the *Complement* of the *Poles Elevation* and *Reclination* of the *Plane*, that

that by working (as hath been shewn) you may find the place of the Substilar Line, and the Angle the Stile makes with it ; for having the Substilar Line, you know how to draw the Line of *Contingence*, and to describe the *Equinoctial Circle*, by which all the Hours are described on the *Plane*.

*To draw a Dyal on a Direct South or North Plane Inclining or Reclining.*

*Direct Reclining or Inclining Dyals* are the same with *Erect Direct Dyals* that are made for the Latitude of some other Places ; the Latitude of which Places are either more then the Latitude of your place, if the *Plane Recline*, or less, if it *Inclines* ; and that in such a proportion as the Arch of *Reclination or Inclination* is.

Thus a *Direct South Dyal Reclining* 10 degrees in *London's Latitude*, (*viz.*  $51\frac{1}{2}$  degrees) is an *Erect Direct South Dyal* made for the Latitude of  $61\frac{1}{2}$  degrees. And a *Direct South Dyal Inclining* 10 in the Latitude of  $51\frac{1}{2}$  is an *Erect Direct South Dyal* in the Latitude of  $41\frac{1}{2}$  degrees, and is to be made according to the Direction given in *Operat. III.*

O P E R A T. IX.

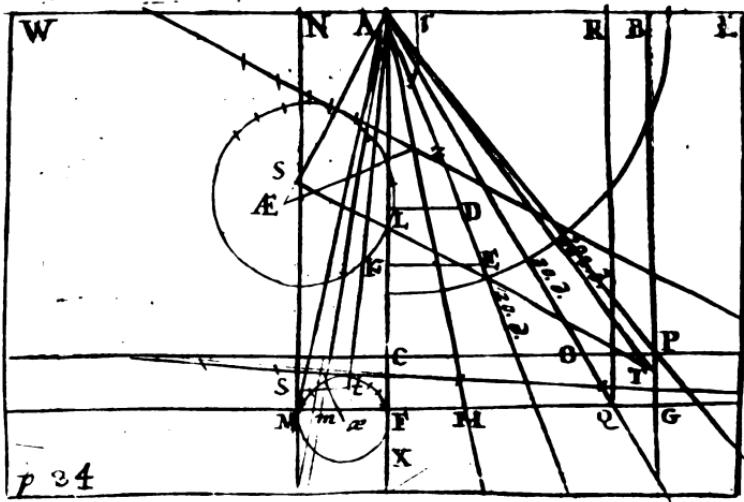
*To draw a Dyal on a South or North Inclining Declining, or Reclining Declining Plane.*

**T**Hese four sorts of Dyals, *viz.* the *South Inclining Declining*, and *South Reclining Declining*, and *North Inclining Declining*, and *South Reclining Declining* are all projected by the same Rules ; and therefore are in effect but one Dyal differently placed, as you shall see hereafter.

First,

First, draw on your Plane a straight Line parallel to the *Horizon*, and mark one end *W* for *West*, and the other *E* for *East*. On South Incliners and Re-cliners, *E* on the right hand, and *W* on the left; on North Incliners and Re-cliners *E* on the left and *W* on the right. Chuse a point in this *Horizontal* Line for a Center, as at *A*; through this point *A* draw a Line perpendicular to the *Horizon*, and on this point (as on a Center) describe a Semi-Circle, one *Quadrant* above, and another below the *Horizontal* Lines, (though for this Example I describe but one.) Then if the Plane respect the South, set off in the lower *Quadrant* from the perpendicular, the Declination, the Inclination, or the Reclination, and the Complement of the *Altitude* of the Pole; and thro' these several settings off in the *Quadrant*, draw straight Lines from the Center *A*, then take in the *Horizontal* line towards the Semi-circle, a convenient distance from the Center *A*, as *B*, and through the point *B* draw a straight Line parallel to the Perpendicular, and prolong it thro' the Polar line, as *B P*; thro' the point *P*; draw a Line parallel to the *Horizontal* line, as *PC*; this line will cut the Line of *Obliquity* in the point *O*, then measure the distance of *A O*, and set off that distance on the Perpendicular from *A* to *F*, and through the point *F* draw a straight line parallel to the *Horizontal* line, as *F G*; for the *Horizontal* Intersection. Then measure the distance of *C O*, and set off that distance on the Perpendicular from *A* to *L*; from the point *L* draw the line *L D* parallel to the *Horizontal* line, to cut the line of *Declination* in the point *D*. Then measure the distance of *A B*, and set off that distance in the Line of *Declination* from *A* to *E*; and from the point *E*, draw a straight line parallel to the *Horizontal* line *W E*, to cut the Perpendicular in the point *K*. Measure the distance of *E K*, and set off

set off that distance on the other side the Perpendicular in the *Horizontal* Intersection, from F to R, and from the point H draw H N parallel to the Perpendicular to cut the *Horizontal* line in the point N.



Then to find the *Meridian line*, *Substile* and *Stile*, do thus. If your *Plane* be a *Southern Incliner*, or a *Northern Recliner*, measure the distance of LD, and set off that distance in the *Horizontal* Intersection from F to M, and through the point M draw the line AM for the *Meridian* line. Then add the distance of AL to AK, thus: Measure the distance of AL, and place one Foot of your Compasses in the point K in the Perpendicular line, and extend the other to X, and measuring the distance of AX, set it off in the line of *Obliquity* from A to Q; and from the point Q draw the line QR parallel to the Perpendicular, and cutting the *Horizontal* line in the point R. Then measure the distance of AR, and set off that distance from H

Y

in

in the *Horizontal* Interseftion to S on the line H M, and to the point S draw the line A S for the *Subſtile*. Then measure the distance of Q R, and ſet off that diſtance perpendicularly from the point S to T; and laſtly, from the point A draw the ſtraight line A T for the *Stilar* line, which *Stilar* line being perpendicularly erected over the *Subſtilar* line A S, will ſtand parallel to the *Axiſ of the World*, and caſt its shadow on the Hour of the Day.

But if the Plane be a *Southern Recliner*, or *Northern Incliner*, meaſure (as before) the diſtance of L D, and (as before you were directed) to ſet it off from F in the *Horizontal* Interſection on the right hand the perpendiculaſ line: So now, ſet that diſtance from F to m in the *Horizontal* Interſection on the left hand in the Perpendiculaſ line, and draw the line A m for the *Meridian Line*. Then as before you were directed, to add A L to A K; So now, ſubſtract the diſtance of A L from A K, and the remainder will be L K: Set therefore the diſtance of L K from A to q in the ſame line of *Obliquity*, and from the point q draw the line q r parallel to the perpendiculaſ. Meaſure then the diſtance of A r, and ſet off that diſtance in the line H N, from H to s for the *Subſtilar* line; then erect on the point s a perpendiculaſ, and on that Perpendiculaſ ſet off from s to t the diſtance of q r: And laſtly, from A draw the Line A t for the *Stilar Line*.

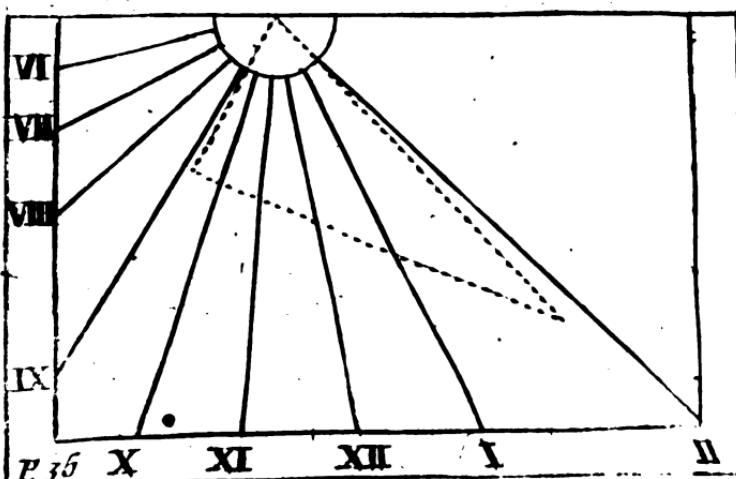
If K falls upon L the *Plane* is parallel to the *Axiſ of the World*, and the *Dyal* drawn upon it will have no Center; But s will fall upon H, and A H (or A s) will be the *Subſtile*.

I ſhall give you two Examples of theſe Rules: One of a *Dyal* with a Center, and the other of a *Dyal* without a Center. And firſt,

O P E.

## OPERAT. X.

*How to draw a Dyal with a Center, Declining 20 Degrees, and Inclining 30 Degrees.*



Having by the foregoing Precepts of the last Operat. found the *Substile*, *Stile* and *Meridian*, you must (as you have often been directed) chuse a point in the *Substilar* line; through which, at right Angles to the *Substilar* line, draw the line of *Contingence* as long as you can; then measure the shortest distance between the point of Intersection and the *Stilar* line, and transfer that distance on one side of the line of *Contingence* upon the *Substilar* line, and so describe the *Equinoctial Semi-circle* against the line of *Contingence*: Then lay a straight Ruler to the Center of the *Equinoctial Circle* as at *A*, and to the point where the line of *Contingence* cuts the *Meridian Line*, as at *Z*, and mark where the straight Ruler cuts the *Equinoctial Circle*,  
Y 2 and

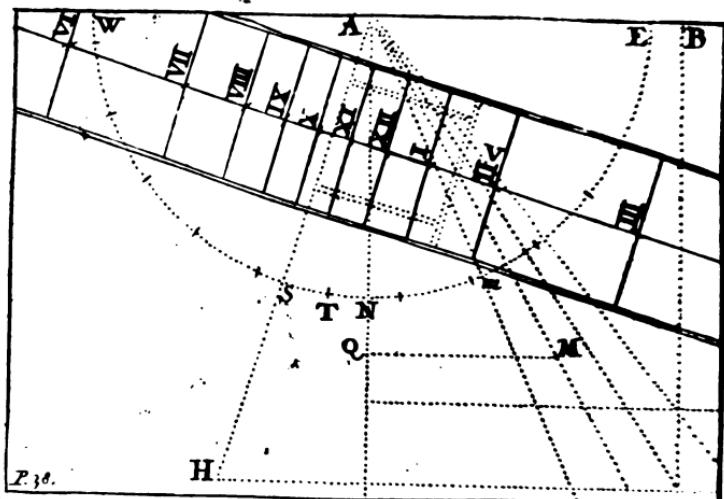
and from that mark begin to divide the *Semi-circle* into twelve equal parts, and by a straight Ruler laid to those divisions and the Center of the *Equinoctial*, make marks in the *line of Contingence*. Then shall straight *lines* drawn from the Center A of the *Dyal*, through every one of the marks in the *Contingent line* be the Hour lines of the *Dyal*, and must be numbered from the XII a Clock line towards the right Hand, with I, II, III, IV, &c. And the other way with XI, X, IX, &c.

## O P E R A T. XI.

*How to draw a Dyal without a Center, on a South Plane; Declining East 30 Degrees, Recilning 34 Degrees 32 Minutes.*

**H**aving by the Precepts of Operat. IX. found the *Subtile*, you must find the *Meidian line* otherwise than you were there taught: For, having drawn the *lines of Latitude, Declination and Reclination*, and found the *Subtile*, measure the distance of B P, and set it off on the *line of Declination* from A to K, and draw from the Perpendicular A F the *line KQ* parallel to A B: then measure the length of K Q, and set it off on the *Polar line AP*, from A to V; then take the nearest distance between the point V and the *line AB*, and set it off on the *line QK* from Q to M; through which point M, draw a *line* from the Center A; then measure with your Compasses in the *Semi-circle WNE* (which in this *Dyal* may represent the *Equinoctial*) the distance of the Arch N m, and set off that distance from the Intersection of the *Subtile* with the *Semi-circle* at S to T in the *Semi-circle*, which point T shall be the point in the *Equinoctial* that you must begin to divide the Hours at, for the finding their distances on the *line of Contingence*.

Then



Then consider (according to the bigness of your Plane) what height your *Stile* shall stand above the *Substile*, and there make a mark in the *Substile*; for the distance between the Center A, and that mark must be the height of the *Stile* perpendicularly erected over the *Substile*, as at I. Draw through this point I a *line of Contingence*, as long as you can to cut the *Substile* at right Angles, and then laying a *Ruler* to the Center A, and successively to each Division of the *Equinoctial* make marks in the *line of Contingence*, and through those marks draw straight *lines* parallel to the *Substile*, which shall be the *Hour lines*; and must be numbered from the left hand towards the right, beginning at the XII a *Clock line* with I, II, III, &c. and from the right hand towards the left on the XII a *Clock line* with XI, X, IX, &c.

The *Stile* to this Dyal may be either a straight Pin of the length of A I, or else a square of the same height, erected Perpendicularly upon the I, in the *Substilar-line*.

## O P E R A T . XII.

*To make a Dyal on the Cieling of a Room, where the Direct Beams of the Sun never come.*

Find some convenient place in the Transum of a Window to place a small round piece of Looking-Glaſs, about the bigness of a Groat or less, so as it may lie exactly Horizontal. The point in the middle of this Glaſs we will mark A, and for distinction-sake call it *Nodus*. Through this *Nodus* you must draw a *Meridian line* on the Floor, thus: Hang a plumb-line in the window exactly over *Nodus*, and the shadow that the plumb-line casts on the Floor just at Noon will be a *Meridian line*; or you may find a *Meridian line* otherwise by the Clinatory. Having drawn the *Meridian line* on the Cieling, thus: Hold a *Plumb-line* to the Cieling, over that end of the *Meridian line* next the window; if the *Plumbet* hang not exactly on the *Meridian line* on the Floor, remove your hand on the *Cieling* one way or other, as you see cause, till it do hang quietly just over it, and at the point where the *Plumb line* touches the *Cieling* make a mark, as at B; that mark B shall be directly over the *Meridian line* on the Floor: Then remove your *Plumb line* on the *Floor*, and find a point on the *Cieling* directly over it, as you did the former point, as at C, and through these two points B and C on the *Cieling*, strain and strike a line blackt with *Small-coal* or any other *Caulor* (as Carpenters do) and that line BC on the *Cieling* shall be the *Meridian line* as well as that on the *Floor*: Then fasten a string just on the *Nodus*, and remove that string, forwards or backwards, in the *Meridian line* on the *Cieling*, till it have the same Elevation in the *Quadrant* on the *Clinatory* above

above the *Horizon* that the *Equinoctial* hath in your Habitation and through the point where the string touches the *Meridian line* in the *Cieling*, shall a line be drawn at right Angles with the *Meridian*, to represent the *Equinoctial line*.

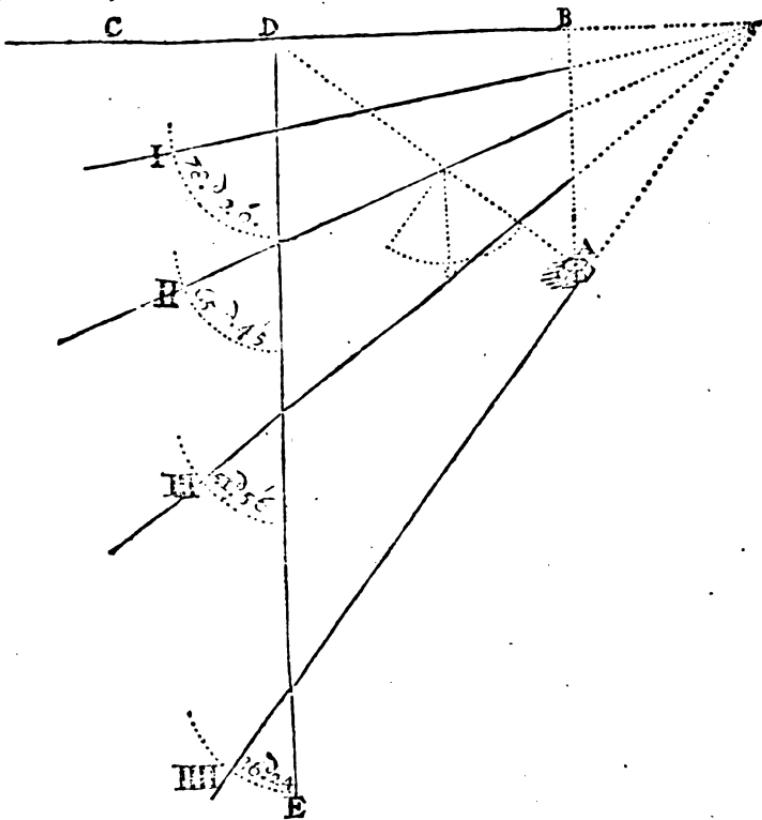
Thus in our Latitude the *Elevation* of the *Equator* being  $38\frac{1}{2}$  degrees; I remove the string fastened to the *Nodus* forwards or backwards in the *Meridian line* of the *Cieling*, till the *Plumb-line* of the *Quadrant* on the *Clinatory*, when one of the sides are applied to the string, falls upon  $38\frac{1}{2}$  degrees, and then I find it touch the *Meridian line* at D in the *Cieling*; therefore at D I make a mark, and through this mark strike the line DE (as before I did in the *Meridian line*) to cut the *Meridian line* at right Angles: This line shall be the *Equinoctial line*, and serve to denote the Hour Distances, as the *Contingent Lines* does on other Dyals, as you have often seen.

Then I place the Center of the *Quadrant* on the *Clinatory* upon *Nodus*, so as the Arch of the *Quadrant* may be on the *East* side the *Meridian Line*, and underprop it so, that the flat side of the *Quadrant* may lie parallel to the string, when it is strained between the *Nodus* and the *Equinoctial*, and also so as the string may lie on the Semi-diameter of the *Quadrant*, when it is held up to the *Meridian Line* on the *Cieling*. Then removing the string the space of 15 degrees in the *Quadrant*, and extending it to the *Equator* on the *Cieling*, where the string touches the *Equator*, there shall be a point through which the I a Clock Hour-line shall be drawn: and removing the string yet 15 degrees futher to the *Eastwards* in the Semi-Circle of Position, and extending it also to the *Equator*, where it touches the *Equator*, there shall be a point through which the II a Clock Hour-Line shall be drawn. Removing the string yet 15

further to the Eastwards in the Semi-circle of Position, and extending it also to the *Equator*, where it touches the *Equator*, there shall be a point, through which the II a Clock Hour-line shall be drawn. Removing the string yet 15 degrees further to the Eastwards in the Semi circle of Position, and extending to the *Equator*; there shall be a point through which the III a Clock Hour-line shall be drawn: The like for all other Afternoon Hour lines. So oft as the string is remov d through 15 degrees on the Quadrant, so oft shall it point out the Afternoon distances in the Meridian line on the Cieling.

Having thus found out the points in the *Equator* through which the afternoon Hour-lines are to be drawn, I may find the Forenoon Hour-distances also the same way, *viz.* by removing the Arch of the Quadrant to the *Weft*-side the Meridian, as before it was placed on the *East*, and bringing the string to the several 15 degrees on the *Weft*-side the Quadrant; or else I need only measure the distances of each Hours distance found in the *Equator* from the Meridian line on the Cieling; for the same number of the Hours from XII, have the same distance in the Equinoctial line on the other side the Meridian, both before and after-noon: The XI a Clock Hour distance is the same from the Meridian Line, with the I a Clock distance on the other side the Meridian; the X a Clock distance, the same with the II a Clock distance; the IX with the III, &c. And thus the distances of all the Hour lines are found out on the *Equator*.

**Now.**



Now if the Center of this Dyal lay within doors, you might draw lines from the Center through these pricks in the Equator, and those lines should be the Hour lines, as in other Dyals : But the Center of this Dyal lies without doors in the Air, and therefore not convenient for this purpose : So that for drawing the Hour lines, you must consider what Angle every Hour line in a Horizontal Dyal makes with the Meridian ; that is, at what distance in Degrees and Minutes the Hour lines of an Horizontal Dyal cut the Meridian ; which you may examine, as by Operat. II. For an

an Angle equal to the Complement of the same Angle, must each respective Hour line with the Equator on the Cieling have.

Thus upon the point mark for each Hours distance in the Equinoctial Line on the Cieling I describe the Arches I, II, III, IV, as in the Figure, and finding the distance from the *Meridian* of the Hour Lines of an Horizontal Dyal to be according to *Operat. II.* Thus,

The  $\left\{ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix} \right\}$  a Clock  $\left\{ \begin{matrix} 11.40 \\ 24.15 \\ 38.14 \\ 53.36 \end{matrix} \right\}$  whose Com-  $\left\{ \begin{matrix} 78.20 \\ 65.45 \\ 51.56 \\ 36.24 \end{matrix} \right\}$   
Hour-  
Line. plement to

I measure in a Quadrant of the same Radius with those Arches already drawn from the Equinoctial Line,

for the  $\left\{ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \end{matrix} \right\}$  a Clock Hour  $\left\{ \begin{matrix} 78.30 \\ 65.45 \\ 51.56 \\ 36.24 \end{matrix} \right\}$

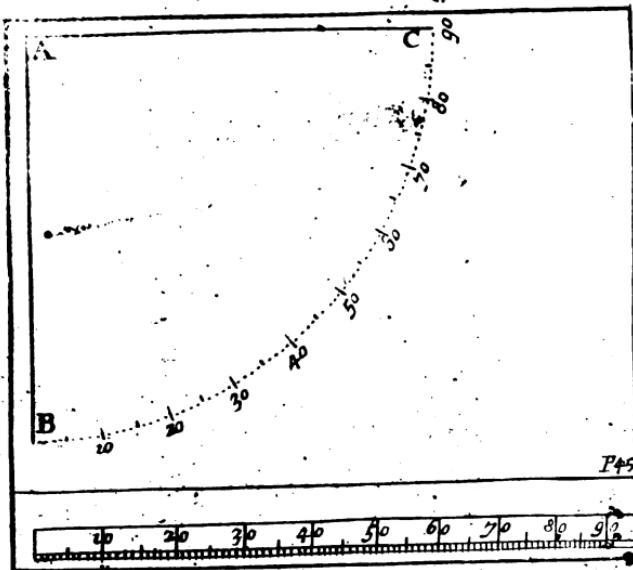
and transfer the distances to the Arches drawn on the Cieling: For then straight lines drawn through the mark in the Arch, and through the mark in the Equator, and prolonged both ways to a convenient length, shall be the several Hours lines (aforesaid;) and when the Sun Shines upon the Glass at *Nodus*; its Beames shall reflect upon the Hour of the Day.

*Some Helps to a young Dyalist for his more orderly and quick making of Dials.*

**I**T may prove somewhat difficult to those that are unpractised in Mathematical projections, to divide

divide a Circle into 360 Degrees (or which is all one) a Semi-circle into 180, or a Quadrant into 90 Degrees; and though I have taught you in the projecting the *Horizontal Dial* the original way of doing this, yet you may do it a spedier way by a line of Cords, which if you will be curious in your Practise, you may make your self; or if you can count it not worth your while, you may by it already made on Box or Brass of most Mathematical Instrument Makers. This Instrument is by them call a *Plain Scale* which does not only accommodate you with the divisions of a Quadrant, but also serves for a Ruler to draw straight lines with; the manner of making it is as follows.

Describe upon a smooth flat even grain'd Board a quarter of an whole Circle, as BC, whose Radius AB or AC may be four Inches if you intend to make large Dyals, or two Inches, if small; but if you will, you may have several lines of Chords on your *Scale* or *Rule*. Divide this Quadrant into 90 equal parts, as you were taught in the making the *Horizontal Dial*



Then draw close by the edge of your straight Ruler a line parallel to the edge, and at about  $\frac{1}{2}$  part of an Inch a second line parallel to that, and at about  $\frac{1}{8}$  of an Inch a third line parallel to both. Then place one Foot of your Compasses at the beginning of the first degree on the Quadrant described on the Board, as at B, and open the other Foot to the end of the first degree, and transfer that distance upon your Rule, from B to the first mark or division, between the two first drawn lines. Then place one Foot of your Compasses again at the beginning of the first Degree, on the Quadrant described on the Board, as at B, and open the other Foot to the end of the second Degree, and transfer that distance upon your Rule from B to the second mark or division between the two first drawn Lines; and thus measure the distance of every Degree from the first Degree describe on the Quadrant, and transfer it to the Rule. But for distinction sake, you may draw every tenth division from the first line parallel to the edge of the third line, and mark them in succession from the beginning with 10, 20, 30, to 90, and the fifth Divisions you may draw half way between the second and the third parallel lines; the single Divisions only between the two first parallel lines. So is your lines of Chords made.

*The use of the Line of Chords.*

**A**S its use is very easie, so its convenience is very great; for placing one Foot of your Compasses at the first Division on the *Scale*, and opening the other to the 60th Degree, you may with the points of your Compasses (so extended) describe a Circle, and the several Divisions, on the *Scale* shall be the Degrees of the four Quadrants of that Circle, as you may try by working backwards, to what you were just now taught in the making

making the *Scale*: For as before you measured the distance of the degrees of the Quadrant, and transfer'd them to the *Scale*, so now you only measure the Divisions on the *Scale*, and transfer them to the Quadrant, Semi-circle, or whole Circle discribed on your Paper. For *Example*,

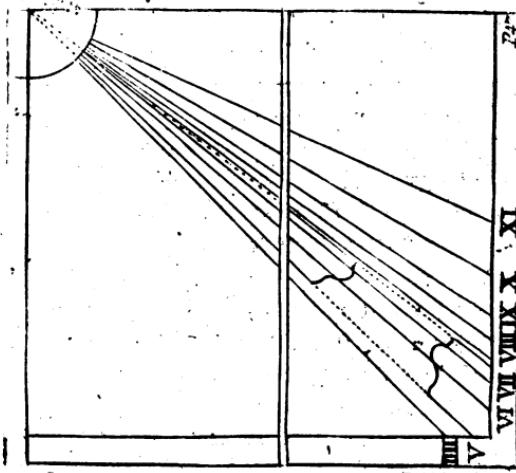
If you would measure 30 Degrees in your described Circle, place one Foot of your Compasses at the beginning of Divisions on the *Scale*, as at A. and extend the other Foot to the Divisions marked 30, and that distance transfer'd to the Circle, shall be the distance of 30 Degrees in that Circle. Do the like for any other number of Degrees.

You may draw your Dyal first on a large sheet of Paper, if your Dyal Plane be so large; if it be not so large, draw it on a smaller piece of Paper; Then rub the back-side of your Paper Dyal with small Coal, till it be well black't; and laying your Paper Dyal on your Dyal Plane, so that the East West, North, or South lines of your Paper agree exactly with the East, West, North or South situation of your Dyal Plane; then with Wax or Pitch fasten the Corners of the Paper on the Plane, and laying a straight Ruler on the Hour-lines of your Dyal, draw with the blunted point of a Needle by the side of the Ruler, and the Small-coal rub'd on the back side of the Paper will leave a mark of the lines on the Plane.

If you will have the lines drawn Red, you may rub the back side of your Paper with *Vermillion*; if blew with *Verditer*; if Yellow with *Orpiment*, &c. Then draw upon these marked Lines with Oyl Colours, as you please.

If

If your Dyal Decline far towards the East or West, the Hour Lines (unless projected to a very great lenght) will run very close to one another; therefore in this case you must project your Dyal



on a large Table, or sometimes on the Floor of a Room, and cut it off as far as you think good, from the Center; for the further from the Center, the larger the distance of the Hour-lines.  
See the Figure.

*An Explanation of some Words of Art used in this.*

**A**ngle. The meeting or joyning of two Lines.

**Arch.** A part of a Circle.

**Axis.** The straight Line that runs through the Center of a Sphere, and both ways through the Circumference: though in *Dyalling* it is all one with the Diameter of a Circle.

**Clinatory.** See Fol. 8, 9, 10.

**Chord.** See Fol. 44, 45, 46.

**Complement.** The number that is wanting to make up another number 90 Degr. or 180 Degr. or 360 Degrees.

*Con-*

**Contingent.** A Line crossing the Substile at right Angles.

**Degree.** See Fol. 12.

**Diameter.** The longest straight Line that can be contained within a Circle, *viz.* the Line that passes through the Center to the Circumference both ways.

**Dyal plane.** See Fol. 7.

**Elevation of the Pole.** So many degrees as the Pole is elevated above the *Horizon*.

**Equinoctial.** The *Equinoctial* is a great Circle that runs evenly between the two *Poles* of the World. But when we name the *Equinoctial* in this Book, we mean a small Circle which represents it; and is the Circle or Arch of a Circle which is divided into equal parts, to find thereby the unequal parts on the *Line of Contingence*. In the *Horizontal Dyal* it is that Arch of a Circle marked GCH.

**Horizon.** Is a great Circle encompassing the place we stand upon; but in Dyalling it is represented by a straight Line, as in *Operat. III.* In the *South Dyal* the Line VI A VI is the *Horizontal Line*.

**Latitude.** The Latitude of a Place is the number of Degrees contained between the *Equinoctial* and the place inquired after.

**Line of Contingence.** See *Contingent*.

**Magnetick Needle.** The Needle touch'd with the *Loadstone*, to make it point to the North.

**Meridian.** Is a great Circle of Heaven passing thro' the North and South points of the *Horizon*; but in Dyalling it is represented by a straight Line, as in *Operat. II.* in the *Horizontal Dyal* the Line XII. A is a *Meridian line*.

**Nad'r.** The point directly under our Feet.

**Nautical Compas.** Is the Compas used by *Navigators*, whereon is marked out all the 32 Winds or Points of the Compas.

**Oblique**

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*Oblique Plane.* See Fol. 7.

*Parallel.* See Fol. 6.

*Perpendiculer.* See Fol. 5.

*Pole.* The North or South Points on the Globe of the Earth, are called *North* or *South Pole*.

*Quadrant.* The fourth Part of a Circle.

*Radius.* Half the Diameter of a Circle.

*Right Angle.* A straight Line that falls Perpendicularly upon another straight line, makes at the meeting of those two Lines a Right Angle.

*Semi-Circle.* Half a Circle.

*Semi-Diameter.* The same *Radius* is.

*Sphere.* The highest Heaven with all its imagined Circle, is called the *Sphere*.

*Stile.* The Gnomon or Cock of a Dyal.

*Substile.* The line the Stile stands on upon a Dyal Plane.

*Triangle.* A Figure consisting of 3 Sides and 3 Angles.

*Zenith.* The point Directly over our Head.

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