Attached are 132 pages of the much larger 3rd edition – published in 1703 – of

Joseph Moxon’s *Mechanick Exercises: OR THE DOCTRINE OF HANDY-WORKS. APPLIED TO THE ARTS OF SMITHING, JOINERY, CARPENTRY, TURNING, BRICKLAYERY.* ... 

Only the sections on Smithing and Joinery are in this pdf, including the original plates associated with the text.

*On the left is a contemporary portrait of Moxon, (1627 – 1691).*

My intent is to make more easily accessible Moxon's discussion of joinery tools that exist at the close of the 17th-century, and allow readers of my Chapter 3 of the British series, “Overview of the Origins and Evolution of Britain's Woodworking Tools -- Medieval to 17th-century”, the opportunity of knowing how an informed person of the age describes common woodworking tools then in everyday use.

Through his popularizing works on maps, geography, navigation, astronomy, mathematics, architecture, and “mechanics exercises” in the later 17th-century, Moxon becomes noted as a hydrographer, mathematician, and instrument-maker. According to his preface in *Mechanick Exercises*, he himself has

> for many years been conversant in Smithing, Founding, Drawing, Joynery, Turning, Engraving, Printing Books and Pictures, Globe and Map-making, Mathematical Instruments, etc. ... all of which [he points out] work upon Geometrical Principles.

It is in 1677, under the general title, *Mechanick Exercises*, that Moxon begins publishing “treatises” on the trades of the smith, the joiner, the carpenter, and the turner. While these fourteen monthly issues constitute his first volume of *Mechanick Exercises*, at the time, the book’s reception is less than he anticipates. This is, remember, the age of Restoration Britain; that is, after a long Interregnum – which begun with the beheading of Charles I in 1640-- in restoring royalty to the throne.

And it is this light that Moxon attributes the slow sale of the first numbers of *Mechanick Exercises* to the current political turmoil in Britain, for the so-called Titus Oates plot is occupying the minds of British citizens, at least those citizens who live in London. (More info in Glen Adamson, *The Craft Reader* and Albert Edward Musson and Eric Robinson *Science And Technology In The Industrial Revolution* Manchester, University press, 1969, page 22.)

While Moxon's works are read by such prominent British scientists of the day as Robert Boyle (1627-1691), John Evelyn (1620-1706), as well as other members of the Royal Society, they are in language understandable by literate craftsmen. They provide, in fact, a good example of how, late in the 17th-century, the scientific spirit is even permeating lower levels of British society.
Mechanick Exercises:

OR THE

DOCTRINE

OF

HANDY-WORKS.

Applied to the Arts of

Smithing

Joinery

Carpentry

Turning

Bricklayery.

To which is added

Mechanick Dyalling: Showing 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 Arithmetical Calculation.

The Third Edition.

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

LONDON:

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 disdained, 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 healthful this their diversion is, their minds and bodies find; and how harmless and honest, all sober men may judge? that geometry, astronomy, perspective, music, navigation, architecture, &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 astronomy be known to any perfection, but by instruments made by hand?
PREFACE.

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 Inconveniencies 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, 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 proper Members (as Instruments) to perform it.

Nor is it easy 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 Tediouus 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,
PREFACE.

improv'd, by having the Secrets of all Trades lye open; not only because much Experimental Philosophy, is Couched 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 undertaken this Task, though I could have wished it had been performed by an abler hand than mine; yet, since it is not, I have ventured upon it.

I thought to have given these Exercises, the Title of The Doctrine of Handy-Crafts; but when I better considered 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 Practice and Exercise; therefore I shall not undertake, that with the bare reading of these Exercises, any shall be able to perform these Handy-Works; but I may safely tell you, that these are the Rules that every one that will endeavour to perform them.
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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,
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Jacks, Hinges, Screws, Clocks, Watch-es, &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 Joinnery, 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.

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

This Definition, needs no Explanation; 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.

THE 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.
work, for easiness of management, and so broad as you think convenient; it may be built with hollow Arches underneath, to let 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 Thung of Leather, or an Iron Chain or Rod, as E; which reaches up to the Rocker, and is fastened there to the farther end of the Handle, as at F. This Handle is fastened a crofs a Rockstaff, 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.
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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.

Here 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-nosed 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, CC the Handles.

Of the Hammer, and the Sledge.

Here 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 weilded, 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
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
Of the Hand-Vice.

Of 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.

Plyers are of two Sorts, Flat Nos'd, and Round Nos'd. Their Office is to hold, and fasten upon all small work, and to set 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 Plyes, must also
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.

Drills 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, A B 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 smallest 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.
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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 tempered, with several holes in it, each less than other, and in those Holes are Threads 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 Slicc, 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

A 4
SMITHING.

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 into 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 designed to, ought to have a proper Heat suitable to that purpose, 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-fear, 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.

There 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 Sparkling, 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 forged 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, finooth 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-flaff 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 stroke you take, you hold your work firm.
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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-heat of your Iron, or if it be very large, almost a Flame-heat; 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-heat 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.

You may have occasion sometimes to Braz 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 Bellowes 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 Ufes, you may have occasion to apply them.

Of several Sorts of Iron, and their proper Ufes.

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 satisfy 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 waftes 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 Ufes; 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 Pefcles 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, coarse 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 ofteneest before it break, which is an Argument of toughness; and see it break found 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 found, and well wrought at the Mill.
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 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 strokes forwards, still keep your hands moving circularly till you have finished your full Stroke, that is, a Stroke 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.

In Fig. 1. 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-Chisel, but you mark the out-lines of your intended Hinge, as Fig. 1. the Cross-Garnet, either with Chalk, or else rafe upon the Plate with the corner of the Cold-Chisel, 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-Chisel in your left hand, and set the edge of it upon that Mark, or Rafe, and with the Hand-hammer in your right hand, strike upon the head of the Cold-Chisel, till you cut, or rather punch the edge of the Cold-Chisel, almost thro' the Plate in that Place, I say, almost through, because, should you strike it quite through, the edge of the Cold-Chisel 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-Chisel; besides, it sometimes happens, that the Anvil, or Stake, is not all over so hard as it should be, and then the Cold-Chisel would cut the Face of the Anvil, or Stake, and consequently spoil it. Therefore when the edge of the Cold-Chisel comes pretty near the bot-
bottom of the Plate, you must lay but light blows upon the **Cold-Chisel**; and yet you must strike the edge of the **Cold-Chisel** 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-Chisel**, remove the edge of it forward in the Rafe, 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

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[Diagram]
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the **Tail piece**, a-thwart the Plate as **CD**, 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...
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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 Chops 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-heat; 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 hammered 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-heat, or a Flame-heat, 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 hardned 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-heat, 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 Grinde 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
true Square-filing the Upper-side, as you were taught Page 15, 16, 17. is a great Ornament.

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

(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-Chisel, 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 Dusetails, 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.

As 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. A A A A the **Main-plate,** B C the **Key-hole,** E D E E the **Top-book,** E E **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,** L L the **Staples.**

In Fig. 3. A A A A the **Cover-Plate,** B the **Pin,** B C D the **Main-ward,** D D **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,** E E the **Cross-ward,** F the **Main-ward,** G G **Cross-ward,** H the **Shank,** I the **Pot,** or **Bread,** K the **Bow-ward,** L the **Bow,** B C D E E F G G the **Bit.**

First, Cut out of an Iron Plate with a *Cold-Chiffel,* 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 D, describe the Arch E D E for the true Place the Top-hoop 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 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 Rivet 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 hardned 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 Point 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 steady in the Centre-hole of the Plate, when the Pin is rivetted 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.

Rivetting is to batter the Edges of a Shank over a Plate, or other Iron, the Shank is let into, so as the Plate, or other Iron, may be clinched close, and fixed between the Battering at the End of the Shank and the Sholder. So that

When you Rivet a Pin into a Hole, your Pin must have a Sholder to it thicker than the Hole is wide, that the Sholder slip not through the Hole, as well as the Shank; but the Shank of the Pin must be exactly of the Size of the Hole the Shank must be Rivetted into, and somewhat longer than the Plate is thick; file the End of the Shank flat, so shall the Edges of the End, the easiplier batter over the Plate; then put your Shank into the Hole, wherein it is to be Rivetted, but be sure you force the Shank close up to the Sholder; then turn the Top of this Sholder downwards (Plate and all) upon your Stake, but lay it so, as that the Sholder lie solid, and the Shank, 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 Shank, turning with your Left-hand your Work round to the Face of the Hammer, till you have battered the Edges of the Shank 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 Rivetted; then lay heavier Blows upon it, sometimes with the Face, sometimes with the Pen of the Hammer, till the End of the Shank is battered effectually over the Plate.

One main Consideration in Rivetting is, that the Pin you rivet in, stand upright to the Plate,
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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 Plyers, 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 filing 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 Riveting-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 GG, 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 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 on 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
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S M I T H I N G.

The Cross and Hock-wards is made, or, at least, entered 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 Chisel, as you was taught Page 11. 12. But you must take care that your Chisel be neither too thick, or too broad, for this Punching of Wards is only to give the thin Files 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 Chisel 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 aforefaid, 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,
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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 easy Play, fasten these Staples by Riveting 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 rivetted (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.
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Shank of the Screw. Last of all, rivet 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, left 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 Chisel 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-nosed Tongs,
Tongs, and take another Heat, and with speed (left your Work cool) screw the Shank into the Vice, so as the Sholder may fall flat upon the Chaps of the Vice; then hammer upon the Head, and square the Sholder on two Sides, do the like for squaring the other two Sides. This was, in part, taught you before, in Page xi. but because the cutting this Iron Rod, or Bar, just above the Sholder 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 xi. 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 Riffings 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...
Threds 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 Thred 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 Thred it made about the Tapering.

To fit the Pin therefore to a true size, I, in my Practice, use to try into what hole of the Screw-plate, the Tap or place of the Tap, (if it be a taping 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 Threds 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 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 Threds of the
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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 Threads in the Nut.

But though small Screws are made with Screw-plates, yet great Screws, such as 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.

The Threads 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 entire piece with the Spindle, will be as strong as the Worm in the Nut, tho’ the Worms 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.
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Turn up a Rod of Iron, to twist round about the Grooves on the Spindle, and then take it off, and Brace 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 Mettal 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.
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-lead 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 width at the first, is, because your Hand may carry the Cold-Chisel somewhat awry, and should your Cold-Chisel 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, filing 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 Groove 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, 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 Metal 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 **Metal**; 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**.
MECHANICK EXERCISES
OR,
The Doctrine of Handy-Works

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

Of Jacks.

Fig. 1. is call'd a Worm-Jack. AB the Fore-side, AC the Back-side, AA the Top-piece, BC the Bottom-piece, altogether the Jack-frame, EEEK the Main-Spindle, NON the Main-Wheel and Barrel, O the Barrel, D the Wind-up-piece, fastned into the Barrel, FF 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, II the Fly, T the Socket of the Fly, V the Struck-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-Spindle, as you are taught Numb 1. fol. 8, 9, 10, 11, 12. and then file it as you were taught Numb. 1. 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.

The 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, choose 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
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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 appli'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, left 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 shouder 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 pinch 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-heat, I say, almost a Blood-red-heat; 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 Square-bore, you must 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. L fol. 9.) that it behoves you to Hammer or Forge your Work as true as you can, lest 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 sure 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
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The Reason why I told you, you should draw
fourth the Rod to almost three times the Dia-
meter of the Wheel, and not to the Geome-
trical proportion; is, because that in Hammer-
ing 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 Bicker of the Anvil,
holding with your Tongs the inner edge of the
Wheel upon it, and Hammering upon the outer
dge 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
dge of the Wheel, somewhat more than a quarter
of an Inch deep, and spreading somewhat wider
towards the outer edge. The notches are to re-
ceive the four ends of a Cross Forged somewhat
thicker towards the ends than the thickness 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) at 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 let 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 forged 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 observed 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 opened their compasses to divide them: For if by luck, they at first open their compasses to such a width, as will 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 marked 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 described 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 aslant 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 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 wobble 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 flip 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

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be describ'd without a particular Figure, which therefore I have inferred. As in Fig. 2. A the Barrel, B the Main spindle coming through the Barrel, a the Center of the Tumbler moving upon the Center-pin, which is fasten'd into an Iron-plate behind the Barrel. b The Coller upon the Main-spindle, from which proceeds a Tongue, which passes through a pretty wide hole at c in the Tumbler, as far as d the Catch of the Tumbler. The Tumbler moves as aforesaid, upon the Center hole, but receives the Tongue through it at e, and passes as far as e. 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 Coller about the Main-spindle allows it; but were the Center-hole a, and its Center-pin fit, and the Hole e, and the Tongue that also passes through it also fit, and the Coller 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 place'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 d, 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 forge'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 direct-
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1. Lay 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 Fil'd 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

D 2

Breath
Breaft, 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 you must thrust or lean hard with your Breaft 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, left the Hole be wrought aslope in the Iron.

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

c A Duffiail, is a Figure made in the form of a Doves-tail, and is us'd by many other Handy-crafts, as well as Smiths, but most especially by Joyners, as I shall shew, when I come to Joynery.

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

The manner of making Molds to Cast Lead-en-Bullets in.

Infert 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 Hemispheres, 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 a 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-stroaks 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-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 Molds, 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 rubbed 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 Vise, 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 easy, 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 turned 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
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But the inside wants cleaning, for hitherto it is only Punch'd. Therefore you must provide a *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 *Shank* may come through the *Gear*.

In this Section you see, first the use of a *Using-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 *Molds*, or some other accidental Uses.

*a* A *Gear*, is the hole through which the Metal runs into the *mold*. The Word is us'd by most Founders.

*b* 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 *Shank*, 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 *Shank* 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.

Square and flat Bars, sometimes are by Smiths; Twisted for Ornament. It is very easily done; for after the Bar is Square or flat Forged (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-vice, &c.

Of Case-hardning.

Case-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-fores, &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 hardened takes a better Polish and keeps the Polish much longer and better, than if the Iron were not Case-hardned. 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 Loam, made as you were taught.
SMITHING.

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 indifferent 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 some-what a course Grain. But if it be well wrought and proves found, it makes good Edge-tools, Files and Punches. It will work well at the Forge, and take a good Heat.
SMITHING.

The Flemish-steel is made in Germany, in the Country of Stiermark and in the Land of Luyck: from thence brought to Colen, and is brought down the River Rhine 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 Chisels 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 Dantzick comes some which is call'd Swedish-steel: It is much of the same Quality and Fines with Flemish-steel.

The Spanish-steel is made about Bizay. 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 unfound, 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
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There is another sort of Steel, of higher commendations than any of the foregoing forts. 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-heat; 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 easy blow. Geog. Rea. fol. 279.

The Rule to know good Steel by.

Break 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.
HAVING chose your Steel and forger'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-heat 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 failed 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 itself, and the Steel cool with the Fire.

Of Hardning and Tempering Steel.

English, Flemifh 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 quenched 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 allunder: 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-chisels and Punches, that Punch into Iron and Steel: The dark goldish Colour for Punches to use on Brass, and generally for most Edge-tools: The blew Colour gives the Temper to Springs in general, and is also used to Beautifie both Iron and Steel; but then Workmen sometimes
times grind Indigo and Sallad-oyl together, and rub that mixture upon it, with a woollen Rag, while it is heating, and let it cool of itself.

There is another sort of Hardening, call'd Hammer-hardning. It is most us'd on Iron or Steel Plates, for Dripping pans, Saws, Straight-Rulers, &c. It is perform'd only, with well Hammering 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 Verfe us'd among Smiths, when they Forge Edge-tools,

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

The End of Smithing.

MECHA
MECHANICK EXERCISES;

OR,

The Doctrine of Handy-Works

The Art of JOINERY.

Definition.

JOINERY, 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 entire 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 Flained,) or else they are Pared, that is, the irregularities that hinder the closing of the two Pieces are cut off with a Pairing-chisell. 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 a Clamp one piece of Wood to the end of another piece of Wood to keep it from Casting or Warping.
By **Square**, 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 **Miter**s 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**, **Octagon**, &c. Figures.

§ 1. **The Names of Joiners Tools describ’d, in Plate IV.**

A Work-bench. b The Hook in it, to lay Boards or other 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 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 steady 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 b in the Bench: Its Office is to keep the Work-fast upon the Bench, whilst you either Saw, Tennant, Mor-
Mortels, or sometimes Plain upon it, &c. It performs this Office with the knock of an Hammer, or Mallet, upon the bead 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 bead 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 bead of the Hold-fast being knocked, 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 opposite 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 opposite edge of the round hole in the Bench. Sometimes a double Screw is fixed to the side of the Bench, as at e; or sometimes its farther Cheek is laid an edge upon the flat of the Bench, and fastened with an Hold-fast, or, sometimes, two on the Bench. e A Mallet.

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

A Fore Plain. a The Tote. b The Mouth.
c The Wedge. d The Iron. e The Sole.
f The Fore-end. g The Britch. f g h 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 Jointer. The edge of its Iron is not ground upon the straight, as the Smooth Plane, and the Jointer 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 Jointer, Workmen set the edge of it e Ranker than the edge either of the Smoothing Plane, or the Jointer; 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 Foynter, 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 you in Smiething, 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 Foyntery, for the reason there alleged in Smiething, 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.

When 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 Joiners call
call *Cros grain'd Stuff*: If it be *hard* or *curling*, you must not *set* the *iron* very *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 *Hammer* upon the *Britch* of the *Stock*, and afterwards upon the *Wedge*; for this knocking upon the *Britch*, 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 consequentially 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 *Britch* raises the *Iron*, so it also raises and loosens the *Wedge*; therefore (as aforesaid) whenever...
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 Planing, 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 Stroke 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 Stroke, and so continue your several lays of Planing, 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 *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 *Jointer*. B. 2.

The *Jointer* 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 *Joint* 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 *Jointer*, 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 inured the Hand to. The *Jointer* is also used to *Try* Tables with, (large or small) or other such broad Work; and then *Jointers* work, as well upon the *Traverse* with it, as with the Grain of the Wood,
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 Joyns of Mitters and Bevels; but then it is used in a different manner from other Plane: For if the Miter and Bevel you are to fit be small, you must hold it very steadily 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 steadily: Then apply the sawn Miter, or sawn 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 wield 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.
The 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.
The Rabbet-plane marked B 5. is to cut part of
the upper edge of a Board, or other Stuff,
square, 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 an-
other; this lapping over is called Rabsetting.
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 borne off the Stuff, to hinder the square
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.
The Plow marked B 6. is a narrow Rabbet-
plane, with some Additions to it: viz. two
square Staves, marked a a (yet some of them
have
have the upper edges of them rounded over for the better compliance with the Hand.) These Staves are let stiff through two square Mortises 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 Rabbot-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. Joyners 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 Mortesles 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 Mortesles of the Stock, you must stiffen them, by knocking a little wooden Wedge between the Staves and their Mortesles.


Here are several other Planes in use amongst Joiners, called Molding-planes; as, the Round, the Hollow, the Ogee, the Snipes-hill, the Rabber-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 hardnes, or softnes 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,
degrees, with the Sole of the Plane: But if it be very hard Wood you are to Plane upon, as Box, Ebony, LignumVitæ, &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 Plane, 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 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.


When you grind your Iron, place your two Thumbs under the Iron, and your Fingers of both Hands 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 steadily kept to that Position, your Basil will be Hollow, and the smaller your Grind-
stone is, the hollower it will be. You may know when it is well Ground, by the evenness, and entireness 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 side 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 lightly 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 hollowness 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.
§ 10. Of Chisels of Several Sorts.

And first of Formers.

Formers marked C 1. C 3. are of several sizes:

They are called Formers, because they are used before the paring Chisel, 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 Stroke, 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 Heve 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 unluckily 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 Chisel. When it is used, the Heve of it is knockt upon with a Mallet, to drive the edge into the Stuff.

§ 11. Of the Paring-Chisel.

The Paring-Chisel marked C 2. must have a very fine and smooth edge: Its Office is to follow the Former, and to pare off, and smooth, 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 Mortes-Chisel.

The Mortes-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 Basil as you may see in the Figure. Its Office is to cut deep square holes, called Mortices, in a piece of Wood. Joiners use them of several Breadths according as the Breadths of their Mortices may require.
§. 14. Of the Gouge.

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

These several sorts of Chisels Joiners have of several Sizes, that they may be accommodated to do several Sizes of Work.
MECHANICK EXERCISES;

O. R.,

The Doctrine of Handy-Works

Continued in the Art of JOINERY.

§ 15: Of the Square, and its Use.

The Square, marked D, is two adjacent 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 Mortise in it, as long within a quarter of an inch, as the thin piece (called the Tongue) is broad, and stiffly so wide, as to contain the thickness of the Tongue. The Tongue is fastened into the Mortise of the Handle with Glue 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 Inconvenience, 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 Squareness 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 outside 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 Squareness 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 agree in Line with the insides of the Square, it is true Square. Or if they would try the inward Squareness of Work, they apply the two outsides of the Square to the insides of the Work.

§. 16.
§ 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 show'd pretty hard into the Teeth of the Bench-hook, that it may lie the steadier. 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 straight in its length and breadth as you can with the Fore-Plane; which you may give a pretty good guess at, if the edge of the Iron have borne 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 Rulings 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 planed straight in length and breadth, yet because the Iron of the Fore-plane for its first working the Stuff is set Rank,
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 tried 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 Rishings be great, you may, for quickness, hew away the Rishings 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-froaks 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 proposer, 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, press 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 diminished 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 

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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.

You must take care in Mortessing and Ten-
nanting, 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 equaling strength: But the equaling 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 Ten-
nant is subject to. Besides, it is easier to split
Wood with the Grain, than to break Wood across
the Grain; and therefore the same Wood when
posted as a Tenant, is stronger than the same
Wood of the same size when posted 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,
cross 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 Mortes. If you make the Mortes too wide, the sides of the Mortes will be weaker than the sides that contain the Mortes: 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 equalizing 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 equalizing of strength must be referred to the Judgment of the Operator. Now to the Work.

The Mortes to be made is in a Quarter four Inches broad. In this case Workmen make the Mortes an Inch wide, so that an Inch and an half Stuff remains on either side it. Therefore your Stuff being squared, 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 Mortes shall be, then open your Compasses to two Inches, and prick off that distance in one of the Lines, for the length of the Mortes; 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 Mortes be struck out on the Quarter. If your Mortes 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-Chiffel with its Bafil 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 Bafil of the Chiffel will no longer force the Chips out of the Mortefs; then remove the Chiffel 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-
Mortefis through, or (if not through) to the intended Depth; then with the Mortefis-chiffel work nearer the drawn Lines at the ends of the Mortefis, (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-chiffel, and then pare the ends, as you were taught to work with the Paring-chiffel: Then with the broad Paring-chiffel, pare the sides of the Mortefis just to the struck Lines; so is the Mortefis 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 thickness 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-chiffel, pare the Work close to the gaged Lines for the Tennant. Then try how it fits the Mortefis: 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 Mortefis too wide at first, or the Tennant too narrow.

Then with the Piercer pierce two holes through the Sides, or Cheeks of the Mortefis, about half an Inch
Inch off either end one. Then knock the Tennant stiff into the Mortefs, 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 Mortefs is made in. Then with the Paring-chiffel 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-tennanted end of the Stiles, and another Mortefs 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.

The 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 Mortefs in it, of an equal depth, the whole length of the Handle: Into this Mortefs is fitted one end of the Tongue, but the end of the Handle is first Bured off to make an Angle of 45 Degrees with its inside. This Tongue is (as the Square) Pin'd and Glewed into the Mortefs of the Handle.
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.

As 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-Diametral 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 Glue 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 Glued, or otherwise 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 Chisel 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 thickness 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 thickness of the Stuff, and so will the Triangle a b c be left for the other half thickness of the Stuff. But that end of the piece marked 1, which joins to the piece marked 2, must, upon its Bevil-sroat, 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 Glue into one another, but if you think Glueing 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
JOINERY:

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.

There 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 into 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 Mi-
ter, 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.

The 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 side. It
is used for Gaging Tenants, 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 Mortets 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.

The 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.

The 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.

The 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.

The 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 ab-
out 12 Degrees with the left side of it: And af-
terwards set with the Whetstone, as the Irons of
Planes, &c.

§. 26. The Use of the Saw in general.

In my former Exercises, I did not teach you how
to choose the Tools a Smith was to use; be-
cause it is a Smith's Office to make them; and be-
cause 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 Know-
ledge of all Smith's Workmanship, especially to
those that should concern themselves with Smith-
ing; but to those that shall concern themselves
with Joinery, and not with Smithing; it will be
necessary that I teach them how to choose 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; choose 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 twilling 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 be-
gin 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 lit-
tle a-slope towards the left, or, almost down-
right. Having filed one Tooth thus, all the reft
must be so filed. Then with the Saw-wrest, mark-
ed 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 Ho-
izontally 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 sec-
cond Tooth from you: Then skipping two Teeth,
they again put one of the Notches of the WREST be-
tween 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 some-
what 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 Work-
men 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
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 halfquarter 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 unfawn Stuff; which is an ease to his Labour, and enables him the longer to continue his several Progessions 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 proportional 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 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.

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

The Pit-Saw is not only used by those Workmen that make Sawing Timber and Boards their whole Business, 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 Compasses 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 swiftly 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 strongly against the Stuff, that the Dust, or Atoms...
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-prickt, 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 Compass, or sometimes a Pricker, or a Nail allope towards that end into the prick set off, and putting the Noofe at the end of his Line over his Compasses, &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 front, (called great Trussels) with four Legs, these Legs stand spreading outwards, that they may stand the firmer: Over these two Trussels the Stuff is laid, and firmly fastned that it shake not. Its outer side from whence the Pricks were set off must be Perpendicular, 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.
MECHANICK EXERCISES;

OR,

The Doctrine of Handy-Works

Continued in the Art of JOINERY.


The 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 stroke of the Saw.

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

These 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.

§ 30. The Use of the Compass-Saw, marked Q in Plate 4.

The Compass-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 Compass kerf; and therefore the edge must be made broad, and the back thin, that the Back may have a wide kerf to turn in.

§ 31. Of the Rule marked D in Plate 5.

The 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 Tim-
Timber: The use of which Lines and Tables have 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 straightness or flatness 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 Compasses marked E in Plate 5.

The 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.

The 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.

The 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 greasy, for that will spoil the clamminess 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 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-Beer 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-Beer chance to be new, and its Yeast not well settled from it, or so stale, that it be either Draggy, or any whit mingled with the Settlings of the Cask.

§ 35. Of using the Glew.

Our 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 joistle 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 extremum Edges, may make one end of the Joint Open.

§ 36. Of the Waving Engine.

The Waving Engine described 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 square strong piece of Wood, about six Inches high, and five Inches square, as G. This square piece hath a square wide Mortise in it on the Top, as at H. Upon the top of this square piece is a strong square flat Iron Coller, somewhat loosely fitted on, having two Male Screws fitted into two Female Screws, to screw against that part of the wooden Piece un-mortesfed 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-mortesfed 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 DE, 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 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 flip 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.

§ 37. Of Wainscoting Rooms.


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 Panel, above the Base. K The Large Panel above the Middle Rail: And L The Friese Panel above the Friese Rail.

The Friese Rail is to have the same breadth the Margent of the Stile hath; The Middle Rail hath
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 Rails 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 abc d &c. intending, at the latter end of these Exercises, to have explained the Terms those Letters refer'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.

Architrave. See Plate 6. l. is the Architrave Molding.
Augre § 24. Plate 4. fig. K.

B.

Bass. 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 unlimited.
Beak. The end of the Hold-fait. 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.
Caf. Stuff is said to Cast, or Warp, when by its own Dryth or Moisture, or the Dryth or Moisture of the Air, or other Accident, it alters its flateness 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. Thus the ends of Tables are commonly Clamp to preserve them from warping.
Compass-saw. See fol. 9. and Plate 4. fig. R.
Corinice. See Plate 6. g. 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 Branch shoots forwards, the Grain of that branch shoots forwards also, and so runs across 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 across 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 sown 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.


*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.


J O I N E R Y.

Frame. See fol. 59, 60.
Frame Saw. See § 28. and Plate 4. O.
Frieze. See § 3.
Frieze Pannel. See Plate 7. L.
Frieze Rail. See Plate 7. F.
Frowy stuff. See § 3.

G.
Gage. See § 21. and Plate 4. G.
Gimblet. See § 23. and Plate 4. I.
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.
Hold-fast. See § 1. Plate 4. H d.
Husk. See Plate 6. n.

I.
Inner-square. See § 15. and Plate 4. D d.
Joint. See fol. 59.

K.
Kerf. The Sawn-away slit between two pieces of stuff is called a Kerf. See fol. 95.
Knot. See § 36. fol. 104. and Plate 5. fig. 7. N.
Knot. See Plate 6. o.

L.
Large Pannel. See Plate 7. K.
Lying Pannel. See Plate 7. 1.
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.
Mortes. Is a square hole cut in a piece of stuff, to entertain a Tennant fit to it. See § 17.
Mouth. See § 2. B 7. a The Mouth.

O.
Ogee. See Plate 6. c.
Outer Square. See § 15. and Plate 4. D c.

P.
Pannel. In Plate 7. I KL are Pannels, but disting- guished by their Positions.
Pare. The smooth cutting with the Paring-Chiffel is called Paring.
Plaifer. See Plate 6. f.
Peircer. See § 22. and Plate 4. H.
Pit-man The Saywer 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.

H Planchier.
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JO N E R Y.

Planchier. In Plate 6. between A and B is the Planchier.

Plinth. See Plate 6.


Pricker. Is vulgarly called an Awl: Yet for Joiners 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 splintering.

R.

Rabbet. See § 7.


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 panels of one straight side of Wainscoting is said to run Range.

Return. The side that falls away from the front 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.

Saw- wrest. See § 26. fol. 97. and Plate 4. O.

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

Scribe.
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.
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.
Stile. The upright Pieces AA in Pl. 7. are Stiles.
Stops. In Plate 6. k k are Stops.
Stuff. The Wood that Joiners work upon they call in general Stuff.
Swelling-Frieze. In Plate 6. r is the Swelling-frieze.
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 Mortese. 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.
Top-man. Of the two Sawyers, the uppermost is called the Top-man.
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 Exercifes will be of Carpentry.