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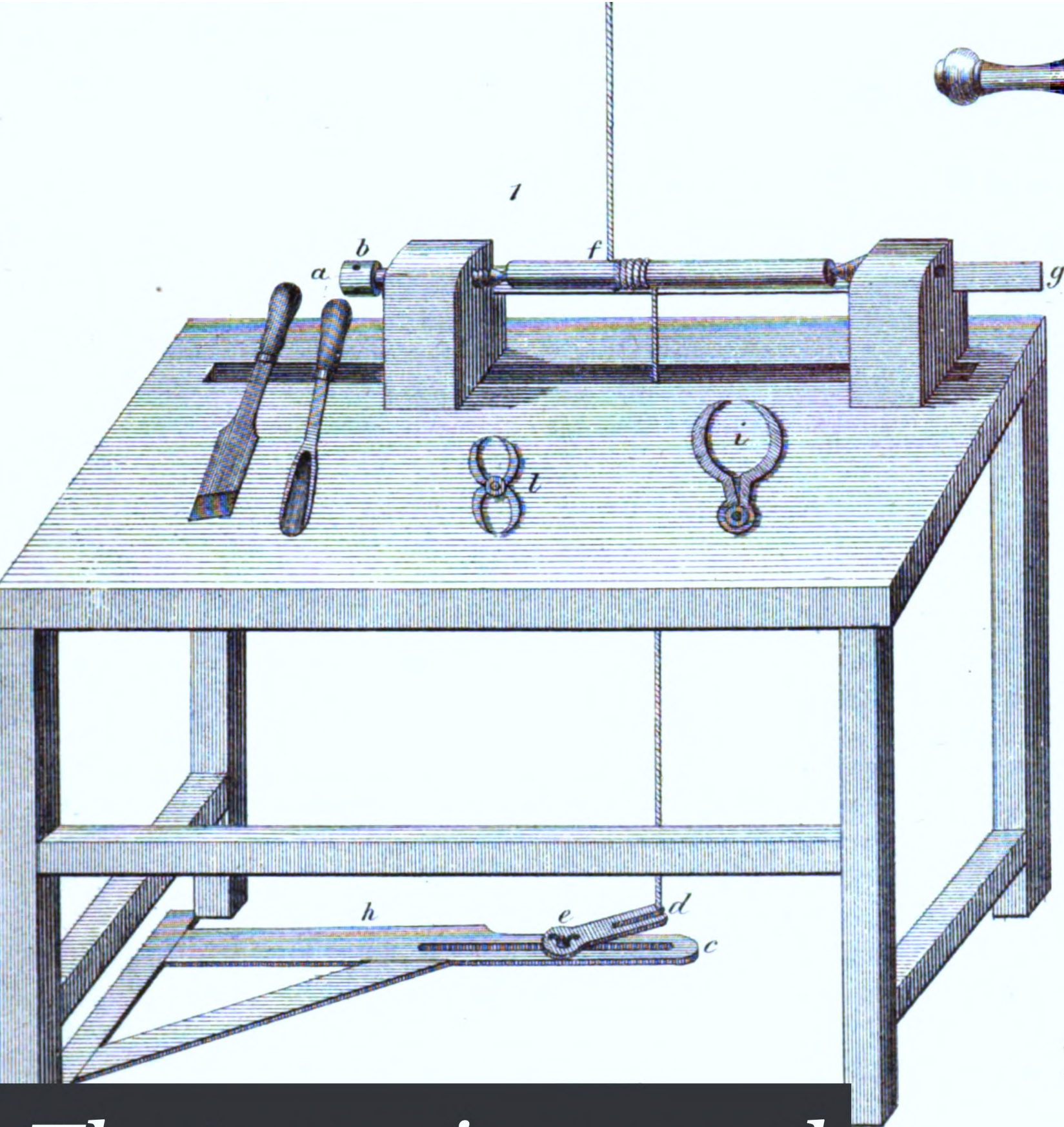
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# *The turner's manual*

L.-E. Bergeron



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THE

# TURNER'S MANUAL:

BEING A COMPLETE TRANSLATION OF THE VALUABLE WORK

BY

L. E. BERGERON,

WITH THE IMPROVEMENTS AND ALTERATIONS INTRODUCED UP TO THE PRESENT TIME.

ILLUSTRATED WITH FINE WOODCUTS

AND

*Lithographic Engravings of the Original Plates,*

ALSO OF THE VARIOUS MODERN APPLIANCES. BEING A PERFECT EDITION OF THE WORK OF  
M. BERGERON, SUPPLEMENTED WITH

ORIGINAL NOTES AND APPENDICES,

NECESSARY TO RENDER IT

A COMPREHENSIVE ENCYCLOPÆDIA OF TURNING,

PLAIN AND ORNAMENTAL, IN ALL ITS BRANCHES.

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LONDON:

PUBLISHED BY F. OFFEN, 3, YORK STREET, COVENT GARDEN, W.C.

1877.

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## P R E F A C E.

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I am prompted to edit this work for two reasons: 1st, because there exists no better treatise upon the subject; and, 2ndly, to meet the requirements of many thousands who have been waiting in vain for a modern work of this description.

M. Bergeron's work is replete with valuable information upon the subject of Plain and Ornamental Turning, and, though published so long ago, many of the methods detailed in his book are in use at the present day. It is true that many improvements have taken place, many new inventions have been developed since his time, but the ground-work remains the same. The mechanic has apparatus made upon a correct and improved form; but in most cases they (the tools) simply perform those operations which were in use at the date of M. Bergeron's book, with this difference, viz., that the instruments of modern make are capable of producing, under skilled hands, specimens of remarkable accuracy and detail. The old turners, indeed, surprise us with their skill, considering the almost rude instruments with which they had to deal—so much more to their credit. This should stimulate the mechanic, whether amateur or professional, of the present day to further exertions.

The translation is as literal as it is possible to make it. I have erased certain portions which have no interest to the reader, such as the Introduction, &c., and other minor details which do not bear directly upon the object of the work. In many cases the technicalities have presented some difficulty, but this has been overcome, and I trust that the reader will find nothing obscure in these pages.

I hope that this work will prove to be of as much value as it has been my earnest wish and desire to make it. The drawings of the modern instruments will be made to scale by myself. I trust that any short-comings that may be found in the book (and I fear they will be occasionally discovered), will be pardoned, and at the same time pointed out, so that they may be rectified.

In conclusion, I wish my readers every success in the Mechanical Art. I feel sure that with attention and perseverance the trials and difficulties which beset the way of the *Tyro* will vanish.

D. A. A.



# Woods.

## CHAPTER I.

### UPON THE NATURE AND QUALITY OF WOODS.

**I**T is necessary that the Turner should be to some extent acquainted with the nature and qualities of the various woods with which he has to deal, as he has to select some substance for the article he is called upon to make, and to advise in many cases on its selection for a particular object. Without such knowledge the Turner would often find himself in a dilemma; for though there are many woods to choose from, they are not all suited for the same class of article. It is not my intention to write a long treatise upon this branch of the subject, but to endeavour to give the reader a plain and lucid idea of the various substances with which he is likely to meet. With the exception of the most important woods in general use, the others will be referred to and considered as lightly as possible. Those woods which are in daily use will be first treated upon, and to give the reader a better idea of their appearance, I shall refer to the coloured engravings interspersed in this chapter.

It is well known that every year trees are covered with a fresh ligneous layer or skin which encircles them, and this is usually called the annual layer. Each layer is separated from the preceding one by the collection of a substance called *medullary*, because it resembles somewhat the nature of the pith or marrow. Besides these circular layers (each of which shows the number of years of the tree), there is a communication starting from the centre of the tree to its circumference; which resembles an infinity of divergent rays, which are called *medullary* growths, and seem to be for the purpose of feeding the *medullary* layers. In any fragment of wood it is easy to see the direction of both, but it is not politic to use the wood in any direction of its grain.

Theory can be applied in a number of cases in the selection of woods and the way of using them; as theory may decide on the success and duration of a machine, which, if it had otherwise been constructed, would not have met with the same success. We think that in a subject which catches the eye as well as the mind, it is not enough to indulge in metaphysical descriptions, as the eye must be inured to recognise each kind of wood, pointing out its characteristic features, according to the precept of Horace:—

“Segnius irritant animos demissa per aurem,  
Quam quæ sunt oculis subjecta fidelibus.”

Sensations which reach our minds through the ear,  
Produce less impression on it than objects which strike our eyes.

**FIR**

(Fig. 1, Plate I.) is the most common wood used in the arts, and of which there are several species and qualities, viz. :—Deal, Pine, and Fir, which are three trees growing to perfection in the north of Europe. In general use they are often confounded, though they are sensibly different. Deal, used in joinery, is of a yellowish white. It is very soft, and can be perfectly planed lengthwise, *or with the grain*; but as a rule it cannot be worked across the grain. It cannot be turned, its pores being very distended, the centre point of the lathe constantly varying the size of the hole on account of its softness; but as it is often required to make boxes, cases, &c., we are induced to briefly mention it. Its texture is so peculiar that it seems to be formed of two various substances. The annual layers sensibly differ from the matter interposed between them, and are even different in colour. The latter is darker, the former lighter. As the tree produces a number of branches issuing from its stem (without being identified with it), there occur a multitude of knots, which quickly dull the edges of the trying and smoothing-planes. Tree-knots, from which the branches spring, are of a different nature to the remainder of the wood; they seem to be nothing more than an extravasation of the ligneous juices combined with a resin. They are very hard, and in working Deal the knots often come out bodily and leave a hole, which must be plugged up. As the pores of Deal are so distended, the wood is rather light, at the same time it is very pliable and elastic. Formerly it was used to make lathe-bows. Deal grows very tall and straight, for which reason it is used for the masts of ships, scaffold poles, floor-boards, &c.

**OAK.\***

(Fig. 2, Plate I.) This wood is used for building and art purposes; it is not of much use for the lathe, as the pores of the wood are so open. It has been proscribed for all works in which it is necessary to make sharp, fine, and conspicuous mouldings. Oak is a large forest tree. Few trees partake of the quality of the ground in which they grow so much as the Oak; in damp places it grows well enough, but acquires little firmness. It grows well in sandy places, but partakes, as it were, of the soil, for the sand seems to be driven into the wood, much to the detriment of the tools. The Oak which is cut up in Holland is the finest, but being so *greasy* and tender, tenons and mortises cannot be well worked in it; for wainscoat panelling it is unequalled. That of the Vosges has all the requisite qualities for joinery, but it is not so fine as that which is sawn lengthwise, coming from Holland. There is another kind which comes from Fontainebleau; this is full of knots and is used only for common purposes, such as seats which have to bear much strain, forms, tables, exterior doors, etc. If we attentively look over a board of Oak from which the bark has not been taken away, it will be seen that there is a white part usually called by the workman *alburnum*; this shows that the wood is not quite ripe, and is liable to rot. When in the forest, Oak is sawn lengthwise in boards; they always take care to lay aside those pieces coming from the white part, as the boards taken from the heart of the tree are much better and harder, and consequently more expensive, than those sawn from the white part. There are certain eyes and veins in Oak by which the workman judges the quality of the wood; it is true that wood

\* The hardest Oak is the English, but that which is imported from Riga, Dantzic, and Memel has a very beautiful grain. It is said that the Oak imported from Styria, Istria, and Italy, is as good as the English Oak for many purposes. It is used in government dockyards. The Asiatic Oak is fine and close in the grain, and resembles in colour the Black Walnut-wood. The graining in Pollard-Oak is very beautiful, and the wood is extensively used in the manufacture of furniture.

thus cut (from the centre) is always stronger than any other, but to get at such truth, we must look into the various methods of cutting or sawing woods.

We said before that the growth of trees takes place circularly, and that each year adds a circle to a tree, so that the age of a tree cut crosswise may be ascertained by the number of circles concentric to the pith or core. There are various ways of sawing a tree lengthwise, one is to obtain as many parallel boards as possible, which is the French method (fig. 11, Plate 37). It is certain in that way of sawing, the annual circles and the medullary productions are almost always cut nearly perpendicularly, so that they should appear on the edges of the board, and such circles are called the *mesh*, though at times scarcely visible. The Dutch, on the contrary, generally saw a tree lengthwise, in four parts, at right angles, and take afterwards each kerf perpendicularly to the base of the triangle, the angle of which is the heart of the tree; a specimen cut is given (see fig. 12, Plate 37). In such a case it is certain that the annual layers are above all the medullary productions which are nearly parallel with the kerf, and that they appear on the board; this preserves the natural texture of the wood and makes it stronger, whilst in the other case the texture is divided.

#### ELM,\*

(Fig. 3, Plate I.) is a fine forest tree. If it is not so generally and extensively used as the Oak, it is no less valuable for some purposes; with Elm the felloes and naves of wheels, presses, large screws, and other such works are manufactured; it is pliant, hard, and easy to work; but it is more susceptible of strain than the Oak; it is extensively used by carriage builders. Its bark, which we will not analyze, is commonly in the form of scales, and is remarkably different to that of the Oak. Between the bark, properly speaking, and the tree, there exists a spongy substance of a different colour to the bark, but which is a part of it. Then comes the *alburnum* of the wood, which is yellowish, and the layers of which lie closely side by side. When it is used it is recognized by a number of stripes, which distinguish it from other woods; the *alburnum* does not extend very far. The heart, which is brown, striped with white, is an excellent wood; the knots are not of the same character as those in the Oak, and still less in Deal, as they are very adhesive to the contexture of the wood, and are firmly embodied in it. The knots appear to increase the intertexture of the Elm-fibres, and give it much strength; for this reason Twisted-Elm is selected for the naves of heavy cart-wheels. Twisted-Elm is a name given to those small branches which grow annually; as the knots multiply a sap is formed which intersects the fibres and seems to produce knots rather than a regular and natural vegetation. It is easy to understand how the spokes of heavy cart-wheels, forcibly mortised into wood of this kind, gain great strength. But when the naves are selected from pieces of wood *with the grain*, as in carriages, they often split after a short time, in spite of their being encircled with iron hoops. Excellent lathe-frames can be made with Elm, and, being a heavy wood, it is much better than Walnut or Beech, though these woods are often used for this purpose. Good screws and other large utensils are made with it, and it is especially adapted for large screw-nuts. Elm, when growing, is similar to Ash, for which it is sometimes mistaken on account of its colour, which is nearly the same. It works well in the lathe, and for chair-legs, swing-bars of carriages, and many other objects, such as hammer-handles, &c., it is extensively used. The pores of this wood being very open, it does not take a very good polish. There are knobs or excrescences in Elm,

\* There are two species of Elm, viz., Wych-Elm, and Rock-Elm. The former is light in colour, and grows straighter than the common Elm. The latter is very pliable, and is used for making bows, &c.

which are of a different nature to the tree; a section of such a knob is seen in Fig. 4, Plate I. The grain, which is very fine and close, takes a fair polish, and in the lathe may be used for many purposes. On account of the variety of threads and fibres which run in all directions, it is difficult to use the smoothing-plane on this wood. It is seen that such ligneous production is but the result of an extravasation of sap, since none of the fibres grow with any regularity; this also applies to the knobs, in which the knots are very numerous, and produce a pleasing effect. When using this wood for the manufacture of furniture, it is sawn into veneers, like Mahogany, &c.

### BEECH,\*

(Fig. 5, Plate I) although less strong than the woods we have spoken of, is, nevertheless, fit for many purposes, which renders it valuable. It grows in forests to a great height, and is distinguished by the whiteness of its bark and its mottled and glossy surface. It is much used for butchers' stalls and in joinery, though not by the builder. Being very strong, arm-chairs, sofas, bedsteads, and many articles manufactured by the cabinet-maker, are made with it; a dye of walnut peel applied to this wood makes it very like Walnut-wood. It is also dyed with soot, but this is not half so good as the former.

This wood is easily turned, but the pores being large and open, it does not take a good polish. It is distinguished from Walnut by the absence of worm-holes, and it has a well-marked glossy *mesh*, which grows aslant, from the centre to the circumference. This is another of its characteristics. When we ponder over the various natures of the number of woods growing on the same soil and nourished with the same juices, we cannot disregard the immensity of the Creator's views and the mighty power of the Creative hand. Every tree has its own qualities, its form nearly constant, its leaves invariably the same, and its special texture.

### HORNBEAM (YOKE ELM),

(Fig. 6, Plate I.) is a forest tree, the leaves of which resemble those of the Elm. There is a large and small Hornbeam, the small one is called Wych. The bark of the large tree is of a light grey hue, and is sometimes white in places, spotted with various colours. It appears that some peculiar insects take up their abode in this tree, as the bark is punctured in many places, so as to lead us to surmise that they have dwelt there. The wood is white, the longitudinal fibres are interwoven with transverse streaks. The bark is rather thin, and the annual layers are very close. When cut with a sharp tool the wood takes a sort of polish. Some care is required in selecting the wood; that which grows in a damp soil is greasy and without consistence, and it is whiter than others, but this is looked upon as a bad sign as to its quality. Hornbeam turns well, its pores, without being close, are very fine; but the wood is liable to split unless it is perfectly dry. When still fresh it is well adapted for screws of medium size, the threads of which can be cut exceedingly sharp. Mallets, skittles, and other such articles, are generally made with this wood, and it answers the purpose extremely well, when selected from the knotty parts. Cabinet-makers use it for the black squares in draught and chess-boards, the white squares being filled in with Holly. It is rarely or ever used for joinery or wheelwrights' work.

\* Tredgold says, that only one species is common in Europe; in England, the Buckinghamshire and Sussex Beech are esteemed the best. The colour is influenced by the soil, and is described as white, brown, and black.

The lathe-cord should be sufficiently twisted, without being too hard. It is sold everywhere, under the name of whipcord ; it is a cord with three strands, or in three. As to its thickness, it should neither be too small nor too large. If the latter, it is harsh and stubborn, and as it makes two turns upon the work, if it is of a middling or small diameter it wears itself and soon ravel out ; and again, if too fine a cord it will last no time. Some people use a little cable-cord, which is a kind of cord with seven or nine threads, very tightly twisted and hard, but it ought to be rejected on account of this hardness, because if put upon smooth or finished work it is apt to leave the marks of its threads imprinted on it.

Catgut is the best to use ; but it is very dear, and as when turning between two centres we are often obliged to rough-down work only roughly cut with the hatchet, and consequently, having sharp edges, the catgut soon wears out, thus entailing considerable expense. It should be reserved for the overhead-motion, and where an endless cord is used.

Nothing wears out sooner than a lathe-cord ; to prevent this it is a good plan, when it begins to wear, to pass a slightly damp sponge over it, being careful not to do so when the cord is being used, as it would leave a mark on the work.

Fig. 1, Plate XV. represents a piece of roughly-shaped wood, placed between the two centre points ; the workman is supposed to be facing the reader in such a way that his work can be seen ; *g* is the rest on which the tool bears. The workman resting on his left leg, places the right foot on the treadle, and in order to give as many turns to the work as possible, without much raising the foot, it should be placed nearer to *h* than to *c*, more especially if the work is not very large, and does not offer much resistance to the roughing-down. Nothing is easier than to use the gouge ; there are, however, some difficulties to be overcome in cutting the wood properly. We have not thought it possible to explain the position of the tools by an illustration of a workman holding them in both hands, and turning, but have given side-views of the tools and of the work.

Fig. 3, Plate XV. represents the position which ought to be given to the gouge, and, as a rule, to all other edged tools, in order to cut the wood properly. Many people hold the tool perpendicularly to the axis of the wood, without reflecting that they only scrape or tear it. On the contrary, the sharp edge should make nearly a tangent with the circumference, the superabundant wood coming upon the tool as if to be carried off. We say nearly a tangent, because the tangent being a straight line perpendicular to the end of the diameter only touches the circumference, therefore the tool which follows this line will not cut the wood. To explain more clearly, we should say that the tool ought to form the smallest chord possible ; because if held in a line approaching the diameter, it would be as if we forced the sharp end to enter the work a little, and that by the power of the treadle we took off what resisted the tool. It will be readily understood that this would produce nothing but a series of scrapes, and by looking at a piece of wood roughed down with a gouge, we can see if the tool has cut or scraped. *A* is the wood being turned, *a b* is the gouge held on the rest *c*. The handle *b* is usually held in the right hand, the left hand clutching the top of it, the four fingers being above, and thumb underneath, exactly in front of, and against the rest *c*, in such a way that the left hand leaning against the rest serves to stop the tool and prevents it taking off more wood than is required. We say this is the usual way of holding the tool, nevertheless, it is a good plan to accustom oneself to changing the hand, as in many instances it is much more easy.

The left hand must not, however, hold the tool so tightly, or lean against the rest so firmly that the sharp edge catches the wood both going and coming ; on the contrary, it must be held with the left hand lightly, in order that it may yield to an almost insensible motion, which carries it

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towards the wood when the treadle descends, and away from it when it rises. We shall understand how little the tool need be withdrawn towards oneself, if we reflect that all the surplus wood having been taken off at the last revolution of the work, if the tool is only moved a hair's breadth it will touch the wood no longer.

Fig. 4 Plate XV. represents the way the tool is held. A is the left hand, which, as one sees, clutches the tool, the fingers above, and thumb underneath. B is the right hand, which holds the handle c; the left hand does nothing but sustain the direction of the tool, the right hand sustaining the effort against the chip or shaving being taken off. One must not suppose by the way in which the left hand grasps the tool, that it must be held forcibly, but a little experience will teach this far better than anything we can say.

The shape of the gouge sufficiently indicates that each stroke of it makes a circular groove upon the wood; these are made the whole length of the cylinder, at equal distances from each other, and as nearly as possible of an equal depth, so that the bottom of each groove is of an equal diameter, and to make sure of this, we take the callipers  $\ddagger$  (fig. 1, Plate XV.), or the one shaped like an 8, lettered  $l$  of the same figure, and measure the distances from one to the other; but we must be careful to open the callipers rather wider than the intended diameter of the cylinder, and to keep them at this size. When the cylinder is thus roughed down lengthways with the gouge, we take off, with small strokes, all the ribs which separate each groove, endeavouring to make it smooth, leaving only very little ridges, which cannot be helped, on account of the shape of the tool, and then we use the chisel, which of all tools is the most difficult to handle.

Many turners use chisels ground square, such as fig. 5, Plate XV. but as in turning with these we cannot take the wood in front, that is to say, parallel to its length, and are obliged to slant the chisel to the axis of the work (fig. 6, Plate XV.) which obliges us to hold the body to left or right, out of its perpendicular, according as one inclines to one side or the other. Many prefer, and this is the best method, to use chisels ground obliquely, such as fig. 7, Plate XV. then it is sufficient to hold the tool perpendicularly to the wood, so that the bevel is oblique, as shewn by fig. 8, Plate XV.

There are many reasons for thus taking the wood obliquely to its fibres, instead of in front, or parallel to them. The first is, that wood thus cut offers less resistance, and that the pores cut in this way are hidden in the wood itself. Secondly, it is because we ought never to cut wood except with the middle of the sharp edge, and that as we suppose the wood to be already roughly round, the part of the chisel which does not cut leans upon a perfect circle, not allowing the tool to cut otherwise than in the direction given it by the part upon which it rests.

This tool must also be poised nearly in the direction of a tangent to the cylinder. If we wish to take off a little more, it is placed in the direction or position of a chord to the circle, and to judge if the tool is properly placed, and cuts the wood well, we look if the shavings it makes are large, curled, and of an equal thickness.

Care must be taken in carrying out our instructions, with respect to the inclination of the tool upon the wood, not to fall into extremes. Beginners are apt to deceive themselves, they notice that the more they slant the tool the more cleanly it cuts, the shavings being also more curled, but as then the too great obliquity of the tool makes it approach the perpendicular to the axis of the cylinder there can be hardly more than a trifle of the width of the bevel cutting the wood, therefore, instead of planing or smoothing the cylinder, as we should do, the surface will present nothing but a succession of furrows, composed of parts of circles of very large diameter, and it will be impossible to entirely efface the almost insensible ribs or ridges left after it. It is, therefore,

necessary in smoothing a cylinder that the chisel should slide evenly the length of the work, and this movement ought to be as equal as possible, without stopping or jolting it. Unless this is done, every renewal or stroke of the tool will be visible on the cylinder, and for this reason we recommend much practice in order to acquire an experienced hand.

We have said that the qualities of the shavings ought to be largeness and cleanness (or polish). Now for obtaining this the obliquity of the tool must be as slight as possible, and yet sufficient to cut cleanly, that is, it ought to form an angle of about 20 degrees with the axis of the cylinder.

Nothing is to be feared in this operation from the lower angle of the tool, but it is not the same with the upper one, which, as already described, should always be raised above the wood, and never scrape it. When we hold the chisel too much in front of the work, in order to turn more smoothly and equally, the upper angle often enters and tears the wood, and as this generally happens when we least expect it, the entire circumference of the cylinder is scraped, the surface at this part being irremediably spoilt (this accident is termed a "master stroke").

In using the chisel it is above all things very difficult to turn true, indeed, it is almost a physical impossibility. To convince ourselves of this, we need only turn a part to the left, then to the right, and see if the surfaces meet perfectly, for this reason, when we are anxious to turn a piece to match another, we scrape it in a way which will be described in the proper place.

We have seen some people, especially Germans, hold the chisel in a manner odd enough, but very good for cutting the wood properly. They pass the left hand behind the cord, hold the cylinder with the four fingers, putting the thumb on the bevel, and by this means they keep the tool more steady upon the part already turned and circular, the variation of the hand being less felt on the work. We have seen this plan employed very successfully by a wind-instrument maker, who turned very well, and very cleanly, bodies of flutes in boxwood, and bassoons in maple. This double experience on hard and very soft wood proves that this plan can be applied to many cases, but principally when the work is weak and thin with respect to its length, because then the effect of the tool combined with that of the treadle tends to make it bend, and consequently it is not turned truly round, because the wood is scraped by jolts, instead of being cut evenly.

When the cylinder is turned passably, the hand should be passed over it from one end to the other, to see if there are any undulations which escape detection with the eye. The perfection of the work is judged of in this manner.

Whatever skill may be acquired, a cylinder is never perfectly round, several reasons preventing it, the unequal density of the wood, and the unskilfulness of the turner. To assure ourselves of this fault, we should take a sharp point-tool, holding it to the surface of the turning cylinder in such a way that it just barely touches it; we shall then see that the point of the tool will mark all the projecting parts, not touching the others, an incontestable proof of what we have said. When assured of this imperfection, we must take heart and begin again.

Unless the hand is very experienced and steady, it will be quite impossible to correct with a chisel the imperfections we discover. The surest way is to take the gauge again, and only to cut what wood exceeds the perfect roundness, leaving the rest untouched. Then again use the chisel, trying to work it better than at first; if this is repeated a few times, perfection will at last be attained.

We see that in doing this we continually diminish the diameter of the wood, and if a fixed diameter was given for the cylinder, it will have been already passed. For this reason we should never undertake valuable work unless sure of our skill,

Besides the difficulty of turning perfectly round, and of well smoothing the work, there is that of preserving the same diameter from end to end ; and though we can use the callipers to work when it requires a mathematical correctness, as in the bearings of a machine, which ought to be perfectly cylindrical, still we may be mistaken, according to how the callipers have more or less tightly clasped the part where they were applied. There is also an error on this account, into which we fall without perceiving it, from not being aware of the cause.

Supposing we wish to turn a perfect cylinder, we "*gauge*" it (this is the term for measuring its width with the callipers), carefully in a part of its length, for example, at one of the ends. A little further on we see if it has the same size, in this part we find it imperceptibly larger, the callipers pass, but a little tighter, we are, however, contented. We try a little further on still, the same thing occurs, we are again satisfied ; and thus, after having measured in little distances all along, the callipers always passing, though each time a little tighter, we fancy the work is perfectly cylindrical ; it, however, is far from it, because if we put the callipers again to the end from which we originally started, we are surprised to find a considerable difference.

The cause of this is easily seen. Each time we measure the callipers open imperceptibly, and all these openings, accumulating together, give finally a very sensible difference. We must, therefore, see each time if they fit with the same ease, and in order to judge better, we should not force them to pass, but suspend them over the work, holding them lightly, and abandoning them to their own weight ; if they pass with the same ease, we can feel assured of the proof. Still, it would be as well to go back to the part where we commenced.

All these details will seem more than minute to most of our readers, who, impatient to turn, imagine that it is quite sufficient to cut wood passably ; only those who are themselves experienced and skilled will appreciate the necessity and importance of our instructions. But as our only aim is to teach the perfection of the Art, and to instruct those who are inexperienced, we are obliged to follow the plan we have already traced. How many persons there are, who, having neglected the preliminary stages, turn a number of complicated pieces, full of faults, and know the cause, but have not the courage or patience to retrace their steps !

The rest of the work required to finish the cylinder cannot be done until one has become, to a certain extent, master of the chisel ; it is to cut the two ends at right angles. To do this we use the upper angle of the chisel, or one of the two in a square chisel ; but in this operation we encounter a double stumbling-block, either to hollow the end if the chisel held edgewise on the rest inclines too much outside ; or, to make it bulged, if too much slanted towards the cylinder.

But this is not the only inconvenience we have to fear ; we risk, besides, that the chisel in taking the circumference of the circle not meeting with sufficient resistance, will trace on the cylinder a deep line in the shape of a screw, which may happen, even to the most skilful, when it is least expected. The reason is this, a lathe-chisel has two bevels, the ends of which are supposed to be in a line with the breadth of the tool. Thus, though the bevel which leans against the end of the cylinder is in the plane of the circle described, it is not less true that the cutting-edge of the chisel is directed obliquely to the cylinder ; and thus, though the edge of the circle only slightly catches at the cutting-edge, the resistance pushes the tool towards the holder of it, and the force continuing, in spite of all precaution, makes one continue to cut the wood, which on account of the direction of this angle can only be done obliquely, and, on account of this obliquity, a line shaped like a screw is traced on the cylinder, already far advanced, before one has time to stop the tool.

To prevent this we must first make a chamfer on the angle of the cylinder with a chisel ;

and with a middling-sized gouge take off any obliquity caused by the saw-cut. We must be careful in this, as in the preceding operation, to raise the hand which holds the handle of the tool, so that it may always be in a radius with the centre of the work.

This difficulty deters many workmen, who, unable to use a chisel, take a point-tool, but this, instead of cutting, only scrapes the wood, whereas the chisel, well directed, cuts sharply and cleanly, and in concealing its pores almost polishes it.

## PART II.

### ON TURNING HANDLES.

**A**S it is very useful to beginners who wish to learn the Art of Turning thoroughly to have considerable practice in cutting wood properly, we think that after having had some experience in turning cylinders, it would be well to amuse themselves by making their own tool handles, though they may not have occasion to use them until they become more expert. But as some risk is run of the wood being spoilt, only a common kind should be experimented on at first, recollecting that soft woods are the most difficult of all to turn. This is the way to make handles all of the same size.

One should have made, or, if sufficiently supplied with tools, make with sheet-iron a "templet" of the shape represented by fig. 9, Plate XV. the two pointed ends of which determine the length of the handle. A hole should be bored in it, by which to hang it on the wall when not in use. This equality in the length is not necessary, but simply agreeable to the sight when all the tools are ranged in the rack. The usual length is about  $3\frac{1}{2}$  inches, including the ferrule. A billet of wood should be cut into several pieces of about  $4\frac{1}{2}$  inches long, or thereabouts. They are split with the riving-knife, in such a way that they possess the required thickness and size of the large part of the handle; they are all roughly cut with the hatchet, and then put between the lathe centres (because up to now we are supposing there is no mandrel-head, or that it is not made use of); and if one has already acquired sufficient experience, so as not to need to trace a circle at each end, it is put between the centres, as nearly in the middle as possible, as well as the eye can judge. At first the centre screw is only tightened slightly, and the wood is made to turn by putting down the treadle. It is very easy to see if the points are in the centre properly, but if this can not be judged by the eye, a piece of red chalk should be held to the work, to see if it marks equally on all parts of the circumference; if the wood is more to one side than the other, to the part which is too much forward we give a slight tap with the mallet, or hammer, or the side of a chisel, and by this means the centre recedes. We try again, continuing until it is right. We should begin by making with the gouge a kind of pulley *f* at one of the ends, keeping two turned-up edges for holding the cord. For this we should always choose the worst end of the wood. Then we place this pulley

and the cord near to the left centre, for greater ease. The handle is then roughed down lengthways with the gouge. The end which ought to receive the ferrule is cut at a right angle, and from this point we trace with the templet, the ends of which should be very sharp, a circle on the handle, near the pulley, and by this means we get an equal and permanent length. Care should be taken that the cylinder is of a proper and equal size for all the handles, especially at the part where we have reserved the pulley.

A certain number of brass ferrules should be obtained ; we choose one, and chamfer with a half-round file the inner angle of one of the ends of this ferrule, and taking with a pair of callipers (fig. 15, Plate II.) a very true diameter of its interior, we have by the other end of them the size which the tenon must be to make it fit. With the angle of the chisel we trace on the cylinder the depth of the ferrule, then with a middling-sized gouge we take away nearly as much wood as will reduce it to the required size. We cut at a right angle, and even slightly under-cut the part against which the ferrule ought to rest ; and lastly, with the chisel, make the tenon the proper size, that is, a little larger than the callipers indicated, so that it must be forced in. Without this precaution the ferrules are apt to come off ; the heat of summer drying the wood they get loose, and easily fall off the handles. For this reason we should only use thoroughly dry and well seasoned wood.

For turning this tenon with the chisel great experience in using the tool is necessary, as if the hand varies a little, or the turning is not perfectly circular, the ferrule fits badly, as can be seen at once. Beginners should finish this tenon with a single-bevel chisel (fig. 3, Plate XII.), that is to say, with those used for turning hard wood, or shell ; it ought to be well set, and held to the tenon very nearly in its diameter, a trifle above, to take as little wood as possible. If, however, we are turning soft wood we must never use this chisel, as these woods must be cut, not scraped. We then stand the ferrule on end, the indented part being upwards, on a hand-anvil, beak-iron, or other very hard, even body. The handle is then held to it, and made to enter by striking it at the opposite end, and this is continued until the ferrule is fitted evenly and properly upon the part prepared for it. It is then returned to the lathe, and if the operation has been properly performed, the ferrule will turn true, or nearly so ; if this ferrule has been polished or ornamented, and not spoilt in fixing, it can be left as it is ; but we should see if the part which rested on the anvil, or beak-iron, is bruised, and if so, we should give it, on the lathe, a slight touch up with the point-tool, to do up the end ; then another touch with the same tool to take off the sharpness of the angle.

As in this operation we should be careful to preserve the centres, when hammering from above, we return the handle to the lathe, and if the force to which it has been subjected has a little deranged the roundness, this is perceived by holding a small gouge to it ; the part which projects should then be tapped with a mallet, and the handle finally finished in the lathe.

We cannot fix a size for workshop tool-handles, it is entirely a matter of taste ; some people like them uniform, others desire them all of different shapes. Fig. 10, Plate XV. seems to us the best. The flange, or enlargement, makes it easier to hold, and the fingers easily grasp the small part.

Let us suppose, then, that we adopt this shape, and that our piece of wood, with its ferrule, is a cylinder of the proper size, nothing remains but to give it the adopted form. We take off with a gouge all the superfluous wood, gauging it from time to time with callipers, at proper distances from the ferrule, so that the space and enlargement are equal, and little by little, we shape it up with the gouge, as required.

At this part we again verify with the templet the length the handle should have, by resting one of its ends against the ferrule, and the other near the pulley, trying to give it the required shape.

If we like, we can make a little beading above the enlargement, close to the ferrule; this sets off the handle, and can be done, when finishing it, with the chisel.

When the handle is roughly shaped with the gouge, it is finished off with the chisel. It is in the small part, and at the enlargement near the ferrule that we should know how to work right and left with a chisel. Every time that we round a part, we should use that which is nearest the lower angle of the chisel, and the work must not make an entire revolution at each stroke of the tool, but be turned during this revolution, in such a way that at each movement of the treadle the chisel turns upon the round part. If we worked otherwise we should see upon the spherical surface as many ribs or ridges as there had been strokes of the chisel.

Therefore we should cut, first the wood from *a* to *b* (fig. 10, Plate XV.), then from *c* to *b* for the same reason, and unless thoroughly experienced, the two cuts of wood at the bottom of the hollow (*b*) never agree; nothing is more difficult. The chisel is reversed for rounding from *c* to *d*, and with the lower angle we make the foundation of the space for the little beading, and this space is nothing but a very acute angle forming two circles which meet each other.

The beading being of a very small diameter, ought also to be cut with the lower angle of the chisel, that is, very little of the bevel should cut the wood, and the chisel should always be turned when the treadle goes down. We cannot repeat too often, that nothing is more difficult than rounding properly, particularly very small parts. If a turner can make a cylinder properly, and round a beading, cyma or ogee, he has proved everything in his favour, he cuts wood well; but we should see him work, as very often defects caused by unskilfulness are repaired by the application of cuttle-fish, or otherwise.

When the chisel enters a hollow it is often too large, it should, therefore, be slanted a little, and by this artifice we can make, with even a large one, a very curved line; it is a proof that we handle or manage the tool well; also for making the two cuts meet at the bottom of a hollow we should hold the chisel in this same manner.

We must take care, however, not to cut the wood in ascending; thus we cut from *c* to *d*, in going towards the ferrule; then from *c* to *b*; afterwards from *a* to *b*, and, lastly, from *a* to *e*; by this means the fibres are cut cleanly; and the pores hidden.

If the wood is cut clean, and the strokes of the tool meet properly, the work is perfectly round; if the wood is even but slightly hard, it ought to be nearly polished and fit for use; we should take from the lathe-bed a handful of fine shavings made with the chisel, and, grasping the handle, make it turn surrounded with these shavings, this helps to give the work a lustre.

We may suppose by the shape of the handle (fig. 10, Plate XV.), that it is finished, but that the pulley remains; though as something yet remains to be done to this handle, we will describe, presently, how to cut this pulley.

If this handle was of valuable wood, it should be cut at first nearly to the required length. Instead of the pulley part which becomes wasted, we should reserve the part *e*, *a*, cylindrical, for receiving the cord, while all the remainder of the handle, from *a* to *c* is finished. Then, putting the cord in the hollow, *b*, we finish the end *e* in a pear like shape, abutting the centre of the point, the hole of which should be as shallow as possible, but there will always be a mark of this hole, which is not right, and does not occur in the method previously described, otherwise, the waste is so trifling that it is not worth consideration. When we come to overhead motion, we

will explain a simple way of turning this handle, so that it has no mark from the centre. The above is the mode in which handles are finished without overhead motion.

The hole which ought to receive the tang of the tool should be in the centre of the handle; no way is surer than to bore it in the lathe, and this leads us to collar-plate turning.

The collar-plate is a piece of iron, brass, or wood, in which are made one or more tapering holes for holding the end of the cylinder, or any other work, and by means of which we are able to work at the end without being troubled with the back centre.

A (fig. 1, Plate XVI.) is a "Collar-plate head;" B is the plate, which is generally round, made of brass, with a circular-hole bored in the centre, in which enters an iron bolt with a head turned perfectly round and true to fit the hole, in length a little less than the thickness of the plate. At the end of this round part is a square, a little shorter than the thickness of the head. Lastly, the rest is screwed and receives a screw-nut, which bearing against the head and pressed against it, tightens the plate. The shape of the bolt can be seen (fig. 2, Plate XVI.), its nut by itself (fig. 3, Plate XVI.), and key for fastening it (fig. 4, Plate XVI.).

We see that this wheel turns on its centre, on the collar (*a*) of the bolt (fig. 2, Plate XVI.), and as on the same circular line there are a dozen conical holes of varying diameters, and we hold opposite to the centre-point that one which fits best the piece already rounded at the end.

Excellent collar-plates are also made of iron; the expense is much greater but the work turned by them has a much more gentle movement, and besides as to either oil must be put, if ivory is being turned, or wood of a light colour this oil forms on the brass a dark mud which leaves a brown mark on the work which nothing can efface.

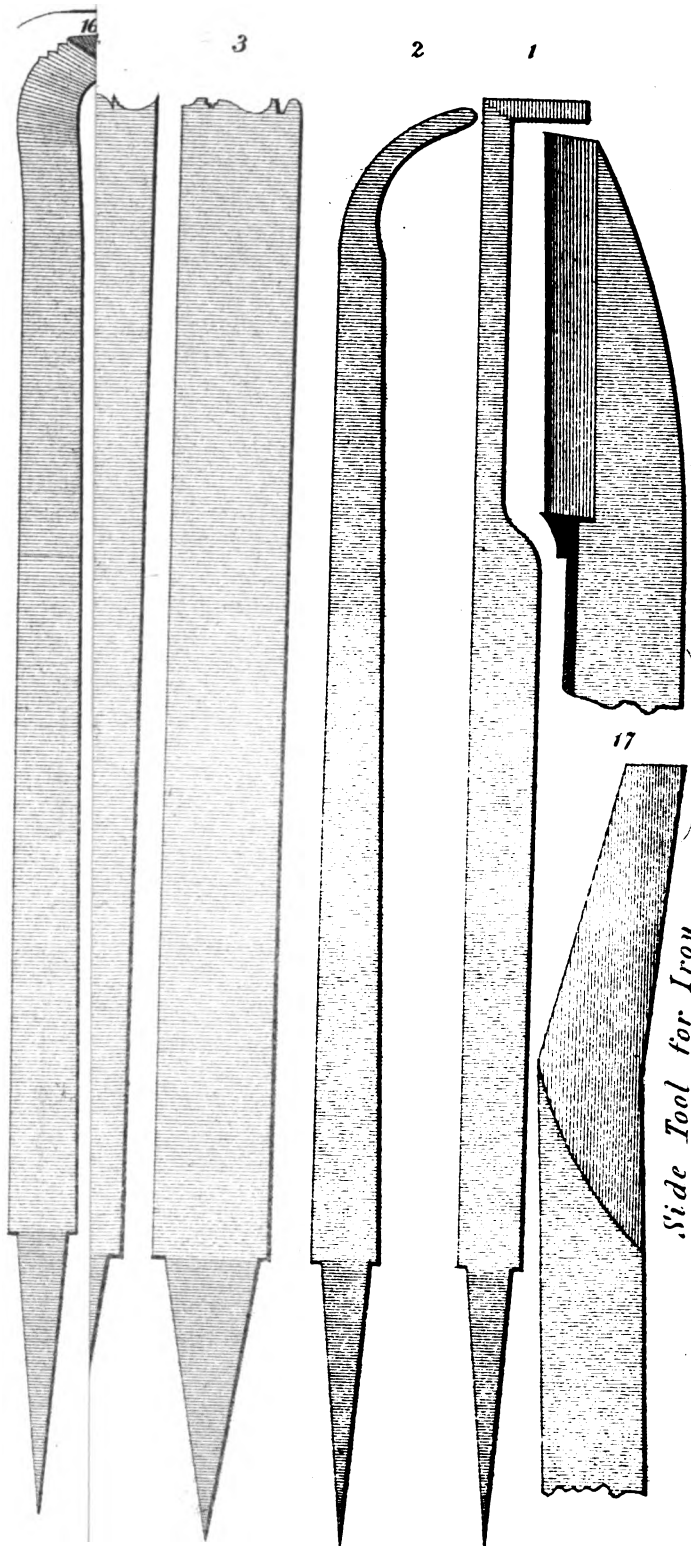
There is a very economical manner of making these plates. They can be constructed of wood by placing in the lathe small parallel planks, from 6 to 7 inches in length, and 4 inches in width. A small notch (fig. 6), is made in the bottom, by which it is fastened, and placed at the required height.

This is how these plates are pierced on a lathe without a fly-wheel. The operation is much more difficult in this case, but as we have undertaken to detail every separate process, this one had better be explained.

A mandrel (fig. 5), upon which a groove is made, is turned between the two centres. A long conical shape is given to it, and with a bow-drill a cylindrical hole is pierced in that part of the plate intended for the conical-hole. This hole should be slightly smaller than the one intended to be inserted in the plate; the conical-mandrel must fit it tightly, so that the plate may fit firmly on it. The mandrel must then be placed between the centres to see if the plate turns in the same plane; that is to say, to observe if it does not incline first to one side and then to the other, as generally happens. It must be adjusted with a mallet till it turns truly; then with a half point-tool with a square edge (fig. 7), the hole in the plate must be inclined and made conical. When the wood is quite bored out the plate will come off of its own accord, but it will be necessary to measure with the callipers if the cone is large enough for the part intended to receive it.

The best wood for these kind of plates is one that is hard and of a close grain, such as the Sorb-tree, or the Hawthorn.

Before the plate is used it should be rubbed with soap; for it is well to mention that woods likely to rub one against the other should always be lubricated with soap and not with oil. The latter gets into the pores, swells the wood, stiffens the tenons, and makes friction very laborious.

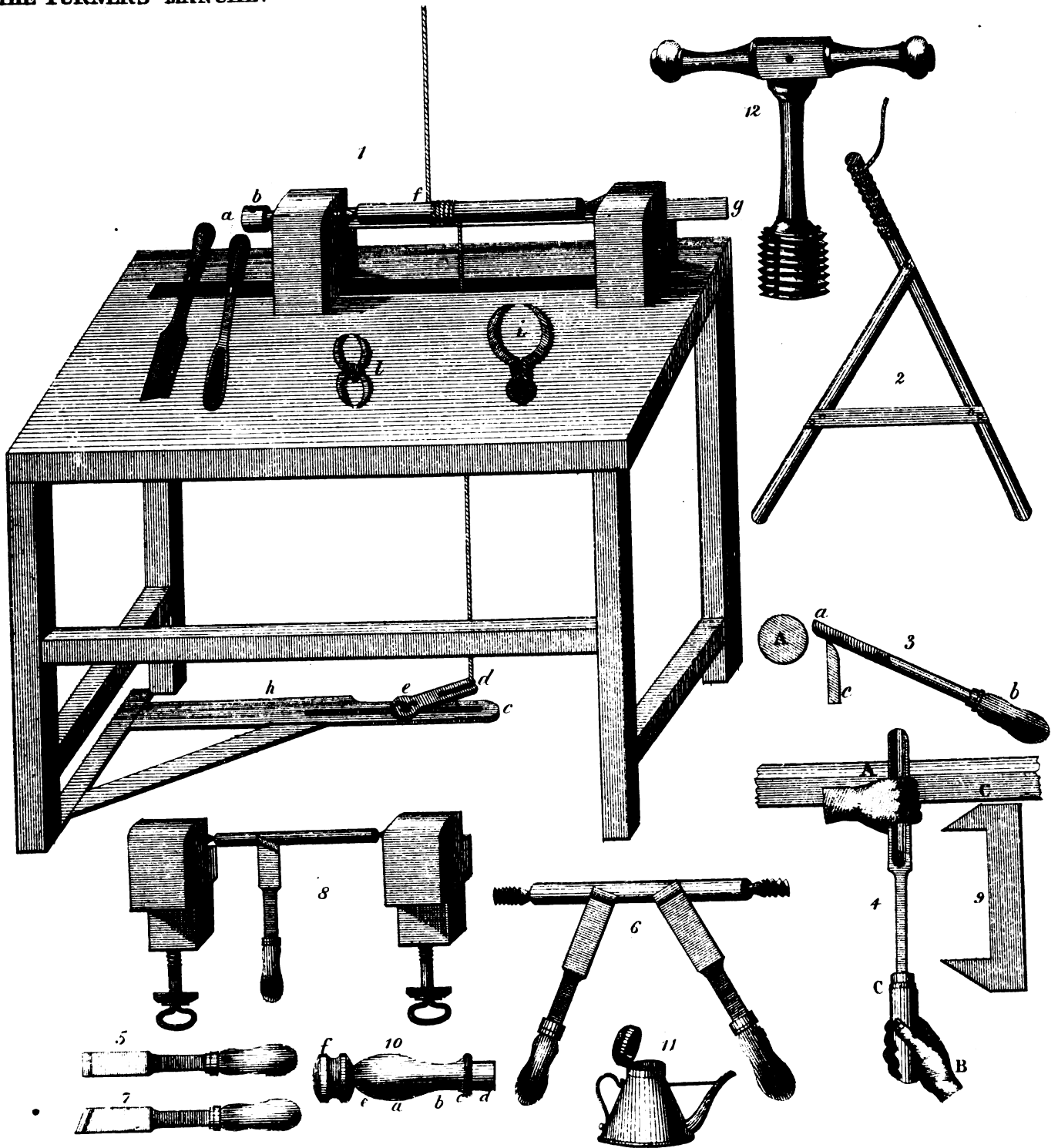


*Side Tool for Iron*

Vincent Brooks Day & Son, Lith.







Thomas Brooks Day & Son, Ltd.



Whatever may be the kind of plate used (the last is certainly the least advantageous), the collar-plate, attached to one suited to the size of the cylinder about to be placed on the lathe, must be held close, and when the hole is concentrically opposite the centre, the screw must be tightened till the plate is firm and cannot give. The handle must now be placed on the left centre, then, holding it by the ferrule in the plate, the turner must work the treadle, and see if there is too much or too little friction. The collar-plate, which is not yet very tightly fastened on the lathe-bench, must be adjusted till the lathe turns with sufficient ease.

The wedge must be introduced into the groove at the top of the collar, and as this wedge is larger at one end than the other, it must be pushed forward until its lower end nearly reaches the centre of the cylinder in the lathe. A sharp point-tool must then be applied to the centre, and the hole made large enough for the spoon-bit it is intended to use. The hole is then deepened with the spoon-bit, the latter being occasionally withdrawn and cleansed of the borings by dipping it into grease or passing it through a candle. When the hole is deep enough, cease boring. A large spoon-bit must now be firmly held opposite the hole, the left thumb being placed on it, in order to steady it, and to keep the hole exactly in the middle. The spoon-bit must then be gradually forced in, the borings being frequently emptied, till it has reached the bottom.

The turner should keep a large stock of spoon-bits of various sizes, so that the hole may gradually be made to accurately fit the tool to which it is intended to put a handle. The tangs of all tools, however, taper downwards, and if the hole were of the same diameter throughout its whole length, the tang, though fitting tightly at the top of the hole, would be loose at the bottom, and would wobble in the operator's hand. Each successively larger spoon-bit, therefore, must be less deeply inserted, in order to give the hole the necessary conical shape; if this is done the whole length of the tang will fit tightly, and the tool be firmly fixed in its handle. The best way of ensuring this is to finish the hole with a taper spoon-bit (fig. 15, Plate XII.).

It will be found difficult at first to make the hole perfectly straight. The best directions we can give to ensure this is to warn the turner to hold his right hand at such a height as will make the spoon-bit a continuation of the axis of the wood on the lathe. With a little care, however, the second spoon-bit, particularly if its edge is sharp and cuts well, ought to remove any irregularity of direction. We have elsewhere spoken of the best way to give spoon-bits the keen edge they require.

When the hole in the handle is made it is easy to discover if it is exactly in the middle by replacing the handle between the centres. If it turns as truly as when it was finished, it is a proof that the hole is in the right place. Too great exactness is not, however, necessary. If the tool is almost in the centre of the handle it is sufficient. Our somewhat precise instructions are in the interests of perfect art, and to impart an exact knowledge to beginners.

Nothing now remains but to finish the opposite end of the handle. Having replaced it back again between the centres, with the chisel almost cut through the division between the pulley and the end of the handle, and give the pear-shaped extremity of the latter a symmetrical shape, taking care to remove all traces of unevenness. When the turner is about to completely separate the pulley from the handle, the treadle must be worked very slowly, for the material is there so weak that it cannot withstand any great strain. The wood might break, and the handle would be jerked into the turner's face, or through the windows of the workshop, the result being that its extremity would be disfigured by the traces of the fracture; to efface which it would be necessary to alter the shape of the handle.

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When, therefore, the grooved part being still connected with the handle, the turner has given the latter all the finish he desires, it must be finally polished with a handful of shavings, as we have before explained, and taken off the lathe. He must then place it in a vice, and cut off the pulley with a saw, a little further from the handle than at the division marked by the chisel. The end can then be finished, first with a rasp, and afterwards with a smooth file.

We have given these details of the different operations proper to handle-turning, less for the sake of the handle itself, than with the purpose of minutely explaining the manner of turning any other kind of work. These details, therefore, we shall not consider it necessary to repeat.

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## PART III.

### THE MANUFACTURE OF BRASS AND IRON FERRULES.

**B**EFORE finishing this chapter, the turner will, perhaps, be anxious to learn how brass and iron ferrules are made. The process is as follows :—

Take a pair of shears (fig. 19, Plate XVI.), and cut a parallelogram of brass, long enough for five or six ferrules, and as broad as three times the diameter of the tenon intended to be inserted in them. The brass ought to be about a  $\frac{1}{8}$ -inch in thickness. It should be tolerably well flattened upon a polished block, without being too much hammered, which is unnecessary. Rough down the longest edges, and with a smooth file take away the roughness left by the first file. Then place a straight rule against these edges, and if they seem even and uniform, give a few strokes with the smooth file at right angles to them. The reason for this will be seen presently. Now, upon a round mandrel (fig. 18, Plate XVI.), if the turner has one—if not, upon a cylinder of hard wood—roll up the parallelogram till its long edges nearly and equally meet. The natural elasticity of the material will at first hinder them from exactly touching. To induce them to do so, fasten at short intervals round the cylinder some ligatures of binding wire; tie these with a pair of hand pincers, the twist being made on the side of the cylinder opposite to its open joint. The edges will then exactly meet. Some borax, prepared as we are about to indicate, must be dissolved in some clean and very pure water, and in this water must be put some solder, the ingredients for which we give elsewhere.

After the edges of the parallelogram have been once filed, the operator must be careful not to touch them with his hands. Perspiration, or the dirt which necessarily accumulates on the fingers, would be enough to prevent the solder from taking proper effect. The solder requires equal attention; and it is placed in borax water to prevent it from getting greasy.

The borax should be thus prepared :—As it easily boils at a high temperature, and as, in boiling, it throws off particles of the solder, it is well to place a small quantity of it on a thin plate of sheet iron or brass, and to lay the plate horizontally on some live coals. The borax will instantaneously rise, and then as quickly subside. The plate may now be taken off the fire; when it has become cold, the white powder left upon it should be scraped with a knife, and placed in a small brass box, fig. 16, Plate XVI. Small portions of the solder must be placed almost contiguously along the fissure in the brass tubing, the inner surface of the latter having been first carefully wetted with borax water. Now cover the whole length of the fissure with the calcined borax, so that the solder is quite concealed. Then, with a pair of long gilder's tongs, fig. 17, Plate XVI., hold the tube over some red hot coals in a stove. The water applied to the joint, in evaporating, is likely to cause a disturbance which might disarrange the solder, particularly as this has been applied to a round body; it is well, therefore, not to leave the tube on the coals till the evaporation has ceased. When that is over, pile the coals around the tube; the borax will shortly begin to swell a little, and then subsiding, will cover the whole of the solder with a layer of vitreous matter. This is the time to blow from a little distance with a bellows of moderate size, fanning the air at the same time with a hand screen, so as to cause the fire to give out a uniform heat. Now comes a very difficult moment. The solder melts rather sooner than the brass, but, as the difference of period is very trifling, if the operator's attention is for a moment drawn off, or if he plies the bellows too hard, it is by no means unusual for the whole tube to melt and so become worthless. The likelihood of this mischance is increased if a sufficient space is not left between the coals, so that the solder, which must be carefully watched, can be distinctly seen.

Before the solder runs, the borax becomes completely vitrified, and a slight grey vapour is given off; as soon as it does this, the solder melts, assumes a very brilliant hue, and spreads. If it is seen to be melting uniformly in every direction, the coals should be moved so as to decrease the heat, the tube should be seized with the gilder's pincers, taken gently off the fire, and placed on the floor to become cool.

As we have already said, it is necessary to use the pincers with considerable caution, and for this reason. Brass is merely copper fused and mixed with zinc; the addition of the latter makes the metal lose its homogeneousness. Now as one of the component parts of the mixture grows cold sooner than the other, if the tube is too roughly squeezed, or shaken, or struck, before both metals have acquired a certain degree of coldness, one will give, though the other will have acquired solidity; hence a solution of continuity between the two.

If the solder does not melt equally, it is a proof that the heat of the fire is not everywhere uniform. In that case, the tube must be seized with the pincers and carefully held where the fire is hottest, thus forcing the solder to melt, bit by bit, from one end to the other. But this is a difficult operation, and is seldom succeeded with at the first attempt. Habit is the best instructor.

We advise those, who, not being often in the habit of soldering, have not much experience, to manufacture their ferrules, one after the other, by the process we have just explained; if a forge is at hand, they can be soldered at a charcoal fire. This is the quickest way, but it requires great care on account of charcoal's extreme heat. The ferrules should be held over it with the pincers; the solder will then soon melt. If the tubing is very small, the soldering can be done at a piece of charcoal with a blowpipe and a lamp (fig. 33, Plate X.).

When, by one means or another, the soldering has been got through with, the wire must be

taken off; this will often be found soldered to the ferrule, but it is easily removed with the pincers. The work should then be placed in an earthen jar full of diluted aquafortis, to remove the borax.

Diluted aquafortis is common water in which a few drops of nitric acid have been thrown. Its strength should be tested by dipping the finger in it, and then touching the tongue, it should only cause a slight biting sensation. The aquafortis has the effect of removing the borax and the oxidation produced by the fire.

We have said that the borax becomes vitrified and facilitates the fusion of the solder. It may interest some to learn the physical cause of the fusion of the solder by the borax. The latter is by no means an active agent in the fusion, but, in becoming vitrified, it covers the solder with a crust, which concentrates and increases the heat and accelerates the fusion. Moreover, it scours the parts over which the solder will spread, and prevents the heat from oxidizing them.

The file touches which we recommended should be given at a right angle to the two long edges helps the solder when fused to thoroughly cover the joint. If they were made in the contrary direction, it is clear that the task of the solder would not be so easy. It is a process which it is well to resort to every time solder is used; we shall have occasion to speak of it more than once.

It is sometimes, perhaps, desirable to put iron ferrules on the handles. There are several ways of obtaining these; first, by cutting off the ends of gun and pistol barrels. But, as the diameter of these is rarely more than  $\frac{3}{8}$  to  $\frac{3}{4}$  of an inch, and as it would be expensive to have larger ones cast, here is an easy method of making iron ferrules of all sizes.

Take some of the sheet-iron used for sawing stone, this is generally about a  $\frac{1}{16}$  inch in thickness and is made of very soft metal. Cut off from it strips as broad as the intended length of the ferrules; then cut them of a length of about  $\frac{3}{4}$  of an inch wider than three times the diameter of the tenon; hammer them well on the anvil, then take hold of them with a chamfer-clamp (fig. 15), and place the clamp in a vice, with a file make at one of the ends a bevelled edge, very straight and very sharp; when this is done, turn them round and make a similar bevelled edge at the other end; then roll them up on the beak-iron till the two oblique edges touch one another, cover them with borax, and take care that they exactly meet. In order that they may do so, fasten round them, as in the case of the brass ferrules, some wire, and solder them, not with large lumps of solder, but with a small piece of latten, which will easily melt when exposed to a good fire and a pair of bellows.

This is called hard-soldering, and is often used. When the object it is desired to hard-solder is of a considerable size, it is well to use powdered glass instead of borax, which is always expensive. Prepare the end of the ferrule which is to come next to the handle with a file, and then turn it. But we are anticipating. We intend by and by to explain how to turn iron and brass, a process that requires altogether different tools from those used in wood turning, and we will say no more here. What has already escaped us will be enough for the present for those who know how to turn.

After turning a dozen or two handles, the beginner will have learned to cut wood tolerably well, and will consequently be able to turn other objects.

## CHAPTER III.

## On Hand-Winders and Spinning-Wheels.

## PART I.

## HOW TO MAKE A HAND-WINDER.

**OF** the different objects that can be made at the lathe, we shall take special care to speak of those that will both interest and afford experience to the turner. We are now about to describe the way to manufacture a Hand-winder (fig. 1, Plate XVII.). As the manufacture of this article includes the art of the carpenter as well as that of the turner, it will give the beginner an opportunity of practising the handicrafts connected with that with which we are more especially concerned.

We shall name no particular wood, the reader may select that for which he has a preference.

He should take a sound piece of wood, 7 or 8 inches square, and a good inch in thickness. This must be carefully planed on both sides till its thickness is uniform. A hole of from  $\frac{3}{8}$  to  $\frac{7}{8}$  of an inch in diameter must now be made in it with spoon-bits of gradually increasing size, and this must be bored out with a screw-tap cutting a thread about  $\frac{5}{8}$  of an inch in diameter. We shall presently explain the screw-tap and the way to use it.

Now turn between the centres a cylinder about  $\frac{5}{8}$  of an inch in diameter, and from 6 to 7 inches in length, but keep a much thicker part, of from  $\frac{7}{8}$  to  $1\frac{1}{8}$  of an inch diameter, at the end of the cylinder, such as is represented in fig. 10, Plate XVI. If the thread made by the screw-tap is exactly perpendicular to the wood, it ought to fit closely against the thick part of the cylinder, and when placed between the centres on the cylinder, it ought to turn truly.

The workman should now, with a gouge, make a circular moulding half the thickness of the block of wood, which we shall henceforth call the *Foot of the Winder*, and the profile of which is represented in fig. 11; or if he prefers it quite round, he must trace a circle on the wood, and cut it out with a turning-saw.

A beginner will find a difficulty in turning this foot. As it is not possible to cut wood well by holding the gouge against the circumference, it must be held on the surface, the edge nearly, but not quite, parallel to the wood's axis. The inequalities left by the saw must be removed first, and then with a very sharp gouge the surface must be smoothed, and the proper shape given to it.



If foreign wood has been used, it can be left as above, but if ordinary wood, such as the White Hawthorn or the Pear, has been employed, a circular groove, from  $\frac{5}{8}$  to  $\frac{3}{4}$  of an inch deep, must be made on its lower surface, broader at the base than at the top, about an inch from the edge, which must be filled with lead, in order to steady the foot.

Before running in the lead, it is advisable to take the gouge and make some notches in the channel of the groove, to prevent the leaden circle, which will be unable to escape on account of the peculiar shape of the groove, from turning and moving in its prison. Or, better still, drive a few nails, leaving their heads exposed, into the groove; these will catch and hold the lead.

Place this circular piece of wood, the groove uppermost, upon a firm table; melt some lead in an iron spoon with a lip, and pour it into the groove; if this has been prepared with a little white resin, the molten lead will run round and fill it. The lead, however, should not be too hot, or it will warp and split the wood. To ascertain if it is of the right degree of heat, dip a piece of white paper into it; if the metal is of the proper heat, the paper will merely assume a slight reddish tint.

Let the lead get cold, and then put the foot back again on the mandrel, in the position it was turned in. For this purpose, corresponding lines should have been traced with a pencil on both the foot and the mandrel. This and all similar tracings are called guide marks.

Nothing is so soft and so easy to turn as lead. First, roughly shape it with the gouge, cutting away but little of it. Lead is a greasy metal, and the part cut away has a tendency to stick to the parent material. To obviate this, frequently rub the circle with soap and water, or with a rag steeped in it; the cuttings, particularly when the point-tool or the chisel are used, will come off cleanly and easily.

When the circle has been cut down, by holding the gouge very obliquely against it, take a sharp chisel with a single edge and hold it at right angles, or even more obtusely, to prevent vibration, against the lead. This vibration, or trembling, will arise, and gradually increase, unless the hand make a great effort to conquer it. It generally occurs whenever a tool is held at right angles to the object upon the lathe; when it once sets in it is impossible to prevent it from increasing. The only thing to be done is to vary the position of the tool, so as to continually shift the direction at first given to it.

This circle of lead can also be turned with a rather broad point-tool; the latter should be broad so that the edge may be long without being too sharp, and thick enough not to vibrate.

The foot is now finished, at least, if care has been taken to cleanly cut the flat part of the wood with the different one-edged chisels and the point-tool, and if the moulding has been made with the proper gouges. Some glass-paper must now be carefully passed over the edge and the mouldings. It would even be well to reverse the cord upon the pulley, so as to polish the pores by rubbing them the other way.

Now comes the question of the shaft to support the winder. The turner must first decide the form he intends to give it. A skilful workman generally traces an outline as large as the shaft itself is to be, and uses it as a guide while he turns. Without attempting to give the palm to our own ideas on the subject, we may quote the following as one that has pleased many. It is represented in fig. 12. It is a kind of baluster, the tenon of which is replaced by a screw, to enable it to enter the block. This screw is next to the shoulder A; then comes a square; then a half-round, or a moulding; then another square; then a hollowed portion leading to a third square, whence swells the thicker part, this suddenly merges into a long neck topped by a listel, upon which rests the cross-pieces that form the arms of the winder. Then comes a slender stick, tapering a little to its upper

end, where comes a screw about  $\frac{3}{8}$  of an inch in diameter, which is intended to receive the cap (fig. 13.) The baluster terminates in a steel rod, tightly fitting into a hole made in the middle of the upper end of the baluster, and on which the winder turns. This it does with great facility, owing to a little brass collar being fixed on the rod.

Fig. 14 represents a couple of balusters in half profile; these can be altered according to individual taste. Fig. 1, Plate XVII. represents the whole winder.

As it is more convenient to joint the arms so that they may fold up against the cup that holds the ball of worsted and take up less room, we shall be particular in the following description to point out both methods of construction, without, however, giving a separate cut for each, so as not to crowd the plate. Moreover, when the arms are out-stretched, the joints, if properly made, are scarcely visible.

We will begin with the winder, the arms of which are jointless.

Take a piece of wood about an inch thick, and from 10 to 12 inches in length. Cut it into shape with the hatchet, put it on the lathe, and turn it into a cylinder. This method of procedure, besides giving experience to the amateur, best enables him to determine the length of the mouldings. When, therefore, the cylinder is quite round, and the ends cut off at right angles, mark off about a couple of inches from the right extremity with the corner of the chisel. Measure off on the drawing, which should be of the natural size, the height of each part of the moulding with a steel spring compass (fig. 12, Plate I., Vol. II.) Next to the two-inch length already marked off on the cylinder, which is intended for the screw-tenon that will be inserted in the foot, mark off the length of a square, of a moulding, and of a groove or a half-round, according to taste. Then that of a second square, and of the thin neck which gives relief to the belly of the baluster. Then that of another square, of the bellied part of the baluster, of a fourth square, of a beading, of a fifth square, and finally that of the socket on which the winder turns, immediately beneath the brass collar. Make a mark right round the cylinder at each of these measurements and then, starting from the tenon at the end, measure the whole length, to see if in these fractional distances the total has not been exceeded; a circumstance that often happens, as a slight excess in each fraction amounts to a considerable aggregate difference. If a mistake is discovered it must be rectified.

This is a good way to proceed, but we advise amateurs to dispense with all these measurements, and to trust to their eye alone to reproduce the model on the wood. To do so will give practice both to the eye and the hand, and greatly diminish the expenditure of time.

When all this is done, if the cylinder is a little too long, cut it off exactly at the last mark. Put the new end back on the centre; the hole which this will make will be useful by-and-by. This is a rather difficult operation, particularly for beginners; they make bad guesses as to which side the eccentricity lies. It is best to find the exact middle with the compass, and to, but gently at first, insert the centre, so as to be able to shift it slightly one way or the other if necessary. Or if the variation is too trifling for the eye to detect, the plan pointed out in the last chapter can be had recourse to.

Let us suppose, now, that the cylinder has been cut down to the proper diameter, which ought to be exactly that of the thickest part of the baluster. These are the next steps. Cut away the wood of the part intended for the screw-tenon, till the exact thickness necessary for the outside diameter of the screw is left. For instance, if it has been decided that the screw should be from  $\frac{1}{4}$  to  $\frac{3}{8}$  of an inch in diameter, and a thread has been bored in the foot by a screw-tap of that calibre, roughly cut the tenon with the gouge and finish it with the chisel, making it

a little smaller, so that it may easily enter. This smaller part should not be more than from  $\frac{3}{8}$  to  $\frac{1}{2}$  of an inch long, and should be cone-shaped. The shoulder must now be cut out with the angle of the chisel, and, in order to make the foot stand evenly, the protruding end of the tenon must be gently removed, and its diameter from one end to the other made uniform.

Now take the cylinder off the lathe. Place it upright in a wooden or iron vice, between two pieces of leather, to prevent it from being marked. Rub the tenon with a little dry soap, then, inserting it into the thread, screw it gently in. If it bites properly, go on screwing gently till the top of the thread fits close against the shoulder. We will not say anything here of wooden threads, for these we must refer the reader to fig. 8, Plate VI. Vol. II.

The little plate placed on the thread, and equal in size to the cylinder intended for the screw, prevents the V which cuts the wood from quite touching the shoulder. The screw, therefore, does not exactly go quite home. When the top of the thread has almost reached the shoulder, unscrew it, take out the screws which fasten the plate, and, removing the cylinder from the vice, carefully put the screw back into the thread, so that it may pass without being hindered by the V, and turn it till the top of the thread presses the shoulder. In spite of this precaution, however, it will be found that it never goes quite home. There are two ways of remedying this. One, to put the cylinder on the lathe, and with a narrow gouge to cut away the wood close to the shoulder; the last turn of the screw not being very necessary, particularly if the thread is of a tolerable size. The second, which is the best, is to give the end of the thread a conical shape.

When the screw is finished, put the cylinder back on the lathe, and with a pair of callipers (fig. 18, Plate I. Vol. II.), take the diameter of the square next to the foot. For fear, however, of losing the marks made on the cylinder, deepen them with the angle of the chisel, taking care to cut only as the treadle descends, and never when it rises. To do the latter would have the same effect as to use a point-tool reversed, and would spoil the wood.

Make this square the right size, cutting the wood as cleanly as possible with that part of the chisel next to its lower angle. Then shape the moulding that comes next with a gouge, and finish it with a chisel of the proper size. Now hold the upper angle of the chisel against the wood perpendicularly, and cut the part that ought to be square; then, in order to enable the chisel to cut cleanly in a very limited space, deeply cut away the narrow neck that follows the square with a rather large gouge; this will give more room. Then finish the square with the chisel. Shape the beginning of the narrow neck with the angle of the chisel, so that the square may stand out well in relief, and then finish the neck.

This narrow neck demands considerable care if it is to have a pleasing appearance. Its outline ought not to be an arc of a circle, but a curve drawn from different centres, such as is represented in fig. 2.

It is scarcely worth while to stop to describe the way to shape the rest of the baluster; a little taste and a little experience will soon show. It will be seen that before turning the stem that supports the winder, a round must be made on it between two squares, or any other moulding, as long as it finishes off the top of the bellying part of the baluster. The screw end of the stem ought not to be more than  $\frac{3}{8}$  of an inch in diameter; it must, however, allow the crossbars to revolve very easily. The length of this part ought to be a little greater than the thickness of the arms. The part on which the crossbars actually revolve ought to be a little the thickest. The projecting part must be cut into a screw and rounded at the top. This is then capped with a nut, fig. 13, Plate XVI., which will rest upon the crossbars, and enable the inside to be lifted by the arms without separating it from its stand. This nut should be made out of a piece of wood

from 15 to 18 lines in thickness. It must be made into a female screw, and placed upon the worm made in the upper end of the baluster. The whole is replaced in the lathe, and the nut is given the shape shewn in fig. 13, with a square at its base of about  $\frac{3}{8}$  of an inch in thickness. Six or eight facets should then be given to this square to enable the fingers to easily clasp it and screw it on. Finally, the rounded head of the baluster should be fixed in a plate, and the hole made by the centre should be deepened, with a very small spoon-bit, till it is about half of an inch in depth. A small steel rod, filed to a point, softened and stained blue, in the manner we have previously described, must be placed in the hole. This will work in a small brass collar we shall presently describe. We have omitted to remark, that while the baluster is being turned the cord should rest upon the narrow neck, and that while the neck is being turned it should be placed on the thick part of the baluster. Here will be seen the advantage of our advice to use soft whipcord; in the present case, indeed, it would be wise to keep the wood from being marked, by wrapping it in a piece of skin or soft leather.

The foot is now completed. The edge, however, may be fluted, as in Plate XVII. fig. 1, or in Plate XVI. fig. 14. Marks must be made, exactly opposite to each other, on the upper and lower rims, and the flutings carefully cut between them. They should then be hollowed out by the hand with gouges of different kinds, hereafter referred to.

It will be remembered that the tenon was made two inches long, and that the thickness of the foot is only about three-fourths of an inch. We advised this excess of length in order to facilitate the entry of the screw into the thread; the first turns of the screw, moreover, are generally indifferent and irregular, so that when the work is completed it is well to be able to cut them off. The length of the tenon, therefore, should be reduced to an inch. The thread of the excess should be removed with a narrow gouge, sharpened lengthways, and finally cut through with a chisel. If the chisel were used first, the twist of the screw would prevent it from cutting true, and the work would be spoiled.

All that now remains to be done is to fix the steel rod at the end of the shaft of the foot; it is essential that it should fit exactly into the centre of the axis, and this is the mode of procedure.

Place the foot back again between the centres, and let the cord pass over the thread of the screw. Put the upper end of the foot in a plate, and insert into the hole at its extremity a piece of steel wire of a suitable size. When it is inserted, observe if it turns truly, then, with a file, point it, taking care that as it turns the point always remains truly in the centre. Blunt the point a little, to prevent it cutting the collar, and then, with a small file, mark the steel where it emerges from the foot, to serve as a guide, and to enable it to be replaced as before after it has been hardened.

Now to make the actual winder. With a saw cut the wood that has been selected into two long pieces. Make these pieces two feet long, a quarter of an inch thick, and from one inch and an eighth to one inch and a quarter in width. Plane the broader side well. Adjust one of the narrower sides with a square, and then, with a carpenter's gauge, reduce both of them to exactly the same width, following the marks of the gauge with a sharp plane.

Take, also, two other pieces of wood, about four inches long; give them the same width and thickness as the two first. Bisect the length of each piece, and mark the point of bisection on the broader side (*a* fig. 4). Then, starting from this point, mark with a compass, on either side of it, as at *b*, *b*, half the width of the other piece. Do this to both pieces. Then, with a square that has a rim upon one of its side pieces (Plate II. fig. 4, Vol. II.), trace marks at these points, right across the arms of the winder, at right angles to them. Now, from the centres of each of the

extremities (*c, c*) of the larger arms, taking care that these centres are equidistant from the longitudinal centre of the whole piece, mark off a width slightly less than that of the arm, *d, d*, and with a straight rule draw lines from these marks to the ends of the line traced perpendicularly across the arm at *b, b*. This will make each arm narrower at its extremity, as in fig. 4. Do the same to the other long arm, and cut them both down to this lesser width with a plane.

Now, with a carpenter's guage, measure half the thickness of the arms, and mark it off on both of them at *b, b*. With a small saw cut the wood through at *b, b*, till the above mark is reached, and remove it with a very sharp chisel. Care must be taken to cut away the wood exactly to the mark of half the thickness, as well as to the perpendicular lines at *b, b*. Do the same to the other arm, and place the first at right angles across the second, the mortises fitting exactly into one another. If all has been correctly done, the result will be a perfect cross, held together by the exactness of the dove-tailing, and of the thickness of a single arm.

The same process must be resorted to for the shorter arms. There will then be two sets of cross-pieces.

If, in cutting the mortise, the centre (*a*) is lost sight of, it is easy to again find it. Draw diagonal lines from the four extremities of the perpendicular lines at *b, b*; the point of intersection will be the centre.

From this centre make a mark on each arm of each cross-piece, at a distance equal in length to an inch less than the length of the smaller arms. Exactness is here very necessary. Make a hole with a centre-bit at these points of three-sixteenths of an inch in diameter.

There will now be four holes in each cross-piece, exactly corresponding with one another.

In the centre of each cross-piece make a hole of a proper size; that is to say, the hole in the longest cross-pieces should be a very little larger than the diameter of the part it is intended to receive, while that in the shorter arm should be from three-eighths to half an inch in diameter.

The cross-pieces must now be firmly glued together. To secure this, take a rasp and roughen the wood at the bottom of the mortise-holes; the glue will settle in the rough places, and firmly grip the wood.

Put each cross-piece in a holdfast, or press them in a joiners' cramp-iron. A description of the latter has been given in the chapter on Carpentry.

While the glue is drying, turn four balusters to connect the upper cross-piece with the lower one. The shape of these balusters is a matter of taste; but it is well, for the sake of harmony, to give them the same outline as that chosen for the foot of the winder.

Take a hatchet, and cut four pieces of wood from three-eighths to half an inch in diameter, and about three inches long. One inch of this length must be devoted to the pulley for the cord of the lathe. Put the pieces between the centres. Turn them carefully; they will require a good deal of attention, as small objects are more difficult to turn than large ones. Tenons must be made at each end, of about three-sixteenths of an inch in thickness, so that they may fit tightly into the holes of a like diameter already made in the cross-pieces.

When the four balusters are turned, and tenons have been made rather longer than the thickness of the arms, saw off the pulley. Smooth the tenons with a rasp, and the hole intended for them with a half-round one; then glue the balusters into their places. Put a weight on top of each baluster, so that the arms above them may be driven quite home. It will at once be seen that if the balusters are not of exactly equal lengths, the two cross-pieces will not lie in parallel planes.

When the glue is dry, rasp away the protruding portions of the tenons, if, that is to say, the

holes in the arms quite pierce the latter, and finish off with a smooth file. The work, however, will have a neater appearance, and will be quite as solid, if the holes in the arms are not allowed to quite penetrate them.

Now, from the main centre, mark off four equidistant points on each arm, so that the last is at about an inch and a half from their extremities. Pierce holes at these points with a centre-bit three-sixteenths of an inch in diameter, inclining the drill-bow a little to the outside. This is to allow the pegs intended for the holes to lean rather away from the centre, and prevent the material being wound from slipping off them.

The cup to be placed at the top of the winder, and intended to hold the ball of worsted, has now to be turned. Its form is seen in fig. 5.

Take a piece of well-seasoned and sound wood, without knot or blemish, and about four inches in length. Place it between the centres, and give it the external shape seen in fig. 5.

It should now measure, from the rim of the cup to beneath the moulding at the foot, only two-and-a-half inches. The rest of the original length must be devoted to the tenon, which must be made of exactly the diameter of the hole pierced in the centre of the upper cross-piece. Reduce the length of the tenon to rather less than the thickness of the upper arms. First, however, the cup has to be hollowed out, and, to do this, it must be placed in a plate. Give it the internal shape necessary, without making the wood too thin or leaving it too thick. Let the outlines of its internal and external sections represent two eccentric circles of different diameters, as seen in fig. 6.

This cup can also be hollowed in the manner employed by the turners of large objects, the manufacturers of mortars, large spoons, etc. They first turn the outer part, giving the cup the proper shape; they then hollow it, leaving a solid portion in the middle, and leaning their tool to one side on an iron rod placed on the centre and on the rest, until the inside is finished. The solid portion is then removed by undermining the part next the bottom of the cup till it easily comes away.

This method seems better than the first we have described, as the plate always leaves a mark on the outside of the cup; the diameter of the plate, moreover, is usually too small to allow room for the cup, and it is necessary to make a special plate.

A notch has now to be made at the bottom of the cup's tenon, to receive the brass collar; as at present we are not supposed to be dealing with a lathe with an overhead motion, and as it is somewhat difficult to turn the object we are speaking of on an ordinary lathe, we make a point of describing the methods that can be resorted to in any case. A mandrel with points should be constructed, such as is shown in fig. 7. This is a wooden cylinder, from three to four inches long, and about three-quarters of an inch in diameter. In one end of this mandrel, which must be abruptly cut off, three pieces of steel wire as large as an ordinary nail must be inserted, so as to form the three angles of an equilateral triangle. These wires must then be filed down till they are not more than an eighth of an inch long. This mandrel will be useful in a variety of instances.

Now take a small piece of wood about three inches square, and about a quarter of an inch thick. Mark a circle on it, and cut it out with a turning saw. Trace a smaller circle in the middle of this piece of wood, of the size of the mandrel's end, and fix the mandrel to the wood, exactly in this circle by striking its other end with a hammer.

Place the whole back again upon the lathe, and if the centre is difficult to hit upon, find it by the method we have already explained, taking care to be sure that the mandrel turns truly.

Now cut away the circular piece of wood with the gouge till its diameter is but little larger than that of the cup; then further lessen its diameter to the extent of about two-thirds of its thickness, so that

the thinner portion fits into the cup, and the rest leans upon its rim. The cup is now furnished with a tangible centre, to guide the insertion of the steel point.

Place the whole back upon the lathe, the end of the tenon being in the plate. By this means the circular notch, intended for the brass collar, can be made on the end of the tenon.

Make a little indenture at the end of the tenon, of about three-sixteenths of an inch in depth first with a point-tool, and then with a small one-edged chisel. Now, leaving the work still upon the lathe, take a file and make a small round piece of brass, a little larger than the part it is intended to fit; this piece of brass should be about three-sixteenths of an inch in thickness. Fit it on, striking it with a light hammer, till it is well home and seems solidly fixed. Brass requires to be turned in a particular manner. The chisel must be held beneath it. If it were attempted to cut brass in any other way, it would be impossible to turn it smoothly.

Mark the centre with the extreme point of the chisel's angle. Deepen this hole with a small and very sharp point-tool, in such a manner that the hole be conical, and its vertex exactly in the centre. That the winder turns in a perfectly horizontal plane depends on this.

The hole can be deepened with a brass borer, described in our chapter on the "Drilling of Woods and Metals." There is nothing more to be done but to turn the arms, which, fitting tightly on to the tenon, and being glued there, solidly fasten the cup to the cross-piece.

Now take a piece of wood of a convenient size, and hollow it out to exactly the tenon's diameter, either with a spoon-bit, or on a plate in the lathe. Fasten it securely to a cylindrical mandrel. Then turn it to the shape shown in fig. 8, or as nearly so as possible; make its diameter about three-eighths of an inch greater than that of the tenon, and its length such, that, being driven home and glued there, it is exactly flush with the end of the tenon.

In describing the way to make the cup, we did not explain how it can be hollowed out. As this process may prove interesting to beginners, we will say a word or two about it. Cut the inside out with a gouge, which must be held obliquely to the interior; finish it with a chisel with a single sloping edge, as in fig. 6, Plate XII., and of the same curve it is intended to give the cup; if the curve be less, it will be impossible to remove the ridges left by the chisel. The best way is to make a cardboard model of the intended curve shown in fig. 6, and to use a compass with a sharp point; in this manner the beginner will be sure to hollow the cup properly.

All that now remains to be done, is to round the ends of the arms. A smooth file must be used for this. The ends must be then polished with some shave-grass (a kind of dry, very coarse grass, which, rubbed against the grain, has a considerable effect upon wood; its botanical name is *Equisetum*), or with polishing paper. The rough edges of the arms must be similarly removed.

The four pins must be carefully turned. A graceful shape should be given them, such as that shown in fig. 9. The pin, which is capped with a little point, may seem difficult to make on an ordinary lathe, but enough wood can be left beyond the head, and the pin can then be finished in a plate, the part beyond the head being allowed to protrude. In figs. 10, 11, and 12 the different shapes for the heads of these pins are shown; but in all cases they must be finished in a plate to prevent the centre from leaving any traces. The winder is now entirely complete.

As this kind of winder takes up a good deal of room, on account of the length of the long cross piece, some makers prefer to cut off the latter's arms about a couple of inches beyond the four connecting balusters. In this case the larger arms are not made of a single piece, but of two parts, each about two inches longer than the smaller ones. To each of the four arms on the lower cross piece another is afterwards added, of similar breadth and thickness. Figs. 13 and 14 represent one of the

original arms and one of the supplementary ones. A tenon and a mortise-hole is seen at their respective terminations; these require to be very nicely adjusted, but as the joining requires a hinge-joint, each tenon must be dove-tailed, as in fig. 15, both at its end and at its shoulder. When all the parts exactly correspond, the dove-tailings fit, and the joinings perfectly meet, a hole must be perpendicularly driven into each arm. It will be best to commence this hole on both sides and continue it till it meets, in order to ensure its exact perpendicularity. Then, with some strong wire make some bolts of the shape shown in fig. 16. The easiest way to make these is to heat the end of the wire, and with a pair of round pincers (Plate IV. fig. 4, Vol. II.) twist it into a loop, as in the cut. Polish the places blackened by the heat with a very smooth file, flat or half-round, as may be most convenient; file the bolts away to a point, taking care to blunt the points, so that they may neither scratch nor injure the wood.

The winder is now finished. In going through its different details, we have explained a variety of operations which will be of use on many occasions, but which we shall not again inflict upon our readers unless it is absolutely necessary to do so.

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## PART II.

### WINDER WITH LANTERNS.

**T**HERE is another kind of winder, so very handy that a lady can carry it about with her, and that can be fixed to a table or a couple of chairs.

Take two pieces of wood about a quarter of an inch thick, and trace upon them with a steel compass a circle of about  $3\frac{1}{2}$ , or, to be very exact,  $3\frac{1}{8}$  of an inch in diameter. Cut them round with a turning saw. Make a hole about a quarter of an inch in diameter in the centre. Turn a cylinder of hard wood about three inches long, and make its thickness, for about a third of its length, about a quarter of an inch; causing it to taper still further towards the end. Take care to keep a pulley at least an inch thick upon the cylinder for the cord. Fix one of the circular pieces of wood to the cylinder, and turn it very round and very true; but, as its slight thickness makes it fragile, the turning must be done very gently and carefully. Give it no mouldings, except, perhaps, at the rim, a little beading on the upper side, fig. 18. Take a point-tool, and, about three-quarters of an inch from the rim, and on the same side as the beading, trace a mark as in fig. 19; this will be explained directly. Polish both sides of the wood, as well as the beading. Now take the circular piece of wood off the mandrel, and turn a second one in an exactly similar manner. Then turn two more of a smaller diameter; their lower sides must be quite plain, their upper ones can be ornamented according to taste. These should be made of wood about three-eighths of an inch thick. Fig. 20 shows the kind of mouldings that can be here used. Trace a circle on the lower surfaces of all the four, pieces about half-an-inch from the rim, with a point-tool. Take care that this circle meets where the wood is thickest.

Divide this circular line, on each of the four pieces, into eight equal parts, and, with a spoon-bit with three points, make a hole about one-eighth of an inch in diameter at each point of division. But care must be taken that the holes do not completely penetrate the two smaller pieces. Now



turn sixteen straight pieces about three-sixteenths of an inch in diameter. Make tenons at each end of them of one-eighth of an inch in diameter, and let the length from one shoulder to another be exactly four inches. When the uprights are quite smooth and polished, glue eight of them between each of the larger and smaller circular pieces of wood, as in fig. 21 ; the tenons must be fastened into the holes with strong and very hot glue.

Now turn two central uprights, making them of such a length as to allow the lanterns to rest upon a shoulder much lower down on each central upright, as in *a*, fig. 22. Beneath this shoulder is a screw-tenon, whose use we shall presently explain.

Then take a piece of very hard wood, from four to four and a half inches long, one inch thick, and about three inches wide. This piece of wood, shewn in *A*, fig. 21, cannot be made on the lathe ; it must be entirely hand-manufactured. Cut away the middle of it with the turning-saw, as seen in the cut. Shape it externally, as shewn ; then, leaving the two ends of the size determined upon, lessen the thickness at each side of the curved part by about one-eighth of an inch. Finish the whole with the rasp and the grater, and polish it with a smooth file. Pierce holes above and below to receive the screws, and cut threads in them with a screw-tap ; the upper one to receive the tenon of the central upright, the lower one for the screw of the vice, *a*, fig. 21. It will be well to glue a piece of cloth beneath the upper square to give the screw a firmer purchase.

In turning the central upright, a tenon of half an inch in length and about one-eighth of an inch in diameter must be made at its upper end. The length of each lantern must be carefully measured, and the shoulder of the tenon must not be allowed to exceed by more than the smallest fraction the total length of the lantern, so that the cup about to be placed above the tenon cannot touch the lantern or prevent it from freely revolving.

All that now remains to be done is to turn a cup to place on the top of each lantern. The shape of this cup is a matter of individual taste. The one shewn in *B*, fig. 21, may, however, serve as a sample. We say nothing here of the way to turn the cup, we have already described the process.

Enough has now been said on this subject. Fig. 21 represents this kind of winder complete ; the details we have entered into are more than sufficient to make the beginner grasp the whole process of its construction.

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### PART III.

#### ANOTHER METHOD OF CONSTRUCTING THE WINDER WITH LANTERNS,

**T**HE winder we are about to describe only differs from the preceding one in the manner its lanterns are placed. We will, therefore, take it for granted that we already have a couple of lanterns fixed in their central uprights, and capped with cups or any other ornament.

Thoroughly plain and smooth a piece of wood of the required thickness; make it about 16 inches long and from 7 to 8 inches wide. Either round the ends or make them quite square; but in either case carefully polish the edges with a smooth file, following the grain of the wood. Then, with the same kind of wood make a couple of rods, almost a foot long, and not more than 2 inches in width. Finish them carefully, and give them a thickness of about three-eighths of an inch. Round their ends, and run a moulding right round the surface that will be uppermost; or if this is too troublesome, they can be left square, a chamfer being run all round them with a file. If it is desired to give an extra finish to the work, first trace the intended width of the chamfer with a carpenter's gauge, and then, with a grater, a rasp, and a file, finish it off. This, however, must not be done till the work is nearly finished.

Now trace on the two surfaces of each rod a couple of lines with a carpenter's gauge, which must be held so that the lines are parallel. The distance between the latter should be from five-sixteenths to three-eighths of an inch. Make a small opening at the end of these lines, in order to introduce the saw (fig. 3, Plate XXV.) with which to remove the wood between the two lines. Now put the rod in a vice, protecting it with small pieces of wood, and finish off the open groove with the rasp, the grater, and the smooth file; removing the wood exactly up to each line.

The plate shews a part at one end of the rod that has not been grooved out. A hole must be made here, and a thread driven into it to receive the screw-tenon, *a*, of the central-upright, fig. 22. Now make a couple of screws of the shape shewn in fig. 26. In order to more easily allow these to be turned by the finger and thumb, the head of the screw must be given a spheroidal shape; a little button should be added to the top for the sake of finish; and the parts *a*, *a*, *b*, *b*, fig. 26, must be sawn off at an equal distance from the centre. Polish the surfaces left by the saw with a sharp rasp.

Now place the two rods side by side upon the foot, to determine the points for the insertion of the screws. Pierce holes at these points, and bore threads in them. Fig. 27 represents the rods upon the foot.

Fig. 27 shews one of the shapes that can be given to the foot, the two rods lying upon it, and the position of the screws *a*, *a*. It will be seen that if the uprights of the lanterns are inserted at *b*, *b*, it will be easy to bring them close together, or the reverse, by moving the rods to the right or to the left.

To give more finish to this winder, it is possible to run a moulding all round the upper surface of the foot; a hollow half-round, a round between two squares, or a fluting. But this will necessitate the use of several kinds of carpenters' tools, and a sufficient degree of skill in the workman to allow him to hand-make with a gouge the same moulding all round the circular parts.

To hand-make a moulding with a gouge is a difficult process, we will therefore indicate an easier method. Find the centre of the arc which rounds off the foot, place a point there, and fix a wooden rod about two inches wide and one inch thick to it, in such a way that it can easily move.

Now at a convenient distance fix the iron used in making the side mouldings in the same way as is fixed the iron of cart wheels, fig. 55, Plate 9. With this instrument it will be easy to trace the circular mouldings of the two ends. The workman, however, must be careful to cut away but little wood at a time, and to lower the iron at each half-turn till the required depth is reached. If there is any fear of injuring the foot by fixing a point in its centre, it is easy to place a plate above it, and to fasten the point in the centre of the latter. Fig. 25 shows a model of this process.

It is also possible to do without the moulding, and to nail a ridge of the same wood round the rim of the foot. This ridge should be of a thickness of about three-sixteenths of an inch, rounded, and of the same width as the thickness of the foot. This rather difficult operation, however, really belongs to Carpentry. If the wood be Hawthorn, the job will not be so difficult, still less, if it be Walnut, as the latter wood is very pliable; but if it be foreign wood, which is very dry and brittle, the difficulty is much greater.

If the wood is Walnut, measure exactly the circumference of the foot. Saw a rod of the proper width and thickness, but two or three inches longer than the circumference. Shape it properly, plane it down to the exact thickness, and with a moulding plane give its surface the proper beading. Saw one of the ends squarely off, and give its upper side a sloping edge. Nail it down with one or two small headed nails, and continue to apply the rod as closely as possible to the foot. Now hammer in another nail, about three or four inches from the first two or three, then insert a third, and so on, till the last is within three inches of the end. Then, at the exact point where the two ends will meet, saw off the excess, and give the new end a sloping edge in the reverse sense to that of the first, in such a way that the two sloping edges will so exactly meet and overlap, and the rounded upper surface will appear so continuous, that the joint will hardly be visible. Hammer in a couple of small nails close to the sloping edge, the upper one of which should keep the under one in its place, and the moulding will be solidly applied.

It is now requisite to hide the nail-heads, which do not look well upon a polished surface. These must, therefore, be driven in with a blunt punch till they are a little below the surface.

Then take some wax, knead it up with some dust of the wood used, to give it the proper colour, and fill up the cavities above the nail-heads with little balls of the mixture. Polish this new surface with a piece of serge, and all traces of the nail-heads will have disappeared.

Glue can be advantageously used instead of wax for this last operation.

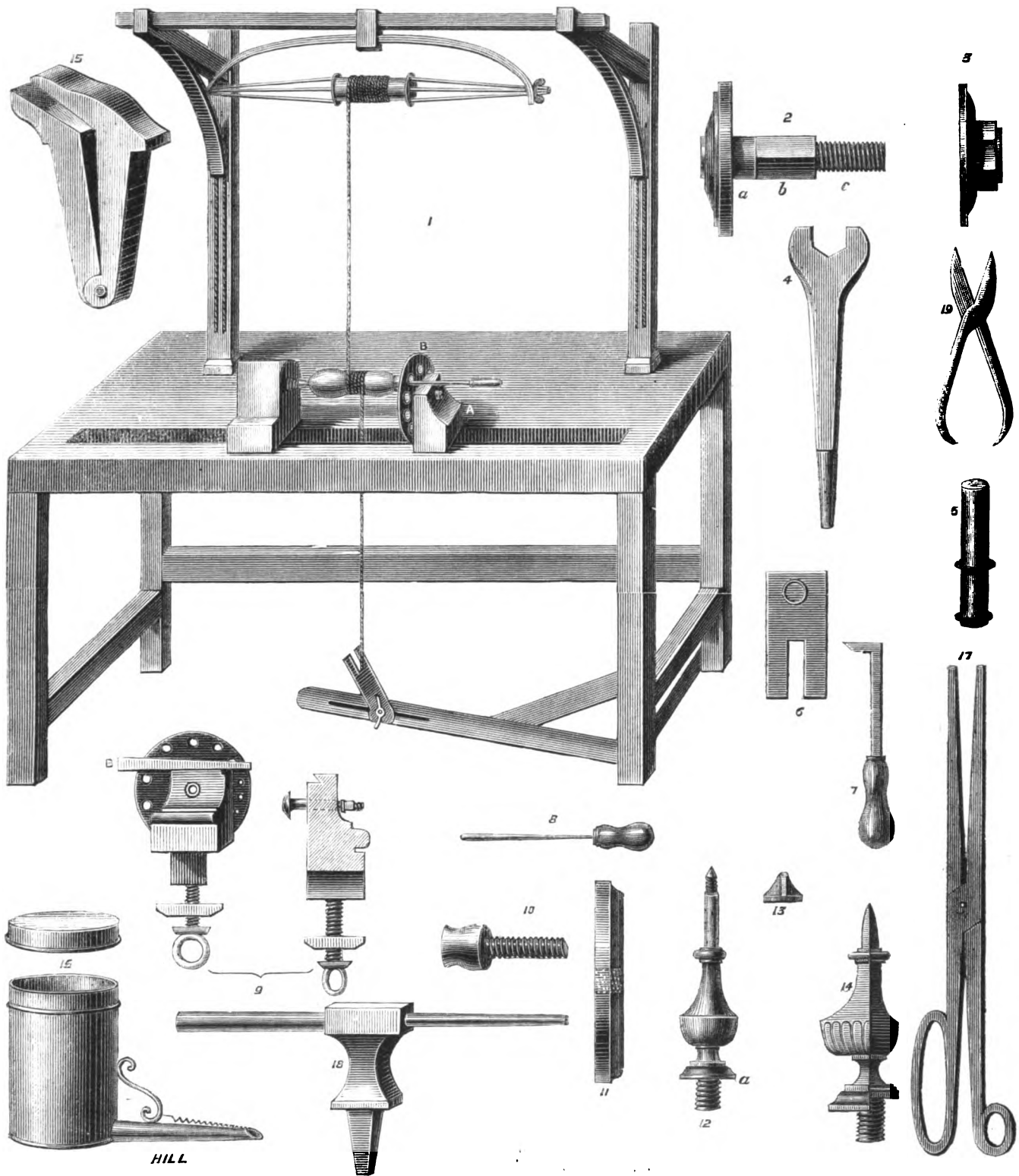
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## PART IV.

### A WINDER THAT CAN BE PLACED ON THE KNEE.

**I**T is often necessary, in embroidering, to wind a great quantity of silk of many different colours. Amateurs, therefore, will not take it amiss if we explain the construction of a winder that will wind the silk off on reels, or transform what is already on the reels into skeins.

Figs. 14, 15, and 16, Plate XX. represents a front elevation of such a winder, its section, and its plan. A single upright, *A*, fig. 14, is fastened to a flat piece of wood, *B*, and kept in its place by wooden nuts beneath. This upright, to which a column shape can be given, is surmounted by a square or four-sided piece, on one side of which a wooden bolt is inserted. On this bolt revolves a wooden circle, *a*, on the thickness of which are six protruding shafts, as at *b*, turned on the lathe, and at the end of each of which are placed a kind of reel, as in *c*, fig. 15. The silk is wound on these reels. One of the protruding shafts has a handle, *d*, which turns the winder. At the other end of the flat piece of wood, *B*, fig. 16, are a couple of uprights obliquely let into *B* at an exactly similar angle. A pin with a handle, *a*, *a*, is passed through these uprights, the reel is unwound upon them, and a skein is made in a few turns of the wheel.





The rims on the reels at the ends of the protruding shafts prevent the skein from shifting ; in order to allow the latter to be taken off, one of the shafts is formed of two pieces joined lengthways by a tenon with an open mortise. This tenon forms a hinge-joint, and, to prevent it from closing, a bolt-pin is inserted in it, which can be taken out when necessary. Thus, when the skein is finished, the pin is taken out, the shaft folds up, and the skein is easily removed.

Another way is to hollow out one of the pieces of the shaft, and to make a tenon on the second piece which will exactly fit into the groove on the other. The two pieces are kept extended by a bolt-pin ; when the latter is removed, the shaft is shortened by pushing one piece into the other.

## PART V.

### A FAGGOT-SHAPED WINDER.

**T**HE following is a description of another kind of winder, which, when closed, has the shape of a faggot. It is a very useful one, and its form is more convenient, perhaps, than that of those we have just described.

This winder (fig. 45, Plate XVII.) is composed of an iron stem, *a*, mounted upon a wooden foot, *b*, which can be shaped according to taste.

*C*, *c*, are a couple of nuts, very similar in shape to those used in the manufacture of umbrellas, upon whose circumference six openings must be made, to receive the ends of a dozen rods, fastened there by a wire, as are the whalebones of an umbrella. These rods are fastened two and two together in the centre by a cross piece of wire, the ends of which are rolled up ring-shape.

The other end of each rod is attached to another rod of the same length, the upper end of which is fastened to the top of the next pair. The upper nut is pierced with a round hole, in which a bolt-pin is inserted. A couple of strings are fastened to this, and attached to the lower nut.

When this pin is turned, the lower nut ascends the stem, and the winder opens more or less, according to the width of the skein.

A cup is placed at the top of the main stem, to hold the balls of silk or worsted.

The rods of this winder should be either round or square. The latter shape is the best, as when the winder is closed it is then nearly cylindrical in appearance ; but it will be as well to round off the outer edges, to prevent their fraying the material of the skein.

## PART VI.

## A SPINNING-WHEEL FOR THE LAP.

**T**HE spinning-wheel we are about to describe can be held in the lap, or on a small table. Take a piece of wood, about an inch thick, and plane it well. Make its edge perfectly square, and round off its two ends. In a word, shape it exactly as is shown in fig. 3, Plate XXXVI. Give it a rim similar to that of fig. 27, Plate XVII.

Turn a couple of uprights of the shape of that in fig. 4, Plate XXXVI.; these should be about eight or nine inches in length, not including the tenon.

Any kind of moulding may be added to them, but care must be taken that that at six and a half inches from the shoulder of the tenon, at *a*, a bellying part be left, in order to give strength to the portion of the upright which will have to act as the axle of the wheel. Make nearly the whole length of the tenon *b* into a screw.

When the two uprights are turned, pierce a couple of holes in the foot, as at *a*, *b*, fig. 3, at an equal distance from the edge, and with exactly so much space between them, that, when the uprights are inserted in the holes, there may be an inch and a half of room between them. Cut threads in these holes, and screw the uprights firmly into them; then, with a compass, mark off on each of them a point, *a*, where the axis of the wheel will come.

When the two holes are pierced in exactly corresponding positions, take a fine saw and make a notch, as shown at *a*, fig. 4, in that which will be placed in *b*, fig. 4, in the proper position of the foot; the wheel, that is to say, being at the right of the spinner, and the reel to the left, as will be presently explained.

There is another method, just as solid and much more convenient, of fixing the uprights to the foot. Instead of making their tenons, *b*, round, and cutting them into a screw, give them a square shape, the diagonal of the square being exactly equal to the circumference of the upright when it left the lathe. When this has been carefully done, put the uprights back between the centres, and, with the upper edge of a chisel, at about three sixteenths of an inch below the shoulder, cut away the four angles sufficiently deep to prevent the gouge that is about to be used from injuring the wood.

If, in giving this tenon a square shape, the amateur is not sure that its diagonal is equal to the diameter of its former circular shape, he can satisfy himself by putting it back on the lathe. Let him now hold a small gouge firmly against the tenon, without cutting it, and turn very gently, he will then soon see if his work is correct. If he discovers any mistake, he must, with a sharp chisel, cut away the excess at each angle, till the dimensions are correct. Then, with a graver and a file, he must smooth the tenon where the circumference has been cut away, not forgetting to have constant recourse to the square. In this way both the square and the round parts of the tenon will be concentric with the rest of the upright.

When the square parts of the tenons are completed, put the uprights back on the lathe, and, with a gouge, remove the surplus square part of the tenons, and reduce them to the size it is intended to give the screw. Then cut a screw on the tenons, right up to the square part, by the method we have previously explained. Next, having cut a thread in a piece of wood of about the diameter of the square's diagonal, place it on the screw, and turn it between the centres, giving it the thickness as we are about to indicate.

Should the method we are speaking of be used, a thread must not be cut in the holes *a, b*, fig. 3; it will be sufficient to take a spoon-bit of a suitable size, and make them large enough to admit the introduction of the tenon's screw. The tenon of one of the uprights must be fitted rather tightly into one of the holes. The square part, which must exactly impinge upon the foot, must be placed so that one of its faces be parallel to the longest side of the foot; then, with a tracing-point, the four sides of the tenon must be traced on the foot.

Now remove the upright, and with a sharp chisel cut away the wood within the marks, leaving the marks just without the part cut away, so that the square may exactly fit. Deepen this hole to rather more than the depth of the square part, applying the edge of the chisel against the bottom so as not to cut away too much, and smoothing the surface with a curved chisel, such as one the profile of which is shown in fig. 41, Plate XVII.

When this has been done, insert the upright in the same position as when the marks were made; to ensure this it will be well to have made a guide mark on one of the square faces of the tenon and on one of the edges of the hole. Insert it carefully, so that it enters easily, but at the same time fits tightly, and so that its end rests evenly against the bottom of the hole. Do the same to the other upright.

The nuts have now to be made. As they must not project beyond the lower surface of the foot (if they did it would stand unevenly), this is how the operator must proceed:

Turn a cylinder of such a diameter that it will exactly fit the hole for the tenon, insert it from above, so that its end, which has been upon the centre, and which will have been properly shaped there, just reaches the lower surface. Cut off the cylinder at about the thickness of the foot, put it back upon the lathe, and repeat this process for the second hole. Now take a spoon-bit of the diameter given to the nut, insert it in the hole made by the centre, and cut away wood to give sufficient room for the nut, leaving enough wood between the external edges and the mortise-hole for the square to prevent the motion of the nut from affecting the solidity of the whole. If necessary, replace the nut upon the lathe to facilitate its insertion, and give it a thickness. As, however, it is impossible to make it penetrate to the bottom of the hole in its suitable present state, recourse must be had to one of the methods used when it is desired to flush either a screw-head or a nut. Pierce, at an equal distance from their edge, a couple of holes right through the nuts (fig. 42), of about one-eighth of an inch in diameter. Care must be taken that these holes are pierced at *a, a*, with the grain of the wood, and not at *b, b*. The reason for this will be given directly.

Then take an iron rod, forked at the bottom (fig. 43). The forks must not be more than an eighth of an inch in diameter. The remainder is flattened as far as *b*, and the round part of the rod is fitted tightly into a wooden handle (*c, c*), turned on the lathe. This tool is termed a *key*. The forks are then inserted into the holes in the nut, which by this means is driven quite home, and keeps the uprights in their place.

The effect of the use of this tool would be to split the wood if the holes were made at *b, b*, but if they are made at *a, a*, with the grain of the wood, the nuts will not give.



If the nut is but small in diameter, the key can be inserted in an ordinary straight handle. This will be sufficient in many cases.

If the holes to receive the uprights have been carefully drilled perpendicularly to the foot, the shoulders of the tenon ought to rest evenly upon the latter all round.

We have promised our readers that this work will give every detail that can either shorten an operation or lessen a difficulty; we commend to them, therefore, the following precautions:—

It will be remembered that it is the centre point of the spoon-bit which determines the position of the hole the tool-makes. All who have used the latter are aware that if it meets with a knot or some eccentricity of the grain, the point will be turned aside, and the hole will fail to receive the direction intended. When we said that the holes in the foot were to be stopped with pieces of turned wood we took it for granted that the grain of these pieces would run perfectly straight, and that nothing would occur to turn aside the spoon-bit. The efforts, nevertheless, made by the point which moves in a circular direction, and by the edge which cuts the wood, often cause the central point to slightly shift, thus affecting the proper circular shape of the mortise-hole, and preventing it from being concentric with the tenon. In such a case the nut will refuse to fit properly, and it will be necessary to diminish its diameter, making it touch closely on one side, and leaving a gaping space on the other; a very defective result. To prevent this we advise our readers to turn the nuts across the grain of the wood, wood of the same kind as that the foot is made of, and to satisfy themselves that it is without knot or blemish. They can be turned with the help of a chuck of a suitable size (fig. 7), the centre of the lathe marking the spot at which to apply the central point of the three-pointed spoon-bit.

These details are general, and apply to other cases besides the one under present consideration; they may, moreover, be of assistance in suggesting a quantity of expedients that circumstances may make useful. It is part of our task to suggest expedients and ideas to our readers. As they acquire experience they will themselves invent methods which their own intelligence alone will give creation to.

We have now to make and fix the wheel A, fig. 6, Plate XXXVI.

This is an operation demanding great care and attention. Take a piece of wood of about an eighth of an inch thick and about thirteen inches in diameter, fig. 1, Plate XVIII. The wood must be perfectly sound, and without knot or blemish. On this piece of wood trace a circle nearly 13 inches in diameter, so that when it has been turned the wheel will be exactly a foot wide. Cut out the circle with a turning saw.

It would be much easier to make this wheel on the lathe with the overhead motion, but in order to satisfy those who only possess an ordinary lathe, and who are, nevertheless, desirous of amusing themselves, we will describe how to turn it between two centres.

Make a hole in the centre of the circular piece of wood of from five-eighths to six-eighths of an inch in diameter; tightly insert in this hole a slightly conical chuck, fig. 46, Plate XXVII. If the latter does not fit tightly there will not be enough friction, and the resistance of the wheel may cause it to turn upon its axis—the chuck. Instead of using this kind of chuck it is feasible to attach a very strong one with three points to one of the sides of the wheel. Held in this chuck the rim and the two faces of the wheel can be turned, mouldings according to taste, such as are shown in profile, fig. 2, being added to it. The wheel should be made one foot in diameter. Now hollow out a circular groove right round its circumference. Hollow it out as if the wheel proper was about to be cut away from the rest of the circular piece, but leave enough wood to allow sufficient solidity for the following operation:—

Take the wheel off the lathe. Make a quantity of little indentures with a gouge in the groove, removing the borings from each, so that the ring of lead about to be run into the groove will hold firmly to it. Take a strip of cardboard long enough to more than go round the rim of the whole circular piece. For this purpose it will be best to paste together several strips, one on to the end of the other, cutting their edges slantways to hide the joinings. Fasten this band round the rim of the wheel with some string. Then glue a spout, made of a small piece of pasteboard, square at one end and round at the other, and gutter-shaped, to the band. A basil-edge must be given to the round part and the two sides of the spout to allow it to fit closely to the band. As it is possible the lead might escape between this band and the wheel, no matter how carefully they have been joined together, take some whiting and mix it with some water, adding a little glue, until a thin paste is produced. Apply this paste all round between the band and the wood; it will stop all apertures.

Now melt sufficient lead, or better, tin; a good deal will be required. If the metal is too hot it will overheat the wood, split it, and warp the wheel; if it is too cold, it will not run properly. Dip, therefore, a small piece of white paper into the molten metal. If the paper turns slightly yellow, or red, the heat is sufficient; if it reddens too much, the heat is too great. Now place the wheel in the groove of the lathe and pour in the whole of the molten lead by the spout already made. The operator must not forget to pierce a couple of vent-holes in the pasteboard close to the spout, to allow the escape of the air displaced by the lead. To neglect this would lead to the formation of flaws, which would detract from the required result.

Pour the lead into the groove till it is quite full, then leave the whole to get cold.

The chuck must not have been removed during this operation, as it would be difficult to replace the wheel truly in the lathe.

Now take off the pasteboard band, and put the wheel back on the lathe, in order to trim the leaden circle with a gouge. It will be best, however, to allow the whole to rest for a day or two, and to let the heat produce whatever effect it may on the wood, and proceed, meanwhile, to the execution of the other processes necessary for the finishing of the wheel. There are the naves, the spokes, the pendants, the surfaces, and the ornaments to turn. These require a great deal of patience and skill.

Let us first take the nave. Roughly shape with a hatchet a piece of sound wood, rather less than two inches in diameter, and rather thicker than the space intended to be allowed between the uprights. Pierce, with the grain of the wood, a hole of about three-sixteenths of an inch in diameter. Insert in this hole a chuck (fig. 47, Plate XVII.) with a pulley at one end, about the same size as the chucks we have already spoken of, and turn the nave upon the lathe, both on its circumference and its two sides, then remove the chuck.

It is often necessary to use these chucks, which should be kept ready of all sizes. This is the way to make them. A first requisite, however, is to understand how to turn iron; if the amateur cannot do this he must be content to buy his chucks ready made. If the chuck is to be more than three-sixteenths of an inch in diameter, take a piece of rounded iron, if less, a piece of steel. The reason for this distinction is that thin iron easily bends, and that the chuck would lose its straightness; while steel, being much tougher, has more power of resistance in small dimensions. Prepare the iron as smoothly as possible with a file. Make one of its ends of the proper length to fit into a pulley for the cord, and tightly insert in this pulley a piece of wood of the right length and diameter. Place another pulley, turned on the lathe, on the chuck, and make a small puncture at each end of the latter for the centres to fit into. See that the pulley is tightly enough

fitted on the chuck to prevent it from slipping round, place the whole between the centres and turn the end pulley. Now remove the second pulley, put the chuck back on the lathe, and turn it with iron turning tools, or with the graver. When the chuck is quite round, finish it off, while it is on the lathe, with a smooth file, beginning at the end, which ought to be rather larger than the remainder, and leaving it gradually thicker towards the pulley. The file will leave some rough curved lines on the chuck's surface, and enable it to grip anything that may be turned upon it. A quantity of these chucks should be kept in stock, of different lengths and dimensions; but they should never be made of iron wire, as this kind of iron has a tendency to split and become a mere bundle of fibres, with but little power of self-adherence. This will be at once seen by breaking an end off a piece of iron wire. Now place the nave on a chuck of a size proportionate to the hole already made, and turn it to the shape shewn in fig. 4, or to any other convenient one. Whatever form be given it, however, it is necessary that the faces, *a*, *b*, be given the right thickness, to enable them to turn without wobbling between the two uprights, and that the rest of the nave be ornamented with such mouldings as are shewn in the plate, narrower than the part *a*, *a*.

Now take a piece of steel that will exactly fit the hole in the nave. The length of this steel must be the thickness of the nave, plus, at one end, the diameter of that portion of one of the uprights where it is to be placed, and at the other, the thickness of the other upright, together with an additional quarter of an inch for the winch of the nut. Then take a file and prepare the central portion of the steel, making it first square, and then eight-sided, and rather smaller at one end than the other. Then, upon an ordinary lathe, turn as smoothly and as straight as possible the two collars already roughly prepared with the file. Finally, making it of a still smaller diameter, turn the end that is to be cut into a screw to receive the winch which will form a shoulder against the collar.

The end of the chuck must first be cut into a screw with a double-screw-tap (fig. 20, Plate XXI.). These are the best, as they do not weaken the metal, are not easily bent, and as the threads they cut are not choked. Put the chuck back on the lathe, to see if cutting the screw has altered its concentricity. If it has done so, the balance must be restored by striking it with a small mallet on a block, or on a thick piece of lead. Finish the two ends and polish them.

It is customary to make the collar next to the winch much longer than is really necessary, for the convenience of the spinner. It is a useless expedient, but we leave it to individual taste.

Now force the chuck tightly into the hole in the nave, in such a way that the shoulders of the collars impinge upon its two faces. Place a pulley on one of the collars, fastening it with a brass nut, which, pressing against the pulley, will press it against the nave. For fear, however, of the bobbin's slipping round upon the chuck, it would be well to knock three or four short nails into the pulley; these will grip the nave and ensure the whole turning together, in spite of the natural resistance which will presently become considerable.

Give a finishing touch to the nave, which generally requires it, and carefully polish it.

Bisect the thickness of the nave, and mark the point of bisection with a slight chisel mark. Then, along this line, divide the circumference into eight equal parts, and with a three-pointed spoon-bit, of at least three-sixteenths of an inch in diameter, make eight holes of an equal depth, taking care to hold the drill-bow in the direction of the radius, so that the spokes may be equidistant. Now turn eight spokes, as in fig. 3, or of any other shape, being careful to make their lengths, from *a* to *b*, exactly equal. At one end of each make a tenon, just large enough to fit the holes made in the nave. Fit the tenons into the holes with glue, but in order to place them

correctly it will be as well to have recourse to the wheelwright's method. Get a small rod, about one-eighth of an inch in thickness or thereabouts, about five or six inches long, and of a sufficient breadth. At one of its ends make a hole which will just receive the axis of the nave. Above the rod place a small wooden wedge, which also fits tightly on to the axis, to prevent the rod from varying, and to keep it closely applied to the surface of the nave. About five inches from the centre insert a nail into the rod; this will serve as a compass.

Put some very hot glue in one of the holes in the nave, dip a spoke in the same glue, and then insert it in the hole. Drive it home with a mallet, so as not to injure the end. Endeavour to prevent it from inclining either to the right or to the left; if it appears to lean too much to one side strike it with the mallet on the opposite one. Now, with a dry rag, quickly and carefully remove all the surplus glue on the nave and on the tenon's shoulder, taking care not to injure the polish the wood has received upon the lathe. Then hammer home the nail in the rod till its point is flush with the end, *a*, of the spoke. Now insert a second spoke with the same precautions, turning the rod, and taking care that the nail's point touches the spoke's end, as it did that of the first one. The others must all be inserted in the same manner; if the operation has been cleverly managed they ought all to be in the same plane.

All the above, however, can be still better accomplished by putting the chuck and the nave back between the centres. After inserting the first spoke, the rest must be placed within the circumference of the wheel, as close as possible; then as the others are inserted, turn and see if they all graze the rest at the same intervals.

This being done, place the rest in the direction of the diameter, to ascertain if the spokes are all of equal length. Make them so, removing any excess with a file. The nave and spokes are now ready for their tire, which, during their manufacture, has had time to get perfectly cold. However, as it is usual to embellish the wheel with pendants or other ornaments between each spoke, it will be as well to give the wheel a still further cooling-time while these are being made.

Fig. 5 represents the shape of an ornament that can be added to the wheel. As these ornaments must of necessity be very small, it is rather difficult to turn them on the ordinary lathe. It would be easy enough to turn them on the lathe with the overhead motion, but we will be faithful to our pledge, and explain the method of making them on the only lathe which we suppose the amateur to have in his possession, the lathe with centres and cone-plate.

It would not be possible to turn these ornaments by putting the cord on them. The operator must take as many pieces of wood as there are ornaments, giving them a thickness of rather more than an inch more than is required. He must make a pulley for the cord at the worst end, and in this way he will succeed in turning them. Skill with the chisel is here particularly called for. Very narrow ones will be required for the portions where larger tools could not be used; particular care being taken not to injure the wood with a chisel with a single bevelled edge. The work should owe all its finish and polish to the way in which the chisels are handled. At one end a portion of the wood must be kept large enough to hold the centre till the turning is finished. At the other, next the pulley, a tenon must be made large enough to allow of the ornaments being fastened inside the wheel. Twelve can be added instead of six, but in that case they must be made of much smaller dimensions. If the wheel were made of some dark foreign wood, such as Violet-wood or Rose-wood, the ornaments, and even the spokes, might be made of ivory, the white of which, contrasting with the dark wood, would have a good effect.

Without entering just now into detailed particulars of ivory turning, we may warn the amateur that ivory cannot be turned with an ordinary chisel. It must be roughly shaped with a

round tool, and finished with chisels with a single bevelled edge, and with point-tools. As ivory is very expensive, and as it would entail considerable loss to waste it in making a pulley for the cord for each separate ornament, it will be well to begin by turning the tenon, which should be glued into a hole made in the end of a pulley. We shall return to this when we describe the lathe with the overhead motion.

It is now necessary to finish the wheel. Place the circle back upon the lathe; it will probably be found that it no longer turns truly. This is owing to the effect of the heat of the lead. The increase in momentum must not surprise the amateur; five or six pounds of lead or tin will of course have augmented it, and in order to the better to control its revolutions on the lathe, it will be well to give an extra turn of the cord round the pulley.

The next thing to do will be to lighten the wheel by turning the lead. Clean the work-bench thoroughly to prevent the lead shavings from getting mixed up with those of the wood. Carefully cut off the projection left by the lip by means of which the lead was poured in, as well as those made by the two vent-holes; then, putting the wheel back on the lathe, gently apply a gouge to it, cutting it more vigorously as soon as the whole circle has been operated upon. It will be well, in order to avoid touching the wood, to have made the first groove on a pasteboard gauge, traced with a compass, figs. 6 and 6 *a.*, and to make the second with the same gauge, in which, from the same centre, a circle of a lesser diameter has been described; that which has been removed will be the thickness that ought to be allowed for the leaden circle.

In order to turn this lead properly the gouge ought to be held in the position of a tangent to a circle. If it were held more directly against the lead it would produce furrows on the surface, and would easily catch in it. A smaller and sharply-cutting gouge will enable the amateur to remove all ridges, and to make the groove perfectly smooth. As the lead is cut away the wheel will become lighter, and will turn more easily.

In order to decide the more easily how thick to make the leaden circle, its two edges should be trimmed on the thickness of the wheel; a chisel with a sloping edge should even be applied to it throughout. When the groove is finished the two faces of the wheel, which should have been previously carefully shaped, must be completed. Then make the internal diameter of the wheel exactly that of the spokes with point-tools squared to the right and to the left, fig. 7., Plate XVI. Finally, finish it, making the internal surface perfectly even, so that both sides exactly correspond. If the operation has been carefully executed the tire should fit easily all round the nave, and the latter, with the spokes, should fit closely, but without requiring any force, within the tire. Before fastening them together the interior of the circle must be divided into sixteen equal parts, eight of which are intended to receive the spokes, and the other eight for the ornaments. At the points where these last are to be inserted pierce round holes with a bow-drill, if, that is to say, the wheel is large enough to permit the use of this instrument. If it is not use the blade of a drill-bow in a straight handle. Finally, polish the interior with a piece of dogskin or with the paper we have already spoken of.

When all this has been done, place the wheel on the lathe, and examine if it turn truly. Then take a centre-bit, and make eight holes corresponding exactly to the places where the spokes are to meet the nave, and fasten in the first one with a rather large nail, the head of which will be concealed in the lead. To prevent any injury to the groove, drive the nail home with a blunt punch.

Put the wheel back on the lathe to see if it is still true. Correct any deviations, and fasten in the spoke opposite to the one already inserted; then a third, and so on, replacing the wheel each time upon the lathe for the purpose of setting right any irregularity caused by the insertion of the spokes. If, when all are inserted, the wheel appears faulty, place it on a solid bench, and strike any spoke that may be out of position gently with a mallet, on the side opposite to that towards which it leans. The nail will lend itself to this slight rectification if the deviation is not excessive, and if the wood be not too fragile. It is best, however, not to drive the nails completely home till it is clear that the wheel is quite true.

If, in glueing the spokes to the nave, it should happen that they do not all converge exactly in the centre, a result that would prevent any two opposite ones from forming a single straight line, the error can be remedied before fastening them in the circle. To do this, place between each of them, towards the nave ends, a rod of the same length, and tighten them more or less, exactly measuring their respective intervals with a compass, one end of which is placed in the hole made by the lathe's centre. Then fasten them to the circle.

It is clear that this wheel ought to turn perfectly true. The nave has been turned upon the axis, the axis itself has been turned upon its centres, and upon these last the wheel has been finished; there has been nothing to throw it out, unless it be the natural action of the wood, however dry it may have been.

There is another manner of putting this wheel together, on which we will say but a few words. It will be remembered that in the former process the spokes were only fastened to the circle by nails; it would be a much more solid piece of work if tenons were made at each end of the spokes, but, in that case, it would be impossible to insert them in the holes prepared for them in the way indicated in the above method of making the wheel. The following must, then, be the means adopted:—

The nave must be made of two separate pieces, each piece being turned perfectly straight on one side, upon an iron spindle, as we have explained. Take care that these two surfaces are not smooth; indeed it will be well to roughen them here and there with a point tool, in order to allow the glue to take a hold. Glue them together in three or four places only, so that the holes made by the centres correspond. Now, as the former nave was made upon its axis, and as the holes are already pierced in it, make a couple of guide marks upon the circumference, and with a mallet sharply knock the two parts of the nave asunder. Then make eight holes within the circle, at equal distances, but of little depth, so as not to reach the leaden rim. Glue the tenons of the eight spokes into these holes, and, closing the two parts of the nave once more together at the places marked, grip between them the tenons of the other ends of the spokes, and glue spokes and both parts of the nave solidly together. The tenons will now be fastened together with glue at both ends, and the wheel will be much stronger.

For the sake of the zealous amateurs who desire to accomplish everything in the most finished manner, we subjoin a third method of making the wheel, as neat as it is solid.

Pierce a sufficient number of holes in the nave, and cut rather a deep thread in them; then, with a spoon-bit, cut away the first two or three turns of the worm, taking care that they are cut away equally all round. Turn the spokes, leaving a cylindrical part at the bottom of each, of the exact size of the hole just widened with the spoon-bit. The main length of the spokes may be of any shape, but a small and very short tenon must be made at their other ends, to fit into the holes in the circle. A shoulder must be left above each of these tenons, to impinge closely against these holes.

It will easily be understood that when the spokes are tightly screwed into the nave their lengths will be lessened, and will be equal to the wheel's inside radius; the circle, therefore, will easily be inserted. Now slightly unscrew the spokes and insert the tenons at their other ends into the holes made in the circle; as the round portions of the lower ends of the spokes' ends will fit tightly into the parts of the threads enlarged by the spoon-bit, this slight shifting of the spokes will not be noticed.

The wheel, after this operation, must be placed on the lathe, and if it appears at all out of shape the spoke at the faulty part must be tightened, and the one opposite loosened.

It is a little difficult to turn a wheel whose weight is increased by seven or eight pounds of lead or tin. The difficulty, however, can be overcome in the following manner. The process is a delicate one, and demands the use of the lathe with the overhead motion; we must, therefore, anticipate a little, and give details to which we shall not return.

When the hollow rim has been made in the wheel, before pouring the lead into it, mark off upon it, as we have already explained, an arc of a circle of a smaller diameter. Then, with the radius of this smaller circle, describe another, cutting away its concave part. Take a chuck of a large diameter, and turn upon it the circle which will be a guide to the thickness of the lead, fastening it to the chuck with a few screws. This circle may even be cut out with a turning saw. Turn the interior surface of the shape of the concave-gauge already made, and give it a couple of shoulders to impinge upon the external diameter of the wheel. When this is done take the circle off the lathe, and cut it, with a fine saw, into two equal parts, which must be applied to the external diameter of the wheel in such a way that the shoulders closely fit to it. Indeed, in order to prevent the circle from being lopsided, which would have the effect of making the lead too thin on one side and too thick on the other, it will be well to make a cheek-piece to place against one of the faces of the wheel. The spout to receive the molten metal must be fixed in the joining of the two parts of the circle; if this precaution is not taken it will be impossible to withdraw them without breaking them. Nor must the vent-holes, the need for which we have already explained, be neglected. For all these details see fig. 6, which gives an elevation of the whole; *a* is the wheel, *b* the external circle, which, as is shown, enters sufficiently into the groove to leave room for the lead, and, by means of the cheek-piece *a*, fits closely against one of the faces.

Carefully fix the little ornaments in the holes made between the spokes for the purpose, and glue their tenons to the nave.

It is scarcely necessary to remind the amateur that the spokes ought to be very slight, so as not to give the wheel too heavy an appearance; the same remark applies to the ornaments.

Now to make and place the truck that carries the heck and the spindle.

Fig. 7 represents a front view of the truck; fig. 8 represents it in profile. Fig. 8 also shows that it is inclined in a contrary sense to the wheel. This is to prevent it from ever leaning towards the wheel if the action of the cord, which passes over the lathe and over the pulley, should tend to press it forward. The following is the way to make it:—

First turn a piece of wood as in *a, a*, fig. 7, leaving at each of its ends a bellying part for the reception of the tenons we are about to mention, as well as to prevent it being weakened by the holes that will have to be pierced in it. Make a couple of holes, one in each bellying part, and exactly in the same line. Turn two uprights *b, b*, of the same size, with mouldings according to taste. At their lower ends make tenons to insert into the cross piece *a, a*, and at their upper ones cylindrical tops, the use of which will be presently explained. Finish them off with some kind of ornament, according to taste. Before taking them off the lathe take a chisel and make on each of

them two slight marks, at exactly corresponding spots, and at a distance of three-eighths to one-half of an inch apart.

Now make a hole in the spheroidal ball which is in the middle of the cross-piece ; this hole must not entirely pierce the ball, nor must it be exactly in a line with those for the uprights, but a little to one side. Then turn the foot, the tenon of which must be of a half-flat square shape, about an inch long, an inch wide, and about half of an inch thick. The shoulder should be rather more than an inch in width, in order to give greater firmness to the truck ; finally cut the tenon into a screw, with a screw-tap of about three-eighths of an inch in diameter. Now cut a mortise, about one-eighth of an inch wide, almost entirely through the cylindrical part of each upright. Insert a small piece of ox-hide in each of these mortises, cutting the hide neatly off above and below ; fasten it in with a headless nail, having first made a hole with a smaller borer for fear of splitting the wood. Each upright will now be in the position shown in fig. 8, in which the piece of ox-hide is shown at *a*.

The truck we have just described is that belonging to a spinning wheel with a treadle. The truck used with the spinning wheel for the lap differs only from the other in the shape of its foot, which has but one tenon. Figs. 6 and 7, Plate XXXVI., show a pattern of this truck.

Upon the foot (fig. 3, Plate XXXVI.) cut a mortise (*c*) about three inches long, and of the same width as that of the tenon of the truck. This mortise must be made a little to one side of the exact middle of the foot, as is shown in the plate, to allow the cord which passes from the wheel to the pulleys to be perfectly straight, and to prevent it from leaving the grooves.

In a line with the centre of this mortise, and parallel to the edge of the foot, pierce a hole about three eighths of an inch in diameter, of such dimensions, in short, as will enable the screw, which has the same diameter, to work freely in it. Make this hole at least an inch larger than the mortise ; that is to say, let it penetrate quite an inch deeper than the latter. It will be well, indeed, not to pierce the hole for the tenon till the latter is in place, in order to allow the foot to fit more exactly against the bottom piece. As, however, the tenon might split, it will be best to merely mark the spot on the tenon where the hole ought to come, and then, removing the tenon, place it in a vice (to prevent the wood from splitting) and make the hole. Cut the thread with the same precaution.

Now turn a screw, termed a regulating screw (fig. 9, Plate XVIII.) beneath its head is a nut which fits exactly against the end of the foot. The length and the breadth of this screw must be such as will enable it to easily fit into the hole made for it. A little distance from this screw cut a circular groove, the use of which will be presently appreciated.

Hold this screw against the under side of the foot, exactly in the spot where it is intended to insert it. Carefully mark the position of the groove *a*, and make a mortise there of the size of the screw, and as broad as the mortise made in it. The mortise on the foot ought not, for the sake of appearances, to be pierced quite through to the upper surface. Prepare a piece of wood (fig. 10) which will exactly fit into the mortise in the foot. Cut it round, making it of the diameter of the mortise in the screw ; and when this screw is in its place and passed through the tenon of the truck, insert the little wooden peg which ought to fit the mortise in the screw exactly, and keep it firmly in its place. Cut off what projects beyond the bottom of the foot, and it will now be seen that the screw, being prevented by the peg that holds it from doing more than turn upon itself, will advance or withdraw the truck in whose foot it is inserted.

The reels on which the thread is wound in spinning can be obtained almost anywhere, the heck also ; we shall, therefore, say but a very few words in explaining their manufacture to those who wish to make them themselves.



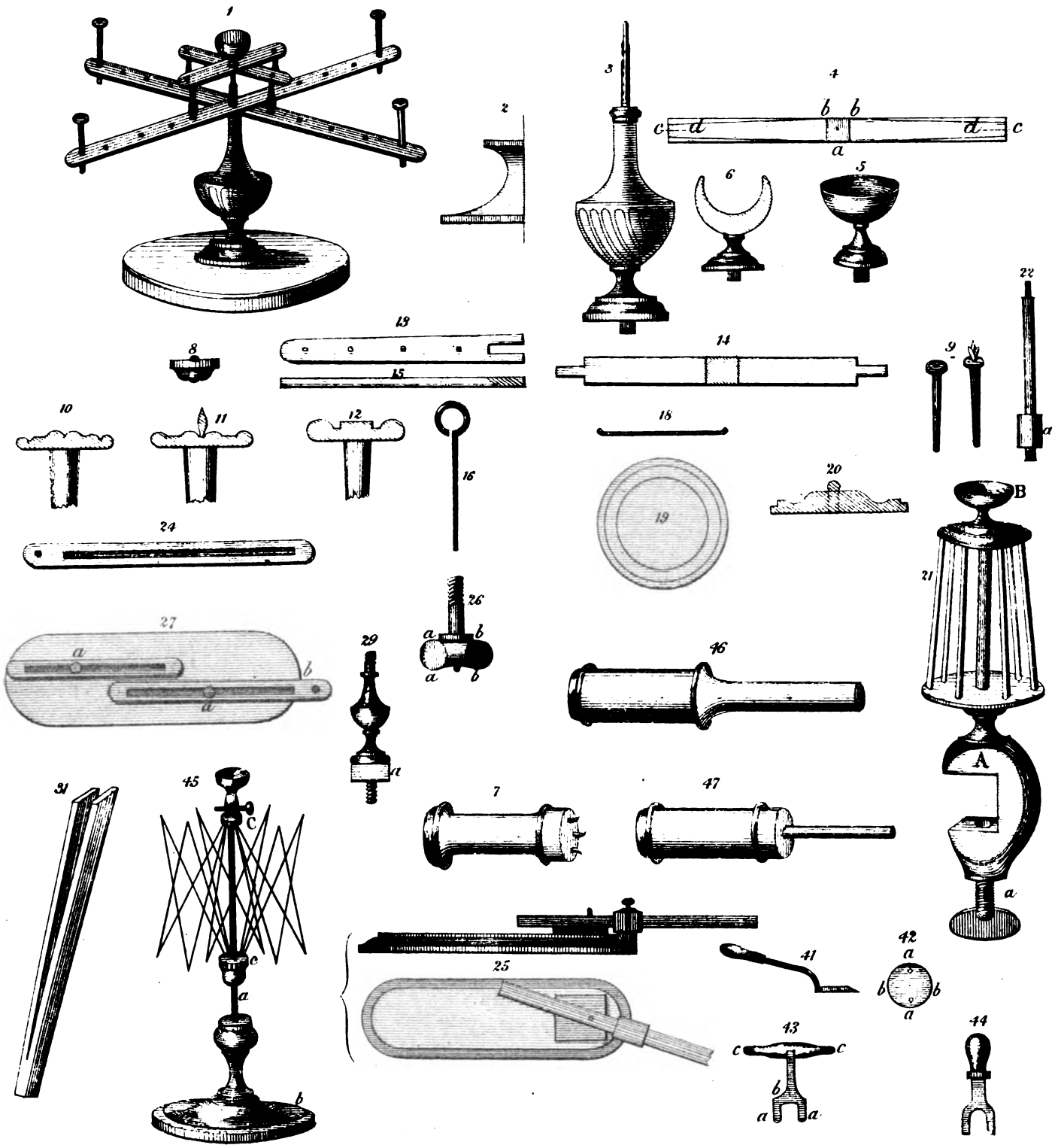
Fig. 11 represents the reel and the heck as they appear upon the wheel. The heck is merely an iron spindle, to one end of which is soldered the part with teeth shown in the plate. This part is a thin piece of sheet iron or brass, about seven-sixteenths of an inch wide, and of such a length that when bent it will be about the length of the rod. Fig. 12 shows it before it is bent. In the middle is the hole for the spindle, fig. 13, which grows gradually smaller towards one of its ends. At the other is a shoulder-piece, against which the heck impinges, and where it is soldered. At *a* (figs. 11 and 13) is a hole, which, starting from the circumference, issues at the centre, at the extremity *b, b*; it is through this that the thread passes on to one of the shuttles, and thence on to the reel, round which it winds itself.

The tin ends (*b, b*, fig. 11) pass into the little leather pieces at the top of the truck's uprights, and, lubricated with a drop or two of oil, easily turn there. At one end of the reel is a pulley; it works in the spindle with but little friction; in the centre, and a little to the side of the pulley, is a small bolt projecting to the extent of about three-sixteenths to a quarter of an inch; this prevents it from touching the other pulley, a circumstance which, if it occurred, would make the friction too great. The pulley, *g*, must fit tightly into the spindle, so that when it turns it will carry with it both the spindle and the reel. Now place a cord over the wheel—a coarse silk cord is generally used—allowing it to pass over the pulley of the reel, thence over the large wheel, and thence over the second pulley. The ends of this cord must be fastened together either by a knot—the worst plan—by a piece of silk, or by another method, which we will describe when we come to speak of the lathe with the overhead motion; here it would lead us into misplaced and tedious details.

The head of the spindle ought to be next to the spinner, the pulleys furthest from her. Through the hole in the end, and through the centre of the spindle, pass a little piece of handspun thread. Fix it to the shuttle, and then give it two or three turns round the reel. It is evident that when the wheel turns it will carry with it the two pulleys. One of them, that which is fastened to the spindle, will give the proper twist to the thread, while the other will cause the reel to revolve. We beg our readers to observe that the twist of the thread depends upon the diameter of the pulley affixed to the reel, and that the smaller its diameter the greater the twist.

The winch-handle is all that now remains to be made. The following is an ingenious manner of making it. Take an iron, or better, a steel rod, about an eighth of an inch thick, and half an inch broad. With a forge, if the amateur has one, or with a hot coal and a pair of bellows, give the rod a C shape. As, however, a wider part must be left at each end, take a broader and thicker rod, and give it also a C shape. When its two ends have been shaped and flattened, as in fig. 14, finish off both sides of it as completely as possible, and, placing it on a smooth block of wood, file these sides and the ends as well; the latter should be thicker on one side only. Finish it with a file, and make its upper angle (where the ends are thickest) into chamfers, equal all round the circumference, internal and external. Round off the two ends, and with a blunt file and a little sweet oil polish the two surfaces and the chamfers. Finally, giving the middle of each end a blow with a centre-punch, make holes there, sufficiently large to allow one of them (*b*, fig. 14) being given a thread of the size of the screw at the end of the axis. Take a steel compass (fig. 4, Plate III. Vol. II.) and trace a circle from this point as a centre. Do the same to the other. Cut a thread in the hole at *b*, but merely pierce that at *a*. Make the exterior angle of the two round parts into chamfers.

Fraise the hole, which is simply pierced (we have elsewhere explained the meaning of the word fraise). Take a piece of round steel, drawn on the draw-bench and whitened. Make a small



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tenon to it with a hand-file. This is a trifling operation, but we will explain it in detail, as the process is useful in many cases.

Grip the piece of steel in a hand-vice (fig. 10, Plate IV. Vol. II.) allowing but little more than the intended length of the tenon to project. Take a little brass plate, almost as big as a farthing, and make a hole in it large enough to receive the steel. Put the plate in the vice, and resting the steel upon clamps held in the vice with channels of different depths and widths, shape the tenon with a flat-file, leaning the face which is not cut against the brass plate. Then, turning the vice as is required, the tenon can easily be made the right size to fit the hole it is intended for. The shoulder of the tenon will be made very circular and very upright, which, unless the above precaution had been taken, would have been difficult; but it will be as well, before undertaking the operation, to re-temper the steel by the methods we have already pointed out, as passing it through the draw-bench has a tendency to considerably harden it, and in this state it soon injures the files. This should be done every time it is necessary to file steel; the only trouble the process will give will be that the steel will require repolishing with a little emery powder, between two pieces of white wood.

This steel rod ought to be about an inch and a quarter long. A second similar tenon must be made at its other end.

One of the two tenons must now be rivetted to the C-shaped winch-handle. The wood which projects beyond the thickness of the part where it is placed must be reduced by striking the fraise with a hammer. In order to accomplish this, fix the steel firmly in a vice, in such a manner that it projects as little as possible, so that the strokes of the hammer may be more steady. The rivetting should, if possible, equally fill the fraise; but, as it is possible that the end of the steel leans more to one side of the C than to the other, great care must be taken, and a square should be frequently used. When the rivetting is properly finished, file the surplus till the joining is no longer visible. Hollow out a piece of round brass about a sixteenth of an inch thicker than the steel rod that has just been filed. Fit this brass tube on to the steel, on which it should turn freely, but not too loosely. The tube ought to be slightly shorter than the steel rod, measuring from the tenon's shoulder to its base. Now, on the upper side, make a rivetting with a very flat curve, and such that the tube revolves easily on the rod. Then add the faces to the brass, and give the tube a little play at its mouth.

Turn a wooden handle, of the shape shown in fig. 15, but first hollow it to a depth of about a sixteenth of an inch longer than the whole length of the tenon, making the part hollowed out of such a diameter that the brass tube will just tightly fit into it. Make it of such a length that the ball at the end, which must not be hollowed out, overtops the top of the rod. Finally, put a little oil into the tube, and make the ball fit into its place by striking it with a mallet. The handle will now turn without showing any rivetting beneath, as is often carelessly allowed. As water is used in spinning, to tighten the thread between the finger and thumb, it is usual to add a little arm to the wheels on which to hang a cup.

Turn a couple of cylinders, as at *a*, *b*, fig. 16, of equal length. They should be made out of a piece of wood about an inch and an eighth in thickness. Keep a part at each end of the original width, and reduce the cylinder between these two ends to a diameter of about three-eighths of an inch. If, however, the middle be reduced to this smaller diameter before the two thicker ends are turned, the resistance offered by the thicker diameter might cause vibration, and induce the chisel to cut untruly. First, therefore, use the gouge to reduce the middle to a diameter of about seven-sixteenths of an inch. Then, having given each cylindrical end a length equal to its diameter, cut

them off at right angles, and round off each, ball-shape. In order the better to succeed in accomplishing this, trace upon a piece of cardboard, or, better, upon a piece of thin brass, an arc of a circle of about an inch or an inch and an eighth in diameter; this must be used as a gauge. When both the balls are perfectly round, the centre stem can be reduced to the thickness required, and can either be ornamented with mouldings or be left plain.

Now cut away from each ball as much wood as exceeds the diameters of the stems, by means of a couple of parallel strokes in the same plane; this will give each piece the shape shown in fig. 16. Polish the surfaces with the rasp, taking care to preserve the proper thicknesses. In order to be sure of this, it will be well to, now and again, test them with a correct rule; and, finally, when they are placed one against the other, the faces of each ought to coincide without the stems touching. Carefully see if the centres of both circles, both above and below, are concentric, and make a hole of about an eighth of an inch in diameter through the two centres, which should lie one above the other at *c*. Insert between these surfaces a piece of well-polished brass, of the diameter of the part to which it is affixed; then, with a small piece of round brass, make a rivet which will exactly, but not too tightly, fit the holes, and neatly remove what projects, trying, from time to time, if the friction is sufficiently slight by folding the tin arms one over the other.

The hole *c* ought to be seven-sixteenths of an inch in diameter, to receive the screw which fastens the part to the foot of the wheel; the hole *d*, in which a thread must be cut, carries a small cup resembling those on the winders we have already described; it must be made so that a little glass goblet for water can be inserted into it.

This description would be incomplete if we omitted to speak of the distaff. It is shown in fig. 17, and we fancy that anyone who sees it in the plate will be able to make it on the lathe. There is a small brass crescent at *a*, which is usually placed there; it is inserted in a hole made at the top of the distaff.

The stem of this distaff is long and thin, and it is rather difficult, in turning it, to prevent the chisel from cutting untruly; the following is the method that must be adopted:—

Turners of chairs content themselves with making wooden pins, fig. 18, which, as they diminish towards the end, are easily inserted in the holes made in the lathe's rest, at the spot where the tool offers its greatest resistance. These pins are driven in till the hooks upon them touch the piece that is being turned; to keep it in its place a wooden wedge is forced into the hole from the outside, that is to say, from the operator's side, to tighten the pin. If the pin be long, two or three may be inserted.

Fig. 19 represents a much more suitable and more convenient instrument than the above; *a*, *b*, are a couple of spindles fastened with tenons and mortises into the bar *c*, at a suitable distance apart, so that the bar of the lathe will have plenty of room. Fasten a piece of steel with a couple of rivets inside the spindles; the steel must be held in a watch spring, or a piece of cold hardened brass, and bent at the top, as is shown. By this means the piece will be solidly fastened to the bar. To make it firmer still, a screw with a flat head, which will press against the bar, may be placed in front at *a*. Lengthways on the bar *c* is a mortise-hole about three-eighths of an inch broad, and about three inches long. The square tenon of a small upright *d* is placed in this opening; the end of this tenon is cut with a thread, so as to allow of its being fastened by a screw from underneath in any position required. A mortise-hole, three-sixteenths of an inch in thickness, an inch and one-eighth in length, and parallel to the groove of the bar, is cut in the upright. A little wooden wedge of sufficient thickness, but not so wide as the length of the mortise-hole, is inserted in the lathe to fix the mortise, which is at both ends, at the required height,

and to make it possible to exactly grasp the diameter of the piece being turned. In the right face of the upright is a screw, which, being driven against the wedge, holds it fast at the height desired. At the opposite end to the spindles is a screw *f*, whose head *g*, leaning on the work bench, prevents the rest from shifting, and lends stability to the piece being turned. A quantity of wedges of different sizes should be kept in stock.

Finally, instead of this instrument, the amateur may use a collar-plate, the wheel and the wooden plates of which have been taken off and replaced by a small piece of wood, which can be fastened at the desired height by gripping it between the T and the collar.

The distaff, which is from fifteen to eighteen inches in length, may seem an awkward object to carry about ; in that case it may be made in two pieces by cutting a hole for the tenon of the stem in the axis of the bellying part.

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## PART VII.

### SPINNING-WHEEL WITH TREADLE.

**S**OME people prefer turning their spinning-wheel with their feet. We will, therefore, describe this kind of spinning-wheel. The wheel has a large diameter, and if the amateur has not a single piece of wood large enough for it to be made out of, two must be used. The plain groove and tongue, however, will not suffice ; the edges of the two pieces of wood out of which the wheel is to be made must be prepared so carefully that the joining is almost invisible, both above and below. Put the two pieces on the bench, side by side, and with a compass, mark at the joining the two circles which are to form the wheel. At these points, in exactly corresponding places on each piece of wood, make mortices of about an inch in depth, about as broad as one third of the thickness of the wood, and of exactly such a length that when the wheel is put together and the groove is made, the mortise will remain untouched. The amateur may make himself certain on this point by tracing, from a common centre, at the two joinings only, an arc of a circle corresponding in size with the bottom of the groove that will be made upon the wheel. The mortises should not penetrate as far as this circle.

Now make a couple of dummy tenons, of the same dimensions as the mortise holes, but not quite so long as their depth. Take a rasp and roughen the tenons, to help the glue to take a firmer grip, and glue them into their places with some strong and hot glue ; then put them under a strong holdfast, where they must be tightened with a cramping-frame, a tool described in our chapter on "Carpentering." If the joining has been well accomplished, the wheel will now be as strong as if it had been made out of a single piece of wood. To altogether hide the joining, it would be well, if the wood has any strongly-marked grain, to see that this matches at the points of contact.

The wheel we are speaking of, which ought to have a diameter of 15 or 16 inches, will have a very powerful swing, and it is seldom that an amateur has a lathe strong enough to resist it. It will be a good plan, therefore, to strengthen the lathe by placing one or two props at each end, which, wedged against the ceiling, will keep the lathe steady. For fear of injuring the ceiling, it will be advisable to interpose a piece of wood of at least eight or ten inches square between it and the ends of the wedges.

For the same reason, the large size of the wheel, it should be placed upon rather a large chuck; a chuck whose pulley should be about two inches in diameter, and the hole made in which should be about one inch and an eighth in diameter. While the chuck makes two revolutions, though the large diameter of the wheel will not make more, still, as the rapidity increases in proportion to the length of the radius, the resistance increases in a like ratio, and makes the operation one of some difficulty, particularly when the lead has been run into the groove.

We will not dwell on the method of making this wheel. The details we gave about the preceding one are sufficient. We will confine ourselves to remarking that the wheel would be much more easily turned on a lathe with the overhead motion, than on the ordinary lathe with centres. The uniformity of the continuous motion considerably diminishes the vibration; but we have promised to suppose the lathe with centres to be the only one within reach of the amateur, and we adhere to our promise.

As this wheel has a much larger diameter than the last, the ornaments to be placed between the spokes must be much more numerous.

As the spinning wheel we are describing only differs from the preceding one in its foot, we will confine ourselves to that part.

Fig. 20 represents the spinning wheel complete. The wheel is supported between two uprights as before, and these uprights are fastened to the cross piece A, B, by screws placed beneath.

The frame is made of four pieces, A, B, C, D, finished with the plane, and fastened together at their ends by four screws, *a, b, c, d*. Two uprights, turned on the lathe, and ornamented with mouldings according to taste, are attached to the frame with screw-tenons, the screw-holes being beneath. These four uprights are joined near their lower ends by two cross pieces, turned upon the lathe, and by tenons placed to the bellying parts which have been reserved in the added mouldings. In front, and just at the foot, is a cross piece, fastened in the same way as the others, but it is flat and made with the plane. Finally the two hindmost uprights are also fastened together by a cross piece made with the plane, and which has also screws and mouldings. A treadle is attached to the first cross piece by which the wheel is turned. It is customary to fasten a small upright *c*, fig. 20, to the treadle with a small piece of catgut. The knot of the catgut is shown at *a*. At the top of this upright is the hole for the axis of the hand-winch.

The truck is arranged in a very different manner; *i* is a piece of wood, at each end of which and at an equal distance from the bars A, B, is a forked opening which receives the two bars, above and below. On this cross piece are attached the two uprights, which carry the shuttle and the reels in the same way as they were carried in the preceding wheel. The cross piece, *c*, is thick enough to allow room for the screw *e*, which is kept back by a method we have already explained, and fits into the worm cut in the cross piece *i*. The axis of this wheel may differ from the preceding one in the fact that it prolonged behind the hindmost upright and bent at right angles with itself, as is shown in fig. 22. At the top of the little rod, fastened to the treadle, is a hole into which is inserted the button at the end of the piece with the elbow, and which communicates with another of the size of the piece with the elbow, represented on a larger scale in fig. 23.

We gave such a minute description of the first spinning-wheel that we think we have said enough to prevent any difficulty of construction arising in this one. We will be silent, too, as to the very inferior spinning-wheels we meet with in the country; they are exactly like the last, except that they have no mouldings, that the wheel is slightly larger, and that it is not weighted with lead.

## PART VIII.

## FLEMISH SPINNING-WHEEL.

**F**IG. 1, Plate XIX. represents this spinning-wheel in a finished state. The foot that supports it is very solid, and stands very firmly on account of the space between the four uprights. The following is the method of its construction :—

Turn a round foot on the lathe. It should be made of some precious wood, such as rosewood or mahogany, or at any rate of pear or walnut wood. Give this foot a diameter of about twelve inches, and make a slight moulding on its upper rim, such as a quarter-round, a shafferoon, &c. Prepare a suitable piece of wood, and mark out upon it the four pedestals, *b, b, b, b*. Fig. 2 shews that the front pair of these pedestals are more inclined to the foot than the other, while fig. 1, or better still, fig. 3, which represents the foot seen from beneath, shows that the four pedestals diverge, following the direction of two diameters of the circle; that is to say that each leans slightly away from its two neighbours.

The following is the way to fasten the pedestals to the foot. Paste some white paper on a table, and trace upon it the design of the foot; then, with a sliding square, take the shape of the joining-places and mark them on each pedestal at the place where the tenons will come. Make a dovetail at this spot, rather shorter than the thickness of the foot; trace beneath the latter the exact place of the tenon, which must also be dovetailed; and, in order to enable the tenon to be inserted in the foot, lengthen the mortise-hole towards the centre of the foot, but at right angles, so that the tenon may freely enter. When the dovetail is properly made, insert the tenon in the square mortise-hole, and thence into its proper position, where it should fit very tightly. When the four pedestals are thus in position, take a piece of square wood and stop up the mortise-hole and that side of it which is next to the tenon; then glue it in such a way that the joining is as little visible as possible. The two pedestals that are in front are joined by a cross-piece, thick enough to allow of the treadle *c*, fig. 1, and *a*, fig. 2, being fastened to it. This treadle is attached to the cross-piece by a strong wire bent at right-angles, the pointed ends of which, after passing through a hole made in the treadle, are inserted in the cross-piece. The edge of the foot is made circular, so that in working the treadle the leg is not chafed by it.

Above the foot are two uprights, *d, d*, figs. 1 and 2, turned in column shape, but the length of which prevents their being given regular proportions. Their total height should be at first equal to the diameter of the wheel, which ought to turn freely over the foot; these lengths make any convenient moulding; then, decreasing the thickness of the upper part, beginning from just above the moulding *a*, turn the rest of the upright cylindrically to the top. The length will now be about a foot. For the complete wheel, and for details the amateur must be guided by the model made to the scale of two feet, which is the under one; the model on the scale of one foot, which is by the side of the other, must be used for the parts to which we have given double proportions. The eye will be an easy guide in this. Make a cylindrical portion or tenon at each end, rather thick at the bottom, and long enough to allow of a thread being cut upon it and a nut being screwed on beneath, as is shown at *a, a*; the nut may be hidden in the thickness of the wood.

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At the top of the two uprights is a cup, the small size of whose foot does not admit of a thread being cut in it. The screw must, therefore, be made at the bottom of the cup, A, A, fig. 4, and the thread into which it is to be inserted must be cut in the upright itself. These uprights are joined together at the top by a cross-piece, shown in fig. 2, and represented separately on a large scale in fig. 5. This cross-piece has two holes made in it for the reception of the tenons *a*, *a* fig. 4; there should be the same interval between these holes as between those in the foot, so that the direction of the uprights remains parallel. The cross-piece is kept in its place by the two cups, the bases of which press upon it. In the centre of the cross-piece is another hole to receive the collar of the regulating-screw, A, fig. 5. This is how this screw is made and kept in position. Turn a cylinder thick enough to receive the twist of a screw with a close thread. Cut a thread in it, and then, having replaced it on the lathe, give it a bellying part, as at *a*, fig. 6; then turn a cylindrical part of a lesser diameter than that of the screw, which will fit into the handle of this screw, as in fig. 6. To make this handle, roughly turn a sufficiently large piece of wood; prepare it at one end and place it in a plate; then pierce it with spoon-bits of different sizes, and finish the hole till the cylindrical part of the screw fits tightly into it (see fig. 7). The cylinder ought to fit tightly into the handle; finish shaping it on the lathe, taking care that the cylinder turns truly; then pass the cylinder into the hole in the cross-piece, put some hot, but rather thin, glue on the cylinder, and, without giving it time to get cold, force the cylinder into the handle right against the cross-piece, where it must be fastened with a pin (*a*, fig. 5), in such a way that it turns easily, but not loosely. It will be advisable, before glueing these parts together, to rub the collar as well as the hole with a little soap, to prevent the friction from making the wood creak. For the same reason the interior angles of the holes should be a little rounded off.

As most of the separate parts of this wheel are made upon the lathe and afterwards finished with the plane, the mouldings shown upon the cross-piece in fig. 5 should be turned between the centres before adding the screw and the handle.

The moveable cross-piece which carries the heck (fig. 8), has now to be made. The two holes *a*, *a*, must be large enough to allow them to slide easily on two uprights A, A, fig. 2, and of the same distance apart as are the uprights themselves. The hole *b*, fig. 8, has a thread cut in it to receive the screw (fig. 5), which being fastened to the cross-piece carries that with it (fig. 8). It will be seen that one end of this cross-piece is longer than the other, with regard to the position of the holes through which the uprights pass; the longest end is placed at the bevilled edge of the foot, the side on which the spinner sits. Fig. 8 shews the mouldings that can be added to this cross-piece. In its thickest face are a couple of holes, which admit the tenons of the two arms A, A, kept in position by the nuts *c*, *c*, which bite the screw-ends of the tenons.

A mortice is made in the length of these arms. Some pieces of ox-hide are placed in this mortice, and on this leather turns the spindle, as we have described when speaking of the preceding spinning wheels. A pulley, (fig. 9), with a good deal of friction, is fixed to the spindle, which it causes to turn; and a reel (fig. 10), turning at its extremity a pulley, revolves freely on the spindle. A glance at the different figures in the plates will explain that the regulating-screw, as it causes the cross-piece to rise or fall (fig. 8), increases or diminishes, as may be desired, the tension of the double cord, which, put in motion by the wheel, turns the bobbins.

Fig. 2 represents the shape that the nave ought to have to turn freely between the two uprights. Place the wheel in position, and pass the axletree through the two holes and into the nave. Take the small button at the end of the winch-handle, which prevents the truss rod from shifting, and screw it on. A mortice may be made in the shaft next the winch-handle, and a small part of

the other end be cut into a screw. Add a nut, which may be sunk in the wood-work, and the wheel will be solidly fixed to its axletree.

The remaining two uprights, one of which carries the water-cup, and the other the distaff, have now to be made. These uprights (E, E, fig. 1) are rather higher than the top of the wheel. They are fastened to the foot of the wheel (A) similarly to the uprights that support the wheel, by tenons and nuts, as shewn at *b, b*, fig. 3; the whole of this length is turned of a cylindrical shape, except at their base, where a plinth is left. At the upper end is a moulding or beading, which forms the astragal. A thread is cut in their lower ends to receive the screw beneath the cup as at A, fig. 4. An arm, in two parts, E, F, which fold one over the other, enables the spinner to shift the position of this cup whenever she likes. The way in which this arm is made to revolve at the top of the upright is very simple. It turns upon a round-tenon beneath the cup. As for the hinge in the middle of the arm, it requires a particular precaution. If the amateur rested content with making a tenon beneath the cup, and after passing it through both divisions of the arms, fastened it beneath with a nut, the screw would undo itself as the arms revolved. The following is the method to pursue, a plan that can be applied to every instance of a couple of arms turning upon a screw pin, which it is wished to lessen or to tighten at will, without fear of their coming apart:—

Turn a piece of wood long enough and broad enough for the vase. Beneath the latter make a cylindrical part, a hair-breadth's less in length than the thickness of one of the arms, and mark off their lengths with a slight touch of the chisel's edge. Mark off, in the same way, a second length, equal to the thickness of the second arm; and then, having divided the whole length into four or six equal parts, place it in a vice, and give a square shape to the last cylindrical part, making the shoulders abut against the first chisel-mark. This square shape must be given with the file and rasp, with great care, so that the diagonal width from angle to angle be equal to the diameter of the former cylinder. Now, put the work back on the lathe, and, next to the square just made, turn another cylinder equal in diameter to the diagonal of the square; this cylinder, which must be cut into a screw, should be long enough to be passed through the screw-plate. Then turn a round-shaped nut in the lathe, of about half an inch in thickness, and cut a thread in it of such a diameter that it will easily fit on to the screw. Make the hole in the arm, which ought to come just above the other, square, so that the square part fits it exactly. During these preparatory operations, the cup ought only to have been roughly shaped with the gouge. It may now be completed. Any shape preferred may be given it, and it will be easily understood that the upper arms of the lever will revolve upon the cylindrical-tenon beneath the cup, while the square portion, next to the tenon, will be held tightly by the nut which is placed below, and that nothing will be able to loosen the screw. But as the threads made of wooden screw-plates are very wide apart, and are, therefore, not always suitable, we shall take another opportunity of showing how to manufacture these fastenings on the lathe with the over-head motion.

All that now remains to be made is the baluster *b*, at the top of which is the table-piece supporting the cup in which the spinner places a glass of water to wet the thread as it passes between her fingers. A glance at the plate will shew that this baluster is very easily made. It is screwed into the arm *F*, and requires no nut beneath. A thread is cut in the upper part of the baluster to receive the foot of the cup. The table-piece, turned on the lathe, fits at its centre upon this screw, and rests against a shoulder cut in the baluster. The cup is hollowed sufficiently to securely contain the glass placed in it. To make this glass more secure still, and to prevent it

from running the risk of falling, should the wheel be knocked against the foot, it will be well to heat a little cement and place it at the bottom of the cup. The end of the other arm is pierced to receive the stem of the distaff *a*, as is shown in fig. 1.

The distaff is merely a rod turned on the lathe, and supported by three or four uprights, as we have above explained. Turn separately a conical piece (*a*), which will fit tightly into it, and beneath which is a mortise. The ribs shown in the plate must be placed in this mortise, and a similar bellying part with a mortise-hole must be made about eight or ten inches from the end. The ribs will be kept fixed by their extremities between the two projecting parts, and will fit, above and below, into the holes already made there, and, if they are of equal length, will make these a kind of regular spindle.

A small crescent of gilt brass is generally fixed at the top of this distaff; it may be made of ivory, if preferred; a tenon must be made beneath the crescent, which must be screwed into a hole pierced in the top of the distaff.

This kind of wheel can be made more attractive in appearance by making all the mouldings of ivory. When first glued in they need only be roughly shaped; they can be finished afterwards. These ivory mouldings produce a pleasant effect, particularly if the body of the wheel is made of some dark wood. They can also be made of holly, or of thorn, whose grain is very fine and very close, and whose colour is of a delicate white. We merely point out these details; the amateur can choose which he prefers.

We have already sufficiently explained the heck and the way to make it; it is unnecessary to repeat what we have said.

If it is desired to give a very high finish to this spinning-wheel, the distaff might be given the shape of a twisted column; but as this is accompanied with some difficulties, we will not stop to now describe the process; we will speak of it when we deal with twisted columns.

In order to perfectly succeed in the manufacture of the different parts of this wheel, they must not be made out of wood prepared with the plane before being turned. If the wood is valuable, to do so would entail a considerable economy, but as the ridges left by the plane would abruptly come in contact with the chisel, the different pieces would be damaged and rendered useless. It is, therefore, better to decide beforehand what sized piece of wood to select for each different part; turn it to its intended shape, and then plane it on the bench. This, however, is not a very easy thing to do, as the circular shape of the parts will prevent the plane from being effectually used. At each end of each part reserve a greater length than is necessary, for the insertion of the points of the bench-hook. Roughly shape with the plane each of the faces that have to be made, taking care to select for surfaces the best and most perfect portions of the wood. This must be done gently, for if the amateur attempts to cut any large shavings from the thick parts, the grooves and narrow parts will run the risk of getting broken. While shaping the wood, examine it with one eye closed, and it will be easily seen if it is even, convex, concave, or out of trim. Whatever kind of wood may be used, it will be well to finish each face with the upright plane, or, better still, with the double-bladed plane. Both these planes, and particularly the last, are well suited to smooth knotty and cross-grained wood; and as each piece will have been carefully polished on the lathe, all that remains to do will be to polish the face.

The shape to be given to the different parts demands that these be made of different diameters. The bellying part of a baluster, for instance, is much thicker than the hollow part of a pedestal or an astragal. If an attempt were made to plane the wood down to the thickness required for the astragal, it would be left too thin for the swell of the baluster. The thickness to

be given to each part must be settled beforehand, and, when these thicknesses have been more or less obtained, the amateur need not trouble himself as to whether the plane has cut away right down to the dimensions of the smallest diameter; this may be seen at *b, b, b, b*, fig. 4, and in all the other figures.

The way we have already described of fixing the glass on the table-piece, *b*, fig. 5, is the simplest and the quickest. If, however, more careful work is desired, one of the two following methods must be resorted to.

Trace upon the table-piece, a circle of the same diameter as the glass, and at a little distance, outside this circle, pierce four holes of about three-sixteenths of an inch in diameter, equally distant from the circumference of the circle. Cut a very small thread in them, and turn four balusters, whose height, the square at the top not included, is exactly that of the glass. At the bottom of each of the balusters make a screw tenon of the same diameter as the thread cut in the hole. It will easily be perceived that when the glass is in the centre, it will be kept in its place by these four balusters, and that the square at the top will rest upon the rim of the glass.

The other method is to make the table-piece thick enough to allow of a mortice being cut in it, capable of containing the foot of the glass, plus a nut projecting some three-sixteenths of an inch beyond this foot. Above the table-piece, another piece may be screwed on to the tenon of the baluster (*b*, fig. 1, and *c*, fig. 2), and a mortise may be cut in it to contain the foot of the glass. Turn a ring of the size of this mortise, and cut a thread in it on the lathe, of the same size as the thread that must be cut in the mortise. When the ring fits well into its place, the mouldings must be made to correspond, as in *b*, fig. 2, care having been first taken to ascertain, if, after putting the glass in position, the ring rests upon the foot.

Take off the nut, and split it in two with a knife or other tool, taking care that the split is not visible; in order to ensure this, it will be well to place the blade beneath. It will be understood that this nut which, when whole, would have given egress to neither the glass nor the foot, will now it is in two parts fit into the mortise, and hold the glass by its foot; and that, if the nut has been carefully split, the split will not be seen when the nut is in its place. This last method is more solid as well as more sightly, but as it can only be had recourse to with the assistance of a lathe with an overhead motion, we have somewhat anticipated in speaking of it here.

## CHAPTER IV.

## Tapestry and Embroidery Frames.

## PART I.

## THE TAPESTRY-FRAME.

**H**AVING described the winder and the spinning-wheel, we will now proceed to give a description of a tapestry-frame.

Fig. 1, Plate XX. represents the tapestry-frame complete. A, B, are two wooden cylinders, generally made of precious wood, such as mahogany, rosewood, &c. These cylinders, which are termed rollers, are about an inch and an eighth in diameter, and about five feet long. The scale at the bottom of the plate will give the exact dimensions. At each end of these cylinders is a strong brass ferrule, to which is soldered a brass cog-wheel; but the wheels of one of the two rollers are cogged in an opposite direction to allow the material to be stretched till it covers the roller from below. In the centre of these rollers and cog-wheels is a square iron pivot, fitting tightly, the collar of which, turned very round, passes through the ends of the cross-piece C, D, on the other side of which it is fastened by a nut, shown in the plate. On the flat part of each cross-piece, and close to their ends, are a couple of catches, *a*, the teeth of which fasten into those of the cog-wheel *b* (fig. 2), and hold both it and the roller fast at the place at which they have been set. In order to easily release this catch it is made to project beyond the tooth which catches in the cog-wheel, and a little beyond the length of the cross-piece; it is then easy to take hold of.

When the cog-wheels and the ferrules are being fastened at the ends of the rollers care must be taken that the teeth of both are so placed that they both bite together in the catch. If this precaution be not taken, when the frame is exposed to a good deal of tension, and the roller is consequently inclined to turn aside, one of the cog-wheels will be completely stopped, while the others will be free from the catch, and the strain of the material will force the wood to give.

The two rollers are turned throughout their entire length, and ought to be perfectly cylindrical, in order to ensure the equal tension of the material, and to prevent creases.

The two cross-pieces *c, d*, as is seen at *d*, fig. 3, are not throughout of an equal width. The two ends are rounded to a diameter rather greater than the diameter of the cog-wheel, *b*, fig. 2, which presses against them, so that the teeth may not injure the hands. To give a greater degree of grace and lightness to these cross-pieces, which ought to be as wide in the centre as at the end, their thickness should be diminished, starting from the round ends, by a couple of invisible curves meeting in the middle. A small astragal *a, a, a, a*, fig. 3, may be neatly and carefully cut in them if preferred. The screw pins, which are fixed into the rollers, ought to pass into the cross-pieces through a hole pierced in the centres of the round ends; figs. 1 and 3 show the nuts which screw on to the bolt-pins on the outer side of the cross-pieces.

The most convenient attribute that the tapestry-frame can have when it is standing up is to be capable of being inclined at the will of the person using it. There are several ways of giving it this peculiarity. One is to make the cross-pieces *c, d*, much wider than is necessary, and to cut in their centres a semi-circular part which will fit into a mortise made in the uprights. This was the method of procedure in tapestry-frames made solely of wood, whose tenons were capped with wooden nuts; but taste having long since insisted on extreme finish in these frames, having indeed made them a piece of ornamental furniture, as much care and study as possible have been brought to bear upon their manufacture. It is this last phase of the tapestry-frame we are here describing.

Take a piece of wood about an eighth of an inch in thickness, and make a model of the brass piece *A*, fig. 3. Beneath the hollow (*b*) cut a couple of shoulders, which, resting against the cross-piece, and being beneath it, will increase its solidity.

Above these shoulders make a fang of about an inch in length; this will enter into the side of the cross-piece, where it will be solidly bolted by two little steel pins neatly rivetted on each side; or if there are any objections to these bolts showing outside the cross-piece, two wooden screws may be used in the following way:—

Select two wooden screws with perfect threads, and a little larger than the thickness of the cross-piece. Prepare the heads and stems of the screws with a file. When they are in position they ought not to bite the wood till the body of each screw has passed through the brass piece, nor ought their ends to be visible from the other side. In this way the work will be very solidly fastened, and there will be no rivetting to spoil the outer side of the cross-pieces. This arrangement will, moreover, enable the frame to be taken to pieces without interfering with the cross-pieces.

Send the piece to the founder, and tell him to make a couple. When they are cast, the first thing to do is to file away the seams left by the joinings of the mould, and to carefully hammer them. For this purpose, take a round-headed hammer of about three or four pounds weight. A hammer used to forge a piece of cast brass should be neither too heavy nor too light. Too heavy, it displaces too much metal at once, and loosens the cohesion of the parts close to the blow; too light, it hardens the surface merely, its too small weight being unable to affect the metal below a trifling thickness.

In order to attain complete success, the best way is to begin by preparing the metal with rather a coarse file, using subsequently, and in a cross-direction, a smooth one. This process removes the microscopic cinders and sand, which, in the process of casting brass, become fused in the metal, to the injury of its surface. Then hammer (while cold, all brass should be hammered cold), the piece all over, always beginning in the centre, and radiating gradually to the circumference, in such a way that the blows form a spiral. Do the same to the other side, taking care that the blows are dealt with an always equal force. We dwell a little on these details, as they

apply to all cases of forging brass. Sheet brass will always bear hammering, and if the piece in question be cut out of this brass, it can be forged at once ; but cast brass is always rather brittle, and it is best to re-temper it at a slow fire, without using the bellows, and hammer it when it has again got cold.

Very thin pieces, of an eighth of an inch in thickness, for instance, which it is desired to reduce to half that volume, in order to make springs, must be considerably thicker before being hammered than it is intended they should be afterwards. Hammer them first gently, or the metal, in attempting to give, being kept in check by the surrounding parts, will split near the edges. Then strike a little harder, and end by giving, all over the surface and with uniform force, some very hard strokes. The metal may possibly crack a little in several places near the edge, but if it has been chosen of greater dimensions than are required, as the surface spreads still more on being struck, there will be enough sound metal left for what is wanted.

When a piece of brass has begun to crack, no more blows must be given in the vicinity of the flaw. To continue to strike it there would be to force the matter to spread still further, and would, in consequence, increase the flaw. But the hammer should be used at each side of the crack, in order to induce the edges to meet, and lessen the fissure.

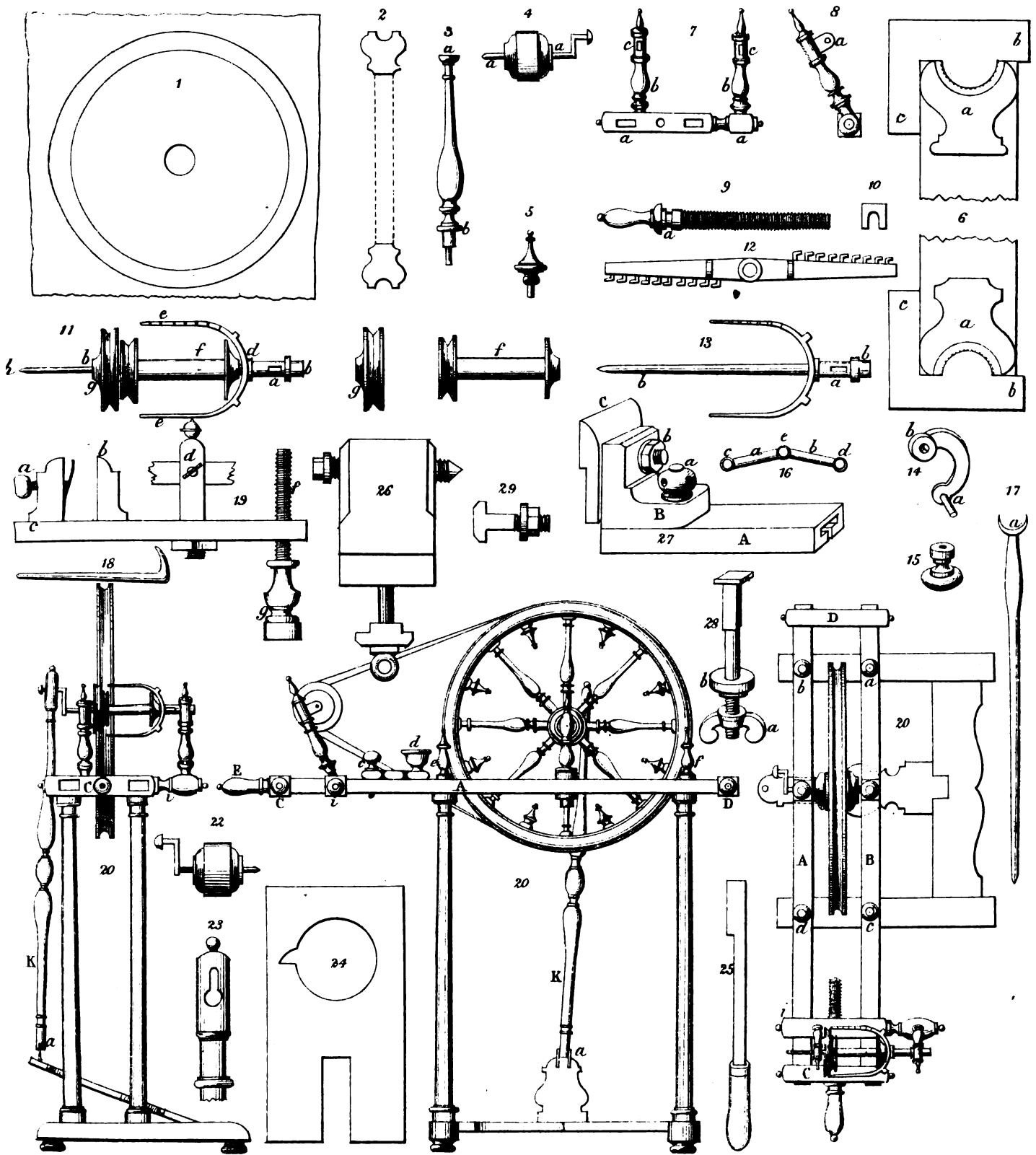
Those of my readers who have not much experience, and who desire to learn how to apply different methods to all sorts of cases, as well as to be taught how to make any one object in particular, will excuse this digression on the forging of brass.

By the above method excellent springs can be made in a variety of circumstances, instead of making them of steel. But let us get back to our tapestry frame.

When the piece of brass has been thoroughly hammered, it must be placed on some smooth wood, and fastened there by five or six nails. Then, with a rather rough file, work it all over, always taking care to cross the strokes ; finish with a smooth file.

Turn the piece over, and finish it on the other side, taking care to frequently measure with a guage, if it is everywhere of equal thickness. This being done, it is a question of giving it its proper shape. First settle the position for the bolt-pin, this being the centre of the movement of the piece, and of the lower part of the frame. Make a mark at this spot with a centre-punch ; then with a compass with steel points turn the outer circular part ; and then two more concentric circles, the interval between which must be cut away. Finally give the piece the shape shown in A, fig. 3. The other might be traced in the same manner, but the best way is to take a borer of medium size, and after piercing the hole through which the bolt is to pass, to pierce a similar hole in the other piece in exactly a corresponding spot. Then fasten the two pieces together, one above the other, with a brass bolt, roughly but strongly rivetted above and beneath. The two pieces can now be filed and finished together, and will be almost identical.

Pierce a hole in the space between the two circles. Introduce the blade of a cutting nut-saw, and cut away all the wood comprised between the two circular parts, leaving the mark, so as to be able to afterwards use the file. If the plates were tolerably thick it would be now easy to make this opening by piercing a succession of holes between the two lines, and removing the intervals with a graver to make room for the file. By this means both pieces are finished simultaneously. Take out the bolt-pins and separate the pieces in order to polish them, first with a stone and some oil, and then with a piece of white wood. Then rub it with a piece of very fine felt to remove the grease and to give it a brilliant polish. Greystone is also used for this purpose. It completely removes all traces of the file, the wood being afterwards polished with some white wood-charcoal. This last method has less effect upon the surface, and ought, therefore, to be preferred. This is the way to polish all brass.



Side Elevation

Front Elevation

Plan

Vincent Brooks Day & Son, Ltd





Now comes the question of the foot. This is composed of two uprights *E, E*, which may be made of the shape shown in fig. 3, the most usual one, or any other. These uprights are fastened at the bottom, by means of tenons and mortises, to the parts *F, F*, the shape of which is sufficiently shown in fig. 3. A cross-piece (*g*) is fastened by means of tenons into the uprights, and in order to render the frame portable and easy to take to pieces, an iron bolt, cut into a screw at the end, is fastened at each extremity of the cross-piece. A brass nut (*b*) is screwed on to the bolts on the outer side of the upright. The bolts are fastened to the cross-piece by pins passed through holes pierced in their ends. At the top of the foot, and beneath the frame, is a shelf, fixed on the uprights in the same way. On this shelf are placed wool, silk, needles, scissors, and other articles used by the embroideress. To prevent this shelf from shifting, and the objects upon it from falling, a tenon is made at each of its ends, which fit into a mortise-hole made in the uprights; in order to make it firmer still, these tenons should not be allowed to project beyond the ends of the shelf, and a mortise should be cut at each side of the latter, into which the uprights themselves will fit. This will keep the shelf perfectly steady; fig. 1 shows the process. A raised rim is made round the edge of the shelf to keep the reels from rolling off.

If the rim is made exactly at the edge of the shelf, thus making an angle in which small objects can get lodged, it will be found very difficult to pick up a needle or any other minute article from the surface of the shelf. The following is a method of making the rim, which will obviate this inconvenience. Take a plane and make some small rods long enough to go quite round the shelf; make them twice as thick as will be required, and cut a rabbet partly against and partly above the shelf. Fig. 17 shows the shape that should be given to this beading. Make the upper projection as large as is thought proper, but take care that the ledge is level with the upper surface of the shelf, or rather that it somewhat projects beyond it, so that a margin is left for finishing it with the plane. Then, with the proper moulding tool, cut a shafferoon on the inner part, that is to say, on the same side as the rabbet, and, with a moulding plane, round off the upper portion of the ledge. Leave a square of about an eighth of an inch between the shafferoon and the rabbet. Make another rabbet, of less than an eighth of an inch in depth, all round the shelf; using a rabbet plane in order to cut neatly. The width of this rabbet must be exactly equal to its projection, so that when it is finished it may exactly meet. The shortest way is to fasten these rods down with a few nails. Drive the latter in till their heads are below the surface, and fill up the holes with some wax coloured like the wood. This is the quickest method of procedure, but it is not the best. As a rule, rims fastened down in this manner give, after a short time, and the interstices admit the dust, dirt, needles, and other small objects. The best way is to fasten them with glue and very small screws, the heads of which should be driven below the surface of the rim. The heads should be covered with wax of the same colour as the wood, and mixed with a little fine sawdust. The work will then be pleasant to look at, as well as solid.

The rollers will stretch the material lengthways; but this is not sufficient, it must be stretched breadthwise, and by its selvage. The following is the way to do so:—

Take a sheet of cast brass, about one sixteenth of an inch thick, and fashion it upon an iron cylinder about 12 or 14 inches long, into a semi-circular tubing. Make four of these, which when joined together, two by two, will make a couple of complete tubes. Solder a hollow rod of brass at intervals of half-an-inch, applying the solder for the same space. Each of these little cylinders must have been pierced in the centre, and turned upon a steel pin, for the purpose of making hinge-joints. Each of the eye-pieces of the latter should correspond in position one to another; and

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when they have been finished with the file, equalised with a broach, and fastened with a pin-bolt, both the tubes will be jointed. They are shown in section in figs. 4 and 5. At the same time as the eye-pieces are soldered to the outside edge of each tube, six or eight small steel hooks, such as are shown at *b*, fig. 5, must be soldered to the inside of two of the tubes. This is a very minute operation, and is difficult to execute; the operator must have considerable skill in soldering to be able to carry it through. There is a risk of the solder running in some places, while in others it is not yet melted; but a little practice will make the process easy enough. All that has to be done is to bear in mind that all the soldering must be done at once. As it is often necessary to solder similar hinge-joints, it is not out of place to detail the process.

The method which we have just been describing of piercing the small cylindrical pieces, and of soldering them where they are to be fastened, is the easiest one, though much the longest, since they all have to be turned of an equal thickness upon a steel shaft or pin. Those who wish to make use of a quicker process must set to work as follows; having first provided themselves with the necessary tools, the principal one being a draw-bench.

A draw-bench is a bench about five or six feet long, and ten or twelve inches broad, supported on four feet joined together by three cross-pieces at *T*. A few inches from one of the ends are a couple of uprights about seven or eight inches high, fixed in the bench by two tenons which penetrate it and are fastened below it by two wooden keys. At the other end are another couple of uprights, through which are inserted the collars of a wooden or iron mandrel, at one of the ends of which is a square, to which are fixed the crossbars; these are composed of two or three double levers. A strap five or six feet long is fastened to the mandrel at one of its extremities, the other one being made into a buckle, in which a triangular iron ring with rounded angles is passed. This ring holds the two arms of a pair of pincers, which close as the strap acts upon the ring. A draw-plate (fig. 12, Plate XXI.) is fastened outside these two uprights; it is quite a different instrument to the plate used for making screws. This draw-plate is merely a steel plate almost three-eighths of an inch thick, and rather broader and longer, pierced with a certain number of holes, round, square, or triangular, according to the shape of the objects to be inserted in them. If round brass that is too large is to be drawn out, one end of it is cut into a point and passed through one of the holes in the draw-plate, which is placed against the two uprights. This end is gripped with a pair of pincers, the edges of which are cut like a vice; the triangular ring is passed through the hooks which are at the ends of the pincers, the vertex of the triangle being towards the pincers, and its base being firmly fastened to the strap in such a way that the more the strap tightens on the ring the more tightly the pincers grip the brass. The mandrel is then turned by means of the crossbars, and the brass is forced to pass through a hole of smaller dimensions than its own thickness. As the diameter of the holes in the draw-plate gradually diminishes, brass, silver, gold, and even steel or iron, are forced through all the holes in succession, with the assistance of a little oil or wax, till they are reduced to the desired size.

This is the way in which brass, iron, steel, silver, and gold wire, of any size, are made, such as metal strings for a piano, silver wire for lace, or gold wire for jewellery.

We say silver wire for lace, as gold lace is nothing but silver lace gilt; a reason which explains why the purchasers of gold lace do not give the worth of its weight in gold, but merely a little more than that of its weight in silver. It is one of the most ingenious operations of art, and deserves to be described.

Take a piece of silver bullion, give it a cylindrical shape, gild and regild it; then pass it through the draw-plate. This is the business of the gold-drawer, so called. The bullion lengthens

itself and takes a round shape with ease. It is successively passed through a number of holes, but care should be taken to re-temper it from time to time, lest it should break in being cold-hammered. This re-tempering should be applied to every metal passed through the draw-bench. The ductility of gold is so great, that a piece of metal, which at first is not longer than eight or ten inches, can be drawn out till it is thousands of feet in length, remaining perfectly gilt to the last. When it is turned into a very fine wire it is used for lace; it is then as pliable as riband, and has all the glitter of gold. But, when the lace grows old, it becomes white; the gilt has worn off and reveals the silver beneath.

The draw-bench has been applied to all kinds of arts. Fine steel for the purposes of the watchmaker is drawn in this manner, as well as gold and silver wire for the jeweller. Watchmakers and jewellers make use of this draw-bench to manufacture the eye-pieces of the hinges of watch-cases. As it matters very little whether the eye be pierced in a full cylinder, or whether it be a small tube, the edges of which just meet, since the solder must take both in the fissure and the groove; the gold, silver, or brass should be at first of a rather long, rectangular shape. Hammer it on a grooved beak-iron into a tube-like shape, insert a steel needle, well polished and of equal thickness throughout, into it; and pass the whole into the draw-bench. The metal, thus compressed, will expand in length, contract upon itself, and form a tubing, the edges of which will hardly be visible.

The needle, which should have been chosen of a greater length than the tubing, is now withdrawn, and the eye-pieces, cut off lengthways, are carefully placed at the proper distances in the groove of the hinge-joint, the joinings being turned inwards. Then, as they are being soldered to the case, or whatever the object may be, the lips of the small tubes are at the same time soldered also, and the hinge-joint is complete.

It is easy to apply this process to the work under consideration. Take a hinge-joint, file and make a straight groove at the angle of each of the tubes, place the eye-pieces at equal distances in the groove, the joining downwards, reserving at each end an inch or so without any. Fasten them with some very fine wire, and after laying some solder along the surface of each eye-piece, together with a sufficient quantity of borax, place them in an evenly burning coal fire; they may even be covered with coal, but not so as to prevent the operator from seeing what is going on. The coals should be blown with a hand-bellows or with a fan, as a forge-bellows merely increases the heat in one spot, a contingency to be avoided, particularly when the object in the fire is of some length, as in the present case. If there is too much solder it will, when it melts, run over into the groove between the two eye-pieces, and prevent the eye-piece on the other part, which has to be fitted there, from entering. It would then be necessary to remove the superfluous solder with a scraper, a long and difficult matter. If, on the other hand, too little solder is used, the eye-pieces run the risk of not being sufficiently soldered; practice alone will teach the right medium. It will be remembered that we have elsewhere said that the solder should be soaked in borax-water to prevent it from becoming greasy, which would hinder it from running properly. A small brass spoon should be used to place the solder upon the eye-pieces, and a small quantity of borax-water should be dropped between them and the groove and allowed to penetrate all round them; this is useful, as the borax will attract the melting solder. When the tube is placed on the fire, the ebullition which always takes place, and which arises both from the evaporation of the water and from the calcination of the borax, must be carefully watched, lest it cause the links of solder to fall into the fire. The tube must be carefully handled, and withheld from or gradually approached to the heat till the evaporation is over and the ebullition has died away. Blow gently

till the borax calms down, and then make the fire clear and equal throughout, blowing uniformly everywhere, and directing the heat where it is required. The best way is to use calcined-borax, as we have already pointed out.

The hinge-joint of each pair of tubes must be even in number on one of them, and odd on the other, and placed at such intervals that when the two tubes meet, the hinge-joints fit into one another's interstices and present the appearance of a perfect cylinder. It is not enough to solder all these hinge-joints in their places; a couple of eye-bolts (*a, a, a, a*, fig. 6), must be soldered along one of the tubes, beneath the hinge-joint. All these solderings must be simultaneously executed. As brass-solder, which is termed *strong solder*, and zinc-solder, do not run easily, and the operator, if not very experienced, might melt his tubes; these hinge-joints may also be soldered with silver-solder. It melts at a less heat, and there is less risk. It will be as well, in order to simplify the process, to allow no more than three hinge-joints to each tube, one to one half, and two to the other; this is shewn at *b, b, b, b*, fig. 6.

When these two hinge-jointed cylinders are completed, nothing remains but to file and polish them; this is an operation that requires some care on account of the quantity of angles and round portions that stand in the way of the direct action of the file. The operator should possess a selection of files of all kinds, and use those most suitable.

It will not be sufficient to have furnished the cylinder with hooks, there must be something to hold the two parts together. For this purpose take a piece of brass about an eighth of an inch thick, about an inch broad, and long enough, when bent into the shape of a ring, to put round the cylinder when closed, and to hold the selvage of the material. There must be four of these rings, and they must be made to fit tightly into each end of the two cylinders. The following is the best way of making the rings accurately and quickly.

Cut the brass strips of such a length that when their ends are soldered together they are just too large to fit into the cylinder. Solder them carefully, and, after filing away the solder that may have run inside them, forge them upon a cylindrical iron-pin. This will at the same time cold-hammer the brass and increase the diameter of the rings. A cylinder of boxwood or other hard wood must now be placed upon the lathe, just the size of the inside of the rings; the latter must be polished with oil and pumice-stone, and their interiors rounded. When this is done, fix them on another boxwood-chuck, on which they must fit tightly. Turn them externally, finish the edges, and polish them, but take care not to alter their shape; then cut them as in fig. 7, where there is an interval of an eighth of an inch to give passage to the material. Two cuts with a saw must be given to make this interval, and the wood between the cuts must be removed. Then once more round the edges, so that they may not catch in the material. These four rings, being well cold-hammered, will not easily open, and will consequently hold fast the two cylinders, round the ends of which they must be inserted while the hand is closing the cylinders. Fig. 8 shews a plan of the same ring. As these rings, when they are not being used, might get mislaid, it is customary to solder a kind of ring-hook to the part furthest from the joining; a tape is passed through this, and all four rings can then be tied to the frame when they are not in use. There are two ways of soldering this work; the first, at the same time as the ring is being soldered; the other, afterwards, by soldering the hook to the tin. But as the whole would have to be heated until the tin melted, it is possible that the ring might suffer, and losing the elasticity that the cold-hammering had given it, become incapable of gripping the cylinder and remain open. We shall describe elsewhere the best means of soldering on tin.

There are cases in which soldering on tin will not prove strong enough. It is frequently

unadvisable, if not impossible, to expose the object in hand to a sufficiently hot fire to be able to make use of strong solder, in that contingency recourse must be had to a solder which contains a great deal of tin and very little brass, and which melts at a much lower temperature than that required to fuse strong solder. It must be added, however, that the above kind of solder cannot be used without giving a red tinge to the metal.

Instead of giving to part A, fig. 3, a fang to be inserted in the cross-piece c, and which is fastened by a couple of rivettings, a couple of flanges may be used, fastened under the cross-piece by two oval-headed bolts, let in through the upper side of the cross-piece, and fixed beneath it by two round and polished nuts, screwed in by a key inserted in a couple of holes or notches made in them. This method of making nuts is very useful in many cases in which it is necessary that they should not project beyond the surface. Now, with some short pieces of soft iron, make a couple of hooks of such a length that when their loops are passed over the ring-hooks soldered to the cylindrical tubes, even when the material is extremely narrow, their ends still project beyond the cross-pieces. These hooks are cut into a screw with a medium thread, and a nut outside the cross-piece fits on to them and stretches the material, the selvage of which is gripped by the hooks which are inside the tubes. When it is requisite to put the material upon the frame, one of its ends must be sewn to a strap c, c, fig. 6, which is strongly fastened to the rollers with some small flat-headed nails. The other end of the material is similarly sewn to another roller, as straightly as possible, that is to say that if the material is cut on the cross at one end, a piece of stuff must be sewn to it to make it even, and to give it what is called a straight-thread. Settle at which end it is intended to begin work, and then turn the frame so that this end is next to the embroideress, as in fig. 6; then, with an iron-peg from eight to twelve inches long (fig. 9) which is placed in one of the holes (*d, d,*) of the other roller, turn this roller so that the material covers it from above. During this operation take care that the tooth of the catch catches in that of the cog-wheel; the whole length of the material will then at once be completely stretched.

Folds frequently occur, occasioned by the different degrees of tension in the warp and in the woof, which, as is known, cross one another. In these cases the cylinder must be opened, and after turning on one side, as much as is necessary, the nuts *e, e, e, e,* the selvage must be hung upon the hooks which are in the cylinder; this is then again closed, and the rings are fixed on to its ends, while the left hand keeps it closed. When the two cylinders are in position turn the nuts *e, e, e, e,* and the material will be stretched as much as is required. When, for convenience sake, it is wished to incline the frame, all that will have to be done will be to loosen the nuts at each side which press on the part A, fig. 3; the frame can then be lowered as much as the circular groove will permit.

This way of holding the selvage of the material is made use of in the most finished and perfect frames. The two large bolts *a b, a b,* fig. 6, are rivetted at the end into a rod of polished iron, upon which are fixed four hooks with a double catch, which grip the selvage of the material and stretch it breadthways.

All the different parts of this frame ought to be put together, filed, and polished with the greatest care. The wood, after being planed and worked up with rasps and files, must be finished off with very fine files, and polished with oil; this last process gives a very durable polish, and one that is not easily injured by damp or dust, as is the case with wax-polish, which should only be used for common work. The following is the way to apply it.

After having smoothed the wood as much as possible, so that no mark is left upon it, and after all the steel parts have been completed and put into position, remove all the latter, first carefully marking their place with a varying number of strokes of a centre punch made on the under side.

Then heat some linseed oil, and while it is very hot apply it all over the wood. Give it at least a whole day to dry, and then with a padded emery-stick and some powdered pumice-stone polish it all over till no mark is left upon it. Take a new emery-stick and powder it with some fine tripoli that has been soaked in water; then dry-rub the whole of the surface, taking care not to interfere with the sharpness of the angles; the result will be a polished surface very fine and very stable; neither water nor oil will be able to damage it, dust will not adhere to it, and the application of a dry duster will make it as bright as when it was new.

It is customary to gild, or at any rate to colour, all the brass parts of the frame; they can also be varnished. The receipt for this varnish is given at the end of this volume.

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## PART II.

### AN EMBROIDERY FRAME.

**W**E shall not speak of the ordinary frame used by embroidery workers. This merely consists of a couple of rollers, often round and sometimes eight-sided, of greater or less length, according to the work, and at the ends of which square portions are reserved, from six to eight inches long, and having a mortise on each face corresponding to the one opposite. Two arms, about three inches wide, three-eighths of an inch thick, and of a length suitable to the opening it is desired to give to the frame, usually one of about three or four feet, are inserted in the mortises. As they are pierced towards the two edges with a row of alternated holes, the rollers, to which are fastened a strap, as in the preceding frame, are stretched by placing a small eye-holed pin, from two to three inches in length, in the centre mortise, as is shown in fig. 9. Embroiders content themselves by placing this frame, already stretched, upon a couple of trestles at a convenient height.

There is another kind of embroidery frame, only suited for small objects, such as waistcoats, women's boots, etc. Fig. 10 shows a section, and fig. 11 a plan of it. Two uprights, *A A*, from twelve to fourteen inches high, with mouldings according to taste, made on the lathe, are fastened at their lower ends to a plank *B* by square tenons, and secured by a couple of nuts, *a a*. The top of each upright is forked, as in fig. 12, in order to support a piece of wood similar to that at *A*, fig. 3; this is shown in fig. 13. The plank *D*, fig. 10 (a plan of which is shown at *B*, fig. 11), has beneath it four small studs, *a, a, a, a*, one inch in length without their tenons, as at *b, b*, fig. 10; these act as feet to the frame, and prevent it from being unsteady. The part, fig. 13, fits into a mortise made in the centre, and beneath the cross-piece, *c, c*, fig. 11. By this means, the frame may be made to incline more or less, as may be desired; while an iron bolt, the head of which is inside, as at *e, e*, fig. 10, the end of which is cut into a screw, and the body of which

passes into the two joints of the uprights, as well as into the piece as at fig. 13, fits into a nut at *d, d*, which, tightening the joints of the upright against the piece, as at fig. 13, holds the frame just at the desired angle. This bolt, its head, and the nut, are separately represented at *e*. The two cross-pieces are rounded on the lathe as far as the portion which is to receive the part, fig. 13, and then cut into screws of a medium thread, in order to obtain the necessary degree of tension, as is about to be explained.

A circular hole is pierced in the extremities of the two rollers, for the screw; and in order to be able to use the rollers in any position, a similiar hole is made in each of their faces. Insert each screw into a circular nut, which should have been made in the lathe, so that they may fit closely against the rollers. At two places on one of the diameters of the rollers, put a couple of studs, made on the lathe, in order to easily turn them; they should be made to press home against the flat part purposely left in the centre. As it is taken for granted that the material is sewn to the straps on the rollers, the screw should be inserted into one of the latter, right up to the nuts, while the other roller is covered with as many folds as possible, until it can just pass between the two arms of the cross-piece that have been cut into screws. The nuts on the other side are then unscrewed; this will release the roller. Then unscrew the other two, and the material will be stretched in the middle of the frame. Continue to unscrew the nuts in order to increase the tension. It will be understood that these screws must be of a certain thickness to withstand the strain put upon them; a strain, the effect of which is to bend and nearly break them; but it must be remembered that the size of the rollers must be proportionate, otherwise the holes for the screws will be too large for the strength of the rollers, and will end by causing their fracture. When the material is stretched lengthwise, the selvage is interlaced with some thin string, and stretched by passing the string to the right and to the left of the screws themselves.

This frame is extremely useful for the reason that it will fold up and occupy very little room, and that on account of its small size it can be taken on the lap, and used at a window, or by the fireside.

The kind of frame known as a tambour-frame is well known. It consists of a thin walnut-wood circle, turning horizontally on a second circle of the same wood; or rather it is composed of a couple of wooden circles, which turn one inside the other. The outside circle is fastened to the uprights in the same way as in the embroidery-frame. A selvage of some material is sewn all round the moveable circle, and filled with wood or cotton. The material is built up on this selvage, and the whole circular superficies is embroidere, leaving the inside circle free. As this embroidering is done with the embroidery-hook, it does not require much tension, and this kind of frame merely furnishes as much as is given to the material by the manner in which it is put upon it.

This, perhaps, would be the place to speak of several other little articles that might amuse the amateur, but as they are too complicated to be made on the ordinary lathe, we will defer their description till we give an explanation of the lathe with the over-head motion, and the work it is capable of producing.



## CHAPTER V.

## The Manufacture of Cases.

**A**N amateur turner is often called upon to make cases for ladies. This kind of work is much more easily made upon the lathe with the overhead motion, but as it can also be produced on the ordinary lathe we will describe how to make it on the latter.

Select a piece of perfectly sound wood without flaw or knot; this is more essential in this instance than in almost any other. Roughly shape it with the hatchet, and place it between the centres. Turn it from one end to the other of an equal thickness. Divide its length into three parts, and reduce the thickness of the third to the right to the diameter it is intended to give to the neck of the case, which ought to be less than the thickness it is intended to give to the cover. Turn this neck with the greatest care, so that it may be perfectly cylindrical from one end to the other. In order to the more completely succeed in doing this, finish it, after it has been turned with an ordinary tool, with a chisel with a single edge, cutting away very little wood at a time. Carefully gauge it with a compass all along its length; cut the shoulder against which the cover will have to rest with a point-tool, making rather a sharp re-entering angle, so that the edges may the better meet. Then polish the neck with some damp shave-grass, taking care to rub in two opposite directions, for fear of using too much friction one way and not enough the other. When all the marks are effaced, cease wetting the shave-grass, but continue rubbing till the neck is dry. The wood will now become much paler than its natural colour; this is the effect of the juice of the shave-grass. All that has now to be done is to pour a drop or two of oil on the neck, and then rub it rather vigorously with a woollen rag, turning all the time, in order to get rid of as much as possible of this oil, which, if much of it remains, leaves a bad polish that tarnishes under the touch, and that soon allows the wood to regain its natural colour.

It will easily be understood that all this friction considerably heats the wood, and that if it had any tendency to split the heat would soon cause it to do so. We add this remark in order to give greater weight to the advice we have already given to choose a sound piece of wood.

In using the shave-grass take four or five strips and make a little bundle of them, wetting them continually in some clear water while using them; but care must be taken that the knotty parts do not touch the wood being polished; the knots, which are very hard, would injure instead of giving a finish to the wood.

Give the end of the neck a slight touch with the point-tool to soften the abruptness of the angle before beginning to polish.

Turn another cylinder of the same wood for the cover ; but as the cover has to be made very thin, and as the neck of the case puts a severe strain upon it, care must be taken to avoid any crack or fissure. When this cylinder, which must be made rather longer than is necessary, in order to leave plenty of room for the cord of the lathe, is turned, that end of it out of which the cover is to be cut must be very neatly finished ; to ensure the cover fitting exactly against the shoulder of the body of the case, it will be well, indeed, to give a rather sharp re-entering angle to the end.

When the case is placed in the plate, add a little oil, as much to lessen the friction as to prevent the wood from getting heated and turning black. If the plate be a wooden one, use soap instead of oil.

First shape the case with spoon-bits of different sizes, till its thickness is nearly that it is intended to give it. In order to better judge of this, and to be sure of the exact thickness of the neck, it will be advisable to make a notch (fig. 24, Plate XVIII.) in the hole in the plate towards the left, about the height of the tool. Make this notch with a three-sided file ; by this means the operator will be able to estimate the thickness of the neck. It is now necessary to employ a tool much used with the lathe with an overhead motion ; it is termed *side-tool*, and is shown in fig. 25, Plate XVIII. This tool only cuts with its extremity and left edge ; thus, in fig. 25, the sloping edges are beneath and cannot be seen. Select one that easily enters into the hole, and which cuts well ; then, holding the left thumb on the key which serves as a rest, and grasping the collar-plate with the fingers, cut out the case without shifting the tool, so as to make it round within and without. Although this operation is rather one of scraping than of cutting the wood, the tool ought to bring away some very fine shavings. Withdraw the tool every now and then, and ascertain, by measuring the external length of the case, if a sufficient distance from the bottom has been reached.

Give the bottom a thickness of about a quarter of an inch, using a tool sharpened along the whole length of its sloping edge, so that the case may be equally hollowed out from one end to another. Reduce the neck to a thickness proportionate to the quality of the wood and the length of the case ; round off the inner end till it finishes almost in an acute angle, making the curve more apparent as the extremity is approached. Then rub the mouth of the case with some dry shave-grass, and the neck and the inside will be finished. The most difficult portion, however, still remains to be made, the cover.

As we have said elsewhere, when the operator wishes to ascertain if a case is well made, he should feel with his finger and thumb if the cover is perfectly concentric with the body of the case, and if it appears to offer an equal resistance throughout. If the two circles of joining are not concentric, it is a sign that either the neck or the interior of the cover are not quite round ; this may be owing to the operator's want of skill or to the wood having shrunk since its manufacture. It will be seen, therefore, that it is very important to take every care to make both the neck and the cover perfectly round.

Cut out the inside of the cover in the plate, as was done with the case, with the greatest care. As it is essential that it should not be of a larger diameter at the bottom than at the rim, and that the inner part should be perfectly straight, it will be well to sharpen the chisel on one side on a stone well prepared with oil.

There is one capital method of finding the right inner diameter to give a cover, in order that it may readily fit the neck of its case. It is to make use of a pair of callipers (fig. 15, Plate I. Vol. II.). The upper part of this instrument is composed of two arched portions, the lower part

has a couple of legs with the feet turned outwards. When it is correctly made, the space between the two upper points gives the external diameter, and that between the two feet the internal one ; but as the smallest miscalculation throws the whole thing out, take a smaller diameter than is apparently required for the interior, and hollow out the cover, according to this measurement, from the rim to the bottom. Then, taking a fresh sharp side-chisel, and having first ascertained that the depth is longer than the neck, finish off with slight strokes, holding the chisel steady and immovable upon the rest. Now see if the neck fits easily into the cover, repeating the attempt over and over again till it enters equally all round and quite up to the top. This part of the operation is very difficult.

When the inside of the case is finished, all that remains to be done is to turn its outside. Place it between the centres and finish it off with the gouge, the ordinary chisel, and a few careful touches of a chisel with a single sloping edge. Provided that enough thickness of wood has been left at the two extremities, the ends may be left square, or they may be rounded off. But, in either case, the marks left by the centres must not be visible ; in order to prevent this a greater length of wood should be left at the extremities than is required, so that the case may be cut off with the point-tool beyond the hole made by the centres ; but these superfluous ends should not be cut off till the case has been externally polished in the same way as has been explained for the neck.

Put the case back in a plate upon the lathe, in order to finish and polish one of the ends ; a common piece of wood can be turned to hold the cover, which can then be finished in the plate ; but as the outside of the case is now polished, and the cord might leave marks upon it, wrap a little leather round it, fastening the leather with some thread.

If it is wished to ornament this case with a few ivory rings, or rather objects, the following is the method of procedure.

Take a piece of ivory of a rather larger diameter than that of the case it is intended for. Fix it on the end of a wooden cylinder turned on the lathe in the following manner.

Melt a little lathe-gum, and dip the chuck and one end of the ivory into it. Having thus joined the two together, leave them to get cold. Then place them between the centres, and turn the ivory to a diameter rather larger than that of the case. Now, putting it in a plate, without losing the centre, cut a mortise in it, with a mortise-chisel (fig. 13, Plate XII.), at the end which joins the body of the case, to about half its thickness, giving it such a diameter as it is thought will allow it to pass over the lid ; then, replacing the ivory between the centres and carefully finishing the rim, cut it to the right thickness with a very narrow, rather thick, long-edged point-tool (fig. 13, Plate XII.). A ring, such as is required, can now easily be cut off. Take a mortise chisel and a point-tool, and cut a place for the vervel in the cover, the holes in which, made by the centres, still exist. Take care that this vervel fits rather tightly, and glue it in. When the glue is dry, put the cover, vervel and all, on the case, and finish it off with a chisel with a single sloping edge, merely just touching the vervel. Polish the whole as has been before described, and before oiling the case, polish the ivory with a little flake-white and water. All is now finished, but care must be taken not to put any oil near the joining, for the glue would soften and the vervel soon come off.

If the ends of the case are square, a similar vervel may be added to each of them, but the amateur, in removing the centres, must beware of injuring the vervel in the plate. It might get loose or turn black, particularly if any oil got to it.

It is best, as a rule, to leave a little wooden cone at each end of the case to receive the centres ;

these are afterwards cut off with a chisel, when the case is completely finished. This expedient prevents any chance of blackening the ends of the case, a contingency that becomes a certainty when it is finished in the plate.

It is also feasible, if the colour of the wood suits, to use tortoise-shell vervels. The manufacture of tortoise-shell, that is to say the expedients adopted to make circles, boxes, &c. of it, demand a detailed explanation that will be given in a separate chapter; for the present it must suffice to say that tortoise-shell vervels can be bought ready-made; we can only here pretend to instruct the amateur how to use them. Let the latter, then, furnish himself with some tubes of tortoise-shell of about the required diameter. Fit one of them tightly on to a chuck made of hard wood, the thickness of which gradually increases. Take the particular kind of point-tool we have already mentioned for this purpose, and cut a vervel of the proper width. Fix it to the case, and glue it solidly on.

When it is required to use glue with very light-coloured shell, or to conceal joinings, it will be well to make use of isinglass dissolved in water, and, if it is used hot, to add a few drops of good vinegar. Isinglass may also be dissolved in spirits of wine, and used without employing heat, which is often an advantage.

The best way of dissolving glue is to break it into very small pieces, add water to it till it is quite covered up, and leave it to soak for from 12 to 18 hours. At the expiration of that time the glue will be quite soft and pliable. Then throw away the surplus water, and putting the glue into a tinned brass bowl, and the latter in hot water, leave it to melt. After a short time, the glue becomes sufficiently liquid to be used for all kinds of purposes. Some assert that this method takes the strength out of the glue, and that it is much better when melted in the ordinary way, by the heat of the fire. We have never tried this latter plan, but we can assure our readers that good glue dissolved in hot water is always very useful.

Carpenters melt glue in water over a fire. Organ manufacturers do the same; but as there are a number of occasions in which it is necessary to use glue for a long time, and that with this method it requires continual re-heating, it runs the risk of getting spoilt; as every time it is made hot, it rises, and forms a crust round the rim of the vessel containing it, and this crust becomes burnt and useless.

Violin-makers use glue with the greatest economy and cleanliness. The surfaces they are accustomed to glue together are so delicate, that it is probable that experience has taught them the best method. They use a leaden pot about three-sixteenths of an inch thick, in which they keep their glue continually hot over some coal-dust in a cast-iron stove. The following is the way to make the leaden pot.

Turn a wooden cylinder about three inches in diameter and about five inches in length; then turn another, with a diameter of about three-eighths of an inch larger than the first; after rubbing this second cylinder with a little oil, make a plaster mould upon it. When this mould is quite dry, fasten the smaller cylinder above it with a couple of iron pins; it will leave all round and below it a margin of three-sixteenths of an inch. Fix it securely, and in a perfectly parallel direction to the mould, lest the lead should alter and disturb its position. Pour some molten lead into this mould, break the latter, and you have the leaden pot. To ensure the easy egress of the core it will be well to make its lower diameter rather smaller than its upper one. Pierce a couple of holes at the two sides, opposite to one another, and pass a piece of iron wire through them; this gives a handle by which it can be carried about.

This kind of glue-pot is a very convenient one, for lead retains heat a long time, and the glue

remains hot without becoming burnt or dried up. It cannot, however, be used over a fire, as the lead would melt; and, on the whole, the hot-water bath is preferable, as it couples the two advantages of keeping the glue hot and of preventing it from drying up. It is so essential to always use very hot glue, and to heat the parts that are to be glued together, that joiners, in order to allow the glue to completely penetrate, put some on the place to which it is intended to glue the object in hand, and then pass hot irons over the part till the glue bubbles up; striking the surface all over afterwards with a broad hammer, to force the glue into the pores of the wood. There should be some limit, however, to this preparatory heating. As an example of the inconvenience of carrying it to excess, it will suffice to heat a piece of wood till it becomes too hot to be touched; if, while it is in this state, some glue is placed upon it, the wood will immediately become covered with a quantity of air bubbles. These are produced by the water in the glue, which the heat has caused to evaporate, but which, being retained by the glutinous portions of the glue, cannot escape. Such a layer of glue dries up in a moment, and loses all its adhesive qualities.

As we have been led into speaking of the precautions to be taken in using glue, we may as well mention a certain expedient to enable glue to take hold of a polished surface. In order to the better understand what we are about to say, we will preface it with a few observations on the manner in which the different kinds of glue used in art-manufactures are made to produce the desired effect.

The most evenly polished surface is in reality only that which possesses the least roughness. However polished, therefore, it may be, the glue fastens on its minutest projections, and lodges more or less thickly in the intervals between. If the wood is a compact one, such as *Lignum Vitæ*, *Ebony*, *Violet-wood*, &c, the glue soon leaves the rough parts it at first fastened upon, and comes off in thin transparent layers. The truth of this is shown by spreading a layer of glue over a surface of marble or looking-glass; after a few hours the whole will easily come away. The same result is produced if some of the best glue is used to fix a slip of paper to a polished rule.

In order to prevent this a little honey should be put into the glue; the glutinous matter of the former mixing with the latter will prevent it from attaining too great a degree of dryness. The objects thus glued together will no longer come apart. Our own experience places this beyond a doubt. We kept, during a whole winter, a slip of hard wood, completely polished and covered with a piece of paper fastened with glue thus prepared, close to a fireside; close to it we placed another piece of paper glued to a second wooden slip with some excellent ordinary glue. The paper came off the latter at the end of a single day; that on the former still held firm at the end of a long winter. The honey, however, must be carefully used; too little will be useless, too much will make the glue too soft.

We trust that these little digressions will not prove disagreeable to our readers; they will teach them more than one little-known expedient that will prove of great use in many circumstances.

## CHAPTER VI.

**The Different Utensils Used in a Workshop.**

**I**N attempting to teach the amateur to turn, we intend, whenever it is possible, to take an opportunity of furnishing him with some practical work by way of exercise; generally selecting an example that will be of use to him.

Seats are a first necessity in a work room, less for the purpose of rest than in order to be able to work in a sitting posture at certain operations which do not permit of an upright attitude; such, for instance, as making exact and long divisions on a piece turned on the lathe or prepared with the plane, tracing dovetailed-tenons, and many others. In such cases the back of a chair is always in the way; even a stool is inconvenient on account of its unchanging height. If the amateur is desirous of tracing on the lathe-bench, a much higher seat is required than when he is working at a carpenter's bench, which is much lower, or then when he is occupied at a jeweller's bench. It is necessary, therefore, to keep a variety of different sized stools. But a kind of stool has fortunately been invented which can be set at any height required. We will explain how to make a couple, one that can be raised and lowered, the other of a fixed height. We will begin with the last, which is the easiest to make.

## PART I.

## AN ORDINARY STOOL.

**C**UT a circle of a foot or thirteen inches in diameter out of a piece of wood of about an inch and an eighth in thickness. Put it on the lathe in a strong three-pointed chuck. Turn it, and on one side cut it into a spherical shape of about an inch deep, extending over the whole surface. In order to give this curve greater regularity trace a cardboard pattern with a beam-compass, and apply it to the concave surface. Round off the rims without adding any mouldings, which would tear the operator's clothes. Turn the other side quite flat, and quite up to the chuck using

a good rule ; then, at about a couple of inches from the rim, trace a slight mark with a square-edged point-tool. Take it off the lathe and carefully remove both sides of the wood, where it has been placed upon the centres, with the gouge and other suitable tools, taking care to follow the same curve. Now divide the mark made upon the lower surface into three equal parts, and at each point of division pierce a hole of about an inch in diameter. If the wood is thick enough to allow of it, it would be more sightly not to drill these holes quite through ; take care also not to incline the spoon-bit towards the outside of the circle, but to give it the same inclination at each hole.

Now turn three legs of the same wood, of such a length as will give the stool the height required. Add mouldings to them, but take care that their lower extremities are pear-shaped and round at the end ; and that there is on each leg a bellying part large enough to admit of a rather large hole and a tenon. At the other end of each leg turn tenons that will exactly fit into the holes made in the seat, adding a shoulder against which the latter will rest. As the holes are not at right angles to the seat, the shoulders must be given a corresponding inclination.

Now pierce a hole of about half-an-inch in diameter right through the bellying part on each leg, at the same distance from the end in each. Fit the legs into the seat, inserting the legs right up to the shoulders. Measure the distance between two of the three legs, and turn a cross-bar, which may be ornamented with mouldings, leaving a bellying part in the centre, in conformity with the general outline already settled upon. At each end of this cross-bar make tenons of a suitable size, with or without shoulders, as may be judged most expedient. Join the two legs together with their cross-bars. It will be well in piercing the holes to be guided by the degree of inclination given to the legs, so as to be sure and make the cross-bars parallel to the seat. A second cross-bar must now be turned, as long as the distance of the thick part of the first from the third leg ; join the latter to the other two with this second cross-bar. This is called a T-joining. The tenons of the cross-bar must completely pierce the legs.

Take the whole to pieces, and make a cut with a saw on the tenons of the two cross-bars, large enough to admit a very thin wedge. This must be managed so that the strain of the wedge is not exerted in the direction of the grain of the wood ; if this precaution be not taken, the wood will split. Join the three legs together, fasten them with glue, and insert a wedge of the same wood in the mortise cut in each tenon ; fasten it with some very hot glue, and as quickly as possible, lest the glue should become set. During this operation, the cross-bars should be placed on a work-bench. Glue the three tenons in their planes in the same way, bringing the shoulders right against the seat. Leave the whole to dry for four-and-twenty hours, and then, with a proper tool, cut the ends of the tenons off flush with the legs.

It is clear that the frame-work of this stool would be much stronger if wedges could be inserted into the tenons of each leg ; but as the holes into which they fit do not penetrate the seat, this would appear at first sight impossible. The expedient, however, we are about to describe will show that it is not so.

At the top of each of the three legs cut a mortise similar to those made in the tenons of the cross-bars, and prepare for each of them a wedge, so shaped, that supposing it to be driven right through the tenon, flush with its under side, it will force the two sides of the mortice to open, and consequently increase the diameter of the tenon. Take a gouge, and widen the holes of these tenons towards the bottom, giving them a swallow-tail shape. Dip the wedges into hot glue, and insert them into the mortices, so that they project beyond the tenons. Place the three legs in their proper position, and having placed a piece of wood beneath the seat, to prevent its curved surface

from making it unsteady, drive the three legs in as simultaneously as possible, striking them in equal alternations, till they are well home and in their right position. It will be easily understood that the wedges thus forced into the mortises have a spreading effect on the tenons, which, having become larger at the ends, can no longer escape from their holes, these being of a smaller diameter at the orifice. The whole stool is thus made as solid as possible. This method of procedure can be applied in a great number of cases.

## PART II.

### A STOOL THAT CAN BE RAISED AND LOWERED.

**T**HE stool whose manufacture we are about to describe is in much demand in amateurs' workshops, from the fact of its being able to be raised or lowered at pleasure. We, however, do not describe it so much on this account, as for the reason that the amateur who learns how to make it will acquire considerable facility in several operations that are intimately connected with the art of turning.

Fig. 1, Plate XXII. represents this stool complete. It can be raised or lowered by means of a screw in the seat, which turns in a thread in the foot. Carefully plane a piece of walnut-wood about one inch thick, very dry and very sound, and then pass the toothing-plane over it, in order to set up a few rough places in which the glue can obtain a firm hold. Take a compass, and, with a radius of about two inches and a quarter, trace three circles on it; cut these out with a turning-saw. Divide one of the circles into three equal parts, each of which is destined for one of the three legs of the stool, and be careful to place one of the points of division exactly in the grain of the wood. Glue a second piece of wood under this first one, in such a way that the grain of the wood comes exactly under the second point of the first; and a third, with the grain under the third point. This will enable the cylinder which is to contain the three legs to be always partly with the grain of the wood, and partly against it, and to be, therefore, very solid. Warm each piece of wood, mark all three, glue them together with hot glue, and place them under a press.

Now take a piece of very thin wood, and make a pattern in conformity with the shape settled upon for the three legs. Prepare a piece of wood nearly an inch thick. Trace upon it the outline of the pattern, which, in order to avoid to cut off wood, must be placed with the grain; and reserve at least one inch for the dovetailed tenons (fig. 2). Cut them out with a turning-saw. Finish them off with files and rasps of different kinds, and take particular care that they are quite equal. Trace a line, *a, b*, that will act as a shoulder to the dovetail, and with a sharp saw and chisel properly finish the dovetail (fig. 3).

Then turn a circle of the same kind of wood, of about a foot in diameter, about two inches wide, and about an inch thick. Leave upright corners in the inside of this circle, and round off the angle of the surface which will come beneath. Finally, at about three-eighths of an inch from the inner rim, trace a mark with a point-tool, on which to pierce the holes necessary for the cane bottom to the seat.



Take a plane and make a couple of cross-pieces about two inches long and about two and a half wide, and arch them a little both inside and outside, as shown in fig 4, so that if the cane with which the seat is bound gives a little with the weight of the sitter, it can never reach the cross-piece. Cross them at right angles, letting them into one another at half the thickness of each. Make a mortise at each end, as is shown at *a, a*, fig. 4; in order to have this the more correctly, take the exact internal diameter of the circle that has been turned, and with the radius of the same circle mark out from the centre of the cross-pieces an arc of the same circle at each end. Fit them into one another by cutting away half the wood of each, and endeavour to make the cross fit exactly into the circle, and to allow the tenons to fit into their proper places. Screw the cross-piece to the side from below with some substantial wooden screws.

After preparing the holes with a drill-bow, a little smaller than the thinnest part of the screw, use a scoop (fig. 18, Plate II.) to widen each hole at its mouth, leaving them, however, still rather smaller than the screw. Grease the screw with some tallow, so that it may not injure the wood, and so that it may be unscrewed or screwed in without doing any harm. In the centre of the cross-piece pierce a hole about half-an-inch in diameter, so as to be able to cut a thread in it of about an inch in width, for the purpose of inserting the head of the screw we are about to speak of.

On the inner surface of the wooden circle (fig. 5), which is to be the seat, or to speak more precisely, on the mark made upon it with the point-tool, pierce a quantity of holes at the same distance apart, about three-eighths of an inch one from the other. These are for the strips of cane for the seat. We shall speak of them elsewhere.

Turn a cylinder about a couple of inches in diameter, and from 18 to 20 inches long, or thereabouts. Make at one end a tenon at least two inches long, giving it indirectly a slightly conical shape to facilitate its entrance into the thread. Cut this tenon into a screw, as has been elsewhere explained. Then, putting the cylinder back upon the lathe, make one end a little smaller, and pass it into a thread of about a couple of inches in diameter, almost quite up to the tenon. Place this screw back again upon the lathe, cut away the first turns of the worm, which are useless, and give its end a pear-shape, adding a ball, or any other ornament, at the end.

In the meantime the three circular pieces of wood that were glued together ought to have become perfectly dry. From the centre trace a circle distant from the rim about the length of the dovetails of the legs, and divide it into three equal parts, taking as the first point that which is exactly in the length of the grain of the wood, so as to be sure that the two others will be in a similar position with regard to the two remaining circular pieces. Pierce a hole in the centre, about an inch and a quarter in diameter, bringing the centres exactly together, and penetrating half through the thickness of each piece from each surface.

The following operation is difficult, but it is necessary. At one of the sides of the hole make a dovetailed mortise about an inch deep. In order to do this the more easily begin this mortise from what will be the lower surface, and deepen it till it is within about three-eighths of an inch of the upper one. Finish this mortise very neatly, and insert in it a piece of wood, prepared with the plane, that does not quite fit its breadth exactly. Cut it off an inch shorter than it would be if it just touched the inside surface. In the empty space in the mortise, and above the piece of wood first inserted, glue another piece which will just fill up the dovetail. This will ensure the hole always keeping its right shape. The free play allowed to the piece of wood will always permit it to advance towards the hole if anything presses upon it from without the cylinder, but it will be unable to give in the direction of its length.

Cut a thread in the hole made in the middle of the cylinder. If the ordinary screw-tap is used for this purpose, it will be well to place on both sides of it a piece of wood with a hole of the same diameter pierced in it, this will resist the effort made in boring. If this precaution is not taken when large threads are being cut, there is a risk of injuring both surfaces.

Before inserting the screw-tap in the cylinder, the piece of wood in the mortise-hole must be fixed so that it completely touches the internal surface of the hole. To effect this a splinter of wood should be introduced, it can be withdrawn afterwards.

A thread with such a large diameter as two inches, and which, owing to the depth of its worm, displaces a good deal of wood, necessarily requires considerable effort to cut. Though the lever may be long, it always gives trouble, particularly when two or three turns of the worm have been cut, since, on account of the conical form of its lower extremity, it presses against the wood everywhere at once. To obviate this, a cylindrical screw-tap should be used, to which is affixed a hollow part, which allows the shavings cut away to escape (figs. 11 and 12, Plate VI., Vol. II.).

The method used by mill-carpenters may also be employed. The fear of making our description too long makes us postpone the explanation of this process, by means of which a thread of 4, 6, or 8 inches, even of a foot, can be cut with the greatest ease, without straining or injuring the wood in the least.

When the thread has been cut in the cylinder, insert the screw in it and turn it between the centres. Finish the two ends neatly off, and slightly roughen the one that will come undermost, in order to give the glue a better grip.

At each point of division, respectively, trace the shape of the dovetail on each leg, making a separate mark on each for fear of confusion. Take a rim-square, and continue the tracings along the whole length of the cylinder, and underlap them beneath it. This may seem a rather difficult operation, but it can be easily carried out in the following manner. Place the edge of a rule on the end of one of the lower tracings for the dovetail, right against the line drawn down the cylinder. Place another rule beneath, at the end of this line, and, shutting one eye, look at those portions of the rules which project beyond the cylinder; when the lower one seems parallel to the upper one, they will be in the same line; then trace it. Proceed in the same way with the opposite side traced beneath the dovetail, and when the rules appear in the same line make the other tracing. The two sides will then be quite parallel. The length of the dovetail can be measured with a carpenter's guage or with a compass.

At the spot where each mortise is to be made, give a cut with a saw, taking care not quite to reach the traced line, for fear of making the mortise-hole larger than the tenon. Remove the wood between, making a narrow cut with a turning-saw from each outer angle to the inside. The chisel may be used, but in that case only half the wood must be cut away from each side, lest the inner surface should be made to split. The mortise-hole will be easily cut. Neatly finish it with a proper chisel, taking care now and again to try if the dovetail fits properly into it. It must be noted that the shoulder of each dovetail should rest against a circular part, that is to say, against the cylinder. Before, therefore, tracing the mortise-hole for the dovetail, take an adjusting-file and remove three-fourths of the width, equivalent to the thickness of the legs, or else give the circular-shoulder the same radius as the cylinder. Unless these precautions are taken, the outer angles of the shoulder will not fit close against the cylinder. This is a difficult operation for amateurs without much experience, but it is necessary to ensure the solidity of the stool.

When the three legs have been tightly fitted into their proper position, take a cylinder, purposely made of the same thickness as the screw, and turn upon it a small piece of the same

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wood, of a larger diameter than the cylinder, and about a quarter of an inch in thickness. Give a little roughness to the surface on which the glue is to be placed, leaving the remaining superficies perfectly smooth. Add any kind of moulding to the upper rim, such as a shafferoon, a quarter-round, or an ogee.

It is necessary that the screw should turn exactly in its thread, neither too stiffly nor too loosely. Use will soon make it do the latter, and as nothing is so disagreeable as a rickety-seat, it is now the moment to make use of the lardon. Just behind the lardon, and at right angles to the axis of the cylinder, pierce a hole, about three-eighths of an inch in diameter, so that it may afterwards be cut into a thread of half-an-inch. Turn a screw with a flat head, and insert it; by this means the stool can be adjusted to any height. It will be noticed that the screw does not press against the thread of the large screw, if it did it would soon destroy it; and that the pressure being exerted along a smaller length, by at least two inches, than that of the lardon, the friction is much lessened, and the solidity of the stool much increased.

Before gluing the seat itself to the screw, a cane bottom must be given it. This is a very difficult operation. Amateurs do not usually do it themselves, and we shall, therefore, give but a very brief description of the process. The cane must be split into strips, about one-sixteenth of an inch wide, and half that thickness. Peculiar tools and considerable skill are required for this work. The strips must be passed through opposite holes, two through the same hole, threading them from one hole to the next, always keeping the smooth surface uppermost. The same process is then repeated across the seat, the strips being passed alternately above and below those stretched in the opposite direction. When a strip is finished, tie it in a knot close up to the hole. Then cross the seat diagonally, this time using only a single strip of cane, and the seat will be finished. It is usual to make a groove to receive the knots and interlacings of the cane. This groove should be cut on the lathe if the part on which it is made is round, with a carpenter's tool if it is flat. The groove and its notch are then covered with a thin piece of wood, which is glued on and finished off afterwards.

The cross-pieces are now put in their proper positions, and the seat is glued on to its screw-tenon, so that when the stool is raised by turning the screw the seat moves with it. This kind of stool is much used by amateurs. The novice who succeeds in making one according to our instructions may flatter himself that he has achieved considerable progress. It must be admitted, however, that the weight of the sitter, that generally bears unevenly on the seat, ends by straining the screw, which soon becomes loose, and may break. The stool shown in fig. 6 appears to us, on the whole, to be more convenient and more solid. We cannot, however, afford the space for a description of the way to manufacture it; but we trust that, after the details we have just given, the plate will be a sufficient guide to its construction. It will be seen that the screw, which is held between two pieces of wood, must be much more firmly placed than a screw which only works into one. Moreover, the lower piece of wood helps to prevent the three legs from being thrust apart, and the whole stool is more convenient than the first. It possesses the further advantage, too, that it can be used without the screw as an ordinary stool, and that it is only necessary to introduce the screw when it is wished to greatly raise the seat.

There is yet another way of making a stool which can be raised and lowered, and that is by cutting a square rabbet in the inner-angle of each foot, in which the feet of another stool can be introduced. Mortise-holes are cut in these feet, while an iron or wooden spring inserted opposite each foot in the lower stool, forces a catch to enter each mortise and thus hold the stool at any required height. There should be an eye-hole in the head of each of these springs, through which

cords or chains are passed, which are then gathered together in the middle in a single loop; by pressing or turning this loop all the catches are simultaneously disengaged, and the seat descends. The mortise should be made with rather a sharp lower-angle, and the catches of the same shape, to guard against the possibility of these catches giving under the weight of the body and breaking the mechanism.

There is also an ingenious kind of chair which can be instantaneously changed into a pair of steps almost three feet high. This clever invention enables the amateur to dispense with the use of a ladder to reach the shelves where his tools are kept, his chucks, or any other objects hung up out of the way. These chair-steps, nicely made, add to the furniture of a workshop, and are at the same time extremely useful.

## CHAPTER VII.

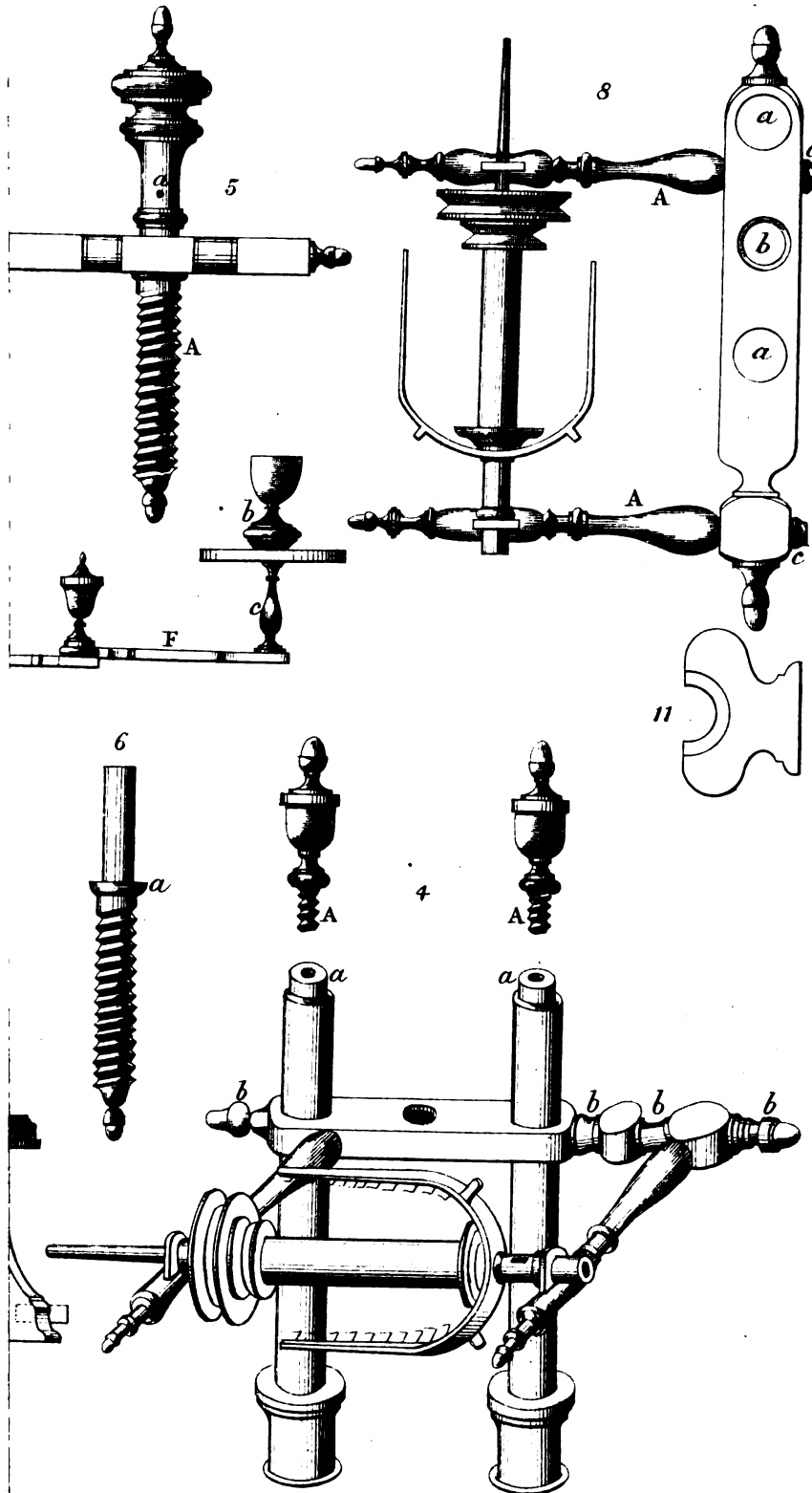
## Various Objects made upon the Ordinary Lathe.

## PART I.

## THE BACK OF A CHAIR.

**B**EFORE passing on to the lathe with the overhead-motion, in order to meet the views of amateurs who only possess an ordinary lathe, we shall give an explanation of several ingenious expedients that can be had recourse to in order to manufacture with the latter objects that at first sight it appears impossible to make upon it. The most embryo turner who has carefully looked at the back of a chair must have asked himself how the curved part was turned. The most simple-minded chair-turner could enlighten him. A piece of wood must be selected whose natural curve approximates, and wood is frequently found with such a curve, to the shape intended to be given to the back. Roughly shape it with a hatchet, place it on a lathe, and, continuing the line of one of the parts, as A (fig. 10, Plate XXII.) to B; the distance B, C will then be the curve it is required to give to the upright.

Take a hatchet and roughly fashion a pliable piece of wood, such as that shown in fig. 11, about an inch and a half thick, and longer than the distance B, C, by three inches. Cut a mortise-hole right through one of the ends of this piece, sufficiently large to allow of the insertion of one of the extremities of the upright. Pass the latter into it, and fix it tightly there with some wooden wedges. It will easily be understood, if the centre of the lathe is placed in prolongation of the line A, B, that the part A, D will turn perfectly true, that it can be turned with gouges and chisels, that it can be made into a perfect cylinder, and that mouldings can be added to it if necessary. When the inner-angle of the curve is reached, take the part off the lathe and insert its other end into the mortise. If the end already turned is round, it is feasible to have another piece of wood with a round hole in it of exactly the diameter of the end which it is desired to insert into it; the other part of the upright can then be turned. Proceed until the same line D, *d*, of the inner curve is reached; this will, on the outside, produce the space D, *e*, which could not otherwise have been reached. When the part is completed, finish off with the plane, removing the surplus wood which remains, and giving a good outline to the two cylindrical portions, either by forming the sharp-angle on the outside, or by rounding it off, as may be preferred.



Vincent Brooks Day & Son, Lith.



When the part is placed upon the lathe, care must be taken that the centre is in the axis of the portion about to be turned; for it would be quite possible for it to be in the continuation of the line A, B, and yet not to be in the axis. This is the time to put into practice the precautions that should be taken to ensure that an object is being truly turned between two centres. Push aside the centre to the right or to the left, as far as a line supposed to be traced from the centre of the hole, in the reverse side, to its extremity; unless this is done more wood will be cut away from one side than from another, and the work will be of uneven thickness. The gouge will show to which side the centre must be thrown back.

This method is more frequently had recourse to than may be imagined. The legs of all sorts of pieces of furniture, the shape of which does not allow of the centres being placed in a straight line, are thus turned. It may, moreover, suggest ideas to the amateur in a variety of circumstances when its employment will prove extremely advantageous.

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## PART II.

### HOW TO MAKE A TWIST ON AN ORDINARY LATHE.

**W**HEN we come to describe the lathe with the overhead-motion, we shall necessarily explain how to make a twist upon it. As the latter, however, can be hand-made, or turned upon the ordinary lathe, we will describe these two methods of making it now.

Choose a suitable piece of wood, and turn it between the centres. In the explanation we are about to give, we will deal with an ebony knife-handle.

Turn a piece of ebony about five inches long. Reserve at one of its ends a pulley for the wood, this will leave about three inches and a half for the handle. Turn it perfectly round, and rather smaller at one end than the other, as are all handles. When it is quite round, lightly trace a mark with a point-tool at each end. Trace another mark along its length, parallel to its axis, and by means of this mark divide the circumference into 3, 4, or 6 equal parts, as may be considered necessary according to the explanation we are about to give. Let us suppose that three divisions have been made. Through two points in these divisions, draw two other lines along the length, as in the first instance. These three points of division will be three cords that are to form the twist.

It must now be settled how many turns the cords are to make in the length of the handle. Assuming that two are the number decided upon, divide the length of the handle into two equal parts, each of which must be again equally sub-divided into three. When all these divisions are made, take a chisel's edge, or a piece of chalk, and draw a line diagonally through one of the points, beginning at the end of the handle, as far as the intersection of the first long division with the first tripartite section of the first half of the length of the handle. Then continue the



line to the second intersection, and then to the third; the diagonal line will now have returned to the point whence it started. It has been carried quite round the handle. Again, continue this line from intersection to intersection till it reaches the under part of the handle, which will now have been twice gone round. Draw a second line from another point, and then a third from the third long division; there will now be three spiral lines, producing the effect of the strands of a rope. This is called a twist.

The intervals between each line have now to be removed. Take some very small rasps with a very fine edge; first use a triangular one. Apply it between two of the three chalk-lines, and begin to remove the wood, without at first turning the hand more than is necessary to slightly advance it. When some impression has been made upon the wood, take a round or half-round gimlet, and rectify the groove, cutting some wood first from one side and then from the other, as the eye dictates. Take care not to cut away more in one direction than in another, and not to make one groove larger or narrower than the rest. Finally, when the groove appears to be all equally hollowed out, round off the cords; bring the tool right up to the chalk-mark, which, however, must be scarcely disturbed, as it is wanted for a guide in what still remains to be done.

At an equal distance from the mark, and at a depth also reciprocally equal, trace, close to each cord, a square, taking the greatest care to mark it as exactly as possible. Each cord should make a half-circle on the transverse section of the handle, together with two squares, and separated from the next cord by a half-round groove. A greater number of cords can be made, separated from one another merely by a little beading; all this is according to individual taste. Skill of hand and patience are everything in this operation, and too much attention cannot be given to it. In any case, perfection will be attained with considerable difficulty. It is in this manner that the ivory buttons used to ornament stick tops are made. The work, indeed, can be rendered more attractive to the eye in the following way, but it will first be as well to explain a few precautions, which, if taken, will add to its finish.

It will be remembered that we recommended that the handle should be made of a smaller diameter at the upper end than at the lower one. It will, therefore, be better that the cords should gradually decrease in thickness towards their upper end, and even that they should be there close together. In bringing this about, instead of dividing the handle into six equal parts, these must be made to cross one another in a regular manner as they approach the lower extremity.

Let us suppose that the amateur desires to make a knife-handle, the cords of which shall be isolated, and stand out upon grounds of different colours, an arrangement that produces a pleasing effect. This will be the way to set to work.

A handle thus made is not likely, on account of the slight thickness to which these various processes reduce it, to be very strong, particularly if it is an ivory one. It will be better, therefore, for the following reason, to select a piece of ivory about as thick as a tooth, than to cut it out of a much larger piece. In the first place, when the ivory is originally of about the required size, its grain is in much better proportion to its superficies. Secondly, as the piece of ivory has to have a hole made in it, it will have much more effect if chosen small, than if cut out of a larger piece, and consequently inclined to become warped. If, therefore, the handle is to be about five-eighths of an inch thick, let the ivory be of a thickness of nearly an inch. Cut it to just the length it is intended to give the handle. Turn it between the centres, keeping it always a little longer than it is eventually to be, and making one end a little smaller than the other. Then make a hole in it, in the plate, with a tongue-shaped awl. The latter must be kept continually wet, this being a peculiarity in cutting ivory.

Leave it on the work-bench for several days, taking care, however, to expose it to neither great heat nor cold, for fear of its splitting or cracking. If it did it would be useless.

Put it back, after a few days, on the lathe, and ascertain by holding the chisel against it if it has at all lost its shape. Turn it till it is quite round, and of as nearly as possible the size required. It must then be finished in the plate, that is to say, that with a side-tool, any unevenness it may possess must be removed. At this juncture it will be necessary to interrupt the work for a little in order to make a special tool.

Take a piece of steel about half-an-inch thick, and from 5 to 6 inches long, hammer it on the forge till it exactly, like the other spoon-bits, fits into the drill-bow; then give it five or six faces, which must be very even and very equal, so that their angles may be perfectly straight lines; make its diameter about three-sixteenths of an inch less towards the apex than towards the bottom. When it is well filed, finished, and prepared, carefully temper it; let it be of a golden colour, and polish the face upon a carefully prepared stone, so that its angles may be very sharp and cut perfectly. See fig. 25, Plate II.

Take a half-round rasp, and make a groove in two pieces of wood that will hold the piece of ivory. Finish the hole in the handle with the steel borer just manufactured; and, if the borer has been properly made, the hole will be long and conical, and have the effect of reducing the thickness of the handle to three-sixteenths of an inch.

Now turn a chuck of some sound kind of wood, such as sorb-wood, wild apple-tree, white hawthorn, or some other, with a pulley at one end of it for the cord of the lathe, and which at the other end fits tightly into the hole into the handle, and which is kept there by friction alone during the following operation. Put this chuck back upon the lathe; the handle ought to be perfectly steady upon it.

First make at the smaller end the place for a golden or silver verve, or other finish, then a beading at least an eighth of an inch wide, but projecting but very little and merely thrown into relief by a couple of cuts with a point-tool; then at an interval of about three-eighths of an inch make another beading, and there lightly mark the division for the twist with a point-tool. At about three-sixteenths of an inch from the end make a similar mark for the corresponding division.

To give this handle a more attractive appearance, it will be well to make four cords instead of three, and to carry them only once round the handle instead of twice; individual taste, however, must decide this point as well as the beadings.

From a point on one of the cords, draw a line along the length of the handle, dividing it exactly into two parts; with this guidance finish dividing the circumference into four. Trace all these lines very lightly, either with the point-tool, or with a tracing-point. Rub the tracings with the fingers, and they will come out with considerable distinctness. Trace the cords with a piece of chalk, starting from one of the four points of division, and continuing the tracings as far as the angle formed by the next longitudinal division and the first circle across the length, and so on from angle to angle. When all the cords are traced, the eye must be used to detect and rectify the places where they seem defective; no risk is run by equally removing the wood between the marks. When a certain depth has been reached, take some half-flat gurllets and make each cord throughout of a regular thickness, by cutting away wood whenever it is necessary; then, with a very finely indented gurllet, make a square on each side of the cords. The greatest exactness must be given to this square, as to its thickness, its height, and its outline. Next, with a half-round gurllet remove the wood between each cord, until the instrument reaches the chuck. In this operation a much thinner tool must be used than is absolutely necessary, so that if it is

accidentally allowed to cut more to one side than to the other, no great harm will be done. When the wood has been all cut away, equalize what remains, both to the left and to the right, so that no irregularity may be seen. End-off these openings towards their two extremities with a slope terminating at one of the circles first traced; there is no need to fear injuring the wooden chuck; use the tools freely, thinking of the ivory alone. If the chuck has not been very carefully made, the handle might possibly turn upon it. It will be well, therefore, to make a guide mark on it, and to wet the wood in replacing it, to ensure it always turning perfectly round.

When all the portions forming part of the mouldings have been carefully finished, and when the largest marks have been removed take some damp shave-grass and polish the handle, inserting the shave-grass into the spaces between the cords; taking care, however, not to blunt the sharp edges of the angles of the squares, if any have been made, nor to flatten the round-beadings. In this operation, as in all the others, it will easily be perceived that it is the hands' business to advance or withdraw on the mouldings, since the work is turning upon itself. A piece of shave-grass may be fastened to the edge of a little stick, cut chisel-shape, to enable the amateur to reach the bottom of the mouldings; in a word, any expedient intelligence suggests may be had recourse to. When a good polish has been given with the shave-grass, and when the marks are no longer visible, take a little flake-white, soaked in water, put it on a soft piece of rag, and give the last finishing touch to the handle, passing the rag carefully along each beading. The amateur must take care that the heat generated by the friction does not dry up the flake-white and allow it to collect in small particles upon the ivory, as this would interfere with the polish. It will be best, when the handle has been sufficiently damp-polished, to wipe it dry, and rub it with a dry rag and some white powder.

Fig. 12 shows the effect of the twist upon the handle, and figs. 13 and 14 the different beadings that can be given to the ends.

Nothing is more pleasing to the eye than a handle thus treated, when taken off the chuck. The transparency of the ivory, the precision of the beadings, the isolation of the cords, lead the amateur to regret that it is impossible to fix the blade to the handle without first adding a more solid axis for the tang.

Turn a piece of ebony between the centres, at least an inch and a half longer than the handle, in order to allow for a pulley at the end for the cord of the lathe. When it is turned round, put it in a plate, and, with a spoon-bit about an eighth of an inch in diameter, make a hole in it of about two inches in depth. This hole is to receive the tang of the blade. Put the ebony back upon the lathe, and give it the same shape as the chuck, taking care, that is to say, that it fits tightly but equally all round into the inside of the twist. Particular pains must be taken that each cord lies correctly throughout its whole length. Unless this is done the slightest shock will break the twist. Polish the ebony carefully, without using oil, and rub it with a very soft piece of rag. Finally, put it back on the lathe, and make a cut in it a hair's breadth from the top, just above where the level of the ivory handle will come, so that, when the tang of the blade is inserted, the shoulder will fit closely against the ivory, and, bringing with it the ebony, make the whole handle more solid. Cut it off below, about three-sixteenths of an inch shorter than the piece of ivory, and, with some good glue, or, better still, isinglass, quickly glue the vervele into the handle. Remove the superfluous glue as soon as possible, to prevent injury to the polish on the ebony.

Now turn an ivory head-piece of a proper shape, making on it a tenon which will tightly fit into the empty end of the handle. Polish it, and glue it into its place. Our readers will recollect the explanation we have already given of the way to turn a rather short object between the two centres, by using cement. Fig. 15 shows the outline that should be given to this head-piece.

The ivory thus contrasting with the ebony in the finished handle, has a very agreeable effect that will reward the amateur for the care and trouble he has taken.

It is also possible to treat the handle so that the spirals do not stand out. In that case it will be best to make a few beadings, which touch one another without any square or interval between them. Fig. 16 gives the shape. Thus treated the effect is also good. We have seen several cases made in these different ways, and all of them, when they are finished with tolerable regularity, were pleasant to look at. In a case, however, the difficulty is to make the spirals of the body correspond with those of its cover. Without a great deal of care, and the nicest regularity in making the divisions, success very difficult.

When a handle is neither hollowed out, nor its spirals made to stand out in relief, the ends must be finished in such a way that the spirals terminate in a point at the centre; this is called *diamond pointing*.

In order to give these handles the last degree of finish, the knife-handle should be mounted upon a very thin piece of gold, within which is a well turned chuck of hard wood exactly fitting the hole. Then, instead of the centre-piece being glued, it must be bolted in such a way that the bolts do not show, or the latter may be disguised as ornaments. The taste and intelligence of the amateur must be his guide in this. As for the case, it will be sufficient to turn two parts exactly alike, and to use a long tube of gold as a neck, which will fit into the part that contains the head; this, however, is not within our province, it is jewellers' work.

The different work we have just described ought to suffice for a yet unskilled amateur. In our second volume we shall show how more difficult work—work requiring greater skill in the use of tools, can be executed on the lathe with centres.

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## PART III.

### DRILLING HOLES IN SMALL OBJECTS.

**T**HE reader who has followed our instructions how to pierce a hole in a piece of wood in a plate, will find it difficult to understand that the hole may not always be exactly in the axis of the cylinder, since we laid stress upon the fact that the hole must be made exactly in the centre with a point tool, and, that as the piece of wood turns upon itself, the hole ought to follow a straight line, representing mathematically the axis of the piece. In spite of this, however, as the wood must necessarily be turned in order to pierce half of the hole in each side, the holes will seldom exactly meet, unless the workman is a very experienced one.

The first cause of the deviation is, that the spoon-bit is not held in the prolongation of the axis, and that if it inclines to one side or the other, the deviation, once set-up, continually increases.

There is, however, yet another cause. In spite of the care taken to hold the spoon-bit perfectly straight, the grain of the wood, which does not always run in the direction of its axis, continually carries the spoon-bit with it. But little wood, therefore, should be cut out at one time, the spoon-bit must be but gently inserted into the hole, the latter must be perfectly cleaned of the sawdust and shavings, and the spoon-bit must be greased every time it is removed. Without these precautions, it is impossible to pierce straight holes in small objects, such as ebony pipe tubes, without the orifice coming prematurely to the surface before the end of the wood is reached, unless, indeed, the objects to be pierced are made much too large, in which case they will have a very awkward appearance. The following is an ingenious plan to prevent this mistake ; its successful adoption will show that the amateur has acquired no ordinary skill.

Jewellers often find it necessary to pierce throughout their whole length long pieces of steel or brass, such, for instance, as the little cylinder which contains the pivot on which turns the minute-hand of a watch. This cylinder is of a very small diameter, particularly in ladies' watches. There are workmen whose skill is so remarkable that we have known one of them lay a wager that he could hollow out the whole length of a very fine pin without emerging till he reached the end, and win it.

Jewellers, in piercing small objects, generally adopt the following plan, using a plate, which corresponds completely to our method. They fix a pulley on the cylinder, on which to place the catgut cord of the drill-bow. They mark the centres with a centre punch, and place one of them upon the end of one of the lathe-centres ; then, gripping a drill in a pair of pin-tongs, perpendicularly to the lathe, they turn the piece with the bow. They take care to frequently get rid of the shavings, in order to prevent the hole from getting stopped up, if brass is the metal ; and they continually add a little oil to it, if it is steel.

When half the hole is finished, they begin at the other end till the two borings meet ; but as, with all their care, it is still possible that there is a slight deviation, they take a puncher and pass it along the whole length of the hole ; the minute exactness of all their work compelling them to make every part likely to undergo friction perfectly smooth and even. For a similar reason it is always well to make the hole at first very small, to allow of the subsequent use of a larger spoon-bit to prevent the occurrence of any angle in the bore.

It is difficult to obtain spoon-bits small enough for very minute borings. They may, then, be advantageously replaced by a drill, especially in the case of ivory and hard woods. The drill must be held very short in a pair of pin-tongs to prevent its elasticity from causing it to give when the hole gets deep.

As the hole gets deeper a shorter and shorter grasp of the drill must be taken by the pin-tongs, and, in order to enable the borings to escape, care must be taken to select a drill the body of which is rather smaller than the head. The following is the way to make a drill :— Take a piece of round steel of the right length, and smaller than the hole it is desired to make. Heat the end of it with a blow-pipe, and slightly flatten it on a smooth steel anvil with a smooth hammer-head. This will make the end of the drill rather harder than its body, but it must be left thick enough to withstand the resistance that will be offered to it, and to allow of the two sloping edges, of which we are about to speak, being given to it. Take a smooth file and make a couple of sloping edges on each face, which will separate the thickness into two equal parts. If it is intended to use the drill upon brass its shape must be pointed by the meeting of two lines formed by the four sloping edges. If upon iron, it should be given a round form by the meeting of two circular sloping edges. Temper it, making it of a red cherry colour, and dipping it into

tallow. Whiten it on the stone, and then, heating it further than the point, give it a golden colour, and let it again cool ; the tempering will now be finished. When a drill is not bigger than a sewing-needle, jewellers content themselves, when its head is heated, with waving it backwards and forwards in the air. It will then be properly tempered, but this requires great experience.

The other end is then filed round, and a length given to it of about three-eighths of an inch ; the end is then rounded, the file being more lightly used about this part, so that the ferrule, fitting tightly on, may be solidly fixed at about three-quarters of an inch from the end.

## CHAPTER VIII.

## Turning with the Hand-wheel.

## PART I.

## THE CHAIR-REST.

**T**HERE are many cases in which it is impossible to turn certain objects on a lathe with a treadle, owing to their diameter being too large to allow of their making many revolutions, or to their excessive weight, which soon gives them too great an impetus, as in the case of the wheel of the spinning-wheels we have already described. Moreover, the retrograde movement which it is then necessary to give, jars the turning-bench and communicates a vibration to the object being turned; a continued movement, on the other hand, if the bench is tolerably firm, causes no vibration. When an amateur first begins to amuse himself with a lathe he fancies that the smallest and lightest will always suffice for him; but if he perseveres and becomes tolerably successful he naturally requires a larger and more complicated lathe, and takes a particular pride in making everything necessary for his work with his own hands. Small things can be turned on a large lathe, but nothing but trifles can be turned on a small one. It is, therefore, the best economy to purchase a large lathe at first start; the plan we have adopted in these pages, and the trouble we have taken to describe a quantity of objects that can be made on the lathe with centres show that we have no desire to persuade our readers into unnecessary expenses. It is, of course, possible to furnish a workshop gradually, as experience and skill are acquired. For instance, it is perfectly possible to turn the wheel of a spinning-wheel with the treadle, but it is extremely laborious; with the hand-wheel, on the contrary, it is remarkably easy. We are led, therefore, into the description of several operations which the use of the hand-wheel enables the amateur to execute with great facility.

The addition of a wheel to the lathe does not in the least change the latter; we shall, therefore, say nothing further of it, except to observe that as it is often necessary to turn very large objects, it is well to be provided with some collar-plates of much greater size than those used with the ordinary lathe. The amateur should furnish himself with two pair, one for ordinary work, the other for that requiring greater power. It will be well, indeed, to procure one or two very long ones, measuring as much as a foot from the centres, as it is often necessary to turn wheels of a very large diameter. If it were very seldom requisite to turn these excessively large objects, we might, when an exceptional case presented itself, make use of an ordinary collar-plate, raised by means of wedges. It will easily be understood that in that case the screws should be of a proportionate length.

As for the large collar-plates, they should extend rather in depth than in height, and should be very broad at the bottom, to enable them to be securely fixed to the bench and to resist the strain they will be exposed to. See fig. 26, Plate XVIII.

When large or iron objects are being turned, it is impossible to be certain that the ordinary rest will resist the strain. The amateur, therefore, should make use of the one shown in fig. 27, Plate XVIII. This is the rest generally used with the lathe with the overhead motion, and will be described in the proper place; but we may at once say that it must be more than ordinarily strong, since the whole strain of the object being turned will be applied to it.

This rest is made of several pieces, of which the following are the names and uses. The base *A* rests upon the bench, and is fixed there in a groove with rabbets, to which is applied a *T*, fig. 28, Plate XVIII., the head of which is round or square, the stem square, and the arms pierced with a thread to receive the nut by means of which the base is fastened to the bench. The nut tightens the *T*, the shoulders of which rest upon the grooves of the base; the part *b* is of turned wood, and between it and the nut is a round plate of brass, which prevents the wood from being injured by the pressure of the screw. In order to prevent this *T* from turning on itself when the screw is tightened, a piece of square wood, equal in thickness to the opening of the groove in the bench, is passed into its stem. As this piece of wood fits squarely upon the stem it prevents the *T* from turning.

*B*, fig. 27, is what is termed the *chair*. It is fastened to the base of the rest by the bolt *a*, in the bottom of which a screw is cut that fits into an iron nut rabbeted on to the top of the base. The head of this bolt is pierced with a couple of holes at right angles to one another, and that completely penetrate it. By means of these holes, into which is passed the end of the key, the chair is fixed to the base. The perpendicular portion of this chair has a square hole in its centre to receive another *T*, fig. 29, Plate XVIII., that holds the wedge *c*, which supports the tool, and which serves as a rest. This wedge should be made of oak, and ought to be cut with the grain, so that, in case of the tools offering a great resistance, it may be able to grip the wood, which it could not do if it were cut against the grain. On this wedge is a portion thinner than the upper part. It is here that comes the head of the *T*, so that, if necessary, the wedge may be pressed close against the work. Remove this wedge, loosening the nut with the key, which, like itself, has six sides. It is necessary to have a quantity of these wedges, of all sizes and thicknesses, according to the dimensions of the object being turned. It will be seen that this rest can be turned in any direction, to enable the turner to cut the wood directly or sideways, but always in a firm manner. These rests are sometimes made with their chair and their base, or only their base, of iron. These rests alone are used in turning metals.

When the amateur wishes to turn an object of a very large diameter this small rest is of no use, even if the wedge be raised as high as possible. For, as it is necessary that the upper part of the wedge should be on a level with the centres, the wedge itself would prove too short, and would be fastened to the chair from too far. This would produce a tremulous motion, caused by the elasticity of the wood. It is necessary, therefore, to be provided with wedges of various sizes.

When an iron or a brass object of a rather large diameter is being turned, the pressure of the tool continually tends to force the work upon the lathe away from the centres, and if the collar-plates do not possess a very wide base, the slightest jerk will throw the centres out of their holes and the work will escape from the lathe. To prevent this, workmen, in the habit of turning large iron objects, put two screws beneath each collar-plate, instead of one. By this means they are fixed to the lathe-bench in a sufficiently firm manner.

All these details explain the necessity of using a very firm lathe-bench. This may be attained by giving the bench considerable weight, or by giving its legs as much spread as possible. This should be particularly attended to in the case of the front legs, since it is precisely here that the



wheel, we are about to speak of, exerts such a strain upon the bench. The hind legs should be perpendicular; if they projected, it would be impossible to lean the bench close against a wall or a window.

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## PART II.

### DESCRIPTION AND CONSTRUCTION OF THE WHEEL.

**S**OME turners, from economical motives, content themselves with making a wheel like a carriage wheel, in order that it may have more swing, and that the man turning it, after it is once well started, may be relieved of part of his hard work. But this plan, advantageous in some respects, has its drawbacks. The wheel is often found to turn more quickly than is required, and in consequence, if the tool is made of iron, it becomes hot too rapidly and has not time to cut the wood properly. The wheel ought to turn slowly and at a uniform rate. This may be seen in workshops on a large scale, where water is the motive power employed.

Fig. 7, Plate XXII., represents a profile view of a turner's wheel, the cord of which turns the object on the lathe. Owing to the great size of the wheel the other details are necessarily represented on an unduly small scale.

The method of construction we are about to describe is the best and the easiest. The spokes of the wheel are sometimes fixed in it in the same way as the spokes of an ordinary carriage wheel; but the tenons of the spokes which fit into the nave are apt to become loose as the wood gets drier, and when the wheel is turning a continued crackling is heard, occasioned by the tenons moving in their mortise-holes. The following is the method that ought to be adopted:

Take a piece of wood 8 or 10 inches long, and about 8 inches in diameter, and pierce a hole in it. Cut this hole so that the square *A* of the axis fig. 8, one end of which is made slightly smaller, fits into it.

This axis is made of iron carefully turned, so that the square is of exactly the length it is desired to give to the nave. At the end of each collar is a square *c, c*, into which fits a handle to turn the wheel. Turn the nave upon its axis. The whole thickness of this nave is turned, as is shown at *a*, fig. 9. The part *b* must be as large a square as possible, and should be made with great care. After this square comes a cylindrical part, following the line *d*, the use of which will be presently explained. Fig. 10 shows the circular part of the nave, the square, and the cylindrical part. During the whole of the construction the greatest pains must be taken to ensure that the square part is exactly in the centre of the length of the nave. Pierce a hole upon the lathe in a piece of wood whose diameter is equal to that of the nave. Then turn it upon the cylindrical part of the nave

or upon any other sufficiently large cylindrical chuck. Take care that the part which will have to come next to the square be cut exactly at right angles, so that it may fit the more closely against the wheel. This square must be made as wide as the thickness it is intended to give to the spokes. Turn the two ends of the nave, giving them the shape shown in fig. 9. Make a guide mark on the square and on the other piece, so as to be able to replace them exactly in the same place.

Now for the wheel. It is composed, as is shown in fig. 7, of four uprights, about five feet long, sometimes indeed, six. Finish them thoroughly with the plane, that is to say, make their thickness and their width exactly equal and perfectly square. On each couple trace a line in the centre of their length, and from this line trace another at a distance equal to the half of the diameter of the square; then, further still, trace other lines at a distance equal to the width of the uprights. Take a carpenter's guage and make a mark at half the thickness; then with a fine saw cut through each mark as deep as half the thickness, and remove the wood between the two saw marks. If this has been properly done each couple of uprights ought to half fit into the other couple, making a double cross. The mortises must be cut smooth with a chisel, according as they require it, in order that the surfaces may exactly coincide, above and below. For fear of making some mistakes, when all these parts are taken to pieces, mark each separately with points, lines, and the black chalk used by carpenters.

At equal distance from the centres marked upon each bar, trace the lines on which the eight cross-pieces, *a, b, c, d, e, f, g, h*, (fig. 7) are to meet; the cross-piece *f* being supposed to be hid by the upright of the foot. Finish each of these eight cross-pieces, reserving a suitable tenon at each of their ends which must be fitted into the mortise-holes cut at the lines marked on each spoke. The four smaller cross-pieces can be easily fitted into their mortises, but with the four larger ones there is a little more difficulty. Take the double cross to pieces, and put a handle to each cross-piece; then, placing the latter in their proper position, insert their tenons into the mortise-holes, at the same time putting the double cross again together. From the centres of each bar again trace the ends as well of the large bars as of the eight small ones, *i, k, l, m, n, o, p, q*, which are fastened by means of tenons and mortises into the cross-pieces *a, c, e, g*. In order to be the more exact, it will be well to have recourse to the method employed by the wheelwrights, which we have already alluded to, and which consists of tightly inserting in one of the collars of the axis a wooden rod, at the end of which is a point that traces all the bars in a circle. At each end of these bars make a tenon about an inch long; this tenon must be inserted into the thickness of the felloe.

The great circle of this wheel, as well as the other two of which we shall speak further on, must be constructed with some precaution; particularly the great circle, the principal use of which is to hold the bars, and to give solidity to the wheel. It is well, therefore, when its different parts are all in their proper place, to be able to tighten them together, and so avoid the loosening and giving of the different portions, and the consequent injury to the wheel.

Take an ordinary compass, or a pair of beam-compasses, fig. 5, Plate I., Vol. II., and upon a piece of wood three or four inches thick, and well prepared with the plane, trace arcs of the size it is intended to make the wheel. Give them the necessary width, but take care to trace them so that each joint may fall in the interval between one bar and the next. In order to prevent arcs of too large a size being taken from cross-cut wood, it will be advisable to make as many of the arcs, termed felloes, as possible. Eight will be sufficient for the wheel we are speaking of.

Cross-cut wood is wood whose grain is cut more or less transversely. Fig. 11, shows an example of such. Let us suppose that we have to deal with a piece of wood the grain of which runs lengthways, and that we wish to cut a portion of a circle out of it; it will be seen that the grain at

the two ends is very short, and that if these ends are subjected to any great strain they will break off there, as where the grain is shortest the power of resistance is least ; and this danger will be the greater according as the circle to which the arc belongs is smaller, or the arc itself larger. The nearer, on the contrary, the curve approaches the straight line, the more the wood will be able to resist. This observation holds good in a variety of cases.

When a sufficient number of arcs has been traced in a sound and carefully equalised piece of wood they must be cut out with a turning saw. Then with a curved plane, fig. 26, Plate XLI, cut away as far as the compass mark inside the arc. Do the same to the external portions of the curve, and then, having traced upon a piece of wood a circle equal to that which the inside of the wheel ought to have, divide it into eight equal parts, from each of which a radius must be drawn to the centre. The arcs must be exactly placed in such wise that all of them project about 4 or 5 inches beyond the mark. See fig. 12, in which *a, b* is the extremity of the radius. On the flat side of each curve trace a line following the direction of the radius ; and, for fear of mixing up the different arcs, number their ends.

Now divide the thickness into three equal parts, both within and without the circle, as is seen in fig. 12. Dispense with the mark first made on the four faces, and trace the mark indicated in the cut, in which the different kinds of lines show how much wood is to be taken from each. Carefully finish off all these parts with good chisels. Try each portion against its corresponding part till all the joinings are perfectly exact. The mortise in the centre ought to be made gradually smaller inside ; a key must then be inserted in it, and the whole solidly tightened and pressed together.

When all the curved pieces have been fitted together, the result, if the work has been well done, will be a perfectly round wheel. Insert the tenons made at each end of the bars ; the wheel ought then to fit rather tightly into its place. The joinings ought to be made between the uprights, and never too close to them, for fear that the mortises that have to be made might weaken them. Trace, therefore, the width of each mortise on its own particular tenon, taking care to properly regulate the distance between the uprights. Then with a joining-guage, fig. 19, Plate IX. (this is a guage with a couple of points, the distance between which gives the tenon's thickness), trace the length of each mortise. Cut out the latter carefully with a mortise-chisel. For this purpose it will have been necessary to take the wheel to pieces. Now put it together again, inserting each tenon at the spot marked for it. Lastly, insert the keys, tighten them little by little, one after the other, and the wheel will be very straight, very round, and very firm.

In turning metals the cord of the lathe is never placed on the great circle. Its too great diameter, in which that of the pulley or the width of the work would be contained too often, would give the piece being turned a too rapid motion. The reader will soon perceive that for this reason it is necessary to make use of rather a small diameter. The larger circle, is only generally used to give an impetus to the action, and to lessen, by its swing, the hard work of the man turning the wheel.

Two or three other circles of different diameter must be constructed in the same way ; but as they are fastened to the bars with nails and screws, it is not necessary to join their segments with the same care ; it will be enough to join them together with flat-joinings. Fasten them to the bars with good wooden screws, and when they are both in their places, verify, by means of the little rod we have already alluded to, if they are quite concentric to the axis or shaft of the large wheel. If there is any mistake it can be rectified by removing the segment which projects. Finally, the circles must be turned by cutting on each of them a groove of about half-an-inch in depth to receive the cord.

It should be remarked that the smallest wheel next the nave ought to be made of much thicker wood than that from which the wheel next in size is manufactured; for, as they are both fastened in the same plane to the base of the great wheel, if they were of equal thickness, and if the circular groove were cut the same distance in either case from the rim, the groove in the smaller one would be covered by the thickness of that on the other, and there would be no room for the cord; double the thickness of the first must therefore be given to the latter. To avoid the necessity of using wood that is too thick, the smaller wheel may be placed alongside the larger one. If the amateur has a proper store of tools, it will be more convenient, quicker, and easier to make these grooves on the lathe; but, besides the fact that this would necessitate the possession of a large wheel, it is seldom that an amateur has room to put one of these collar-plates at the right-hand end of his bench, or that his workshop boasts a beam fixed between the ceiling and the floor to support a point on a level with the collar-plate. Yet this is the plan resorted to by turners who cut mouldings in the felloes of carriage wheels. They place the wheel between the bench and the beam, steadying it with wedges. They even put the side rest upon the bench itself, but this is not at present connected with our subject, so we content ourselves with this simple allusion.

There now remains the foot of the wheel. This foot merely consists of a couple of uprights, only one of which is shown at A, fig. 7, kept in their places by the ties, B, C, the whole being firmly joined with tenons, mortises, and tongue-joints, to a couple of bases, D.

These two bases are themselves joined by a couple of cross-pieces, *r, s*, the ends of whose tenons are alone seen, which regulate the distance between the uprights. The foot of the wheel ought to be made of wood sufficiently strong to enable it to acquire stability from its weight, and to resist the strain put upon it by the efforts of the man or men at the wheel.

When the wheel is in its place it is heavy enough to remain fixed there, that is to say, to remain fixed opposite the pulley of the lathe; when it is not being used it can be pushed into a corner, or against the work-room wall, so as to be out of the way. The cord is the only part that can give trouble, as, in order to take it off, it is necessary to take the lathe to pieces. To remedy this inconvenience, a couple of strong steel hooks (fig. 6, Plate XXXVI., Vol. 2), are made use of; a thread is cut in their holes, and they are fitted on to screws at each of the ends of the cord, which ought to be a seven-stranded one of about half-an-inch in diameter. It will be seen that these hooks, which easily come unfastened, allow the cord to be placed and replaced without taking the lathe to pieces.

A couple of crank-handles must now be forged, with a radius of about ten or twelve inches, C-shaped or S-shaped, according to taste; their form matters but very little, as we are about to explain.

A crank-handle a foot long is nothing but a twelve-inch lever applied to the wheel itself. If it were possible, for instance, it would suffice to place a pin on one of the bars at about a foot from the centre; the motive power would only be exerted through a radius of twelve inches, and, at whatever part it is applied, it is always from the centre to the pin that the force of the lever must be estimated, this lever being nothing but a radius of a circle a foot long. It is, therefore, clear that a crank-handle, the radius of which is straight, would be quite as powerful as a C or S-shaped one, but habit is strong, and our eyes have grown accustomed to the latter.

No amateur who has not worked the wheel himself can form an exact idea of the effort required to turn the object on the lathe, if it be of a large diameter, or made of iron or brass. All sorts of means have been used to diminish this resistance, to ease the man turning, and confine

the efforts he is obliged to put forth as much as possible. A nearly square mortise is cut in the top of each upright (the geometrical shape of the mortise is shown in fig. 13), to allow of the introduction of a body in which the shaft may easily turn. In our description of the lathe with the overhead motion we describe the composition of this body. Both the mortise and the grooves must be made rather smaller at the top, to enable the collars to be kept more firmly in their places, and to allow of their being removed when necessary. When the mortises have been carefully finished with the chisel, holes must be made in four small pieces of wood about a quarter of an inch in thickness, that will exactly grip the collars of the axis. Fix one of them on to each collar, so as to fasten them to the inner surface of each upright, with four thin nails, taking care during the operation to keep the wheel in a perfectly perpendicular position. Fasten a couple of small pieces of wood in the same way outside, but these must be cut sloping down to the exact height of the uprights, and a small neck gutter, called a scuttle, made upon them with some flake-white in paste. Apply this paste all round the small pieces of wood, and leave them till they are perfectly dry. Melt enough matter in an iron spoon and fill up the mortise-hole. When the whole is cool take away the piece of wood, and remove the wheel with its collars; they ought to be easily detached from the axle-tree. Cut them into two parts at the hole, and in a parallel direction to the catch-pin; then take a spoon-bit, and in the middle of the scuttle make a hole in the upper collar, communicating in the centre of its depth with the round part. It is through this hole that oil is added, which, poured in at the centre of the collar, distributes itself along the entire length.

The hole at the entrance of the scuttle must be made slightly larger, a funnel shape being given to it. It will be understood that the motion of the wheel ought now to be as easy as possible.

A hoop of iron or brass must now be placed above it, in the centre of which should be a half-ball, intended to receive the thread of the screw of the vice. The shape is shown in fig. 14. This hoop, which, as is seen in the plate, has a screw at its upper part, serves to more or less diminish the friction of the collars of the axle-tree, and to give them a uniform motion by continually pressing on them. The outer width of the hoop should be of about an inch, or an inch and one-eighth, and it should be fitted into the thickness of the wood. It should be fastened there by four wooden screws, as is shown in the plate. The whole must now be filed and polished.

If the amateur desires to make this hoop of brass, (fig. 13), a mould in three pieces should be made in the following manner. The lower piece is nothing but a small wooden rod, of a suitable width, of a thickness of about three-eighths of an inch at the ends, and so rounded that its depth be about an inch in the centre of the curve. The two sides, made of similar rods, must be joined to the two ends of the first with some thin nails. The model will now be ready for the caster. To ensure its being turned out neatly, to prevent, that is to say, the sand of the mould adhering to the wood and causing a certain roughness in the metal, it will be well to polish the model with a little ordinary varnish that easily dries. When the piece is cast all that will then remain to be done will be to polish the three upper sides with the file; the lower side must only be cleaned. A hole must now be pierced in the centre of the upper part, a thread cut in it, and a flat-headed iron or steel screw made for it.

We must here allude to the best way of selecting screws and their threads. Ordinary workmen are accustomed to use very conical screw-taps, in order, as they say, to make the entry into the nut easy. But, as they are aware that a conical nut is of no use for a cylindrical screw, they attempt to obviate the difficulty by reversing the object in which they are cutting a thread and by passing a screw-tap through from the other side. But this plan is a very faulty one, for the hole

in which the thread is cut, not being cylindrical, as is the screw which it receives, but being, on the contrary, formed by the meeting of two cones which intersect each other, it is obvious that the only part where the screw is properly clasped by the nut is in the centre, and that the two edges scarcely touch the turns of the screw. The threads cut in the nuts must therefore be made rather conical at the bottom ; and in order that the whole of the hole be perfectly cylindrical a screw-tap of a smaller diameter must be used to cut the last turns of the thread. In this way, by putting the whole screw-tap into the nut, the latter's homogeneity is attained, and the screw will bite every turn of the thread.

Too many workmen commit the mistake of making screws whose threads are too large. If the pressure happens to be great, the curve described by the thread upon its cylinder being very much inclined to the axis, it is not unusual to find a screw yield of its own accord and no longer against any pressure ; the reason is the same that causes a printing-press screw to become unscrewed. It is, therefore, best to make the turns of the screw of small dimensions, as the more numerous they are the greater the friction, and, consequently, the resistance.

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## PART III.

### HOW TO TURN AND POLISH IRON.

**T**HE method of turning iron, and the tools employed in doing so, differ from those used in turning wood or brass.

The resistance offered by iron to the tool cutting it is so great that if a sharp chisel were held against a piece of iron in the same way as it is held against a piece of wood the edge would be repulsed without cutting the metal, and would become blunt. It has been found necessary to have recourse to a different method and different tools.

Fig. 1, Plate XXI. shows the proper shape of the tools used in turning iron. The bent part is applied against the rest, which ought to be made of oak, and with the grain. Of oak, because the action of water has little effect upon this kind of wood ; with the grain, because, if it were against it, the edge of the tool might merely splinter the object being turned. It is customary, indeed, to take a well-tempered chisel and make a small notch upon the bent part of the tool, so that the latter, by this means, catching in the wood, becomes fixed there in a perfectly firm manner.

The plate shows the shape of the edge of this tool. It is very ingeniously contrived. In the case of all other tools with but one sloping edge, the opposing action of the metal tends to blunt the tool's edge ; in this case, on the contrary, the metal's action has the effect of strengthening the cohesion of the particles of steel, and of consequently enabling the chisel to offer the greatest possible resistance.

It will be easily understood that in turning iron, the work-bench, the collar-plates, and, particularly the rest, cannot be too solidly arranged. Indeed, whenever the object to be turned is of considerable size, a larger lathe than usual should be employed, unless the one ordinarily made use of happens to be an exceptionally solid one. Exceptional collar-plates and rests must always be used when large iron pieces have to be turned. For this reason soles of frame works and chair-rests are manufactured of cast-iron. They then possess the qualities required, and the metal they are made of is very ductile and easily manipulated with a file. The T-rest must also be stronger than that generally made use of.

In large workshops lathe-benches of considerable size are used, fastened to the flooring. The motive power is water, which turns a paddle-wheel with a slow but uniform movement, exactly suited to the turning of large objects.

There are four principal tools used in turning iron. A round one for roughly shaping, a flat one for the straight part, a point tool for the angles, and a side tool for the inner portions. Notwithstanding what we have said of the ductability and the softness of iron, its cohesiveness and its harshness often blunt the tools employed to cut it. The amateur, therefore, should keep a variety of tools in his workshop, so that when one becomes blunted it will not be necessary to interrupt his work in order to re-grind it. All hollow and round parts are roughly shaped and finished with the round tool; the straight parts and such parts as bowtells, beadings, listels, &c., are shaped with the round tool and finished with the chisel; the same caution applies so all irregular parts, such as the shoulders of tenons and collars. The straight parts, which are perpendicular to the axis, the side of a square for instance, are finished with the point-tool. The latter, however, must not be held as it is when used to cut wood. It is made in the same way, with a couple of sloping edges meeting at an acute angle, but it must be held with a bias to the outer side, so that the edge actually cutting be nearly parallel to the surface the amateur is engaged upon. Finally, all the inner portions must be turned with the side tool. Figs. 14, 15, 16, and 17, Plate XIV. show various sizes of these different tools. They suffice for the turning of a cylinder, an axle-tree, and most of the objects generally met with. But if it is required to turn pieces of a more difficult shape, it will become necessary to have recourse to several other kinds of tool. As a rule, it may be said that the shape of the moulding on the work to be turned decides that of the tool to be used.

It will be seen that owing to the slight projection of the bent part of the tool the rest must be very close to the work. We will bring these remarks to a close, by saying that the sloping edge of the tools ought to be nearly perpendicular to the rest, forming a tangent to the part it is desired to cut. If our explanations have been properly understood, and are exactly carried out, success will be the result.

All that we have above said thoroughly applies to large objects, but if the piece on the lathe is but of small dimensions, such as from an eight to a fourth of an inch, it is easier and more convenient to turn it with a turning-graver.

A turning graver is a well tempered lozenge or square shaped tool, sharpened at one of its sides, as is seen in fig. 3. It is fixed in a handle like those of other tools, held obliquely against the object being turned, and supported on the rest, so that its sloping edge just comes in contact with the metal, and its point below. By this means the edge nearly forms a tangent to the piece being turned, and cuts its surface obliquely. The graving-tool, the lower side of which leans upon the rest, impresses itself gently upon the wedge, and if it is firmly held in both hands, one being placed on the handle, and another on the blade, it will be easy to cut off small shavings and to

turn perfectly round. If the object being turned is a small one, only small graving-tools need be used, this handle being made of a pear-shape to enable the workman to grasp them securely; in this case a wheel is not necessary, the lathe can be turned with the treadle. We have seen skilful turners finish the collars of a lathe axle-tree, and other difficult pieces in this way, as well as cut with such skill, that at the first attempt they removed large shavings from a square-shaped object.

The graving-tool is much used. Watchmakers never use anything else. One of the most difficult operations in the whole of watchmaking, that of raising the pivots, particularly those of the balance-wheel, is performed with it. The precision of the movement depends upon the perfect roundness of the pivots, which ought to be exactly concentric with the wheel and its axis.

To return to the lathe with the wheel. The speed of the motion of the lathe, the friction set up by the action of the tool, the displacement of the metal, are all causes that produce a degree of heat, sufficient to prevent the contact of the hand; particularly if the object being turned is of considerable size; the tool itself will then become very hot and lose its temper. To obviate this the object is wetted; this is done in several ways. Some use an iron-rod fastened in a piece of lead, shaped like the foot of a candlestick, up and down which slides a brass-arm that can be fixed at the necessary height by means of a screw acting in the rod. The end of this arm is split lengthways, and grasps a wet sponge that continuously moistens the object being turned. This method is a good one if the object being turned is only of a small diameter; if, however, it is of large dimensions and requires the removal of considerable matter, the sponge will not be sufficient, and the heat will become too great. In this case it is necessary to use a foot similar to the one just described, but made of wood, and strong enough to support a cup of brass or tin with a long pipe inserted at its bottom. This pipe, which has a very small diameter, should be about a foot in length, and its end should be brought to bear perpendicularly above the spot at which the turner is engaged.

If the water falls too quickly, the end of the pipe must be choked and stopped with a little fine straw, till the water falls only in drops, at about the rate of the beating of an ordinary pulse. If the object being turned is a large one, and large cuttings are being removed, each drop, as it falls, will produce the same effect as if it fell upon a hot bar; in a few moments the surface of the work will be covered with a yellow tinge. This is the rust arising from the iron beginning to oxidize; it disappears with a little friction.

It is a great mistake to suppose that the work will get on more quickly if the wheel is made to turn with greater rapidity; the lathe, on the contrary, ought to be made to revolve gently and uniformly. If the wheel turns too rapidly, the tool has not time to properly cut the matter, it becomes blunt and soon refuses to cut at all. For this reason circles of different sizes are placed upon the wheel; but it is seldom that the largest is used, except to polish or to turn a piece of wood of very large diameter. It is necessary to explain this.

The proportion between the diameter of the wheel and that of the piece being turned determines the speed of the rotation. Let us suppose that the object on the lathe is nine inches in circumference, that is to say that its diameter is about three inches; it is clear that each time the wheel makes a complete revolution the object in the lathe will revolve as often as its diameter is contained in that of the wheel. Thus, if the circumference of the piece is nine inches, and the circumference of the three foot wheel be a hundred and eight inches, the piece, each time the wheel revolves, will make as many revolutions as nine is contained in one hundred and eight, that is, say, twelve. This would be too rapid a rate.



On the other hand, the lever of resistance, of the piece being turned, that is to say, would be too small, being only half the diameter, or one inch and a-half, in proportion to the lever of motion which is the radius of the three foot wheel, or a foot and a-half. If the tool were really to cut the matter, the piece would cease to turn, or if it did turn, would do so much too rapidly. It is usual to place a small pulley, represented in fig. 4, at one of the ends; the diameter of this pulley being more nearly that of the wheel. This pulley can be made in several ways. Some workmen forge a ring, to which four branches, bent at right angles, are soldered, as is shown in fig. 5. They are fastened with good wooden screws, or with strong rivets, to a wooden pulley, in the centre of which is a hole sufficiently large to give passage to the piece of different size it may be required to turn.

For this reason it is necessary to keep them of different sizes, since, as we have already said, the larger the object the slower it ought to turn. Between each branch a hole must be pierced corresponding perpendicularly with that opposite to it. A screw of moderate size is inserted into each of these holes, its head being made four-sided to fit into the loop of a strong key (fig. 24). The work can be tightened, by means of these four screws, until the pulley turns as truly as possible.

The other way of making this kind of pulley, which only applies when it is small, consists of adding four branches to the iron ring at equal distances one from the other. Instead of bending them at right angles, as in the former case, a shoulder should be given to them, as is seen in fig. 6, or better still in profile, in fig. 7. Place this ring in a pulley sufficiently large to hold it, cut mortises to hold each of the four tenons, and fit the shoulders half-way into the thickness of the pulley, so that the ring may be flush with both surfaces. Rivet the four branches, and, putting the ring upon a proper chuck, turn both sides of the pulley, and cut a groove for the cord. At four equidistant points, and equally separated from each branch, make a hole sufficiently large to give passage to the screws and the key that turns them; then, at each corresponding point in the ring, make similar holes to receive the screws. The screws will thus be concealed in the thickness of the pulley, and not likely to catch the hands or the clothes. The great advantage of this kind of pulley is that it takes up the smallest possible amount of room.

It is perhaps as well to remark that the ring ought to be tolerably thick to allow of a sufficient number of turns of the screw being held in it.

The reader will notice in fig. 7, Plate XXII. that the cord is crossed. This is done in nearly all the movements of a motive wheel; first, to enable the man who turns the wheel to have his face towards the work, and to be able to judge when to turn and when to stop, which he would find a difficulty in doing if his back were turned to the turner; secondly, because the cord touches a much greater part of the circumference of the pulley than of that of the large wheel; and that in this way, the friction being greater, the cord runs less risk of slipping, and the resistance opposed to the tool becomes much greater.

When the amateur wishes to turn a piece of iron, he must first slightly mark the middle of each of its ends with a centre-punch, and then put the iron on the lathe to see if it turns truly. If it is not concentric the punch must be gently shifted till it appears to be quite in the centre; a mark must then be made. This punch ought to be of a conical shape, rather longer than the centre of the lathe; if, indeed, the piece being turned is a very large one, the hole should be deepened with a fine drill to prevent the end of the centre from coming in contact with the metal and becoming blunted.

When the cord has been placed over the wheel and over the pulley, the wheel must be pushed

back ; if the workroom floor is slippery and there be any danger of the cord getting slack, the wheel can be fixed by inserting a nail between a couple of the boards. Now put a little oil on each centre, bring the rest close to the lathe, and turn the iron, on which water ought to slowly drop, at the spot when the tool is cutting. Roughly shape the iron at first with a round tool, mark the place for the mouldings, and finish off with a tool of the kind required. Under the hands of a practised turner, the iron ought soon to grow perfectly round and its surface almost polished.

If the whole length of the iron has to be turned, or if it is requisite to turn only a portion of it, it will be impossible to apply the pulley without leaving marks made by the screws ; in this case it will be well to cover the part against which the screws will press with a thin band of brass ; the pulley must then be shifted wherever it is necessary, the wheel being always placed opposite to it.

Most workmen, particularly those accustomed to turn iron, do not allow the cuttings to be wasted ; they are of use in the manufacture of sulphate of zinc. They are also employed in the production of hydrogen gas.

The amateur who has acquired a moderate amount of skill will soon be able to judge when it is best to put the cord on a great or a small wheel, or on this or that pulley. Explanations on this point are of little use, all that can be urged is that the quicker the revolution the less perfect will be the turning. For example, when a skilful watchmaker wishes to turn very delicate and very minute work, instead of using a rather large bow and a cord of gut, he has recourse to a very small bow and a horse hair. This enables him to use a very small pulley.

When a wooden object is being turned, such as a nave, or a mortise is being hollowed out, it is equally unnecessary that the lathe should turn rapidly. There is, indeed, in this case, another objection to rapid revolution, besides those we have adduced in the case of iron turning. It is this ; the tool might cut too deeply into the wood, and, if the lathe were turning at high speed, might break and injure the turner.

While we are speaking of turning iron it will be well to say a word about polishing it. For this purpose rather a worn smooth-file should be used. A little oil should be rubbed upon it, and while the wheel is turning it should be applied to the whole length of the metal, first in one direction and then in the opposite one, taking care to always cross the strokes. Then take a round file, oil it, and repeat the operation.

This method of oiling the file is a very good one when the work is completed ; it prevents the marks from being too conspicuous, and gives a smooth polish to the surface. The next thing to do is to take a piece of willow-wood or other soft wood, soak it in oil and place a little fine emery powder on it. After applying this to the iron, put some still finer emery-powder on it, and some more oil, applying it in a contrary direction, and the metal will soon become polished. If the iron is not too large, use two pieces of willow, one above and the other below ; cover them with emery-powder and oil, and, taking hold of them at the ends, seize the metal between them and rub it up and down in all directions. This process will soon give the iron a thoroughly smooth polish. Use wood cut to a flat-edge at the end for the round parts, and for the angles make use of its corners. Finally, wipe the iron thoroughly with a rag to remove the grease.

In order to give the metal a great degree of brilliancy, rust it in every direction with some soft wood, wetted with a little oxide of iron that has previously been soaked in some water or brandy. The metal will soon darken and assume an excellent polish. The oxide of iron can be replaced by black polish, which must be soaked in the same way.

It may interest our readers if we give them a few details of the way to polish steel and other metals cut into facets.

The amateur must provide himself with polishing blocks of walnut wood, the shape of which must always have reference to that of the objects to be polished ; the flat surfaces are polished on the side of the block, and the concave and convex surfaces on its face.

Some emery-powder soaked in oil is first spread on the block, and then each of the faces of the metal is applied to it till the traces of rust have disappeared. The position of the steel must be varied, according to its shape, in order to avoid undulations. When this operation is finished, the grease is removed from the steel by passing it through lukewarm-cinders. It is then carefully wiped. In order to give it a finishing polish the surfaces of the polishing blocks must be covered with well-stretched ox-hide, fastened with strong glue, and saturated with oxide of iron prepared as above described. The last finish can then be given to the steel by applying it to the polishing blades thus prepared.

To polish perforated objects, which the polishing blades would be unable to deal with, cylindrical brushes, about three inches wide, sprinkled with emery-powder and oxide of iron are used. Each brush must be fitted on an iron handle ten inches long, carrying at one end a conical bobbin with several grooves cut in it, by means of which motion is imparted to it and its rate of revolution determined (figs. 16 and 17, Plate XXII.). These polishing blocks are placed on the lathe's centres and turned by means of the wheel. The greater the motion the more rapidly the object becomes polished.

The metal it is intended to polish must be tempered to a considerable degree of hardness, and made of the finest steel. Cast steel is to be preferred to all other, for the reason that the fineness of its pores and its equality of density prevent the occurrence of either stains or cracks.

The Germans, who manufacture a quantity of iron and steel tools at low prices, make little use of the file for polishing purposes ; they employ polishing blocks of stone of different textures, moved by some powerful motive force. In this way they economise both hand-labour and time. In polishing artistic objects, however, which require more careful treatment, this method cannot be had recourse to, as, in employing it, it is impossible either to give any finish to or to carefully shape the metal.

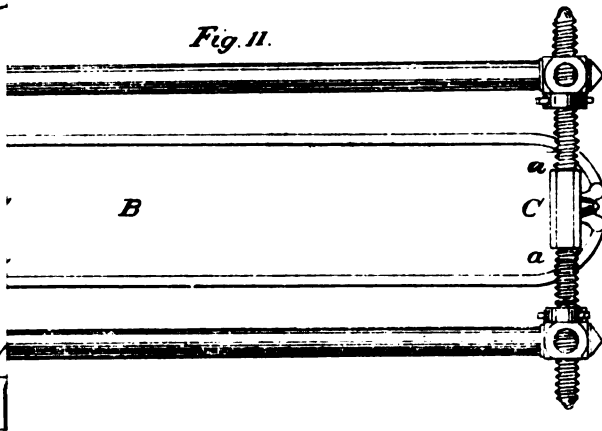
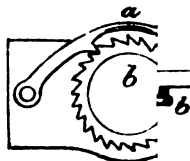
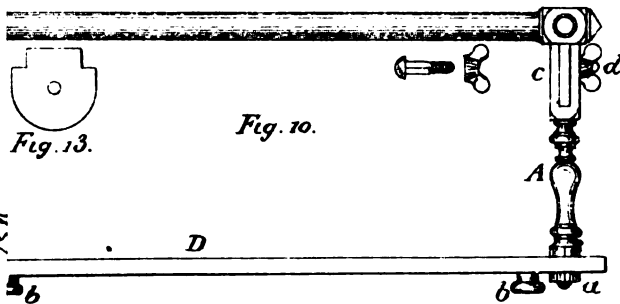
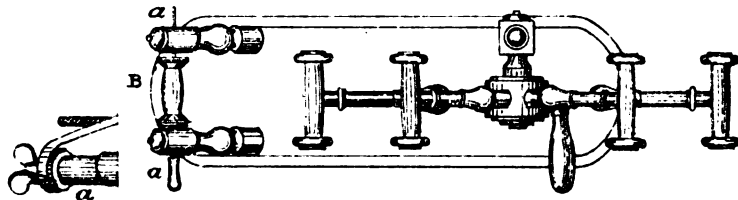
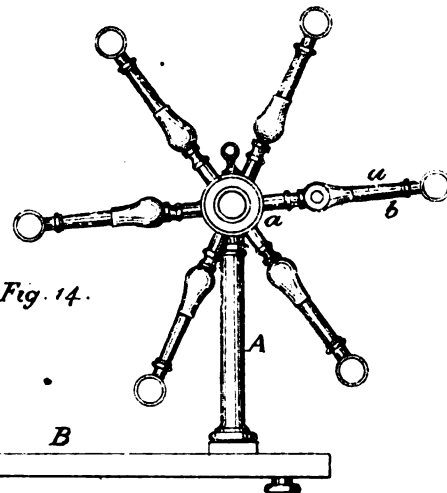
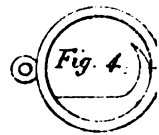
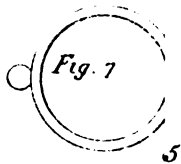


Fig. 13.

Fig. 10.

Fig. 2.

Fig. 11.

Vincent Brooks Day & Son, Lith.



## PART IV.

## TURNING BRASS.

**T**HE texture of the fibres of brass is very different from that of those of iron, the component parts have not the same cohesion, and the matter cut away from it comes away in distinct particles. These particles, it should be borne in mind, are very hot, and as they spread on every side they are liable to fall on the hands and burn them. These burns are painful, and it is well whenever brass is being turned to use gloves; it is, moreover, prudent, since the sparks fly tolerably high, to protect the face and eyes with a leather mask in which a couple of glass eye-holes are inserted.

Those who are short-sighted, or who do not see very well, can have spectacle-lens inserted instead of common glass.

The tools used for turning brass are the same in shape as those used for turning wood; the difference being that they ought to be tempered to a greater degree of hardness and have no sloping edge, so that they may be used to cut with either side (see Plate XIV.).

The shape given to the tools to turn brass speaks for itself as to the way they must be held against the metal. If they were applied a little above the diameter, it is clear that the tool's angle, being a right angle, would not cut the brass; nor would it if it were applied at the centre; the rest, therefore, must be lowered, and the metal attacked below the diameter.

It is true that if the tool had a sloping edge, the brass might be cut away wherever the tool was applied; but in that case the latter would soon begin to vibrate, and when vibration has once set in it continually increases.

There are two advantages resulting from the use of the above tools. One is that their edges do not so soon become blunted, the other, that as the chisel has two surfaces, which may be used alternately, there are practically two tools, and it is consequently only half as often necessary to interrupt the work and have recourse to the grinding-stone.

Those accustomed to turn brass are aware that to prevent the chisel from vibrating as well as to get rid of the marks the vibration causes on the metal's surface, the best way is to hold it slantways, the marks then soon disappear.

There is yet another method of getting rid of the marks caused by the vibration; it is to remove the rest to a greater distance from the work, and to incline the tool to the right or to the left, holding it well below the diameter.

There are a great number of cases in which it is necessary to hollow out a piece of brass upon the lathe. The tools necessary for this operation, or at least to begin the hole, are shaped in this way. Take a piece of round steel, of a size proportionate to that of the hole; flatten the end of it, leaving it, however, of sufficient thickness to resist the strain that will be applied to it. On each of its sides file the shape of an olive in its cup. Make a sloping edge; the two edges being in an opposite direction, so that when the tool is directly facing the amateur he will only

see one of them. This tool must then be well tempered, and as it is well pointed, although, perhaps, on account of the arrangement of its sloping edge it will not seem very sharp, it will be easy to make holes in the brass on the lathe with it. It ought to have a very strong handle to enable it to resist the strain it will meet with; the tang of the blade, indeed, should be square and fit tightly into its socket. This shape (fig. 14, Plate. XII.) is that which is given to all drills used to pierce brass; those used for iron are rounded at the end. The amateur must procure a stock of these tools, of all sizes and diameters, in order to be prepared for any kind of hole he may find it necessary to make.

The point-tool, again (*a*, fig. 10, Plate XIV.), may be used with great advantage in turning brass. It must be applied sideways. As the strain upon this tool is not felt at a right angle to the metal being turned, but in an oblique direction, its use supplies the amateur with yet another means of removing the marks made by the vibrations of a sloping-edged chisel. When the wheel is used the tools must be larger and stronger than when the lathe is turned with the treadle. The man who turns the wheel applies his whole strength to overcome the resistance met with; and as the holder of the tool often only takes into account the natural difficulty of cutting the metal, his chisel becomes affected sooner than he expects, there being often, indeed, a risk of its breaking and injuring him. In order to judge if the man at the wheel is turning too vigorously, or if too much metal is being cut away, it will suffice to suddenly withdraw the tool from the brass; if the man at the wheel was putting out too much strength, he will be carried away by the unexpected cessation of the resistance, just as a man pulling at a heavy weight falls to the ground if the rope suddenly breaks.

Turning with the wheel can only be used advantageously, in turning brass, when it is necessary to turn objects of a large size or diameter. In every other case it is best to use the treadle. With the latter the chisel is more under control, and if mouldings have to be made they are cut with greater precision.

We ought, perhaps, now to explain how to turn small objects on the clockmaker's lathe; but, as by and by, in the course of showing the amateur how to construct certain curious machines, we shall have an opportunity of entering into details, we will not dwell upon the subject at present.

A clockmaker's lathe (fig. 8), is composed of an iron bar, *c*, of greater or less length, according to the lathe's power; at one end of this bar, and forming part of it, is a fixed collar-plate, *A*, on the top of which is an olive-shaped head, *a*, pierced for the reception of a steel cylinder, *b*, pointed at one end, and filed off square at the other.

The other collar-plate, *B*, moves to and fro upon the bar, on which it fits tightly. A screw beneath, *c*, pressing against the bar, fixes it where it is required. Its head, like that of the other collar-plate, is hollowed out, and the cylinders of each ought to be so exactly alike that either ought to fit both. Upon the bar, and between the two collar-plates, is a part, *f*, which admits the end of the rest (fig. 9), and presses it against the bar, when the screw beneath is tightened. The end of this rest, which in this manner can be moved either forwards or backwards, has an olive-shaped head at its anterior extremity; the stem of the wedge fits into this head, and, by means of a tightening-screw, is fastened at the height required by the diameter of the object being turned.

As all the tightening-screws used with this kind of lathe, in pressing against the bar or other parts to fix them in their required place, would soon injure these, care must be taken to

interpose between the ends of the screws and the parts against which they press, a wedge, which, in warding off the pressure, keeps the parts from being injured and adds to the general solidity.

These lathes, which are absolutely necessary in a great variety of cases, will be found very useful.

Their collar-plates ought to be strong but low in height, as far as the object being turned will admit of. If it becomes necessary to have recourse to lathes with rather high collar-plates, these should be chosen as strong as possible, so that there may be no vibration to detract from the perfect roundness of the object being turned, and, consequently, from the perfection of the whole machine in course of construction.

When these lathes are of some considerable size, and the heads of their collar-plates consequently rather long, as the pressure of the screws upon the cylinders just spoken of is only exerted upon the centre of that part of them contained within these heads, in spite of the fact that the amateur endeavours to grip the object being turned as shortly as possible between the collar-plates, and as the cylinders frequently do not fit very exactly in their holes, it often happens that the cylinders give, and assist in causing a vibration that also detracts from the perfect roundness of the object being turned; the plan has therefore been adopted of grasping the cylinders with tie-bands fastened to the heads of the collar-plate, in the middle of which is a screw that presses against the heads. This plan enables the tie-bands to seize and hold the cylinders outside the heads, and prevents the vibration.



## PART V.

## THE LATHE WITH ENGLISH CENTRES.

**W**HEN an object is being turned between two centres, and there is no room to receive a pulley, or it is impossible to add a pulley by which the lathe can be turned with the wheel, either because there is no room, and the wood and the pulley would be in the way of the turner, or because the pulley would have to be so slight that the strain of the wood upon it would make it give, or for any other reason, the method we are about to explain will be found to be of great use. It dispenses with the necessity of taking off the pulley and disturbing the wood every time a fresh object is put upon the lathe, and so saves a great deal of time. The point of the collar-plates to the left is so constructed that the base of the cone it forms does not press against the plate. It is made of three pieces which can be taken apart. The point properly so called is at *a*, the moveable base at *b*, and the body of the centre at *c*, which is square, and is fixed across the plate like the other. *D* is a band which receives the pulley as in fig 2; the moveable boss, *b*, helps to keep the pulley in this band, on the other side of which it is kept in place by the boss, *c*. The movable point is fixed by means of a screw fitting into a thread cut in the inside of the band.

This pulley is intended to give the necessary rotatory motion to the object between the centres; in the extremity of this object is placed the ring shown in fig 3, Plate XXIII.; this is fastened then with four screws.

This ring has an end *a*, bent towards the pulley; its fine surfaces are filed and smoothed; it should be not more than an inch in width, and about a quarter of an inch in thickness; this thickness should be at right angles to the plane of the pulley.

An iron tenon, *a*, is securely fastened to the pulley; this is intended for the extremity of the ring. Thus, when the pulley turns, it carries with it the ring, and the latter the object on which it is fixed. This is a capital plan, and may be had recourse to in a variety of circumstances. We have seen it used to great advantage. By its means screws of four, five, or six inches in diameter and five or six feet long, were cut.

This ring may also be made heart-shaped, as in fig. 4, with a single screw pressing the object being turned towards the lower angle. This is probably the best kind for small objects.

## PART VI.

### THE CARE OF TOOLS.

**T**HE amateur who wishes to keep the tools he uses in his workshop in as good a state as when they were new, ought every now and then to examine them, and do what they may require every time he uses them.

Particular care should be taken in replacing the files and other tools in their proper racks, never to leave them against the wall, however dry it may appear. It is sometimes in the winter so extremely damp that the least contact with plaster or stone is sufficient to rust them. It is best to nail the racks against planks of oak or walnut wood, and then to fasten the whole to a wall; if this precaution is taken rust need never be feared. The same may be said of screw-plates, of both kinds, which are not only liable to get rusty, but to become covered with a kind of grease arising from the dust and the oil with which they are always covered.

We have already stated that the best file, if used for iron or steel, becomes powerless to cut brass. It is best, therefore, to keep some to be used for brass alone. But as it often happens, that, being pre-occupied, the amateur takes hold of the first file at hand, and in an instant a good file is thus spoilt, it will be found to be a good plan to insert all the files intended for brass alone in a particular kind of handle, such as that shown in the plate, and to give them all brass ferrules; while those intended for iron should have differently shaped handles and steel ferrules. To make the distinction still more evident, the handles of the files for brass should all be of one colour, and those of the files intended for iron of a different one.

It will be well to use all files, at first, to cut brass, before using them to cut iron.

The beginner will be surprised to find how fast the file he uses to cut wood will become worn; but if he reflects on the properties, fibres, and textures of most woods he will understand the reason.

The pores of most woods, particularly soft woods whose grain is wide apart, contain imperceptible particles of gravel; and then soon wear and tear the tools, especially files.

Whenever little cuttings of iron adhere to a file, making deep furrows on the work in hand, the amateur should take a wire brush and get rid of them by brushing the file in a reverse direction; another method of partly obviating this inconvenience is to cross the strokes of the file, filing, that is to say, first from left to right, and then from right to left. This will enable the amateur, moreover, to discover if he is using his file in a proper manner, or if he is holding his hand too much to the front or to the rear.

When a file begins to be of no good for cutting brass it should be used for cutting iron; it will answer this purpose for a long time still. All that will be required to be done will be to change its handle.

The fact must not be lost sight of that the least violence easily breaks files, particularly the smaller ones. In taking them out of their handles, these should be held in the left hand, while the right strikes a light blow on the end of the ferrule with some other tool, such as a chisel or another file. The file immediately comes easily out of its handle, and no risk is run of breaking it.

It is impossible to keep in the rack all the files that will be required. Only the large ones can be thus kept, which must have handles of the kind we have just described. The smaller files should have handles of foreign wood, without any mouldings and of a simple conical shape. At one of the ends of the handle should be a small tenon, from three to four inches long, fitting into a long brass ferrule rivetted with a couple of bolts to prevent it from giving. The part of the ferrule protruding some half an inch or so from the handle is empty; this should be filled with common sealing-wax. The tang of the file should then be heated and forced as straightly as possible into the wax; it will now be perfectly firm. This is the way watchmakers put handles to all their files and other tools. When it is required to take a file thus fastened out of its handle, all that has to be done is to heat the ferrule over a light, the file will then immediately come out of its handle. This is a capital method, because the file is quickly and securely fastened in its handle, and because the hardening it acquires from the heating, prevents it from breaking off close to the handle, as often otherwise happens.

It is even worth while to take the precaution of bleaching on the grind-stone a small portion of every file close to the tang, and to then unharden the tang in a pair of nearly red hot forge-pincers, taking care by watching the bleached part not to allow the file itself to become unhardened. If the amateur is afraid of being unable to unharden the tang without affecting the file itself, he should wrap the latter up in a wet cloth, only leaving uncovered the portion he wishes to unharden; if this precaution be taken the file can be fearlessly exposed to a charcoal fire.

It is sometimes necessary to file parts difficult to get at, such as grooves; it is impossible to do this with ordinary files. The file will have to be bent at a double angle as is shown in fig. 17; and as it is of great importance not to unharden the file, it will be understood how necessary it will be to employ the wet-rag process just alluded to for the purpose of such an operation as bending the tang of a file. It will be well to keep re-wetting the rag during this operation. It is, however, in spite of any precautions, difficult to always avoid altering the files' temper, and for the purpose of obviating this difficulty the bent handle shown in fig. 23 has been invented; this handle can be adopted to every kind of file.

Files often get greasy, that is to say, that the parings from the metal in the wood often fill up the teeth of the file, and thus prevent it, though it is still a good one, from cutting. Heat a little water in an earthenware pot and throw in a handful of cinders; then plunge the files in the water, and after leaving them in for a few moments take them out and dry them at the fire. They will soon be as good as ever. A still quicker way is to dissolve some potass in some hot water, to dip the files in it, and to then rub them with a hand brush the way of the teeth, which always run in an oblique direction. The potass is more effective than the cinders.

Unless the amateur has considerable experience in sharpening, the grindstone will soon lose its roundness. He must not wait till this defect has become too great. He should correct it in time by leaning a narrow piece of sheet-iron on a wooden rest and applying it to the grindstone. This will at the same time both smooth the grindstone and restore its roundness.

No matter how good wooden screw-plates are, they often get out of order and the V refuses to

cut, either because use has dulled its edge, or because knots in the wood have made notches in it. The only way to mend this difficulty is to re-sharpen the V, and this demands a great deal of care.

Make a couple of edges on a piece of Turkey oilstone by rubbing it with some sandstone on a tite; the angle of these two edges ought to be very acute, and not be of more than 60 degrees at the most. The inside edge of the V must be sharpened on this angle, which must be oiled; the outside of the V must be sharpened on the flat part of the stone.

It is very difficult, indeed, to hit upon the proper position of the V in a screw-plate. As a rule it may be said that the apex of the V ought to project a little beyond the threads of the screw, and be situated in the prolongation of the first turn of the worm, without troubling about the two upper points.

So much for theory.

In practice it is not quite so easy. We have tried the experiment of cutting a series of threads, from an eighth of an inch in diameter up to two inches and a half, increasing the smaller ones by an eighth of an inch at a time, till they attain a diameter of a whole inch; and increasing the larger ones by three-sixteenths of an inch till the greatest size is reached. We found an immense difficulty in properly placing the V. A hairbreadths' too much too high or too low, and it no longer acts properly. Placed too forward or too backwards in the first turn of the worm, and the same difficulty happens. In spite of all our care we were forced to acknowledge that success in the operation demands a considerable number of preliminary failures. At last, however, after a quantity of futile experiments, we succeeded in properly placing the V at the first attempt. If, therefore, the amateur desires to repair a screw-plate that is out of order, he must lay in a great stock of patience, and follow the process we have just pointed out. If in the screw-plate that requires repair, the V was apparently properly placed, it will suffice, before removing it, to note its position, to preserve the little wedges that kept it steady, and to replace them, after the repairs, exactly as they were; placing the V always a little more forwards, in order to make up for the loss of the edge in sharpening.

Care must be taken to turn the cylinder of nearly the same diameter as the hole pierced in the plate used as a guide to it; if this be not done the thread will be unequal, sharp on one side and dull on the other. The amateur must also take care in replacing a screw in the screw-plate that the V does not come in contact with the first turn of the thread; if that occurs the evil will be increased, and the last turns of the thread will be reduced to nothing.

A few superfluous turns of the thread in every screw must always be cut, these can be removed on the lathe when the screw is finished. This is owing to the fact that the cylinder must always be made pointed, in order to allow it to enter the screw-plate; it follows from this, that the first turns are never regular. They only become perfect when they meet the screw, and can shift neither too much nor too little.

If the thread be cut a little too small for the screw, the following is the way to remedy it. At the top of one of the threads of a wooden-screw pierce a hole right through it. Insert a piece of round steel in this hole, and file it according to the inclination of the thread; then, removing with a chisel a little of the thread, as far as the piece of steel, flatten it with a file. Now pass this species of screw-tap into the thread; the piece of steel will increase the depth of the turns and the cuttings will remain in the notch made close up against the steel. This expedient has something in common with the carpenters' screw-tap, which will be alluded to in Vol. II.

The screws should be rubbed with some dry soap. If the soap were wet it would induce the wood to swell; but grease must not be used, as it causes all the tenons to creak.

All other carpenter's tools can be rubbed with a little grease from time to time, particularly if the wood being operated on is slightly covered with dust or fine gravel, both of which have an affinity for all kinds of wood.

The oilstone must always be kept carefully covered, otherwise the dust of the workshop, mixing with the oil, will form a kind of paste that detracts from the sharpness expected from the stone. This stone gradually becomes injured by age. Furrors appear upon it. In order to repair it, it must be rubbed with sandstone against a flat surface such as marble or slate.

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## PART. VII.

### IRON SCREW-PLATES, PLAIN AND DOUBLE.

**N**OTHING appears so easy as to cut a screw in a piece of iron, steel, or brass, in a screw plate. Yet, however, great the experience the workman has acquired, he will find a difficulty in properly performing this operation.

Screw-plates are of two kinds; those in which holes of different sizes have been pierced in a sheet of steel, and which are called plain screw-plates, fig. 24; and those much more convenient, which are termed double screw-plates, for the reasons that the object being cut into a screw is gripped between two pieces of tempered steel, known as screw-dies.

The first kind are used for coarse work. The piece of steel which is to be cut into a screw ought to be of the size of the hole of the screw-plate, if the thread were removed. It is made a little smaller at one end, and its entrance is made easy by lubricating it with a little oil. It is gripped in a vice, and the screw-plate is gradually made to revolve, the steel being pushed forward gradually and carefully at each revolution. A little reflection will show the defect of this method, and the imperfection of the mechanism. The steel is forced into the hole, the matter is not cut away to make the bottom of the thread, it is simply pushed to one side, to the right and to the left; and instead of having as we hoped, a solid and excellent thread, we obtain a mere punch formed by the meeting of a couple of pressures which, forced to enter the opposing aperture, take its shape; if this so-called thread is filed, and examined with a magnifying glass the real effect of the process will be clearly seen.

Another drawback is that the steel becomes much strained and often gets twisted. If it is particularly necessary that the screw being cut should be very straight, it is disappointing to find it defective in several places. It is certainly possible to partially remedy this defect in plain screw-plates. As a rule they contain a couple of holes of a similar width. One of these holes should be much smaller than the other. In this manner the screw could be prepared in one hole and finished in another; but this expedient will never prevent the chief defect of the process which is that the matter is simply bored out; moreover, the steel in which the screw is being cut will

stretch, more or less, according to its density. The plain screw-plate, therefore, should only be employed for small screws; the double screw-plate should be always used for any screw whose diameter is more than a sixteenth of an inch.

When an object of some size is being cut into a screw with the double screw-plate, the operation still requires the greatest care. If it is far better to operate slowly, and to tighten gradually; than to attempt to cut away a great deal of the matter and spoil a rather long screw, particularly if it is required for a machine that ought to be very exact.

When the bottom of the thread and the end of the hole in the screw-plate have been reached, there is little left to do but to polish. If the screw is still not quite of the right size, it will be best to put it on the lathe and finish it gently with a smooth file, passing it subsequently through the screw-plate. The threads should be examined with a magnifying-glass to see if they are perfect; if they are not they will soon affect the worm into which they are inserted and become loose.

When the screw is entirely finished, its whole length should be passed between two pieces of wood covered with powdered emery, held in a vice, to clean it and remove the marks left by the screw-dies.

We cannot too much insist upon the fact that in cutting a screw it should be frequently fitted into the thread intended to receive it; the latter should always be made first. If it will fit in without requiring any force, it should be oiled and passed right into the thread; in this way the screw will become accustomed to its nut, and revolve easily, but without too great freedom.

When iron or steel is being cut into a screw, plenty of oil should be used. In the case of brass, wax should be substituted. Yellow wax is the best. If oil be used with brass, the application of the screw-plate will cause a loud and continued creaking.

One or two notches should be made with an equalising file in the half-circle of the screw-dies. These notches facilitate the cutting, are useful in getting rid of the part cut away, and prevent the thread from getting stopped up.

As for the parts that cut the screws, this is how they ought to be made. Forge a piece of steel of the length and the thickness required, and, putting it on the lathe, give it the shape shown in fig. 18. At the top is a square, half-flat head, which enters the tap-wrench, fig. 19. Then comes a bellying part or base, on which the tap-wrench rests. The rest is cylindrical. It is first cut into a screw, and the part to be cut into a screw ought to be broader than the stem by the whole thickness of the twist of the thread it is desired to make in it. The screw-plate is then applied to the middle the portion in which it is desired to cut the the screw, taking care to adjust it tightly and very straight. It is then made to rise and fall, gently tightening it each time, adding enough oil to enable it to get rid of the matter cut away by the screw-dies. When the turns of the thread are nearly formed, the screw must be removed from the screw-plate, cleaned, and placed upon the lathe to remove the marks left by the screw-dies. Unless this be done, the thread will be imperfect. It must now once more be passed through the screw-plate in order to finish it. Care must be taken, at this last part of the operation, to slightly tighten the screw-dies at each turn, from the centre to the ends, in order to make the screw conical and facilitate its entrance into its nut. We ought here to remark that in order to properly cut a female screw, three screw-taps of different diameters must be passed into it; the third ought to be almost cylindrical.

There is another quicker method that can be used in coarser kinds of work. It consists in making use of a long and pointed screw-tap, which cuts the female screw at the first attempt, but the latter must be turned round and pierced from the other end to ensure its being nearly

cylindrical. Before tempering either of these screw-taps, four or five round or triangular grooves should be cut in them.

Double screw-plates have the advantage of possessing screw-dies that will cut screws with threads of all shapes, of all kinds of inclination, with curves to the right or to the left, triangular, round, or square. But the method of cutting the screw and of making the screw-dies is in every case much the same. We intend to point out, in our article on the lathe with the overhead-motion, the way to make plug-taps for all kinds of threads, fig. 25.

If, in cutting a rather long screw, it should become slightly warped, it should be replaced on the lathe, the parts where it is out of gear should be marked, and, if the screw is thin, a few gentle mallet taps should be given it; or, if it is tolerably strong, it should be placed on a block of smooth lead and the part that bulges struck with a hammer till the lathe shows it is perfectly straight. In every case it should always be once more passed through the screw-plate in order to make the thread perfect.

Screw-plates, and particularly the double one, are much used in the mechanical arts; skilled mechanics attach great value to a good screw-plate.

They are now constructed of various shapes, as may be seen in figs. 20 and 21.

We advise the amateur who wishes to cut screws to always make use of screw-plates proportioned to the strength of the screws he intends to make. For instance, with a small double screw-plate screws, varying in size from the smallest possible dimensions to a diameter of a quarter of an inch, may be cut; with the next sized screw-plate screws of a diameter varying from a quarter of an inch to half an inch, and so on in proportionate progression. So that if the amateur wishes to cut screws of diameters varying as much as from a sixteenth of an inch up to an inch and a half, he ought to possess at least four double screw-plates.

We do not think we have dwelt too long upon these details. The use of screw-plates is essential in an infinite variety of circumstances which we hereafter intend to describe.

But on this subject we will say no more at present that is solely interesting to those who only possess a lathe with centres, and who do not care to go to the expense of purchasing a lathe of the other kind. We are about to give a description of the lathe with the overhead-motion. This lathe throws open a much wider field, and paves the way for inventions full of cleverness. Besides being able to turn upon it the whole of the objects we have spoken of in connection with the lathe with centres, a fresh new series of interesting and complicated articles can be manufactured, with an ease that is astonishing, by its aid.

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# PART THE THIRD.

THE LATHE WITH THE OVERHEAD-MOTION.

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## CHAPTER I.

## Description of the Lathe with the Overhead-motion.

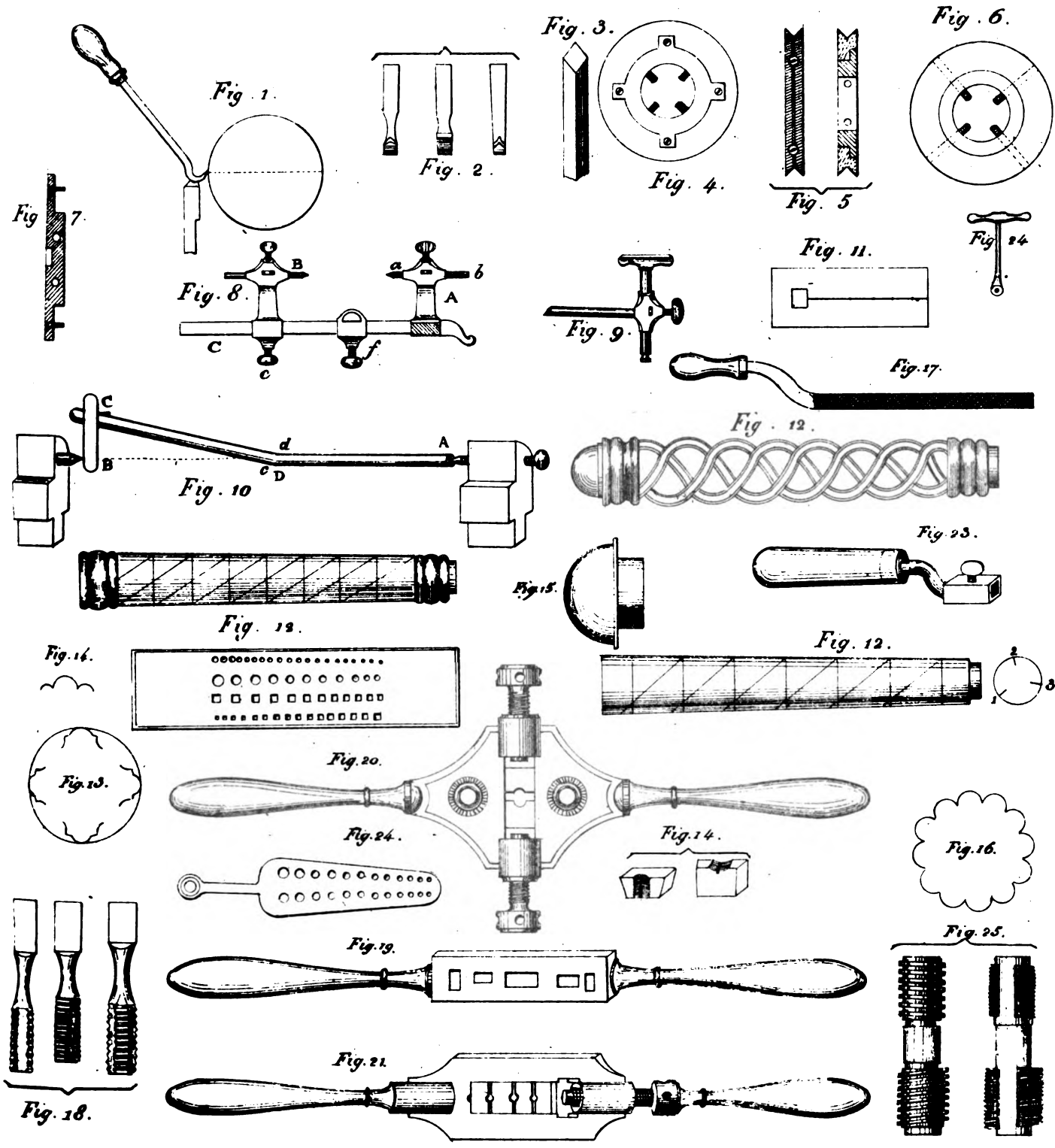
**T**HE lathe we are about to describe is termed "Lathe with Overhead-motion," because, differing from the lathe already described, in which the object to be turned is held between the two centres, this is now held upon an iron mandrel arranged, with the aid of a chuck, so as to secure it by one of its extremities.

This lathe is indispensable in a workshop. It is used in the manufacture of all the various machines we are about to speak of. Our readers must, therefore, bear with us while we give a detailed explanation of it.

There are several kinds of lathes with overhead-motion. The clockmakers', that works upon an iron bar put in motion by a bow; a second kind like, the clockmakers', without a screw-thread; and a third with a screw-thread. It is the last we are about to describe.

A and B, fig. 1, Plate XXIV. are a couple of collar-plates, with mortises to admit the passage of the axis D, *d*. As the distance between these collar-plates ought never to vary, it is determined by a couple of wooden ties, *c*, which, on each side, are glued to the plates, or sometimes fastened to them with strong wooden screws. In order to keep the distance between the collar-plates perfectly constant, the two ties have a shoulder against which the plates rest.

Fig. 2 represents an iron mandrel turned upon the lathe. Upon its precision depends that of all the objects turned upon the lathe with the overhead-motion. *A*, *a*, are a couple of perfectly round and cylindrical bands turning in pads we shall presently allude to; *b* is a triangular groove cut in the mandrel in which works a brass key, called a stop-key, that allows the mandrel to turn upon itself, but prevents it from moving either forwards or backwards; *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k*, are threads of a screw of different sizes according as they may be required of large or smaller dimensions; *l* is a six-sided part, from three-eighths to three-quarters of an inch in length, on which is fixed a pulley fastened by a nut that works on to a screw in a part close up against the pulley. Then comes a bellying-part, *m*, which acts as a shoulder to the pulley, and as an inner cheek-piece to the bobbin, *n*, on which the cord turns; next come a flange *o*, a band *A*, stronger than that at the other end *a*, and a base *P*, very straightly turned, against which rest the chucks. The whole is terminated by a screw or head, *q*, on which the chucks are mounted. At the other end of the mandrel is a smaller base followed by a screw-thread, *r*, on which are mounted the pieces that are added behind.



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Fig. 5, Plate XXIII. is a geometrical plan of the collar-plates, at the ends of which are a couple of grooves broad enough and deep enough to hold the pads, made of some elastic material, in which the mandrel turns. A screw presses against these pads and prevents the mandrel, and consequently the whole mechanism, from shifting; *b, d, c*, fig. 1, Plate XXIV. is a strip of iron, made either of a single piece, or with a hinge-joint as at *c*, separately represented in fig. 23, which is placed upon the collar-plate, and the ends of which fit into the thickness of the wood, where they are fastened in various ways we shall presently take occasion to describe.

Seven mortises of different widths are cut in the length of the hinder collar-plate, *A*, fig. 1; these are for the keys, the use of which is of the highest importance. These mortises ought to be made with great care, and their keys ought to fit into them neither too tightly nor too loosely. Of these seven keys, the first, termed a stop-key, *e*, fig. 1, is made of brass, and contains a double-edged notch at the place where it meets the length of the mandrel, so as to be able to fit into the similarly-shaped groove we have already spoken of as being on the mandrel. This key, as well as the six others, whose shapes are shown in fig. 4, can be shifted upwards from below in its mortise-hole, which is made much deeper than is required, so that it will still reach the mandrel when the latter is raised and stand clear of it when it is lowered. In order to give them this capability of shifting, all the keys are pierced at *a*, towards the hinder face of the collar-plate, and threaded by a pin extending along the whole length of the collar-plate. It will be understood that when the mandrel rests upon its pads it is free to revolve upon itself and to shift forwards and backwards. If the brass key is forced into the groove in the mandrel, the latter's movements become immediately confined to turning upon itself; if, on the other hand, one of the other six is raised, it will press against the threads of its corresponding screw, and, as it is immovable, will force the mandrel to advance and retire as it turns upon itself, according to the screw's pitch; it will be seen that a pencil-point fixed upon a rest opposite the object being turned must describe upon its circumference a curve proportionate to the screw that has determined the mandrel's motion.

As the mandrel is intended to revolve upon its pads with the greatest ease, it is of the highest importance that the bands be perfectly round and cylindrical. It is of equal importance that all the screws be exactly concentric to the band, particularly the screw at the head of the mandrel. It is with this motion of the lathe that the most interesting kind of work is executed, such as rose-turning, profile-cutting, &c. We shall presently explain the method of testing the accuracy of a lathe with an overhead-motion.

As it is often necessary to lift the mandrel from its pads, and as it ought, nevertheless, to be held there firmly and tightly by means of the strips of iron and the gripping-screws, the idea has been entertained of making these strips hinge-jointed, as at *a, a*, fig. 3, and of inserting a moveable bolt-pin in the front-hinge, so as to be able to withdraw it when required and remove the mandrel and its pads. But as it is difficult to obtain well-made hinge-joints, and as they are, moreover, expensive, it is usual to make use of a plain unjointed iron strip, all in one piece, which is fastened to the collar-plate with a long flat-headed bolt, that passes through the front part, pierces the collar-plate, and screws into the opposite side of the cross-strip.

The shape of the gripping-screw, *f*, varies a good deal. At first only flat-headed screws were employed. Then the cup-shaped screw was used, the tail part of which, cut into a thread, exerted the pressure, while the upper portion served as an ornament. Later turners turned the cup-shape of the screw to account. Instead of allowing the oil to penetrate through a small funnel attached to the outside of the two upper pads, it was poured into the cups of the screws, the lower part of which were bored out. A corresponding hole was made in the upper pad, by

means of which the oil was filtered over the bands. As the pressure of the screw upon the pad would soon wear it out, it is customary to insert an iron plate between them of the same shape as the pad.

The continual motion of the mandrel will loosen the pressing-screw and so allow too much play to the mandrel. To remedy this, the idea has been conceived of inserting a counter-screw, or moveable screw, in the stem, which, pressing against the tie-band, prevents the screw from too easily giving.

Curiosity, it has been observed, leads many people not well acquainted with machinery to be continually taking to pieces objects held together by screws. Such persons enter a workshop, talk to the turner, and while he is hard at work, begile the time by surreptitiously tampering with the screws of his lathe. This practice gives a great deal of trouble to the turner, and soon ends by making the screws a great deal too loose. It has been checkmated in this manner. The screws are made without heads, the hole in the centre, for the passage of the oil, is made square, and they are screwed and unscrewed with a four-sided key. An outsider without a key is thus unable to unscrew them, and the turner is guaranteed from the mischievous results of his visitors' indiscretion. This indiscretion, it may be remarked, is amazing. Where is the amateur who has not been more than annoyed by his friends tampering with his gauging-compasses. These are, perhaps, lying open on his workbench, the opening being measurement he wishes to preserve. In comes some fidgety acquaintance, who takes up the compasses and calmly proceeds to lose the gauge by opening and shutting the instrument as an idle woman trifles with her fan.

As the pads soon get out of order, and as it is impossible to use them when they are once injured, we will tell the amateur how to make them himself. The best are made of three parts tin and one part zinc; they can also be made of two parts tin and one of nickel; or brass can be substituted for the nickel and the zinc. But this last mixture is only suitable for pads intended for very large lathes.

For the purpose of casting them, a wooden mould should be made of the shape shown in fig. 17, Plate XXIII. and of the same thickness as the bands. Then take an iron spoon and melt the metal in it, beginning with the zinc, the nickel, and the brass. These metals should always be melted before the tin is added. Stir the molten mixture with a piece of wood, let it cool till it has no other effect upon a paper dipped in it but that of slightly reddening it, and pour it into the mould. If its heat were greater, the metal would burn the mould, and the pads would be full of air bubbles.

The rest shown in fig. 27, Plate XVIII. is greatly used with the lathe with the overhead-motion. It is extremely convenient in turning both the inside and the outside of boxes, cases, &c.

Turners use another kind of rest, shown in fig. 7, Plate XXIII. The bar, *a*, rises and falls by means of an hinge joint; its side can therefore be used in turning the outside of an object, which, as the plate shows, passes between the uprights *A*, *B*. When the turner wants to hollow out, the rest need not be disturbed, all that is required is to loosen the bar on which the tool rests. This rest, however, is very large and cumbersome; and the iron bar on which the tool rests being smooth, the latter is apt to slip and do some damage when the turner least expects it.

But it is without one disadvantage the other rest possesses; the latter requires to be constantly shifted to allow its chair to be placed in the different positions it demands. Yet this inconvenience may be greatly obviated by placing the chair in the diagonal of the square of the ground-plates. By this means it will always be possible to present the face of the wedge to the

part it is desired to turn by merely loosening the lower screw. But the amateur, when he has had considerable practice, gets accustomed to constantly changing the position of his rest, and does it without noticing it.

Another advantage that this rest possesses is that it is easy to raise and to lower it by shifting the wedge.

There is yet another kind of rest, shown in fig. 18, Plate XXIII. The iron wedge, *a*, is similar to those used in lathes turned with a bow; it is placed in the upright, *b*, fixed to the ground-plate, *c*, by a tenon which can turn in any direction, and be raised or lowered at will. The gripping-screw keeps the wedge at the required height. This rest is very useful in turning delicate work, as the corners of the wedge can be placed as near the narrowest mouldings as required.

Here ends our description of the lathe with the overhead-motion; but we shall constantly allude to it again as we are explaining the different objects that can be made upon it.

If any amateur should happen to want to put a lathe with the overhead-motion together for himself, we assure him that it requires the greatest care.

A lathe often either vibrates or turns with difficulty; this comes from the fact that the pads are not exactly placed in their grooves, or that they are too exposed, or that they do not lie quite parallel to each other, or that the key shifts in its socket, and does not grip the mandrel with sufficient tightness.

Let us now suppose that we are in possession of a good lathe with an overhead-motion, fixed securely upon a firm lathe-bench; we will not for the present trouble ourselves with the question as to whether there ought to be a wheel above or below; it is time, now, to set to work; we will explain where the wheel ought to be placed later on.

## CHAPTER II.

## Chucks.

**I**N treating of the lathe with centres we recommended the amateur to make plenty of handles. Our purpose was to enable him to acquire experience in cutting wood with the gouge and the chisel. As an immense number of objects are made upon the lathe with the overhead-motion by scraping the wood, as when a box or case is being turned ; it will be as well for the amateur to perfect himself in this process.

Chucks are indispensable. They are usually made of wood, and sometimes of brass. Within them, or upon them, are fixed the object to be turned ; and as these objects are of infinitely various shapes, diameters, and lengths, it is necessary to keep a large selection of chucks, so as to be able at once to lay the hand upon one suitable to the exigencies of the moment, and not to be obliged to alter and spoil them in order to suit them to the objects being turned.

Whenever a lathe with an overhead-motion is either purchased or constructed, it should always be accompanied with a *pig-tailed* chuck (fig. 11, Plate XXIX., Vol. II.). This is the name given to a chuck, generally made of brass, upon one of the faces of which is a female-screw that will fit exactly on the head of the mandrel. On the other face is a steel rod strongly rivetted to the centre, and cut into a screw like those used for wood ; a screw, that is to say, whose pitch is wide and whose thread is rather deeply cut. With the aid of this chuck all the others are made ; they are usually made of white hawthorn, sorb, pear, or apple wood.

Take a sound piece of one of these kinds of wood, and after having removed all the knotty and faulty parts, cut it into as many pieces of from two to three inches in length and of different diameters, as there is material for. Find the centres of these pieces as nearly as their irregular shape will permit. Drill a hole in it rather smaller than the pig-tailed part of the first chuck, and as nearly as possible at right angles to the plane of its extremity. Then screw the piece on to the steel screw till its end is close up to the end of the chuck. Roughly shape the circumference with the gouge, and with another rather larger gouge of a moderate thickness cut the chuck at the end, presenting the side of the tool to the wood, in such a way, that is to say, that its sloping edge is almost parallel to the length of the wood, and that its groove be slightly turned downwards, and not lie upwards as is usual. This manner of cutting the wood at the end with a gouge enables the workman to cut very neatly and leave scarcely any marks. The plane should incline inwards a little towards the centre, so as to fit more closely against the bottom of the mandrel's head.

Now incline the chair-rest against the surface just made, in such a way that the wedge comes a little below the centre of the object. The amateur, of course, recollects that by loosening the T the wedge can be placed at any required height. Mark the centre with a point-tool. Take a suitably sized spoon-bit and make a hole of about a quarter of an inch in diameter; increase this gradually till its width is but slightly smaller than the width of the end of the thread on the mandrel's head. Give a finishing touch with a side-tool to the hole, the depth of which ought to be a little less than the length of the mandrel's head, and take care that it is as wide at the bottom as at the top; the amateur can satisfy himself as to this with a pair of callipers.

Now comes a portion of the work that demands the greatest care. We assume that the amateur has not yet cut any screws or threads upon the lathe. Remove the wedge beneath the brass key, the bite of which has till now prevented the mandrel from making any movement but a rotatory one within its ties. Raise the key which is below the first turn of the thread of the screw, that is to say the largest, generally that of the mandrel's head. Tighten this key a little against the screw with the wedge that fits all the screws, and withdraw the rest, so that when the mandrel and the object upon it move forward it will not touch them. Take an outside screw-tool, and having placed it so that half its length is outside the hole when the treadle is raised, hold it so very firmly and work the treadle. It is clear that the comb in cutting the wood must make curves inside the hole, and that owing to the correct regularity of its shape its teeth will enter every part of the thread without injuring it. This operation demands a lightness of hand that experience will soon give. What is necessary is to cut the wood only as the treadle descends, and as it is usually with the left thumb that the comb is held on the rest while the latter is grasped by the finger, the lifting of the comb as the treadle ascends is produced by a slight movement of the thumb which alternately raises and depresses it.

The more turns of the thread that are gripped by the key, the more firmness there will be in the movement, and the less will the key be likely to become injured. For this reason the first screw of the mandrel is generally made with a double thread. The direction of this double thread is the same as if there were only one, but as the threads are small, and there are two of them, they catch better in the key.

If the revolution of the mandrel at each stroke of the treadle does not make a sufficient thread, if, that is to say, the comb does not cut it deep enough to entirely admit the mandrel's head, the following process must be had recourse to. Lift the handle, and then advancing the comb by as much as one tooth at a time only, press it down; it is clear that one more turn of the thread will have been made. Continue this till the thread is deep enough; but, if the thread is already deep, the comb must not be allowed to penetrate quite to the bottom of the thread, as too much wood would in that case be carried away, and this would spoil all. But little, therefore, must be cut away at once.

When the thread is deep enough, and equally deep throughout, remove the chuck, with the other attached to it, from the lathe, and, without separating them, try if the screw will enter. It should fit in loosely rather than tightly, because as the wood dries the diameter of the thread will shrink; it is of frequent occurrence for chucks after a short time to fail to fit the mandrel. To remedy this a screw-tap should be procured, the thread of which exactly corresponds with that of the mandrel's head, though it should be of rather a larger diameter. Pass this screw-tap into the holes in the chucks and they will be restored to their original size.

To avoid the trouble of taking the chuck off the lathe every time it is tried, the amateur should take a piece of very dry wood, about three inches long, and turn it to the diameter of the



mandrel's base. Cut a screw at one of its ends exactly similar to that on the mandrel's head. At the other end of the piece of wood cut another, about a tenth of an inch longer, and then remove its thread upon the lathe. The smooth end will now serve as a guage for the hole, the other as a substitute for the mandrel's head (fig. 19, Plate XXIII.).

To make this thread, the comb must be in good cutting order. But as it is impossible to sharpen its teeth without spoiling them, the amateur must be content to set the comb flatways on an oiled stone. Unless this be done, as the wood is merely scraped, there is a risk of splitting the turns of the thread and of carrying them away.

If the wood is too old, or has lost a great part of its sap, it will be difficult to cut a good thread; a little experience, however, will teach the amateur how to remedy this difficulty. When the diameter of the female-screw has been cut nearly large enough drop a little oil into it; then work the treadle and the oil will soak into the whole thread. The oil restores to the wood some of the moisture age has robbed it of.

If, however, a screw be inserted into a wooden thread, the oil will make the latter shrink and creak. In this case, drop as little oil as possible into the thread and allow that little to dry before inserting the screw. Then, as soap has affinity with oil, rub the screw with some; the soap will incorporate itself into the oil and prevent any creaking. If the wood were fresh cut, the thread could be cut with the greatest ease, but chucks made of green wood always end by splitting.

Beginners are apt to make the introductory orifice of all the threads they cut upon the lathe too large; the consequence of this is that the bottom alone of the thread is properly formed.

The greatest care should be taken to make the diameter of female-screws equal throughout their whole length; and for this reason as soon as the end of the worm enters the first turns of the thread the latter should not be touched, but only those at the other end; unless, indeed, the point of the worm be of a conical shape, as sometimes happens.

When the chuck fits upon the mandrel's arm with considerable ease, and presses close up against the shoulder, the pig-tailed chuck should be removed and the last finish given to the outer end of the chuck with a gouge, both on its circumference and its face. It should be terminated without touching it with the chisel, which is not in the least required. When the chuck is finished, a hole should be made in its axis. This will prevent the wood from splitting.

As many of these chucks as possible should be made. As the amateur reads on he will find that he cannot possess too many of them. If the wood in stock is of different thicknesses, they should be made as they come; the following is the way to place them.

As close as possible to the lathe-bench a number of nails are driven into the wall, at about six inches apart, and in lozenge shaped rows; that is to say that each nail in the second row is in the centre of two in the row above it, and so on. The chucks are then hung against the wall by placing their screw holes on the nails. Arranged in this way, a glance is enough to tell the amateur which is the chuck best suited by its size to the work in hand.

Making chucks is a rather wearisome business, especially to an amateur who only desires amusement, and it is possible to buy them ready made.

While we are speaking of the way to make chucks, we will allude to a certain kind which often prove very useful.

Let us suppose that it is wished to turn the ends of a case on the lathe with the overhead-motion, to use a chisel to the neck of a box that closes with difficulty, or to give a finishing touch to a piece of work during completion. It is clear that none of these ought to be fixed on to a

chuck lest they should get broken, or at any rate injured. The following is an ingenious species of chuck that will be of great use in such circumstances.

A sound piece of wood from three to six inches long, and of any diameter required, must be placed on the pig-tailed chuck. A female screw, such as has just been mentioned, must be cut in it. When this fits easily on to the head of the mandrel it must be screwed on to it and turned round, the largest possible diameter being given to it. At eighteen or twenty inches from the end which rests against the base of the mandrel, a groove, *a*, must be made, which must be rounded on both sides in order to make it rather less thick at this part, and to give the piece the elasticity the need for which will be soon understood.

Turn it very round, making it rather smaller towards the end. Take a spoon-bit of at least one-eighth of an inch in diameter, and make a hole in the centre, penetrating the whole length as far as the hole of the screw. Then carefully holding it in a vice, to prevent it from splitting, saw it in two places at right angles to one another; the saw, which should be rather a thick one (fig. 7, Plate IX.), should cut as far as the groove.

An iron or brass ring, the interior of which is a little cut away on one side, must be placed on the small end.

It is evident that if the object to be turned is very thin, and that there is any danger of spoiling the surface, or of breaking it, it will be possible with a side-tool to place the hole of the split chuck at the proper thickness, and to there fix the piece without any friction. If the ring is now slipped on, and forced a little forward, the piece will be tightly held, since each of the four parts is pressed towards the centre by the strain of the inner part of the ring.

Some tighten this chuck by a method that, though apparently more convenient, has drawbacks not possessed by the other. They cast a brass ring, at the two ends of which are a couple of little buttons or tenons which make it revolve. A thread is cut in the inside of this ring in order to make it into a conical screw. A similar thread is cut upon the chuck, which is gradually tightened by turning the ring as may be required.

This method appears to be a much better one than the preceding one. 1st, it tightens the piece more gently; 2ndly, it tightens it equally everywhere, that is to say with unvarying concentricity; while with the other method the chuck can only be tightened in one place at a time, and there is never any certainty that it is not being warped. These apparent advantages, however, are deceitful. Practically the ring with the screw is not so good as the other. However correctly in the centre the chuck may have been pierced, it is seldom that the piece is fastened to it exactly in the middle. If it is tightened with the ring with the screw, it is impossible to again put it straight; while, on the other hand, with the plain ring a mere blow of a hammer to the right or the left will replace the piece in the centre.

Chuck making is as wearisome as the manufacture of handles, but when we recommended the amateur to make handles our purpose was to accustom the amateur to cut wood with ease; now that we suppose he has acquired this knack, it is merely with a view to his comfort that we advise him to provide himself with a number of chucks. It is, indeed, necessary to have a great many, and the amateur will have to lay in a stock of them, though by what means we must leave to his own choice.

A split-chuck must of necessity have been made upon the same lathe as that on which the amateur is about to use it. If they were all of different external diameters, it would be necessary to have as many rings as there are chucks. This can be avoided by making five or six

of the chucks fit on to one ring, six to fit on to a larger ring, and six more for a still larger one. In each kind of chuck pieces of various sizes can be placed, and this is all that is required.

When a piece is placed in a split chuck it seldom requires to be inserted for more than an inch, as the pressure of the ring necessarily rather narrows the entrance of the hole. Its continuation may possibly be of a greater diameter, but when as much as an inch of a piece, no matter of what length, is gripped by the chuck, the lathe cannot fail to firmly hold it. There is an advantage in the hole being wider at the bottom than at the entrance; it is this. In case the piece, owing to its not being exactly in the axis of the chuck and of the mandrel, does not turn perfectly round and straight, a slight blow of a mallet will throw it slightly to one side or the other, as may be necessary. But when the variation is barely perceptible it is sufficient to strike a gentle blow upon the ring or upon the chuck itself. We will return to these details when we explain how to turn with this kind of chuck.

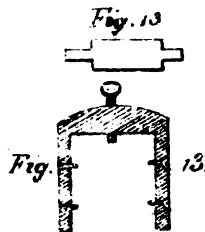
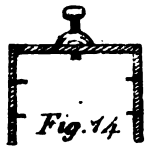
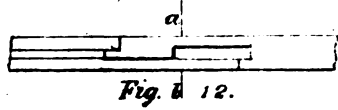
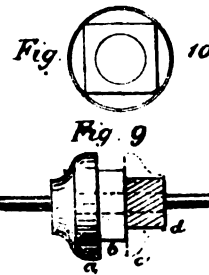
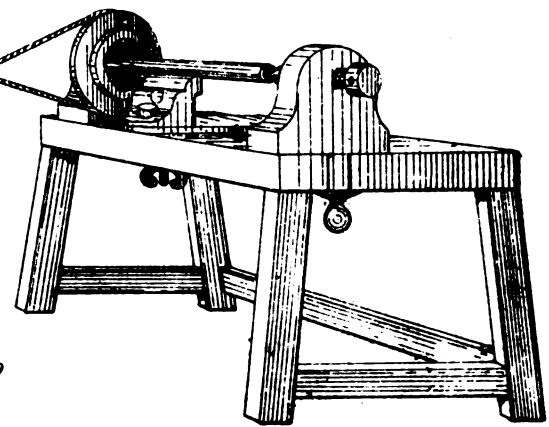
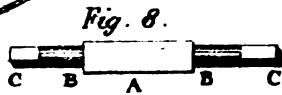
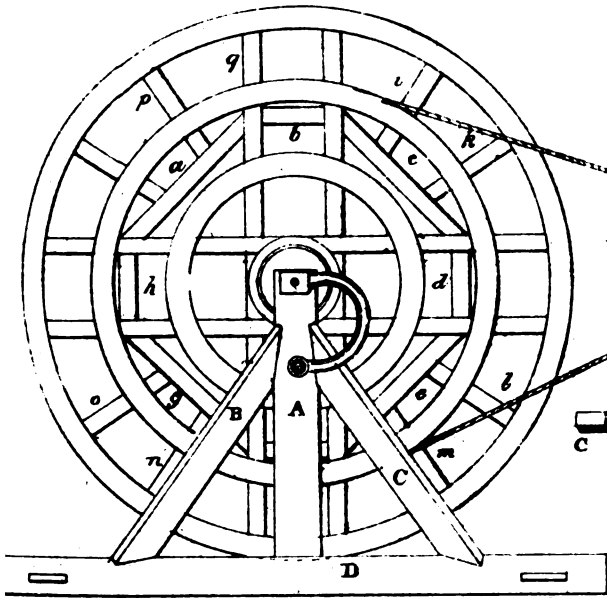
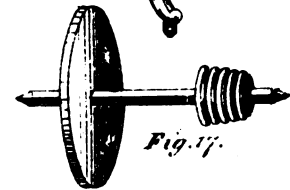
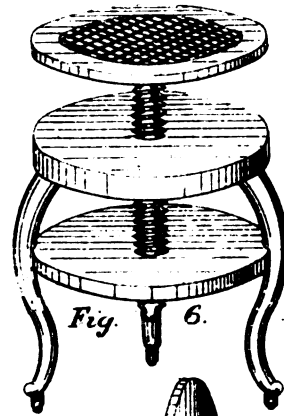
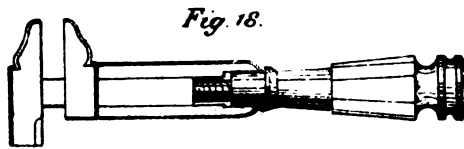
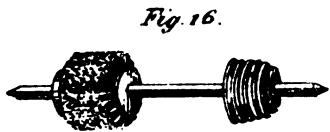
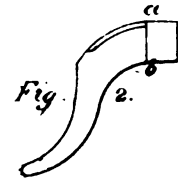
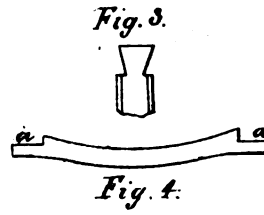
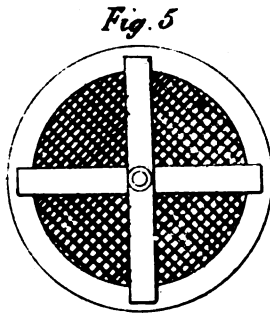
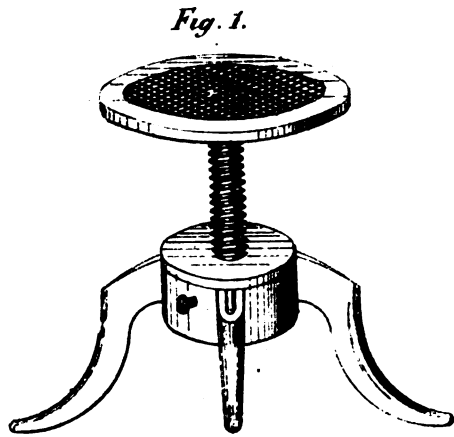
A little experience of the lathe will show the amateur how necessary it is to have good chucks. At the very moment, perhaps, that he is about to place a piece of rather a large diameter upon a short and worn chuck, the latter splits, and is no longer fit for anything but firewood. To prevent this, iron or brass rings must be made, from one inch to five inches in diameter, and placed upon the chucks in the same way as iron hoops are fitted to the nave of a wheel. Such a ring once forced on to the chuck's external rim, it will be possible to exert pressure upon the piece held in the chuck without splitting the latter.

It is not necessary to keep rings of many different sizes; it will suffice to have them of three or four diameters. For instance, there should be four of a diameter of two inches, four of a diameter of three inches, four of four, four of five, and four of a diameter of six inches. They must be made slightly conical in shape so that they can be pushed forward if the wood dries and shrinks. These are all that will, as a general rule, be required. There are cases in which chucks of very large diameter will be required, of as much as twelve, fourteen, and even sixteen inches.

In such cases pieces of walnut wood, about an inch thick, must be placed on the head of the mandrel; after finishing and rounding them on the lathe, the piece of wood from which the frame is to be cut should be placed beneath.

There is yet another very useful kind of chuck. This is a brass box filled with a plug of wood, and used in the same way as an ordinary chuck. When the wood becomes worn out, it is replaced by a new plug, and the amateur has at once a new chuck. These chucks (fig. 12, Plate XXIX., Vol. II.), are made of a diameter of from one inch and a half up to four inches. Their chief advantage is that they dispense with the necessity of continually cutting threads, as in the case of ordinary chucks.

When it is desired to turn a piece of rather a large diameter and preserve its centre, a chuck is used that is merely a brass plate (fig. 91), with a bellying part in the centre of one of its surfaces in which is a female-screw that fits on to the head of the mandrel. Near the circumference are three holes, through which pass three wooden screws, the heads of which are behind, and which can be inserted as far as is desired into one of the faces of the piece to be turned, without penetrating right through to the other surface. In a great variety of cases only one surface is required. When, however, it is necessary to use the other, the three holes must be filled with pegs properly glued in. As the centre of the mandrel, as well as that of the points, is generally raised about seven or eight inches above the level of the workbench, a piece of wood must be fitted in it, and made into a chuck similar to the last; upon its surface must be concentric circles at exactly the





same distance one from the other, and in each circle three square holes. In each hole, place a kind of hook (fig. 20), the stem of which fits squarely into its hole, and at the end of which is a screw fitting into a six-sided female-screw that is tightened behind the chuck. The piece to be turned is placed as much in the centre as possible, according to the circles on the chuck, and fastened in its position by the heads of the hooks. By this method a piece of rather more than a foot in diameter can be turned if the hooks have been placed at six and a half inches from the centre. This kind of chuck is only used when it is necessary to work in the centre of the piece, as in the case of compass boxes, which are square; the hooks would interfere with the circumference.

There are a great variety of cases in which it is much quicker and easier to pierce an object with a spoon-bit upon the lathe. For this purpose there are chucks in the centre of which is a square hole (fig. 13, Plate 29, Vol. II.), into which the square part of a spoon-bit fits; this is kept in its place by a screw at the side.

It is not only wood that the amateur will have occasion to turn upon the lathe with the overhead-motion; he will often have to turn metal. In a great many instances the nature and shape of a piece prevent it from being easily turned upon the lathe. To meet this difficulty chucks have been invented in which the piece is held between a couple of pads, which slip forward or backward in a groove in which they are kept by a pressing-screw (fig. 18, Plate XXIX., Vol. II.). With this chuck a long and thin piece, too flexible to be worked upon the lathe with centres, can be held. The piece is passed into the hole cut in the axis of the mandrel, allowing only the part it is desired to cut to project. Chucks have even been made on which are fastened two jaws of a vice, which, by means of a couple of regulating screws, one of which is right handed, and the other left handed, come open without losing their distance from the centre, (fig. 6, Plate XXIX., Vol. II.). The vice-jaws of this size are strong enough to grip a piece of iron or brass, and allow of its being bent as may be required.

There is yet another kind of chuck with four moveable jaws, called the universal-chuck (fig. 7, Plate XXIX., Vol. II.). This chuck, which we have improved, and the construction of which is exceedingly simple and ingenious, is now very generally used. It is of particular assistance to the amateur, as it enables him to quickly fix the centre of any flat piece he wishes to turn. It has, moreover, the advantage of being able to grip internally or externally. Let us suppose that it is necessary to retouch one of the surfaces of a circle, the external one, let us say; the piece is seized by placing the jaws of the vice inside. There is nothing now in the way of the tool; of course, for the contrary case, the vice must be fastened outside.

It can be used, further, in certain cases as an eccentric chuck, by advancing two of its jaws from left to right, at the distance given. In this operation, as well as in the others, the centre must be taken with the greatest care.

Upon a plate of brass (fig. 71, Plate XXIX., Vol. II.), mounted upon the head of the mandrel, are four grooves cut with the greatest care. Four claws, cut as files, are fitted tightly into these grooves. These claws are pierced with a hole in which a double and often left-handed thread is cut. A screw fits into this hole; one of its ends has a base in which a square aperture is made; a key fitting into this aperture moves the screw. These screws are kept fixed behind the plate by an outside band, in which four conical holes are cut to give passage to the heads of the screws, which are all of the same shape. The other ends of the screws are fastened to the centre of the plate by an iron plug which prevents them from either advancing or retiring, so that when they turn they force the jaws to travel up and down the grooves. In the centre of the plug is a

moveable pointed screw ; this at once receives the centre point found by the compass, and saves much trouble.

In order to find the centre with greater certainty, divisions are made along the edge of each groove ; these act as a guide to the motion of the hooks ; a precaution that is very useful when it is desired to find a centre from a given distance. As any screw that is required can be advanced, it is easy, by withdrawing the opposite claw, to exactly find the centre of a piece.

It may happen that the eccentricity in thread laying between the four screws will be between two of them ; in that case two of them are advanced and two withdrawn, and the piece is moved diagonally.

Chucks have been made of two plates of brass, between which is wheel-work which imparts an equal movement to the four claws ; but this kind of arrangement very easily gets out of order.

We have seen other chucks made of two plates which revolved upon one another upon a centre or pin fixed upon that upon the mandrel. Upon this last is a close spiral-groove from the circumference to the centre. Mortises are cut in the ends of the claws to enable them to exactly fit into this groove. It is easy to understand that if the plate on which the claws are fastened is made to turn, these are forced to follow the grooving, and that they then advance and retire with a uniform movement, and that when once centered they rarely get out of order. Moreover, as these plates, in turning, always tend to tighten the piece between the claws, the piece can be turned without any fear of its getting out of order. It has, however, one drawback ; when the piece is once finished, it cannot be withdrawn.

Often when a piece has been prepared upon the lathe with centres, it is necessary to finish it on the lathe with the overhead-motion. If, on account of its shape, it is difficult to place it on a wooden chuck, or it is found impossible to use the universal-chuck ; recourse must be had to another kind of chuck, known as the cup-shaped chuck (fig. 20), on the circumference of which are four screws ninety degrees distant one from the other, inclining towards the centre, and which, gripping the piece, hold it perfectly firm. For the sake of solidity four other screws are placed immediately beneath the first.

It is possible that the piece may be held firmly enough at the centre, where the screws are, and yet may not turn straight at the outer surface. This comes from the fact that it leans to one side or the other, a fault that it is very difficult to remedy.

It is for this reason that chucks with eight screws are to be preferred. After having determined the centre with the first four screws, and as close as possible to the chuck, the isolated end can be put into proper position by means of the other screws ; this is how medals, which ought to be perfectly even on both sides, are turned ; once a piece, the centre of which has been found with the eight screws, is firmly fixed, the centre of its other extremity having been also correctly determined, the amateur may feel certain that its axis exactly coincides with that of the mandrel.

If there is any danger of the pressure of the screws injuring the surface of the piece, a small piece of brass may be inserted beneath each of them, or a round vervel, shaped according to the curve of the piece. These screws can be tightened and loosened by means of a key similar to that in fig. 21. This kind of chuck, useful in itself, has one drawback. The four screws which project beyond the circumference are likely to tear the hand, especially if the turner gets too close to the chuck

For turning flat or very thin pieces of different diameters, the chuck shown in fig. 10, Plate. XXIII. is indispensable. A brief description of it will explain its usefulness. A thin piece presents at its circumference a very sharp edge, and is consequently difficult to fix in a wooden chuck ; and as these pieces are almost always knotty, it is not easy to turn them.

The chuck we wish to describe is composed of a brass plate from ten to twelve inches in diameter, and about a quarter of an inch thick ; at its back is a bellying part that projects about an inch, and a thread is cut in its interior, as with other chucks, to enable it to be screwed on to the head of the mandrel. Its surface is marked with concentric-rings, about a quarter of an inch apart. Each of these rings is divided into four equal parts, and pierced with four holes, in which a thread is cut to receive screws, which firmly fix the piece by means of four jaws (fig. 10, *b*). In this way it is gripped flatly and firmly against the chuck. Sometimes a centre-screw is added, such as we mentioned in speaking of the universal-chuck. The chuck we are describing has also the advantage of being able to hold and find centres to pieces of all shapes.

There remains the chuck with points (fig. 12, Plate XXV.), which, when fixed upon the mandrel's head, allows the amateur to turn between the centres without disturbing the lathe with the overhead-motion. The steel rod, *a*, upon the circumference, is for the purpose of setting in motion the ring with four screws (fig. 13).

We have still a word to say as to the way to fasten a piece with gum-mastic on to the lathe ; rather a difficult operation.

The gum ought to be in sticks, as we have already recommended. Prepare a chuck, and, working the treadle rather rapidly, apply the stick to the chuck. The heat caused by the friction soon melts the gum, which sticks to the chuck ; the stick should be turned round and round so as to melt it in every direction, and the treadle should be kept in motion to keep the gum in a warm state. Then, without losing any time, the piece should be applied firmly to the chuck, the treadle being still kept going in order to heat the piece and the gum and to cause the latter to adhere to the former. The piece must then be made to revolve to see if it turns round and straight ; if it does not, it must be slightly pressed with the hand in the direction required.

This operation requires a great deal of skill and quickness ; otherwise, the gum will get cold, it will be impossible to either advance or withdraw the piece, and it will be necessary to take it off the chuck and begin it all over again.

The above is a very delicate operation, and it is seldom that beginners succeed with it. It will be found to be of considerable assistance to trace a few circles on the surface of the chuck, in order to judge by the piece's position if it is exactly in the centre.

This method of using gum upon the lathe is often of the greatest use. If it is well applied a piece of any material, even of ivory, can be cut smaller with the greatest ease ; but care must be taken in using the gouge not to attempt to cut too roughly any projecting part, for the slightest shock will separate the piece from the chuck.

The projecting roughnesses, therefore, must be cut away gently and gradually, very little matter being removed at a time ; but as soon as the piece is tolerably round, there is no longer any fear of accident.

If it is desired to place upon the lathe a large piece, or a piece of considerable diameter, the best way will be to first heat both the piece and the chuck, or to melt the gum in an earthen-ware pot ; to then dip the end of the chuck in the melted gum, replace the chuck upon the lathe, and then more leisurely find the centre.



Gum, thus melted, retains its heat longer, and gives the workman more time to operate upon the piece ; but he must not forget to wait till the gum has become quite cold ; indeed, if the piece is of any size, he must avoid leaving it on the lathe after having turned it and found its centre, as its weight will cause it to sink and thus throw it out of gear.

The chuck must be taken off the mandrel, and the piece must be laid flat upon the lathe-bench or some other smooth surface.

When the piece is finished, it is very easy to remove it from the chuck. All that is required is to strike it a quick mallet-blow. If it is polished, and there is any danger of injuring its surface, it can be covered with a piece of linen or cloth, and the blow struck on this material, or even from behind. As a rule the piece comes away with very little gum still adhering to it.

We have now entered sufficiently, we think, into the details of the preliminaries indispensable to turning with the overhead-motion ; to the subsequent operations we will devote a fresh chapter.

## CHAPTER III.

## Box Turning.

## PART I.

## A BOX MADE OF ONE PIECE.

**T**HE first work that an amateur should be anxious to produce on a lathe is a box ; with this, then, we shall begin.

He must first take a piece of any kind of wood he pleases (for it is always upon wood that it is advisable to experiment, this material being infinitely less valuable than ivory or shell). He must prepare it with an axe to the diameter required, and round-off one of the ends with a rasp as much as possible. Its total length must be a little greater than the depth it is intended to give the box, together with that of the lid, and finally, perhaps, somewhat longer, to make allowance for that part of it which fits on to the chuck. If the piece is rather short he must glue it on to the chuck ; but the most ordinary plan is to use chucks hollowed out.

A chuck must then be made upon the lathe, adapted to the size of the piece of wood, and as it is necessary that it should fit very exactly, a brass or iron ring, such as we have already described, must be used to prevent the chuck from splitting. The piece of wood must be made to fit tightly by means of a mallet or hammer, after having unfastened the chuck, so as not injure the lathe by striking it. If it does not turn round, or should the amateur wish to avoid a knot by cutting it away with a tool, or should he, in short, come across a flaw which he wishes to remove, he must throw the piece on one side, until he considers it to be so placed as to have the greatest possible diameter. If he has not yet sufficient practice he must mark the centre lightly, whilst turning, with the edge of a point-tool ; then, with a compass, he must satisfy himself that the piece has the required diameter, throwing it from one side to the other, as may be required, by striking it on the edge, or what is much better, by striking the end of it with a mallet, which will press it in the direction where it is wanting in roundness. Through the whole of this operation some caution must be used in order that the piece may be securely held in the chuck ; otherwise, as in hollowing it out a tolerably strong eccentric impulse is given to it, the amateur runs the risk of seeing it spring from the chuck ; and without considerable practice he will not be able to restore it to its former round state ; which latter requirement is all the more essential the nearer it approaches completion.

The amateur must then begin hollowing out the piece, at first with a point-tool at the centre, to no very great depth, since it is with the lid that he begins; then, inclining one of the sides of the same tool in a direction parallel to the side of the lid, he must enlarge the hole. He will then go back to the centre with the point-tool and continue to act in the same manner in order to work more rapidly.

He will next use a side tool, which ought to be perfectly sharp both at the end and at the side. It is advisable also that the sloping-edge of the end should make an acute angle with that of the side, so that the amateur, when he wishes to remove the wood in one direction only, may not touch another.

It is a matter of great importance that the interior side of the lid should be perfectly smooth, so that it may fit the whole neck of the box evenly. Bad workmen are satisfied if they make it fit only at the bottom or edge, which causes the lid to vibrate when in its proper place. When the piece has been tolerably well rounded and the sides and the bottom cut to a depth of from one-eighth to one-sixth of an inch, or even more, according to the size of the box, the amateur must smooth the bottom, taking care that it be neither convex or concave. He will then finish the sides with a tool that cuts very finely and removes but very small pieces of the wood, especially taking care that the motion of the foot is not communicated to the hand, which would cause the piece to be anything but round. Finally, he must give the end of the lid a slight tap with the end of the tool, inclining it a little, but only a little, inwards, so that this part of the lid may fit the flange of the box very exactly. If the tool is inclined too much, the joint will be at first imperceptible, but in case the external diameter were diminished, the opening between the two will be clearly visible.

The lid having been thus prepared, the amateur will mark its depth with a point-tool inclined at a rather acute angle, taking care that the top of the lid be of sufficient thickness when it is finished. He will then deepen this mark with a point-tool, and afterwards, with a back-saw (fig. 7, Plate IX.), he will separate the lid from the rest of the wood, working the handle continually. In a very short time he will see the lid drop on the lathe-bed, tolerably, accurately shaped.

He must now occupy himself with the box. He should begin by hollowing it out to the required depth, and in order that its inner sides may be quite at right angles with the bottom, for its beauty lies in this part, he should have a tool called a cross-square (fig. 7, Plate II. Vol. II.). This is a very convenient instrument, that is used in a variety of cases where it is necessary that the sides of an object should be perfectly square with its base. This square is composed of a rod of brass or steel, which rests on the sides of the box. In the middle there is a square eye through which passes at right angles another metal rod, which, by this means, is quite perpendicular to the two sides of the first piece. This moveable rod has longitudinal divisions, for the purpose of finding the depth of anything. The rod must be inserted till it touches the bottom; by passing it over the surface of the bottom it will be seen whether it touches everywhere, and consequently whether the bottom is level. Then, by applying it to the inner side it will be seen if this is quite perpendicular to the bottom. The internal diameter must not be quite continued to its proper length; but it should be approximated to as near as possible before making the neck. If the amateur begins by making the neck first and completing it so that the lid may be fitted to it, with even some degree of exactness, and hollows out the box afterwards, he will be surprised to find that the lid has become loose.

This result is produced by the shrinking of the grain of the wood, which causes the box to

contract and loosens the lid. The neck, therefore, should not be finished until it has been hollowed out and nearly given its right diameter. The greatest attention must be bestowed upon this operation in order that the lid may fit evenly. The lid having been made to fit with sufficient exactness, which fact may be ascertained by trying it from time to time, the amateur will then place it right against the shoulder of the box which has been previously prepared with a very finely cutting point-tool; and, if it be necessary, he will give a few light taps with the handle of the tool, all round the lid, until the joint is no longer visible. At this stage of the operation he must finish turning the outside of the box, giving it an equal diameter throughout, and using, in order to give it a neat finish, a chisel with a single edge which cuts very delicately.

The top of the lid must be exactly finished. This should have a slight concave swell in order to present a neater appearance.

Before placing the lid, the depth of the box must be ascertained, so that it may not be cut too near the bottom, and be not made too thin in that direction. The place where it is to be cut must then be rather deeply marked with a very finely pointed point-tool.

The box must then be polished with the greatest care; it is now almost finished. The sharp outline of the angle of the lid must then be formed, as it adds to its neatness. If wet shave-grass is used, as dampness causes wood to swell, the operator must wait until the box dries before removing the lid. He will then give the finishing touches to the inside of the box, and reduce it to the proper thickness. Finally, he will round it gently towards the edges in order to lessen the thick appearance of the neck, which ought not to be quite so deep as the lid.

The box must then be cut from the rest of the block, at the point where it is held by the chuck, by means of a saw, as was done in the case of the lid, and it will immediately drop off. With the remainder of the wood upon the chuck, if there be enough of it, or upon another chuck, a sort of lid may be made in which the box should be inserted as tightly as if it was its own lid. The bottom of the box must then be finished. This ought not to be quite flat, but slightly concave, so that it may stand evenly upon a table or other smooth surface. The bottom is then polished, and the box is quite completed.

## PART II.

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### HOW TO MAKE A BOX LINED AND ORNAMENTED WITH SHELL.

**I**F it is desired to make a box lined with shell and ornamented with hoops of the same material, it is best to make it of boxwood. It is in this way that it is generally made.

Let us suppose then that we have a piece of boxwood of suitable size, without any large knots, and above all without any deep flaws. Saw it in two, its real value will then be easily discovered.

There is room for plenty of choice in these pieces of boxwood, but it is only when completed that it is possible to ascertain their real worth, unless, indeed, the operator has a large previous experience. There are instances in which the caprices of nature have formed perfect pictures, sometimes of human beings and animals, sometimes a landscape, in short some object that seems as if it had been carefully painted. But as these pieces are excessively rare, they ought to be kept solely to be made into lids, this being of course the most conspicuous part of a box, and some other kind of wood of a less costly nature selected to form the cup of the box, unless it is desired that the top and bottom of the box should be of exactly the same material. In the latter case the two parts must be always separated. The piece intended to be made into the main part must be glued on to a chuck properly prepared, and hollowed out in the manner already described.

The lid must be made on another chuck. The box must have no neck, since it is intended to line the box with shell, and part of the shell will serve as the neck.

The inside of the box must now be given its proper size. The sides and the bottom must be prepared with the cross-square already mentioned; but upon them some circular grooves must be cut to retain the glue and make the lining more solid. A fine comb, like that with which screws are made upon the lathe should be used, care being taken that it is not pressed too hard.

We shall describe, in another chapter, the method of working and soldering shell. For the present we will suppose that the amateur is well provided with pieces and plates of all sizes, or at all events with everything necessary for the box with which we are concerned.

If the shell it is intended to employ is not perfectly round externally, and of equal thickness, it must be placed on a chuck made perfectly round. It must be made to fit somewhat tightly, and its exterior must then be rounded, and its bottom edge neatly finished. A few cuts should be made in that part of the shell which is to be joined to the wood to enable it to retain the glue more easily.

The plate which is used to make the bottom should generally be tolerably smooth; a few roughnesses, however, may be made on one of its surfaces with a rough file.

A piece of copper which has been already marked with a punch must be placed at the centre, and the point of a compass placed in the mark, the other point being made to cut. By this means the plate is cut to any diameter suitable to the box.

At the bottom of the box lay a light coating of warm glue coloured with vermillion. This mixture has a very agreeable effect and conceals, besides, the wood which might easily be seen owing to the transparency of the shell. On this coating the plate is then placed. The shell, which ought to fit exactly, is glued in the same way, and the whole is then submitted to pressure, in such a way that the pressing-screw works against a cylinder of nearly the same interior diameter as that of the box, but not quite so deep. All this may be done without removing the box from the chuck.

As to the shell, it is sufficient to place it upon the bottom, a very slight pressure will be all that will be required to fasten it in its proper position.

Isinglass is the best glue for cementing shell to boxes and other objects which require neatness and solidity. Its whiteness does not affect the brilliancy of the colours you wish to preserve; besides, it dries very quickly and binds much better than the best and strongest glue. Ordinary glue has always a brown colour which is transferred to the joints and makes them visible no matter what trouble is taken to make them fit exactly.

For gluing and making fast the bottoms of boxes and other objects of a similar nature small presses may be used (fig. 34, Plate LII.), by means of which three or four, or even a greater number of boxes may be easily glued at the same time. The joiner's press (fig. 17, Plate IX. Vol. I.), may be used for the same purpose. Treat the lid in the same way, and glue the narrow strip of shell on to it very closely. Submit the whole to pressure. Leave the glue to harden for twelve hours, by which time it will be well dried, replace the box on the lathe, turn the inside quite even with a side-tool, leaving sufficient thickness for the neck. It is usual to allow the neck (upon which the lid is to fit), to project beyond the bottom part of the box about one-third of its height.

Turn the outside of the box again lest it may have altered in shape, polish the inside with some finely powdered whiting and oil, and lastly, as a finishing touch, rub it well with tripoli-powder moistened with water.

The lid is finished with the same precautions. And as it is natural to suppose that the amateur wishes to ornament the outside with rings of shell, we will describe the manner in which this should be done.

The lid is placed on the lathe and a groove is made in it, by means of a cross-cutting chisel, to hold the circle of shell. In order that the circle may keep firmly in its place the groove must be made deeper at its base than at the top, that is to say, it must present an acute angle and not a right angle. The groove, however, must not be so deep as to diminish the strength of the lid.

The amateur must now turn a chuck of a peculiar shape. This is really nothing more than a long truncated-cone, that is to say, a cone which tapers very gradually towards its point. A circle of shell, whose diameter is such that some pressure is required to make it enter the groove, is fastened on to this chuck. It must then be cut very evenly on both sides, unfastened from the top of the chuck, and moistened with tepid water so as to soften it.

A few drops of very warm, but not very thick, oil must then be poured into the groove in the lid. Place the circle of shell in it very carefully, so as not to break it, and be sure that it lies very evenly on the wood all along the groove, so that it may be firmly fixed and may be able to take the form of the aperture. A piece of iron, heated in the same way as a soldering iron, must

then be passed all round the outside several times. The shell must be allowed to cool and then turned quite round. Remove the lid from the chuck, and place it in the same position as it will be in the box, taking care not to press it too tightly lest it may get too large and may have too much play when it is refitted on to the box. It would, indeed, be much better to place it on a chuck which grasps it firmly from the outside, but as it would not be possible to make it hold firmly without using some pressure, the circle would probably be carried away. It might also be placed on a split-chuck, such as we have already mentioned, but unless the operator is very skilful in working with this kind of chuck, and can round the piece off neatly in tightly adjusting the ring, we would advise him not to use one, although this plan might be undoubtedly the best. Of the different methods the operator, therefore, must choose that which he considers the best for his purpose. A groove must then be made upon the outer angle of the lid, as broad as it is long, so that the circle may be equal at the top and the sides. This second groove must be still more angular at the bottom than the first. There is more strain here than at any other part of the work, for the effort made to open the box when the lid fits rather tightly tends to cause the circle to start from its position. It must be made to enter as tightly as possible and fixed by the means just pointed out.

One or more beadings, as may be considered necessary, must then be made on the top of the lid. The best way is to make a very narrow one, placed against the angle's circle at a distance equal to its breadth. This is a very difficult operation. The cutting must be made with a very fine cross-cutting chisel, well hardened, so that it may cut very neatly but not very deeply. The hand must be kept very steady or else all may be spoilt. A beading is made on the chuck a little larger than is necessary, it must be just broad enough to fit into the groove. Great care is required in regulating its size, so that it may exactly fit the groove. As to its diameter, it is merely necessary that it should be a little greater than that of the groove, for it is easy on fitting it into its place to remove the excess. Glue the beading into its place, pressing it home along its whole length while the piece is being turned. A number of beadings of any size may be made at a convenient distance from the centre. In the centre itself a button may be added, the same precautions being taken. When these are dry, level and polish the whole.

The box is treated in a similar way while the circles are being dried. No circles, however, are placed on the top of the box, it being evident that the circle of the lid added to one upon the box would double the edge. This would produce a bad effect, unless the two were together no thicker than a single one. As to the external shape of the box no rule can be laid down. They all vary continually and are subject to the caprices of fashion.

When describing in our second volume the nature of eccentric and epicycloidal machines we shall explain the process of ornamenting the tops of boxes with interlaced beadings of shell so as to produce a very pleasant effect.

Boxes of this nature are generally coated with a varnish which, penetrating the pores and the little interstices (or interspaces) between the various beadings, adds to the natural yellow of the boxwood and brings out more clearly the beautiful effects of nature. Red, blue, or green may be added, or what is still better, loam which has merely the effect of darkening the natural colour of the wood. We shall state elsewhere the method of using these varnishes; to avoid wandering from our main subject into an infinity of digressions, we shall now content ourselves with saying that the varnishes may be purchased in flasks ready for actual use. Take a brush, for if you use your fingers you may burn them as the majority of colours are dissolved in vitriol, and lay a thick coat of any colour you fancy. When it is quite dry, the circles of shell are placed

in their proper position according to our previous directions. When the box is finished the whole is polished as before by the methods already stated. A few drops of oil and some tripoli-powder will impart a most brilliant effect. A darker colour may be given by using bister, which burnishes the wood and causes its graining to stand out in high relief.

We began our work upon the lathe with a box so as to afford to our readers the pleasure of learning him how to produce something pleasing. Perchance the amateur may not succeed at the first trial, but it is always well to gain a varied experience.

It very often happens that in turning a long piece on the lathe it is too weak, and its end not stiff enough to keep it in its place on the centre. When this is the case, drill a hole in the middle of it with a point-tool, and fasten it on to a pointed collar-plate. But although the poppits of the lathe with centres ought to be in the centre of the mandrel of a lathe with the overhead-motion, there exists a lighter and more convenient poppit than the two which are generally used. This poppit is simply a collar-plate to which is attached a piece of wood (*a*, fig. 2), through the thickness of which passes a pointed-screw, that moves backwards and forwards at pleasure. By this means a poppit is provided susceptible of really embarrassing multiplicity. By its aid the centre of the work may be altered if required.

It may be easily imagined that it is easier to make a twisted knife-handle on the overhead-lathe than on the centre-lathe. The chuck upon which the ivory is mounted is placed in another chuck, and all that is necessary is to assist the operation with a small pointed poppit. The spiral-twists are easier to make, and the ivory easier to pierce. The ball at the end may be ornamented with mouldings, without being marked at the centre. The piece of wood upon which the ivory is placed that is to receive the knife may be treated in the same way. It can the more easily be made to fit the place it is intended to occupy by gradually removing some of the wood from the parts which may require to be so treated.

A great number of the pieces which are made into spinning-wheels, winders, and other small instruments already mentioned in the instructions given for working with the centre-lathe may be similarly treated. In short the advantages gained by using the overhead-lathe are such that, when it has once been used, it is difficult to go back to the centre-lathe, although the latter may possess greater advantages in certain cases, as when the piece to be worked is rather large and long.

It is not that it is impossible to turn on the overhead-lathe pieces that are long and slender. In this case supports must be used, as previously stated, to prevent the piece from giving. But the method we have suggested as applicable to the centre-lathe cannot be applied to the overhead-lathe, as in the latter case there is no rest to which the wood can be attached. To obviate this difficulty the method explained in the following part should be adopted.



### PART III.

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#### SPLIT-POPPITS WITH SLIDING SUPPORTS FOR SUPPORTING LONG AND SLENDER BODIES.

**T**HE amateur must furnish himself with two or three plates with moveable rests capable of supporting a piece while it is being turned. As they are not like any we have already described we will explain the way in which they can be made.

Fig. 12 represents the poppit. A groove is cut in it, throughout almost its full length, proportioned to the thickness of the wedge, which is from one-quarter to one-third of an inch in thickness; through it a wooden screw with a large head is made to pass. The part *a* has the female-screw and that at *b* contains a smooth hole adapted to the size of the screw. On looking at the plate it will be perceived that on turning the screw the two jaws of the poppit can be made to slide backwards and forwards and clamp the wedge (fig. 14), which has a notch to hold the piece that is being turned. Fig. 13 shows a front view of the same poppit. Two or three similar poppits may be applied to the length of the piece, as may be required.

After examining the plate the amateur will, perhaps, imagine that this poppit can only be fixed on to the frame by means of a compressing wedge (quoin), and remembering what we said about the inconveniences of this method when used by turners of ordinary work, such as noise and vibration, will be surprised at our proposing its use. But there is another way of fastening the poppit to the frame, less firmly, it is true, than by the wedge, but which will be sufficient as there is no great strain.

Make a key (see figs. 15 and 16), of a size suitable to the hole in which it is to work. It should be about a foot long, with a head at one of its ends. In the middle of the head and on its side a thread is cut for a screw at least an inch long. Above this is placed a ground-plate of strong wood (*a*, fig. 15), of the same shape as the key, and fixed thereon at its narrow end by means of some small nails. The key must then be inserted into the hole of the poppit, and the screw tightened, which pressing against the ground-plate beneath the frame causes the key to descend also. In this way the poppit is fixed without effort or noise.

This method is useful, even with pointed-poppits, if the pieces to be turned are not very large; but much more useful when it is only a question of fixing poppits with wedges.

Care must be taken to leave a sufficient length of wood for the tail-piece of the poppit, beneath the hole, so that it may be able to resist both the strain of the screw and the motion of the jaws, which tend to split the wood.

These chucks may be made in a still more convenient way, as will be seen in figs. 1, 2, 3, Plate XXV., where they are not so long; and where the treadle may be worked without any fear of hurting the knee.

The poppit's tailpiece is not longer than the others. It is fixed on the frame by means of a screw, and as it should not be too much tightened, it will be better to fasten it with a thumbscrew, like that of the bolt of the rest. This plan is infinitely more convenient for this kind of poppit, which has to be frequently removed. But in this case the bolt must be fixed in the poppit itself. For this purpose a hole of one-eighth or one-sixth of an inch in diameter is made in the top of the stem passing quite through it. In the tenon of the poppit make a hole of exactly the thickness of the bolt, place the bolt upon the poppit so as to determine where to make a hole corresponding to that in the stem.

Now drill this hole right through the tenon, of the same thickness as that made in the stem, and even a little wider at the entrance. Put the bolt in position, and note the moment when the holes are exactly opposite each other; then pass through them an iron awl of sufficient size which should taper gradually towards the end so that it may enter more easily.

It is evident that the bolt must only have a thread cut in it in the part projecting beyond the poppit, and that the remainder does not require it.

The nozzle of the poppit is composed of two pieces, one of which is moveable on the other and fits into the groove. As this piece must slide backwards and forwards according as it is tightened or loosened, and in doing so may be displaced, fasten on to the poppit two wooden pins which pass into the holes made in the moveable cheek. This cheek is divided to suit the size of the bolt, and the poppit has a thread cut in it as has been said. In this way the wedge is grasped, as may be seen in fig. 3.

We think that enough has been said about this poppit to make its structure and use understood.

From the way in which these pieces are placed on chucks in the lathe, the facility with which those we have already spoken of, in treating of the centre-lathe, can be made, can now be easily understood. Thus the trough intended to receive the ball of thread upon the winder can be made much more easily on the overhead-lathe. It is only a matter of placing the piece to be turned very firmly on a chuck, especially if there is likely to be any great strain. In this way it can be hollowed out and its outer shape afterwards given. But in this case, as in a great number of others, objects of a long diameter must be finished or at least diminished as much as possible before making the lesser ones too small, especially if the former are the parts by which the piece is attached to the chuck. Thus the basin or trough having a tolerably large diameter compared with the tenon which fits into the cross-piece, if this tenon were cut to its proper size before hollowing out and finishing the exterior of the basin, there would be a risk of failing to turn true.

There are cones in which from the nature of the piece to be turned this precaution cannot be taken. It is then for the ingenuity of the workman to find a remedy. If the piece is rather narrow and slender, small stays may be fixed to the frame, and horse-nails fastened to these, thus enabling them to keep the axis of the piece in its place. It is thus that minute pieces are turned, of which we shall speak hereafter, and which are so much admired by amateurs.

If the method we gave for turning the tray of the winder presented some difficulties when adapted to the lathe with centres, it offers none if the overhead-lathe be used. As there must be a female-screw in the centre of the tray, this may be made to fit the nozzle of the mandrel by using a screw-tap such as we alluded to in speaking of chucks; it can then be at once mounted on the mandrel. It might also be placed upon the brass chuck (fig. 9, Plate XXIII.), and fastened there by three screws let into the wood beneath the tray. The holes of these screws can be concealed by making a groove in the circle which joins them; an operation we have explained in our third

chapter. In this case as in the preceding one, the screw of the stem must be made to correspond to the mandrel's nozzle; to finish the lower surface of the tray, it must be placed upon the lathe. It might also be placed upon a wooden chuck with screw-hooks at the circumference of the tray so as to avoid injury to either surface. We dwell upon these details merely for the sake of giving the amateur an idea of the number of resources which can be applied to different circumstances.

It would be much more convenient to turn large pieces with a continuous movement such as that afforded by the use of a wheel; but it is not yet time to speak of the latter.

As there are some cases in which it is better to use the lathe with centres than that with the overhead-motion, and there is nothing more irksome than to continually take the latter down in order to replace the centres, many amateurs provide themselves with both kinds of lathes. Their not being, however, always room for the two, to say nothing of their expense, the convenience of both lathes is supplied by adding the pointed-chuck, spoken of in the last chapter, to the mandrel's nozzle, and by placing a plate with centres to the right. In this way the amateur has a lathe with centres, without disturbing his lathe with the overhead-motion.

## CHAPTER IV.

## Various Ways of Making Screws of all Kinds.

**T**HERE are generally not more than four or six turns of a thread upon a mandrel, which are far from being sufficient for the infinite number of cases in which finer, coarser or very deep threads are required. When this is the case the turns must be increased in number. The manner in which this may be done, is as follows :—

Cast a hollow tube of brass from two to three inches long, with an external diameter of from four-fifths up to an inch, and from one-fourth to one-third of an inch in thickness, so that its internal diameter is a little less than that of the screw which is placed at the end of the mandrel opposite to the nozzle. It may also be made from a piece of wood soldered at both sides, or even from a solid block pierced on the lathe. This last operation entails loss of time and material into the bargain.

We have not yet spoken of the screw at the end of the mandrel, to the left of the amateur. Formerly its direction was always opposite to that of all the turns of the thread of the mandrel, that is to say, that whereas all screws must be turned from left to right to tighten them, and from right to left to unscrew them, the screw in question requires an opposite movement. Hence it is called a left-handed screw. These kind of screws are very commonly used and possess very great advantages in mechanical and artistic work.

To explain what we have said let us take a very familiar example, the four nuts which retain on their axles the four wheels of a coach, two on the right and two on the left. A little reflection will show that this must be so. When the coach moves, the four wheels turn in the same direction; the two screws on the coachman's right, therefore, turning in the direction of an ordinary screw, and the two on his left in the opposite direction; and as the end of the nave constantly presses against the nut which keeps it in its place, the wheels on the right tend to tighten their nuts and those on the left to unscrew them. It would be possible, then, at the end of some time, for the nuts on the left wheel to leave their place and the wheels to become loose to the great danger of the lives of the persons in the coach. We must fit, therefore, to the left wheel left-handed screws which will tighten the screw closely as the coach moves.

In mechanics it is often essential to move two wheels by the same motor; and if this motor is itself a wheel, a pinion, or a lantern, it is evident that one of the two wheels will turn to the right and the other to the left; and that if to these wheels are attached pressure-screws or washers, one will ascend while the other descends, a movement which is the opposite of that required.

This remark is particularly applicable to the rolling-machine, where it is of the greatest importance that the cylinders, in approaching or receding from each other, should be perfectly parallel while moving, in order that the objects which are being rolled should have exactly the same thickness. It is essential, then, that not only should the two screws which press upon the collars descend or ascend together, but that they should be moved by a cog-wheel locking into the two others, each of which is fixed at the head of one of the screws.

But in order to make these sort of screws it is not necessary that the hinder turns of the thread should be left-handed, since cutter-blocks may be mounted on them, by means of which all sorts of screws can be made, right-handed as well as left-handed. Moreover, one of the threads of the mandrel is often made left-handed.

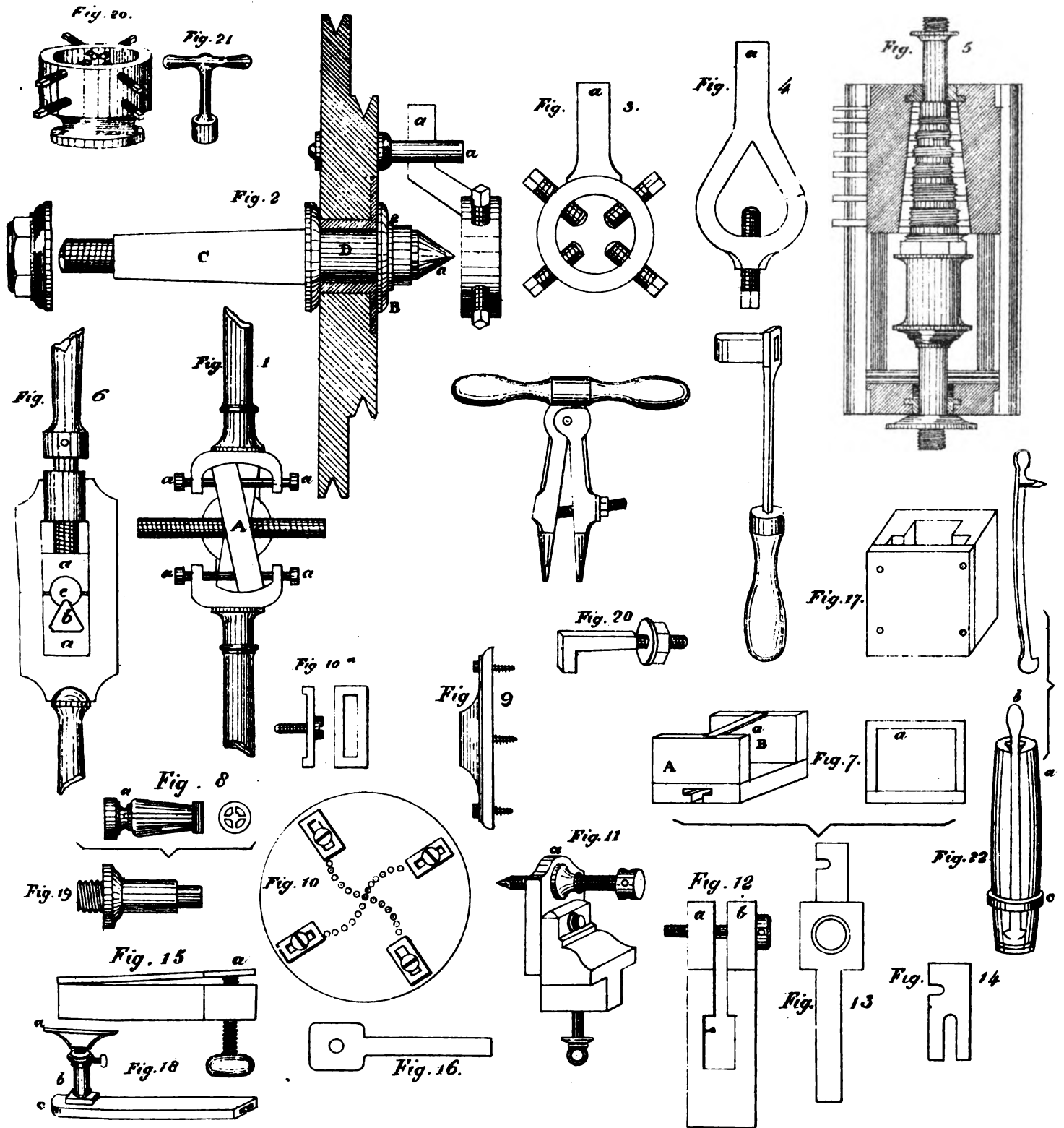
A small poppit must be made to fit almost exactly under the screw to the left of the mandrel fig. 6; it may even be adapted to that of the lathe by means of a few wooden screws (fig. 7.) But the separate poppit is infinitely more convenient and does not injure the lathe.

At the top of this poppit (fig. 6), and in a deep groove a wooden key is fixed, like those of the lathe, by means of a bolt. As the poppit becomes immovable when the key *a* is raised, and it is kept in that position by means of a quoin placed underneath, it is plain that if the screw is left-handed the mandrel must advance and recede in a direction contrary to that of the other screws; but since its first motion is a backward one, instead of advancing as with other screws, and that the base of the nozzle of the mandrel, when the work has been turned round, quite touches the front poppit, it is necessary that it should be made to advance as much as it will recoil before raising the key. As a rule, the key is raised only after the treadle has been lowered, which, in reascending, causes the mandrel to recoil.

Before proceeding to this operation, the interior of the tube must be made perfectly cylindrical by fastening it to a chuck by its exterior. Sufficient thickness should be given it to allow the thread about to be cut in it to fit exactly upon the left-handed screw. To make this female-screw a screwing-comb of convenient size must be used. It must always be one of those which fit the threads of the mandrel. The chuck must be removed from time to time from the lathe to try whether the screw fits exactly; and when it is replaced on the lathe, care must be taken to screw it at exactly its former place; for, however perfect a mandrel may be, however skilled the workman, however round the work, it is difficult to dismount a chuck, and to replace it, without affecting in some way the piece operated on. This arises from the fact that the multiplied efforts of the tool tend to press the chuck against its base much more firmly than can be done by the hand in remounting it. It is well to make a fine mark on the edge of the base with a triangular-file, but deep enough to be visible; and when any piece is being turned, which demands great regularity, make on the chuck right opposite the first mark a second mark, in order to be able, in case the piece be removed from the lathe, to reset it at exactly the same place.

When this brass tube has been perfectly adjusted to the back screw, take it off the chuck and put in its place, and removing the rest to this side of the lathe, turn the tube quite cylindrically upon the mandrel itself. Divide it into as many parts as you wish to have different threads, and at the end of each division make a separating groove; then trace upon a piece of paper the line *a, b*, (fig. 8), equal to the length of the division on which it is proposed to trace the required number of threads, four, five, or six, according as its pitch is to be more or less.

At the extremity *a*, erect the perpendicular *a, b*, and make it equal to the circumference of the tube, that is to say, a little more than three times its diameter; then, from the points *b* and *c*, let fall the perpendicular *c, d, b, d*, thus forming the rectaugular parallelogram *a, c, d, b*. This





parallelogram must contain the circumference of the cylinder exactly. To satisfy himself of the accuracy of the operation, the amateur must trace upon another piece of paper the same parallelogram, cut it very exactly, and fit it round the cylinder. If it wants but the  $\frac{1}{32}$  or  $\frac{1}{64}$  of an inch, he may be satisfied, bearing in mind that the humidity which will be given to the paper in gumming it upon the tube will expand it by about that quantity. Then divide the line  $a, b$ , into as many equal parts as there are turns of the thread. Here we suppose there are five. Divide the line  $c, d$ , similarly, and from the points  $e, c, i, f, r, g, l, h, b, m$ , draw the parallels which are seen in the plate; cut, according to this division, a screwing-tool to terminate the screw; then carefully glue the parallelogram upon the part of the tube where the screw is to be traced, so that the points  $a, c, b, d$ , as well as all the others, may join each other exactly. To prevent the paper from being detached when the gum becomes dry, cut beforehand some cross strokes upon the tube with a bastard-file. The paper having dried, follow, as nearly as possible, with a triangular-file, from the point  $c$  to the point  $e$ , and finish at the point  $b$ , thus producing the screw desired.

Generally, during this operation the paper becomes loose, and the line is difficult to follow; but with a little care the operation may be successfully carried out to the end. Having assured oneself that the cuttings are sufficiently marked, remove the paper, and the thread which has been just traced may be easily followed with the eye. This ought to serve as a guide in the subsequent operations.

Now, placing a somewhat rough triangular-file at the middle of the line  $a, e$ , make a deep cutting, starting from the point  $n$ , so as to form a triangular groove the two upper angles of which follow the lines  $c, e, i, f$ , etc., as far as the end of the screw at the point  $o$ , taking care not to take more from one side than the other and not to incline the file either to the right or to the left. Deepen this cutting until the file touches exactly and along the whole of their length the lines first marked upon the tube; and in order to remove the small roughnesses or hollows which the unsteadiness of the hand may have caused, make the treadle move somewhat faster, and each time that it falls press the file home in order that the inequalities may be removed by the rapid motion.

Apply a comb to make the thread sharp at the end, and having placed a new key in the poppit, the workman will be glad to see the mandrel follow the pitch of the thread. In spite of all the care that may be taken in this operation, it rarely happens that the screw does not show inequalities somewhere. To correct them, take a poppit whose key is placed vertically and press the screw-thread on the side opposite to that at which the tool is applied; by this means the screw-thread is compelled to move between two fixed points, and the comb will remove all the small inequalities without injuring the rest.

It is easy to see that, if, instead of tracing the diagonals in the direction stated above, they had been traced in a contrary direction as from  $a$  to  $f$ , from  $e$  to  $g$ , and so forth, a left-handed screw would have been produced. It will be advisable, therefore, in case of need, to cut upon each tube a left-handed thread, as well as a right-handed one; in this way at the end of a few years of work the laboratory will be provided with a collection of screws, the more valuable because the more complete.

The operation just described is easy only when the screw is large; when the latter is fine, it becomes very difficult and laborious; and as in such a case a triangular-file conceals the thread traced, a slit-file, or a knife-file must be used. By this means the mark will be much better followed.

Trouble and labour have been successfully expended to secure to art the rapid and sure means of making screws of all kinds.



The first machine of the kind made, upon which all successive machines have been modelled, is the machine for cutting fusees, a description of which may be found in Thiout's treatise upon watchmaking, a very curious and instructive work.

This is a cylinder which is mounted upon the machine and turned at the same time that it advances more or less, according as the inclination of the piece moved is greater or less. This inclination can be regulated in a moment at the will of the workman, so that by calculating the number of turns the cylinder makes while advancing through a fixed space, the number of threads there ought to be in this space may be ascertained. Ten and even twelve threads in the sixteenth part of an inch have been in this way chased upon mathematical and other instruments, which require to be minutely divided. If we suppose that the tool which traces the thread is fixed very firmly opposite the cylinder, it ought to cut the screw required.

Let us assume, then, to return to the lathe, that a poppit with an inclined plane, the inclination of which may be according to pleasure, is behind the mandrel (that is to say the left end), that this plane slides perpendicularly into a neatly made groove, and that the motor which causes it to descend is the same as that which makes the mandrel turn, that is to say, the treadle; the mandrel may be advanced more or less, and, consequently, the piece mounted thereon, through a definite number of turns; since it is the inclined plane which moves the mandrel.

We only attempt to give here general notions in order to satisfy those of our readers who can give reins to their imagination, and construct a machine, according to the ideas which the limits we have imposed on ourselves permit us for the moment to point out to them.

To leave our readers nothing to desire, we think it our duty to mention here a very ingenious means of making any kind of screw in an instant. Turn upon the nozzle of the mandrel a cylinder of wood or brass, (fig. 9), and bore a long square hole in it, *a*, which can be closed with a key of the same material, in the form of the quoin at *b*, which is firmly fixed thereto. Take an iron wire, about the thickness of a violin bowstring, and place alongside of this first wire as many iron wires, though much finer, as may be necessary in order to fill the space there must be between the threads of the screw it is desired to make; then, flattening the end of the larger wire to the thickness of the small ones, fix them all by their ends very tightly into the hole by means of the key already mentioned, so as to feel assured that the threads cannot leave their place; bind the wires round the cylinder in the order in which they happen to be; that is to say, between each thick thread there should be the same number of small ones. Fix also the other ends by making them fit exactly into another hole, *c*, so that nothing can possibly put them out of order. The cylinder being thus arranged, mount it upon the nozzle of the mandrel. When the thick thread grips the key, it is clear that the mandrel must move to and fro, according to the inclination given to it, this inclination depending entirely upon the will of the workman, since by varying the number of wires, it may be made greater or less. By looking at fig. 9 sufficient knowledge of this method may be acquired. In case it be desired to make several threads upon a screw in order to give it a greater bite, without altering its solidity, or without increasing its thickness in a manner disproportioned to its length; several thick wires, with the spaces between them filled up with a certain number of small wires, must be wound round the cylinder as in the preceding operation. The poppit and its key are then placed under the cylinder, and the thick wire is made to grip the new key very tightly. Then, shifting the rest behind the lathe, trace upon the tube with a point-tool the screw which the cylinder will produce. It is easy to be seen that it is impossible to use any tool but a point-tool, unless, indeed, a comb is made whose teeth correspond exactly to the distance

between the turns of the thick thread; without this correspondence, one part of the comb destroys what the other produces.

When the screw is once traced upon the tube the cylinder is no longer required, unless it be to make a left-handed thread, which is done by turning the wires in the opposite direction.

We have mentioned this method of making all sorts of screws in order to omit nothing that may be desired and that one ingenious idea may be the means of others more ingenious still.

If it is desired that the key should not grip the wires upon the cylinder for fear of disarranging them, the amateur, after making four or five turns, must only fix the thick wire, but very firmly and tightly, and leave the smaller ones; he must then take a knife-file, and leaning more gently on the wire, follow and complete the cylinder. The screw will soon be traced by this means, and after deepening it with the hand, the tube behind the mandrel must be operated upon as stated above.

The methods hitherto proposed are applicable only to the lathe with the overhead-motion. But there are several ways of making very fine screws of all diameters with the double screw-plate. Artisans, and especially those who have no lathe, content themselves with making threads upon a piece of steel with a suitable file as accurately as they can, after which they add three or four grooves to the screw tap so as to make it cut better. They then temper this tap and make it pass between the untempered screw-dies, each embracing a quarter of the circumference of the cylinder which holds the wires. For this operation they employ the method already explained in making screws with the screw-plate. Whatever pains may be taken in making the threads equal and regular, it is impossible for them to be altogether free from irregularities, whether as regards depth, thickness, or saliency. But these irregularities do not show in the screw-dies, since all the threads pass into all those of the latter. Care need only be taken not to allow the roughnesses of the threads of the screw tap to be too prominent; for these roughnesses, by impressing themselves on the threads of the screw-die might remove too much material, to the injury of the remaining threads, and the screws which these would produce would necessarily have their threads too thick and the hollows too small. Afterwards, one or two grooves must be made upon each screw-die in the same way as those already recommended in the case of the screw-tap. Temper the two screw-dies, then fit into them a screw tap of soft steel, which takes their form exactly, and produces a tolerably regular screw. Finish all the threads with a magnifying glass with a very fine knife file, giving them more depth should they require it. To do this, it is advisable to place the screw tap upon a clockmaker's lathe furnished with a ferule, then by making it move backwards and forwards by means of a drill bow, the same motion will be imparted to the small file.

Lastly temper this screw-tap, as it may be used for making new screw-dies in which the inequalities found in the first set will not then be reproduced. Nothing spoils steel so much as hardening and softening it incessantly. It is for this reason that the practice observed by some workmen of using old English files for making screw-dies, is bad. They imagine that steel used for making files of this sort, being the best, they cannot do better than make it into screw-dies, gravers, and cold chisels. Experience has proved this practice to be vicious, because the steel from which files are made, having been excessively hardened, cannot be softened without greatly altering in quality. However there are a great number of tools that can be made from old files by carefully forging them as we shall hereafter point out.

As we are now describing the way to make screws we may as well describe a very ingenious way of making them in a very short time, left-handed or right-handed as may be required, using the same screw-dies and the same screw-plate. and so producing an identical thread.

Upon the clockmaker's lathe turn a steel cylinder large enough to be made into a screw-tap. It must be made perfectly cylindrical throughout its whole length. Make upon this cylinder, either with a graver, a splitting-file, a knife-file, or, what is better still, a comb, a certain number of circular threads at an equal, but at as great a distance apart as possible, and of the same depth. Temper this screw-tap.

Procure a screw-plate of brass or iron (fig. 1, Plate XXIII.), whose grooves are much larger than the thickness of the screw-dies A, those which we are about to use having no tongue. Take care that the two cheeks of each groove are thick enough for the nuts which are to receive the eight screws we are about to describe. Divide the length of the grooves,  $a, a$ , into two equal parts, and on each of them make two holes in one cheek and two in the opposite one. Cut a thread in these holes and insert bob-tail screws into them. It is by means of these screws that the inclination to be given to the screw-dies with reference to the screw-plate and to each other respectively, is determined and fixed. But as it is not sufficient to keep these screw-dies inclined to each other, and as they ought to move forward in the position assigned to them, insert between the screw and the die small pieces of steel, which, being parallel to each other, will keep the screw-die in place whilst permitting it to slide when the screw is being bored.

Make several pairs of screw-dies which fit exactly into the screw-plate without wobbling, and which, nevertheless, are free to incline themselves more or less as they run over the grooves. Slope them suitably for the screw-tap; then, having placed them in the plate parallel to the plane of the chase, and in a straight line with reference to each other, pass the screw-tap through them, which, however, will only cut circular groovings and not a screw-thread. When the threads have become very deep, carefully temper the screw-dies and the machine will be ready to be employed on the intended work.

Put one of the screw-dies in its place, bring it down just below the joining of the two strips of steel, and incline it downwards at the proper angle, which may be soon learnt by practice and experience; after which, fix it by means of two pressure-screws both on the top and bottom of the second half of the chase. Then fix the second screw-die, and incline it in the opposite direction. Fasten it also underneath by means of the four other screws of the second half of the chase.

If the amateur reflects upon the matter, he will see that the inclination of the screw-dies determines the pitch of the grooves and consequently that of the screw, and that this inclination is right or left according as the screw-dies are inclined to the one side or to the other.

In the example given they produce a left-handed screw; if they are inclined in the opposite direction they produce a right-handed one; but the threads must meet, and this is the only difficulty that remains to be overcome.

The sole precaution to be taken in order that the screw may leave the plate in a neatly finished state, is to try to make the threads join each other perfectly; for if the threads which have been begun to be formed in one of the screw-dies be destroyed by the other, the hollows of the one meeting upon the projections of the other, the result will be confusion.

It will be advisable, therefore, to pass a brass cylinder through the plate in order to ascertain whether one of the screw-dies should be inclined inwards or outwards. It is, also, proper to remark that, supposing the threads not to unite whether they are inclined inwards or outwards, the screws may be neatly made without being identical, since in the one case the screw is shorter and in the other longer; or, to speak more correctly, it will have a double or triple thread. This is evident. The distance between the circular grooves on the screw-dies being determined, the inclination can only be of one thread if the screw is well made. If the inclination is of two

threads, the screw will be double ; if it is of three, it will be triple. Yet it is impossible to be sure that it will be perfect. This method, wonderfully ingenious as it is, is therefore subject to many difficulties which can only be overcome by long practice.

If a right-handed screw is to be made, incline the screw-dies in the contrary direction to that we have just prescribed ; but the workman may always be certain that the screws are perfectly equal, since the same kind of threads will have produced both one and the other.

It is natural to suppose that that which suggested the idea of the method just described is what takes place in a screw-plate where the screw-dies have very fine threads and are not tightly fixed in their grooves. If they should be the least wobbling in consequence of the projecting parts of the threads of one of the screws-dies meeting the hollows of the other, the threads are divided into two parts, and surprise is felt to see issuing from a screw-plate whose threads are well known, threads twice as fine, but which do not advance less quickly into the female-screw made by the screw-tap.

There is a very ingenious way of making either left-handed threads with a right screw-tap, or right handed threads with a left screw-tap. Adjust in a double screw-plate a pair of brass screw dies ( $\alpha$ ,  $\alpha$ , fig. 6, Plate XXIII.), make upon a steel cylinder cut into a screw, or upon a screw-tap three well marked sides, then temper it and replace it in its proper position. In the screw-die of the bottom  $\alpha$ , which is immovable, make a hole  $b$ , of the same shape, and large enough to admit the screw-tap. Then remove the latter from its place and describe part of a circle  $c$  with a semi-circular file as is done upon all screw-dies ; but take care that when the screw-tap is in its place its threads stand out beyond the interior surface of the screw die by the whole of their projection, and even a little further, as the plate shows. This first screw-die must be large enough to contain the hole,  $b$ , and the semi-circle,  $c$ , without diminishing its strength. Place the second screw-die, which also has a part of a circle,  $c$ , corresponding exactly with the first, in such a manner as to embrace two-thirds of the cylinder about to be bored. The screw-tap being tempered, place one of the sides opposite the bottom of the chase. This done the tool is finished. There is nothing more to do but to cut the screw.

Having prepared the steel cylinder for the screw-tap, replace it, adjust the screw of the plate, and bore away. If a left-handed thread is desired, you must turn to the left, slightly elevating the plate during the first turn, so as to gain the thickness of a thread for the purpose of determining the pitch. Reverse the operation to form a right-handed screw. It is easy to perceive that the threads of the screw-tap that has been tempered must impress themselves upon that which has not been tempered ; but, after some reflection, it will be found that this screw-tap would be threaded in a direction opposite to that of the other, that is to say, that if one is left, the other will be right, and conversely ; further it is quite certain that by this method the threads will be exactly the same, and thus you will always have indential left and right threads. It only remains now to complete the screw-tap for use when needed.

As there are a great number of circumstances in which plates of a tolerably large diameter are needed for the lathe to serve as chucks on which to turn circles and frames ; and as the plan proposed for making the female-screw which is to fit upon the nozzle of the mandrel is long and fatiguing, it is infinitely shorter and more simple to use a screw-tap, corresponding to the nozzle of the mandrel (fig. 12, Plate XV.), to make a hole having the diameter of the bottom of the threads with a three pointed centrebit, and to push the screw-tap into it afterwards. By this means you avoid the necessity of mounting it upon a chuck, but you must bore quite

perpendicularly to the plate, so that it may rest evenly on the base of the mandrel. This method has already been pointed out in speaking of the spinning-wheel.

When the diameter of the piece turned is rather large, the retrograde motion of this piece bends the frame and consequently causes a tremor of the lathe which reacts upon the work itself. It is partly to remedy this that these kinds of large plates are turned with the large wheel or with that we shall soon mention. If the frame is not very heavy and solid, as has been several times recommended, it may, in this case only, be strengthened by placing at each end of it two buttresses which lean obliquely against the floor and are there forcibly secured. The facility experienced in turning certain pieces upon the overhead-lathe compared to the lathe with centres, is especially remarkable in turning seats for stools such as we have already referred to. As the three-footed stool ought not to have any mark at the centre, it can be mounted on a chuck of a very small diameter, which is attached to the piece by means of three screws or with glue. As to that which screws up and down, since it is only a circle, it can be turned by mounting it on the nozzle of the mandrel of the overhead-lathe, and by turning it to the other side when the first is finished.

We shall not say any more on this subject. It is impossible not to perceive the advantage of the overhead-lathe, and what has been already said ought to suggest ideas for the infinite number of cases which may present themselves.

When a piece has to be turned throughout its whole length, and also at its two extremities, which can only be done in two operations, the difficulty consists in remounting it on the chuck by the part already finished in such a way that the part presented to the tool shall turn perfectly round and upon the same axis as the first. It is on account of this difficulty that an effort should be made to turn all the pieces which compose a machine at one operation only.

Thus, whatever care may be taken in turning, for example, a wheel perfectly roundly and exactly, if, when it is turned on one side, it is replaced in the chuck in order that the other may be finished, it is difficult to feel assured that the two surfaces are exactly parallel. It seldom turns round and upright on its axis or on the mandrel, although great care may have been taken in boring it perfectly at the centre, and in turning the span and the shoulder which is upon this axis. Seldom, too, can a finished box be replaced on the lathe sufficiently roundly and exactly for the tool to graze it equally in all parts. The same remark applies in the case of a long piece, the two ends of which are to be made perfectly parallel. It is very difficult to succeed in this. This proceeds from the numerous imperfections which are found in lathes that have not been carefully made. It is often owing to the lack of roundness in the collars of the mandrel, often also to the lack of concentricity between the screw-threads and the collars, and almost always to the imperfect manner in which the chucks fit upon the screw at the nozzle of the mandrel. It is worth while reflecting a little upon these matters.

If the nut of the chuck is too loose, it may be tightened by screwing it more on one side than on the other. The sides of the threads always rest against those of the rest; but as they do not fit each other exactly, it is never certain that the chuck is attached by its centre; consequently the work moves to the right and left. To obviate this inconvenience it is necessary that the screw should fit tightly into its nut. This, however, is not easy, seeing that the wood being infinitely porous, changes its diameter perpetually, according to the heat or the cold, the dryness or the humidity; and so you can never feel certain that a chuck will fit exactly upon the lathe. All that can be done is to trace upon the edge of the base a very fine but tolerably deep line to serve as a guide to the chucks when the work begins. Lastly, in addition to all these causes of imper

section, there is a still more important one, viz. the variation of the hand and want of skill on the part of the worker.

In order to have good chucks it is necessary that their screws should be remounted on the lathe at the end of four or six months from the time of their being made, especially if it is summer weather. Almost all their nuts become oval, owing to the wood not drying equally in all its parts. They must, therefore, be made round, an operation which is very difficult and tiresome. If the chuck be supposed to fit tolerably tightly on the lathe, and also that the hole is oval, or that the end which rests on the base is not quite even, however little wood you may take away at the nut, it will become too loose, and you fall into the error just mentioned. The wood, therefore, must be removed only from the narrow part. But as very little, usually, must be taken away, if you are not in the habit of remounting a piece upon the lathe, too much wood will probably be taken away from one side. This is rather remaking the nut than correcting it, and the chuck will be spoiled. The best thing to do is to pass into it a tap whose thread corresponds with that of the nozzle, and of which we have already spoken.

Three or four dozen chucks must be procured, a hole cut in them for the screw, which may be made at another time, but as small as possible. Pierce the chuck in the direction of its length with a spoon-bit of only one-eighth of an inch in diameter, in order that the wood in drying may have a chance of closing upon itself and not crack at the circumference, as generally happens. Keep them for a long time in a place where the sun does not penetrate, and which is neither too dry nor damp. The windows may be gradually opened in moderately dry weather. In a word, allow them to dry slowly, and the fibres of the wood will slowly unite without separating from each other. As much may be said of all kinds of woods. The majority of workmen have methods of their own, in which they have great confidence, but which daily experience belies. Some oil the ends of the pieces, others fasten with very strong glue a piece of paper upon each end. A little reflection upon the physical composition of woods and their textures will show that these proceedings are quite inadequate, and must ever produce an effect different to that intended; for in forcing the water contained in the wood to evaporate by the circumference, you must expect to see chinks and fissures forming. On the contrary, then, we must prevent evaporation escaping this way, and direct it towards the extremities. This may be successfully done by wrapping over the whole circumference and length of the wood parchment or paper stiffened with strong gum.

Woods contain in the first place water of vegetation, and, secondly, water of composition. It is to the quick or slow evaporation of the first that is to be attributed their splitting or not splitting. If then the process of evaporation be so regulated that the fibres have time to unite, there will be no fissures; but if the evaporation is quick and sudden, the contrary effect will take place.

The different shapes of the wood to be dried have, however, something to do with it.

Round pieces are much more liable to crack than pieces already split into two throughout the whole of their length. The reason is simple. A round piece is, as has been said elsewhere, a collection of annular and circular layers. Those at the circumference have a longer way to travel, in order that the circles which they describe should shrink, than those at the centre; and besides, by being exposed to the immediate contact of the air they dry more quickly than those at the centre, and as the latter do not unite and shrink as quickly as the others require, it necessarily follows that they must crack, and the tendency to fissure is greater the further it is from the centre. If, then, wood is kept at first in a moderately cool place, the evaporation will be insensible, each circle will gradually shrink, and there will be no splitting.

As to the pieces split in two, unless they are exposed to very great pressure, they rarely crack, since the two ends of the semi-circles which form each annular layer, have the means of closing together, and in fact do close. It is very easy to become convinced of the truth of what has been said here, if the attention be directed to a log, for example, split in two, the middle of which presents at first a somewhat even and straight surface. At the end of a few days, if it has not split, this surface becomes concave, which proves that the semi-circles have contracted.

As yet we have spoken only of the water of vegetation. That which the chemists call *water of composition* and which in the analysis of woods is easily distinguished from the first, never leaves the wood entirely, though its evaporation does not produce such manifest effects. Thus, however dry a piece of wood may be supposed to be, it always retains a very large portion of its water of composition.

Beams removed from old houses have been split length-ways, and at the end of a few days the surface thus exposed to the air becomes concave; this is caused by the evaporation of the water of vegetation.

It has been stated that a certain method of preventing wood still full of sap from splitting is to throw it into a river, a pond, or better still a dung-pit. It thus loses the greatest part of its water of vegetation, and if during the winter it is taken out, it is supposed, the sap having almost entirely disappeared that there is no longer any danger of its splitting. These particulars, if somewhat minute, will interest those who like to reflect upon the nature of things, and to investigate the causes of the many effects that meet their eyes.

## CHAPTER V.

**Solids and Geometrical Figures.**

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**PART I.**

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## HOW TO TURN A GLOBE.

**B**EFORE treating of rather complex objects, we think it right to give some hints about some which, however simple, present some difficulty, so as to give the amateur practice. Let us then begin with a globe. A globe, which in geometry is termed a sphere, is a solid formed by the revolution of a semi-circle about a straight line, called the axis, and whose centre, situated in the middle of this line, is equally distant from all points of the surface. We advise the amateur to make the globe out of some hard wood, such as box, before doing so in ivory. Turn a cylinder upon the overhead-lathe, having the same diameter as that you intend to give the globe. Finish off its right end exactly at right angles; then, with a point-tool, mark its total length, which must be equal to its diameter, and cut it at right angles. To finish the latter face it will be advisable to fix the piece in an ordinary chuck, or if you like in a split-chuck. Then take a compass and measure the height to see whether it is exactly equal to the diameter of the cylinder. To do this properly you must be perfectly certain that the piece is placed quite round and upright upon the lathe. In the middle of its length make a very fine mark with a point-tool or pencil, which will be of use in the following operation.

Hollow out a chuck so that the cylinder may fit into it crosswise, that is to say, that its length lies in the hollow. But, in doing so, take care that one half of the cylinder projects beyond the chuck, and further that it fits quite accurately. To ascertain this, apply a point-tool to its extremities, and see whether it touches equally. Apply the tool to the mark made by the point-tool or pencil, as aforesaid, and if the cylinder is properly fixed in the chuck, a point only will be made. If, on the other hand, a small eccentric circle is traced about this line, the cylinder is not correctly fixed, and the globe which would result from this operation would not be a sphere, but a spheroid flattened at both its poles.

Then remove very gradually all the angular parts with a sharp cutting chisel until the circle traced in the middle of the cylinder is reached. This is a very delicate operation, as the tool must not be allowed to cut more deeply in one place than in another. This is why we have recom-



mended a very fine mark to be made with a point-tool, or with a pencil. When the piece has been cut away equally in all directions, remove it from the lathe. It will then present the appearance of half of a sphere applied to a plane, the half of a cylinder. Hollow out another chuck so that the half-globe may fit tightly into it, and that the remaining straight part of the cylinder rest evenly upon the face of the chuck prepared for this purpose. In order to make it fit tightly put some glue between the chuck and the other angles. Treat this part in the same way as the other. If the work has been properly done the globe will turn out perfectly round.

It has been said that the cylinder must be placed in the chuck upon its four angles. This is rather a difficult method of making it adhere firmly, seeing that the effort made by the tool in removing these same angles shakes the piece, which may easily fall out, as it is but lightly held. We will state a way of obviating this inconvenience.

The dotted lines in fig. 7 represent the cylinder turned as we have already indicated. The line *a*, lightly traced, is the middle of the cylinder; the lines *b, b*, are the ends cut at right angles, and the lines *c, c*, divide the length of the cylinder into four equal parts. Describe upon the ends or extremities the concentric circles *d*, at the same distance from the angles as the lines *c, c*. Remove all the wood contained between the lines *c* and *d*; and after these angles have been removed, the piece will present the appearance of two truncated cones, resting on the ends of a cylinder. The points of contact between the piece and the chuck are thereby doubled, and it is also easier to turn in consequence of the disappearance of the angles, which cause great jerks and often splinters. All through this operation we advise the amateur to always work from the centre towards the extremities.

In this way the wood will be cut more evenly and there will be no fear of injuring it.

Whatever care may be taken in the operations just described it must not be supposed that it is easy to produce a perfectly round globe.

It is rare, if not impossible, to attain this perfection; for it is particularly here that the want of evenness in the mandrel, unsteadiness of hand, and inaccuracy in the chuck make themselves felt. For, reasoning mathematically, nothing should prevent the globe from being perfectly round; but, practically, the slightest error produces considerable defects. If you wish to ascertain whether the form of the globe has more or less of irregularity, it will be sufficient to remount it upon the lathe, in a chuck specially shaped in such a way that half of the globe is gripped in a direction opposite to that in which it was worked. The tool will then remove all the parts which are not perfectly round.

A surer way is to make with a small piece of wood or of brass, a lunette or gauge, the spring of which shall have the same diameter as that of the sphere. Pass the globe through it in all directions; it ought to fit without meeting with any resistance, but quite closely.

This regularity is of the greatest importance in the case of billiard-balls, which ought to be as perfectly round as possible; if they are not the results which may justly be expected from the impact of the balls and the laws of motion will be continually modified. The ball when set in motion strikes one or more which are at rest in a certain direction, depending on the place where the first ball is struck. If the latter's shape is regular, it ought to keep this motion and communicate a part of it to the ball at rest, in proportion to its size and form; if, on the other hand, one or several of these balls have any irregularities, the impact and displacement will vary with these irregularities. Thus it may be seen how important it is to take every precaution to do the work well. Despite the rules just laid down, and though it may appear that by carrying them into practice you ought to succeed perfectly in turning a ball, it will be found that considerable experience in making them is necessary in order to insure perfect success.

Ivory is a substance so dense that it would seem that a billiard-ball once well made, can never contract any irregularities. Still a little reflection will explain how, some time after they have been bought, they become sensibly oval, or at all events not quite round. The tooth of the elephant is a collection of longitudinal fibres closely resembling those of wood. When, therefore, a ball is made, some of these fibres, which before were enclosed, are exposed to the air, which causes them to dry. This drying can only take place in the direction of the tooth's thickness, and very slightly in that of its length.

If the thickness of the substance is diminished, and the fibres drawn closer, the form of the ball must be sensibly changed. There is no other remedy, then, but to replace it upon the lathe, but this operation must be done by a well-trained hand.

A short time ago a compound-tool was invented, by means of which globes of all sizes could be made with the greatest regularity. We shall give a description of it in our second volume.

But before passing to any other subject we think our readers will be pleased if we give a description of a tool which is used to repair billiard cues when their small end is blunted by use. This tool, (fig. 22, Plate XXIII.), is composed of a cylinder of box or of any other kind of hard wood, *a*, six inches long and seven-eighths of an inch in diameter, having a round hole of from seven-sixteenths to half of an inch in diameter pierced through the whole of its length. Upon the length of the cylinder a groove is made to receive a steel rod, *b*, made into a spring, which is fixed at the bottom by means of a strong brass verrel, *c*, about a quarter of an inch long.

Towards the other end of the rod a cutter is made flush with the upper end of the cylinder. Placed at the top of the rod is a flange, by means of which the spring is opened. At the edge of the cylinder, opposite to the cutter, is a screw, the use of which is to determine the quantity of wood to be removed from the cue.

When it is wished to use this tool, introduce the lower end of the cue into the cylinder, press it against the cutter, and make it turn three or four times to the right or to the left. This will repair the end.

If the cue has been very much injured, the spring must be opened so that the cutter can begin working at the circumference. If necessary, the head of the screw may be elevated, thereby increasing the length of the part of the cue submitted to the action of the cutter.

## PART II.

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### ON CONES AND THEIR FIVE SECTIONS.

**W**E believe we cannot suggest to an amateur a more agreeable exercise on the lathe than that of making figures suitable for the ornamentation of the cabinet of a savant, whilst he, at the same time acquires skill in doing his work well. We shall taken then, as an example, the five conic sections, explaining first what they mean.

Geometry teaches us that a perfect cone (fig. 45), can only be cut in five ways. First, if it be cut in a direction parallel to the base, the section or cutting produces a circle,  $a$ ; if obliquely to the base (fig. 46), an ellipse,  $a$ ; if perpendicular to the base and through the vertex of the cone (fig. 47), a triangle,  $a$ ; if perpendicular to the base and through the side of the cone, as in fig. 48, a hyperbola,  $a$ ; or, lastly, if parallel to the side, as in fig. 49, a parabola. This will be interesting only to those who have some smattering of mathematics, others will only see in it a source of amusement.

It is advisable to make all these pieces of close, hard, and finely grained wood, such as pear-tree, sorb, whitethorn, or boxwood. To turn six cones perfectly equal in height and base, proceed in the following manner.

Let us suppose you wish them to be six inches in height. Take a piece of wood of seven or eight inches in length, glue it firmly on to a chuck, and make it into a cone, such as that represented in fig. 45. Use a good rule to see that its sides are perfectly even, and make its vertex very pointed. Polish it with care, cut its base to the height determined upon, and take care that this base has the right diameter.

To ensure greater regularity in the height and base of this cone, it is convenient to begin by turning it into a cylinder, or, at all events, to give it near the base the diameter the cylinder it ought to have. By this means, in case an error should be made in turning the piece, the base may be moved a little further back without injuring the form of the cone; whereas, if you begin by making a cone which should turn out to be defective, the base being already determined, the piece cannot be moved back without injuring the height of the cone or the diameter of the base. Finally, and this is an equally important reason, it is difficult to describe a diameter on a gradually decreasing surface. This first cone is the type of the five others, or, to speak more correctly, it serves to show the nature, form, and perimeter of a similar solid.

The first section gives a circle. To make this figure a piece of wood is taken of a length the equal to the height intended to be given to it, not including the part which is to be fixed in the chuck. Mount it on the lathe and turn it cylindrically towards the part intended for the base. Diminish its height gradually, until it is equal to the given diameter, and measure it upon the

cone already made. Shape the end with a rule very carefully, and polish it, since this is the part which will meet the eye. Take a pencil and describe very faintly a circle with a diameter less than that the piece will have when it is completed. Remove it from the lathe, and in the circle drill three holes at unequal distances with a gimlet of about the thirty-second of an inch in diameter to a depth of from three-sixteenths to a quarter of an inch. We say at unequal distances, so as to prevent any danger of inserting the bolt-pins, of which we shall speak, in the wrong holes; since, no matter what care may be taken, it is not possible that two pieces united by three bolts, should be sufficiently accurately fitted to enter all the holes alike. But the inequality must not be great. It is sufficient that there should be one direction in which the pieces should easily join, viz, that in which they have been terminated.

Then take some hard brass-wire, that is to say, wire that has been passed several times through a screw-plate, which will have reduced it to the thickness desired, and at the same time tempered it more or less according as it has been passed through a greater or less number of holes without having been softened. It is from this wire that bolts are generally made, on account of its hardness, and this is, therefore, why we shall use it in what we have to do.

Then cut a piece of this wire about two inches in length, and even more if necessary, so that the three small bolts may all be taken from the same piece, one at the end of the other. Bore out to a depth of a quarter of an inch, by means of a very fine screw-plate, and as the brass wire should have been chosen somewhat thicker than the holes that have been made, it ought to fit tightly into the wood, forming its own female-screw. When it fits well, remove it. Insert it into the end of a small rod in which a hole has been made, and cut it to such a length that when put in to its place, it overtops the surface by about a quarter of an inch. Lastly, slightly point the end that has not been bored out, and seizing it with a pair of nippers, place it in its proper place, taking care not to injure the part clutched, so as not to mar the operation which is to follow.

Place two similar points in the two other holes, then, having prepared the end of a piece of wood of almost the same diameter as the top of the cone which has just been made, apply it to the three points, pressing it tolerably firmly, so that the points may leave a mark upon the surface. Then take a gimlet finer than the points, and make a hole at each of these marks. See if the two surfaces placed one over the other join closely, and if they do, remove the piece from the top of the chuck and fix it upon the truncated-cone, to which it ought to serve as a vertex, with a little glue.

As this apex keeps its place by means only of the three points already mentioned, it is evident that great precautions must be taken in order to finish it without moving it. The amateur ought to have began by giving it upon its chuck as nearly as possible the same form it will eventually have, and by cutting it to a rather greater length than is required. Replace it, and fit it so that the join may appear as little as possible. For this purpose the surface of the joining should have been prepared with the greatest care, and its parts have been placed one over the other before the points were inserted in it.

When these two pieces are joined, turn them as if they were only one piece, proceeding as gently as possible, and removing very little of the wood at a time. If you have any fear that you may not be able to finish them in this manner, take a point-tool and mark a centre at the end, and apply the pointed poppit to it as before. Then finish the whole of the cone, leaving only a small end to hold the point, and when the piece has been entirely polished, remove the point and finish the end.

The whole, even the point, could have been finished, and a wedge of hard wood, in which a hole has been punched sharper than the cone, so that the apex of the point may not touch the base, placed upon the poppit, and the entire piece thus polished. This is the most convenient and surest way of giving the cone the precise height it ought to have, and of making its sides perfectly even. But in turning it, take care lest the end does not get heated from the friction, and so acquire a change of colour, or a round mark, which would have a very bad effect.

To point out all the methods which may be adopted in this and similar cases we shall state the way in which the point may be finished, if it does not adhere to its base firmly, and in the case in which a little button has been reserved at the end to receive the point of the poppit.

Take a split chuck hollowed out to fit the diameter of the base of the small cone, and make in it very carefully a groove, in which the angle of the base may rest. Put it in its place and tighten the piece with a ring. In this condition the piece may be easily finished, having first taken care to see that it is perfectly round.

It is unnecessary to observe that the little button reserved at the end ought not to be included in the total height of the cone; if it were, the hole made by the point might be observed and the piece could not be made perfectly pointed.

Too much accuracy cannot be bestowed upon the making of these pieces. Their merit depends upon their perfection; if they are not thoroughly well made they deserve no attention.

The second section, represented in fig. 46, must be made in the same manner. But as the section which produces an ellipse is oblique to the axis of the cone, it cannot be turned upon the lathe without performing an infinite number of useless operations. When, therefore, the cone has been made, fix its end into a vice, and, with a finely sharpened saw, cut it to the required obliquity; for the principle laid down by geometricians, that an oblique section produces an ellipse, is not restricted to a single obliquity. The greater it is, the more elongated will be the oval, and the nearer it comes to being parallel to the base, the rounder it will be.

Having cut it in this way with a saw, smooth the surface with a plane or a very straight file. To make it smooth and level use a good ruler, and apply it in all directions. Then glue a square piece of very fine polishing paper on to a well prepared board, pass the planed surface over this paper, taking care that the hand does not vary lest a convex surface should be produced. Prepare, upon another chuck, a piece of the same wood to serve as an apex to the cone; reduce it approximately to a suitable size. Cut the base to the same obliquity, and prepare its surface by the same means, so that it may fit exactly upon the other piece. Fasten it as before, upon three points, and finish in the same way. These points must not be made perpendicular to the surface from which they project. They should be perpendicular to the base of the cone. without this precaution the two pieces would fly asunder at the first turning of the lathe.

The obliquity of the base of the cone prevents its point from being finished in the manner we recommended in the case of the first section. It must be fixed upon three points, and then finished. But lest it should detach itself, put a little thin but strong glue at two or three places on the surface of one of the two pieces, so that they may unite more firmly. When the glue is dry, finish upon the lathe.

The third cone, shown in fig. 47, a section of which perpendicular to the base is a triangle, is the easiest of all the sections to make. All that is required is to take two pieces of the same wood, with a diameter a trifle greater than required, and of sufficient height, and to dress them perfectly with a smoothing-plane. When the two surfaces fit each other exactly, add three points, as before explained, and glue them in two or three places.

When the glue is quite dry, take a file and make a mark on their extremities, so as to allow of a point being fixed upon each of the joinings. These points will serve as centres whereby to fasten the piece on the lathe, on which its surface must be smoothed, the greatest care being taken with the face it is intended to place in the chuck.

Place the piece on the chuck, making sure that the face dressed on the centre-lathe quite touches the bottom evenly. Turn it as if it were one piece, polish, and finish it exactly as was done in making the first cone. This done, insert the blade of a small knife which cuts sharply into the jointure, taking care not to injure either of the surfaces. They will soon separate. There is nothing more to be done but to remove the bits of glue that may stick to either part by scraping them away with a sharp knife.

The fourth section is quite as easy to make; but as it (see fig. 48), is perpendicular to its base, and you cannot be sure that it will be equally so when on the lathe, you must employ the following method of making it.

First turn a cylinder having the same diameter as the base, or even a rather larger one, dress it perfectly, then cut both ends as near as possible at right angles, making it an inch or two larger than is necessary. Mark the centre at the end opposite to the chuck, and place it in another chuck which is very round and even. This may be ascertained by pressing a pencil against the cylinder while turning, and observing whether it touches all parts equally. Mark a centre on it also. Having removed the piece from the lathe, cut off with a saw a trifle less than one-third of the diameter, secure it in a vice, and dress the surface with a plane, rasp, or a fine file, until it is quite trimmed and perfectly square with its base. Then apply to it, as exactly as possible, using the means and precautions formerly alluded to, a piece of the same wood, of the same length as the cylinder; place it upon the lathe by means of the two marked-centres, and turn the piece that has been added to the thickness of the remainder. Replace this cylinder in a round and even chuck, in which a hole has been made of about one eighth of an inch in depth. If the piece is correct it will turn perfectly upon its centre.

There is nothing more to be done but to turn it as in the preceding case, and with the same precautions. When it is finished and cut to the required height, separate the added piece, and you will have the figure desired. There only remains now the fifth section. This is the most difficult of all to make. As the section must be parallel to the side of the cone, and as this side can only be determined when the cone has been made, the following method is adopted. Take a piece of wood of two or three inches longer than is required, and shape the outer end upon the lathe. Give the base a diameter larger by one sixteenths of an inch than that which it is to have, leaving the excess against the chuck. Mark with a point-tool the precise place where it is to be cut, that is to say, its total height. Beginning operations from this line, give the piece the form of a truncated-cone, whose apex presents a circle of one sixteenths of an inch in diameter. Remove the piece with its chuck from the lathe, and place the whole on a vice, so that the chuck may be tightly gripped. At a point little lower than the base, and close to the chuck, cut with a saw to the depth to be given to the section. This may be of any depth, according to the nature of the case. Then resetting it in the vice in such a position that the side opposite to that on which the section is to be made is perpendicular, remove from the cone by means of a saw the portion intended to be cut off, directing the movement of the instrument in a direction as parallel as possible to that of the side until it reaches the mark of the saw, when the piece will drop off of itself. Finish dressing the surface with files, using a compass to see whether it is parallel, and a correct rule to ascertain whether it is even in all directions. Being assured of this, cut a piece of the same wood to almost

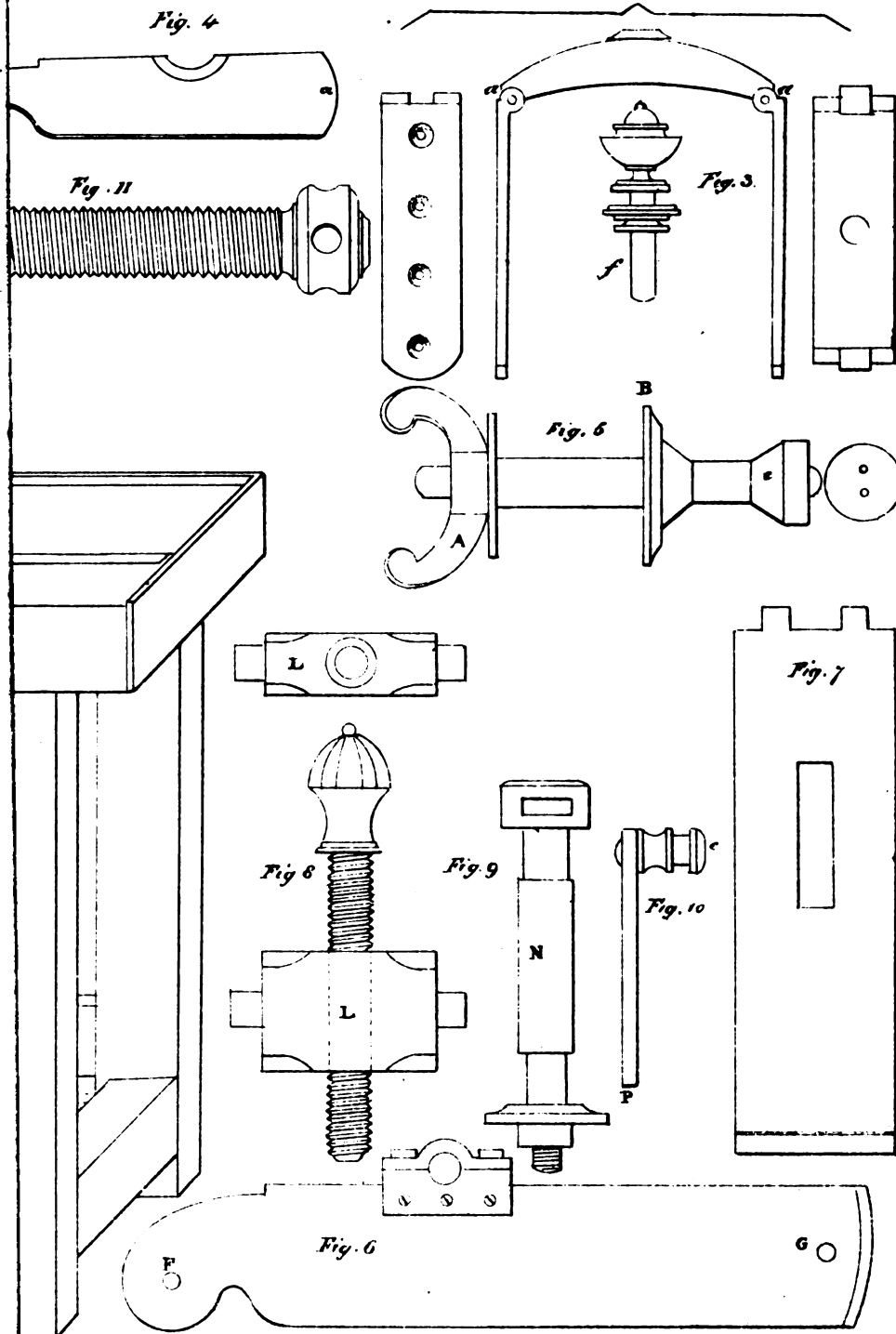
the same obliquity, regard being paid to the fibres of the wood which the perpendicular cutting reveals in the cone, so that, when put in its place, no sensible difference shall be seen in the direction of the fibres. Dress this surface evenly until it fits exactly upon the other; add three points, and glue as before. Replace it on the lathe, and finish by removing a little of the wood at a time with a gouge, so as not to injure the piece. When the surface previously made has been reached, give the cone the required form, polish it, and cut it at the mark already made.

Thus the cones are finished. But it ought to have been remarked in all the descriptions given above, that we have supposed them to be cut on the lathe on their core, which is attached to the chuck. However practised you may be, you must not flatter yourself that you can make such a cutting perfectly correctly. The bottom of these bases, therefore, must be finished, so as to leave nothing imperfect.

Glue upon an oak board, that has been well prepared with a smoothing-plane, a square piece of rough polishing paper; rest the bases of the cones upon it, and turning them with the fingers so that there may not be more friction in one place than another, rub them against it. When they have been rubbed equally all over, pass them over a finer paper in the same way, and finally over an extremely fine paper, this will finish the polishing of their surfaces. During these latter operations, the dust must be shaken off from time to time, lest by remaining on the paper it hinder a proper degree of friction.

Polishing paper can also be applied to the surface of a soft wooden grindstone, about six inches in diameter, and the cones polished by presenting them to the latter which is set in motion by the lathe.

As these six pieces are intended to decorate a cabinet or a library, it is advisable to place them all upon pedestals or carefully turned cylinders; make then upon the lathe as many plates as there are cones, having a diameter of from one quarter to five-sixteenths of an inch greater than that of the bases. Hollow them out a little, so that the pieces may not slip, and may fit into them easily. Make any mouldings you fancy on the outside, and polish the under surface; you have now given them all the beauty of which they are capable.







### PART III.

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#### DEMONSTRATION OF THE SQUARE AND OF THE CUBE OF A BINOMIAL.

**T**HOSE who know mathematics can, by following the principles we have laid down, make for themselves all sorts of geometrical pieces, such as solids of every description, pyramids right and inclined, the inclined cone, the composition of the pyramidal parallelpiped; in short all the geometrical demonstrations, such as that of the square of the hypotenuse, the measurement of the angles in a circle, etc. To these may be added the elements of the calculus, such as the formation of the square and the cube of the binomial. All these figures by speaking to the eye, bring to the mind a conviction of the certainty of mathematical truths; but there are a great number of pieces which cannot be made upon the lathe, and which can only be made by means of a plane or file. We shall content ourselves with stating the way in which the demonstration of the square and the cube of a binomial may be made. A square is the number resulting from the multiplication of another number by itself. Thus, 4 multiplied by 4, gives 16, which is the square of 4. This is how this mathematical truth is demonstrated to the eye. A mathematical point, metaphysically considered, has no magnitude, any more than a line has breadth or thickness. But our senses cannot grasp this proposition. We must then consider the point as occupying space and the line as having some thickness. A point may be supposed to cover a certain part of a line in all directions. Speaking from this we may proceed to the supposition that it covers three or four such spaces. Let us adopt this last hypothesis, as the demonstration we are about to use lends itself readily to it.

Four points placed one after another may represent four unities. If these four points or four unities are multiplied by themselves, the same result is produced as if we added them together or took them as many times as there are unities in the number 4. Thus, four points multiplied by four points must give sixteen points. So much by way of reasoning. Let us satisfy the eye.

We may magnify our point so as to make it measure three lines each way. Not to depart from probability, let us suppose the point to be very fine. When viewed through a microscope, it is many times multiplied. It may then appear to measure three lines each way. Let us put away the microscope and suppose the point to really cover each way four lines.

Four points placed after each other (fig. 17), represent the quantity four. They are four

small squares. If they are multiplied together, that is, if they are added together as many times as there are units in the number four, a square figure will be formed composed of four squares repeated four times, or sixteen squares. Four, therefore, multiplied by four gives sixteen; and similarly any quantity multiplied by itself gives a square.

Take a small piece of wood about three-sixteenths of an inch thick (here the thickness is considered only as being a necessary attribute of matter). Make it three-sixteenths of an inch broad, and four times these dimensions in length. Divide it into four equal parts by marks. Make four similar pieces, place them one by the side of the other, that is, you multiply four by four. If the hand has done its work properly, a perfectly square piece of wood will be the result. It follows clearly from this that a square is the product of one side multiplied by the other. If we suppose a quantity to be made up of two terms, or which is the same thing, of two quantities, called a binomial, we must demonstrate to the eye by the same method what is the product of this quantity multiplied by itself, or, in other words, its square. Suppose, then, that six and four are to be multiplied by six and four; six is what arithmeticians call the first term, and four is the second. Let us suppose six to be composed of six small squares, whose sides are one eighth or one quarter of an inch, according to the fancy of the amateur. Make a square having six small squares for one of its sides, and six times this quantity in following rows.

Instead, however, of proceeding as in the former case, which would uselessly increase the number of pieces, make a square as represented in fig. 18, having six squares on each side. This will give thirty-six squares. Then multiply six by four. This gives the parallelogram (fig. 19) Repeat this last operation, thus obtaining a second parallelogram of an equal number. Square four as in fig. 17. Put all these figures together, as may be seen in fig. 21, and the result will be the large square represented in this last figure. Whence it follows (1), that a square is the product of a number into itself or into a number equal to it; (2), that the square of a binomial is composed of the square of the first term, fig. 18, the square of the second, and twice the product of the first and second, figs. 19 and 20. Mathematicians prove this to the mind; the diagram proves it to the eye.

To be assured of the accuracy of this operation, add the different partial products together and the result will be the total product, 100, which is evidently the square of 10, and 10 is equal in value to the sum of the two numbers of the binomial, 6 and 4.

It is not sufficient to have produced a square, we have still to prove that one quantity multiplied by itself twice in succession produces a cube. The first part of the operation is already done in our first example, since we have multiplied 4 by 4 and produced a square. We have now only to multiply it a second time. Following the principle we have laid down, this operation consists only in multiplying one square as many times as there are units in the number 4, that is four times. But if we have allowed space to the point, we may allow thickness to our square, since however fine the material of which it is made, it has always some thickness. Let us then give it the same thickness as our units have length, for space has three dimensions. If, then, four squares are placed one upon the other, as in fig. 17, the result will be a perfect cube, thus demonstrating the proposition.

Having already squared the binomial, we have now to cube it. Without entering into the details of the operation, it suffices to say that you cube the first term, cube the second, multiply three times the square of the first by the second, and three times the square of the second by the first. Construct, mechanically, a cube which shall have its length, height, and width, divided into four equal parts, and also another divided in the same way into six equal parts. Then make two

parallelepipeds, the surface of each of which contains 108 equal parts, which is three times the square of six, and whose height shall have four such parts. The surface of the other will contain 48 equal parts, that is, three times the square of 4 and its height will contain 6. Collect all these pieces together and the result will be the exact cube of the binomial. The total formed by adding the partial products together will be 1000, which is the cube of 10, or of 6 and 4.

Nothing is so laborious to make as a geometrical figure ; without mathematical accuracy they have absolutely no value. All the surfaces must be dressed upon polishing paper, glued, as we have already stated, upon a board or wooden grindstone. There is no better way to dress surfaces. Join all the parts by means of fine brass points, as before directed, and mark out by means of lines drawn over all their dimensions the primary elements of the figure, that is to say, small squares perfectly equal, whose sides shall be three sixteenths of an inch, or more or less, according as the figure is desired to be greater or smaller.

## CHAPTER IV.

## Regular Polyhedrons.

WE do not consider it our duty to give instructions for all the kinds of geometrical pieces which an amateur might make. We are not at all sure that these details would be a source of pleasure to the greater number of our readers. But for the benefit of those who would like to ornament their cabinets while they are exercising themselves on the lathe, we shall proceed to point out the method of making various polyhedrons.

A polyhedron is a solid figure which has many sides, as in geometry a polygon is a figure having many angles. It is not our intention in this volume to furnish any mathematical demonstrations, as we suppose our readers to have some, if only an elementary knowledge of them.

In all mathematical works will be found an explanation of the different polyhedrons, such as hexahedrons, octohedrons, dodecahedrons, etc. They can be made in cardboard, and their shapes are represented in figs. 9, 11, 13, 15, and 17, Plate XIX., Vol. II. As each face of these polyhedrons is inscribed in a circle, their centre can be determined. If, therefore, it is wished to make a polyhedron on the lathe, it will be well to prepare in cardboard the faces which compose it and to join them together with some gum. Each of the angles of this polyhedron ought to terminate on the surface of a sphere. It will not be difficult, therefore, to determine, after their centres have been marked, the respective positions they ought occupy on a globe.

Let us begin by making a globe of hard wood. Trace thereon all the circles through which the centres ought to pass, and mark them. We take for granted that, in doing this, the amateur has some knowledge of geometry, and that he has also some skill with his hands.

Turn at first a globe of two inches in diameter, or thereabouts, and mark, by geometrical methods, upon it the points which are to be the centres of the circles in which the polygons will be inscribed which are to form the sides of the polyhedron. Then make a chuck hollowed out to suit the diameter of the globe in the following manner.

Take a piece of hawthorn, which should be dry, sound, and, as far as possible, free from knots, at any rate in the front part. If the globe is to have a diameter of two inches, take a piece of wood with a diameter of about three inches. Make upon the least perfect part of it a nut fitting easily, but accurately on the nozzle of the mandrel. We say accurately, because in works of this nature, as well as in all those which require much precision, if the chucks move about upon the nozzle of the mandrel, you can never be sure of holding it firmly by the centre. It is even advisable to fasten the chuck against the base, so that the motion of the tool cannot force it to enter

further. To secure this, make upon the side of the base a slight mark with a triangular file. When the chuck has been well secured, make another slight mark upon it with a pencil or chisel, coinciding exactly with that which has been made upon the base. By this means, if, as often happens, you are obliged to remove the chuck, you will still be able to replace it at the same point by tracing two strokes one across the other. In order to be able to remove it easily, pour a drop of oil into the nut.

The chuck being thus mounted upon the lathe, round it off throughout the whole of its length, and dress its front face with a point-tool. Drill a hole of less than an inch in depth in the globe with a spoon-bit of about a quarter of an inch in diameter, enlarge it gradually with larger spoon-bits, and finally by means of a hook (Plate XIX., fig. 1, Vol. II.) give the hole a hollow hemispherical shape. To guide yourself in this operation make a guage in the following manner:—

Mount on the lathe a small piece of board of one-eighth of an inch, or thereabouts, in thickness, and two inches and a-half, or nearly so, square, and glue it on to a chuck of not more than one and one-eighth of an inch in diameter. To succeed in fixing it more easily on the centre, take care to trace a circle with a diameter of rather more than two inches, and mark its centre clearly. It is by means of this central point that you will be able to judge whether the piece turns round. With a little dexterity, and before the glue has hardened, you may push it in any direction indicated as necessary by the position of the central point. Cut a circle of a diameter of about two inches in the wood. When the circle is detached, smooth its edge with the side of a gouge, as we have said elsewhere, and measure it continually with a compass until the dimensions of the globe suit it with tolerable accuracy; next thin the two faces of the wood a distance of about three-eighths of an inch from its edge. This is why we recommended a chuck with a smaller diameter to be used. Reduce the thickness towards the circumference to one thirty-second of an inch, in order that it may measure more exactly. If this is not done, the thickness, inasmuch as it has two angles far apart from each other, might not allow you to properly ascertain the diameter of a spherical surface.

Replace the chuck upon the lathe, and give it a perfectly spherical shape, by means of half-round tools, constantly measuring it with a wooden guage. As the part hollowed out ought not to have a greater depth than a radius of the globe, trace upon the wood a diameter, that is to say, a straight line passing through the centre; and as the two ends of this line must terminate against the foremost surface of the chuck, they will regulate the depth intended to be given.

If greater regularity be desired, in this case or in any other, the guage might be made of properly prepared brass. This is done in other arts where mathematical precision is required—for instance in making spectacle lenses; whatever kind of guage is used, in order that the globe may keep in the chuck, the sides must be a little less cut away than they would be if their diameter was exactly double the depth of the chuck. But as in that case the gauge could not enter, it must be made smaller than the measure indicates; for this purpose it is sufficient if care be taken to make it fit a little less tightly than the globe in the opening of the compass.

It is useless to give the chuck more depth than is necessary; the shorter the chuck is, the less liable is the piece which is being turned to vibrate under the pressure of the tool. Thus one inch for the part hollowed out, one inch or thereabouts for the nut which is mounted on the nozzle of the mandrel, and five-sixteenths or three-eighths of an inch between the two, in all about one and seven-eighths of an inch, are quite sufficient. Diminish the hinder part of the chuck in order to approximate it to the diameter of the base, and to be able to trace a guide line upon it.

When the globe is once placed in the chuck and fits it somewhat tightly, it is often difficult to remove it. The safest way of doing so without injuring anything is to drill at the bottom of the

chuck a hole communicating with the nut. By this means the globe may be pushed from behind by means of a wooden cylinder, between the end of which and the globe a small piece of cloth may be inserted so that the impact may not cause any damage; or the side of the chuck may be slightly struck.

In this state, if the chuck is carefully made and the amateur is practised in turning very round, he may proceed to make the piece he intends. The globe should have sufficient hold on it. As the central point of the face we are about to make should be marked on the globe, as well as the circle in which the polygon is inscribed, it is very easy to place this point at the centre of rotation. If it should not be quite at this centre, a slight touch with a small wooden mallet will drive the central point to the side where it ought to be. Then take a chisel and cut a plane surface, resembling in its dimensions the side of the card-board figure which is before you. Make in the same way all the surfaces of the polyhedron, and go on increasing them, one after the other, until they are perfectly equal and their angles very sharp. The polyhedron will then soon be completed. We will not dwell upon the details necessary for making this figure. A little geometry and dexterity, and still more a little patience, will suffice to perfect it. But as it is difficult to make each side, at the first trial, the size it ought to be, it is advisable to remove rather less than more wood, so as to go over it several times, and each time to mark slightly the centre of each side, so as to be able to remount it on the lathe should there be need. Polish each face, and then with a compass assure yourself that they are all equal to each other.

It is right to remark that the angles of each of the faces of the polyhedrons ought to be points taken on the surface of the globe; or else the faces will not be equal and the figure will not be inscribed in a sphere. It is to insure its having this important requisite that we recommend each surface to be finished very gradually. Independently of the fact that the globe is at the centre of the chuck and must, for that reason, turn round, and that each surface, consequently, must be equally inclined to all those near it, it will be well to make with a small brass plate a sort of gauge, and to measure accurately from time to time the angle which the surfaces ought to make with each other, to see if they are actually correct. This method, however, entails this inconvenience: the piece must be removed from the lathe and the chuck each time that the gauge is used.

When an inclined pyramid or cone is required to be made, you must not imagine that it is sufficient to make either figure and then cut its base obliquely. We have already seen that the result of this oblique section is to produce an ellipse, if it is made upon a cone; a trapezium if upon a pyramid.

To make the inclined cone (fig. 50), a cylinder must be turned whose height shall be equal to that it is intended to give to the cone, and whose diameter shall be equal to the base. One of the ends of this cylinder will form the base of the cone, and the point for the apex will be determined upon the other. From this point begin making some small facets and work towards the base. You may diminish these facets afterwards by multiplying them until the whole figure becomes round. The overhead-lathe cannot produce this figure. As to the pyramid, it is easy to perceive that it can only be made upon a cone, and that as many faces can be given to it afterwards as may be thought proper.

We shall not dwell any further upon figures and solids, as we intend to return to the subject in the second volume, in which we propose to insert a paper which has been communicated to us by a clever amateur, and the perusal of which will greatly interest persons versed in mathematics who desire to give great accuracy to the manufacture of these pieces.

## CHAPTER VI.

## Games.

## PART I.

## HOW TO MAKE DRAUGHTSMEN AND CHESSMEN.

**A**MATEURS who know how to play at draughts or chess are generally anxious to themselves make the pieces used in these games.

A set of draughtsmen, fifteen white and fifteen black, are generally made of ivory and ebony. Ivory ones are rather expensive if they are of a superior quality, as a perfect piece of ivory has to be selected, and a quarter of an inch of its diameter to be then sacrificed in order to make the men out of the sounder core.

These draughtsmen can be made singly, or several together, according to the length and evenness of the tusk.

If they are made singly, as many circular pieces must be carefully sawn out as there are to be men; and in order to economise the material they must be glued on to a chuck, not placed in one. The upper face must be carefully prepared, cutting away as little ivory as possible. A gauge may be made with a piece of brass, which will serve as a guide for the diameter of each, so as to keep them all exactly equal. As draught-boards vary in size, no particular dimensions can be laid down for the draughtsmen, except that each inner end of the board ought to easily hold two rows of them, one in front of the other, of six a piece, fitting neither too tightly nor too loosely. To obtain the dimensions of the men, therefore, it will suffice to take the width of an inner end of the board (both sides are the same), and to divide it into six equal parts; one of these parts will give the diameter of a draughtsman. They are generally about a quarter of an inch thick, and must all be of exactly the same thickness. The following is the way to make them so.

Turn the draughtsmen, one after the other, glued upon a chuck; give them, with the gauge already spoken of, the proper diameter. This gauge is better than a compass, the opening of which is likely to vary. Make the faces somewhat concave so that the draughtsmen may set firmly on the board; but the hollow must be very slight and the same in each piece. It will be well, indeed, to shape a small piece of metal, and, by tracing a line parallel to the prepared face, determine the depth to be given to the hollow in each piece; then with a file form a curve and



apply it to each face in order to give them the same degree of concavity. This curve must not be of greater dimensions than three-eighths of an inch.

Now take an end of flat steel, wider than the thickness of the draughtsman, and with a file give it a cheek-piece; this must be laid against the edge of the draughtsman, while a point marks the thickness upon each. See fig. 22 for the way this tool ought to be made. It is scarcely necessary to add that it ought to be tempered, and that the kind of tenon which touches the draughtsman ought to be rather round and polished so that it may not injure the surface, which, as well as the edge, should have been previously carefully finished.

When all the draughtsman have been turned and polished on one side, and their thickness marked out, place them in a short chuck with a hole pierced in the centre, through which a piece of wood may be inserted to eject the draughtsman when it is finished; but, as the edge of the two faces ought to be perfectly parallel, great care must be taken that the men are placed quite roundly and evenly in the hollow chuck.

In spite, however, of care and skill, it is almost impossible to prevent the draughtsman from presenting some differences. It will, therefore, be best to use the split-chuck (fig. 8, Plate XXIII).

The surface must in this case be finished with the small rule we have already spoken of, and carefully polished; the draughtsman will then be terminated.

The ebony ones must be made with the same care. In selecting the wood the amateur must beware of splits, which often do not show at first, but which soon reveal themselves. Ebony is more subject to get split than almost any other wood, and as those who sell it generally keep it in a cool place, the purchaser must keep his eyes open.

It is best to cut the men out of a piece of ebony of a larger diameter than is necessary, as the cracks which will possibly make their appearance at the circumference, are not likely to penetrate to the inside.

Turn a cylinder on the centre-lathe, and give it a length equal to the aggregate width of the number of men that are to be cut out of it, adding a sixteenth of an inch for each dividing stroke of the screw, and a trifle for the hole for the centre, as the wood containing this will be useless. Carefully turn this cylinder to the proper thickness. Begin by separating the draughtsman with a cut of the point-tool, and make the cut wide enough to allow the saw to pass without injuring the sides. This is a somewhat difficult operation, and if great care is not bestowed upon it there is a chance of each draughtsman being of a different thickness. In order to ensure greater precision, a tool similar to that shown in fig. 22 may be made use of, with the exception that instead of a chuck-piece it carries a blunt point-tool, which is inserted in the groove already made.

When they are thus separated, the cylinder must be polished, and the divisions deepened with a back-saw (fig. 7, Plate IX.), until the wood is not more than half an inch thick; the cylinder being kept turning all the time.

This method of cutting on the lathe is an easy and a sure one. A back-saw is extremely convenient for the purpose, as it is very thin and its teeth are very fine. The draughtsman may then be placed in a wooden vice and separated from one another.

Now take a split-chuck, the diameter of which allows all the draughtsman to fit tightly into it. Polish the upper face of each piece. Then take another chuck made of very hard wood, boxwood for instance; hollow it out to the diameter of the draughtsman, and make the shoulders at such a depth that the tool when flush with the point of the chuck cuts the men down to the proper thickness, making this at the same time equal in all. Care must be taken, however, when the

tool approaches the chuck, not to touch it in any way; if this precaution be not taken the last draughtsman will be much thinner than the first. The amateur must not forget to hollow out each piece as we have already explained; then polish them and they are finished.

If the amateur possesses a piece of ivory straight enough to allow of all the draughtsmen being cut out of one or two cylinders, they can all be turned together by the process we have just related. As ivory, however, is of more value than ebony, greater precautions must be taken. The thinnest of saws must be used, and the blade must be wetted—this is the way to saw ivory. The pieces must then be given the same thickness as the others, and polished with damp shave-grass. They must then be dried with tripoli, and finally finished off with flake white.

When an amateur undertakes to make a set of draughtsmen he will do well to make at least one extra one, as the pieces are easily lost and it is difficult to exactly match them.

To make a set of chessmen is a very different matter. Each piece requires to be made upon the lathe with the overhead-motion, and upon a separate chuck. When the invention of the rose-turning lathe made it the fashion to rose-turn everything, the mania reached even chessmen, and everybody, regardless of price, was anxious to possess a set turned in this manner. The consequence was that the world was flooded with rose-turned chessmen, utterly wanting in taste. At last the folly of this was perceived, and fashion reverted to the former smooth ones, but more gracefully shaped and more elegantly finished.

It is of this last description that we advise the amateur to make his chessmen. Their infinite variety is very pleasing. We suppose that it will be enough to give in the plate the different types, see figs. 39, 40, 41, 42, 43, and 44. The shapes shown in the plate are not, however, the only ones that can be given to the different pieces; the game, indeed, is of such universal popularity that it is easy to obtain a great variety of patterns. We will only remark that one set of pieces must be white, the other black. The white can be made of ivory, the black of ebony; but generally speaking the first are made of boxwood, the latter of rosewood. Each set must have two castles, two knights, two bishops, a king, and a queen, for the first row; the second row is filled with eight pawns, all exactly similar. The whole difficulty of manufacture lies in making the pieces of the same name identical in form.

The most certain way of assuring this is to make a tool to suit the outline of each chessman; but before using this tool the piece must be roughly cut into shape with an ordinary gouge. It must then be finished with the tool first mentioned, which will give the different mouldings all the precision required. We recommend the amateur, when he uses this tool, to turn gently and to cut away but little wood at a time.

While we are speaking of the manner of making the pieces belonging to different games, we will say a word about lathe-made dice. Many value these more than other dice, as being more even and more perfectly square. The following is the way to make them on the lathe. Take some small pieces of ivory and make them into as perfect circles as possible with a rasp-file; then, putting them into a split-chuck, dress each face one after the other. When they are quite polished they must be marked in the following way. It is customary for the sum of the dots upon any two parallel surfaces of a dice to come to seven. When the six, for instance, is uppermost, the ace will be found beneath; when the five is at the top, deuce will be below; and so on. But this is not all. When a dice lies before the amateur, as in fig. 23, with the six uppermost, the tray must be to his left, the five to his right, the deuce in front, and the four behind. So great, indeed, is the superstition of gamblers upon this point that they generally refuse to play with dice marked in any other manner.

The manner of marking the dice is simplicity itself. The operation requires a wheel of much the same shape as a hand-spinning wheel. The endless cord turns a bobbin which holds a drill. Turning the wheel with the right hand, and holding the dice in the left, the amateur presents the latter to the drill. Dice can be marked, indeed, without the assistance of this machine. A drill-bow (fig. 8), to pierce holes is all that is required. This is placed in a vice; the bobbins and the stem which carries the drill are held between two poppits, and the bobbin and the drill are made to turn with a bow. This arrangement is then used in the same way as the wheel we have just alluded to. All the difficulty lies in keeping an equal distance between the dots, and in placing them in their right positions. For this purpose a well made dice should lie in front of the amateur. When, however, the latter is not very skilful, the position of each dot should be previously determined, and marked with a compass. The point of the drill is then placed in this mark. All that now remains to be done is to blacken the dot. To do this some ivory black, diluted with varnish, must be used. A little of this is placed in each hole. When the varnish becomes dry, the dots are very dark and brilliant.

## PART II.

## GAMES FOR CHILDREN.

**A**MATEURS, who are at the same time fathers, will be glad, perhaps, to learn how to make various articles for the amusement of their children.

Fig. 42, Plate XXVII., is a kind of wooden shoe. Fig 43 is the shoe itself. A round-headed tack is placed in the point to enable the shoe to turn the more easily, and to prevent it from getting worn out too quickly.

Fig. 44 is a well-known plaything. It is a top. It is usually made of boxwood. An iron rod, the shape of which is shown in the plate, is thrust through it lengthways, for the top to turn upon, and to place the cord upon. The end of this cord (it is generally whip-cord) is looped quite round the rod, its end beneath the loop. The loop is pushed down close against the top, and the cord is twisted round the rod till it reaches its upper end. The surplus of the cord is grasped in the right hand, the cord being kept stretched, and the top, with its loose point downward, being held in the same hand. It is then quickly thrown upon the floor. The rapidity of the movement and the unwinding of the cord imparts a rotatory motion to the top, which is all the stronger the more vigorously the toy is thrown and the more tightly the cord is wound.

Fig. 45 represents what is called a humming-top. It is a spheroid, at the small axis of which is a button in which a nail is driven. This spheroid is placed in a chuck and hollowed out till it is only about three-eighths of an inch thick. A rod is passed through the opening, similar to that in fig. 32. A slanting hole is then pierced in the circumference of the top, from left to right; this hole will then have a sloping edge like that of a whistle, and will produce the humming noise peculiar to this kind of top. A string is twisted round the rod, its end is passed through a small piece of wood with a hole in it, which is held in the left hand, while the right vigorously pulls the string. The puller must here take care to stoop a little, as the top must not fall from too great a height. Two persons can join in spinning this top; one holds the small piece of wood with the hole in it against the top, while the other pulls the string.

Fig. 46 represents a toy once much in vogue. It is composed of two cones, rounded at their angles, and joined at their apexes. Both ends are hollowed out, and pierced with a hole. As this toy ought to be made all of one piece, a soft piece of wood must be selected about six inches long and about two and a-half inches in diameter. It must be roughly given a cylindrical shape with a hatchet, and securely fastened into a chuck by one of its extremities. It must then be turned to the shape shown in the plate.

Take a spoon-bit, and in the face, *a*, piece a hole as far as *b*; widen this hole till it is almost an inch in diameter; then with the tool shown in fig. 15, Plate XIII., which has the same effect on the interior as a gouge has on the exterior, hollow out the toy, following exactly the external curves, and giving the wood a thickness of about three-sixteenths of an inch.

Now prepare a wooden stopper that will tightly fit the hole, and insert it. Glue it in and cut a moulding on it

Having done this, reverse the toy, and placing the part already finished in the chuck, go through the same process with the other part. Then, in the central diameter of each cone, pierce the holes *c*, *d*.

The professional manufacturers of these toys shaped them on the centre-lathe, and hollowed them out in a specially constructed plate. After inserting the stopper, of which they always kept a large ready-made stock, they replaced the toy between the centres, and finished it.

This method is the quickest, but it necessitates the possession of a plate with an extremely large diameter.

The principal portion of the toy being thus finished, two ashen sticks, each about a couple of feet long, must be turned upon the centre-lathe, leaving a thicker part at one of their ends to serve as a handle. At their other ends a little groove must be cut to receive the round cord we are about to speak of. One of the sticks must be topped with a small crescent, similar to that we mentioned in describing the distaff, fig. 17, Plate XVIII. A round cord, about five feet long, is then fastened to the two sticks.

The following is the way to use this toy. It is set upon the ground, the cord being placed beneath the point of junction of the two cones. The sticks are held one in each hand, and the performer with them imparts a rotatory motion to the toy, causing it to travel up and down the cord, which can be held vertically or horizontally according to his whim or skill. The air passing between the cones, produces a noise very similar to that made by the humming top.

Skilful players seize the moment when the toy is revolving with its quickest rapidity, to toss it into the air, raising their arms and suddenly opening them; as it falls again, they catch it either upon the cord, or on the crescent fastened to one of the sticks, without allowing it to cease spinning.

As our wish is to provide amateur turners with amusement, and as we write for all sorts and kinds of readers, the latter must excuse us for taking up so much space with trivial details, and not reproach us for having dwelt upon them.

For the same reasons we must be forgiven for stopping once more to explain how to make a rosin box. The explanation may, at any rate, prove useful to violin players.

Turn a box, the internal diameter of which is about an inch, and the depth about half a one. Upon its outside, above and below, make a little bead-shaped flange and a couple of sharply defined small squares, partly to add to its appearance and partly to give greater thickness to its opening, and prevent it from splitting. Inside, at its opening, cut four or six turns of a thread of a medium diameter. Then upon another chuck turn another box, which will easily fit into the inside of the first one. At the bottom of this second box leave a slightly thicker part. In this a screw must be cut to fit into the thread upon the other box. Close against this screw is a shoulder, which when the second box is inside the first, closes it, and answers the purpose of a lid.

The second box should have a thickness of about one-twelfth of an inch. It must be properly hollowed out and cut away beneath the part which serves as a lid. It should be put in its place, and the first box finished, care being taken to make the mouldings and the outline of both boxes harmonise. Between the beadings of the top and those of the bottom make a groove, which will diminish the apparent diameter of the box and throw the mouldings into relief.

Now finish the outer box, separating it from the rest of the wood to which it still adheres. Screw it on to a chuck to finish the lower part, taking advantage of the screw already made.

The amateur will do well to remember that every box which is intended to stand upon a table ought to have a slightly concave bottom, to make it stand firmly. Polish the whole carefully, and the box will be finished.

Nothing now remains to be done but to fill the box with rosin, and to make it ready for use. For this purpose, the amateur, before taking the second box off the chuck, ought to have cut it out into six open divisions, leaving only six solid parts, which will preserve the shape of the box, keep the rosin in its place, and allow the bow to be passed between them and rolled upon the rosin (see fig. 1, Plate XXVI. Wrap the smaller box up in strong paper, fasten the paper together with string, and then, having melted the rosin, fill the box with it. This last, however, must not be done till the rosin is lukewarm. When the rosin is in a liquid state it should be purified by skimming the impurities off the surface, and by draining off any foreign substance that may have got mixed up with it.

Let the whole get cool, remove the paper, and the box will be ready for use.

## CHAPTER VII.

### CANDLESTICKS FOR THE WORKSHOP AND THE STUDY.

**W**E do not intend to lose sight of the object we proposed to consider in writing this book, that of instructing amateurs in the art of turning, and, at the same time, of giving them opportunities to practice it. We therefore always select as examples useful articles, the manufacture of which will give the amateur experience in various kinds of arts connected with that of turning.

A first necessity in a workshop is a candlestick, uniting convenience to lightness. An ordinary candlestick is very inconvenient. Its light is too high. There is often no room for it close to the work in hand, and the workman is forced to place his light at a distance, though he really requires it very near him. We will give a description of a candlestick which avoids these drawbacks.

The first and the simplest, fig. 24, is much used by workmen. It consists of a small piece of wood about six inches square and about an inch in thickness, from one of the edges of which rises a stem, about 12 or 14 inches high and a square inch in diameter, and which is fastened to the foot by a double tenon. One of these tenons is an ordinary one. The other is swallow-tailed one. The last is fastened to the foot at the rim (see fig. 25.)

On two opposite sides of this rim is a swallow-tailed groove; this is shown in fig. 26. An arm slides up and down this stem, carrying a receptacle for a candle; see fig. 27.

This arm ought to work easily up and down the stem, but its weight and that of the candle will prevent it from slipping down, as it is inclined a little forward and catches against the sides of the groove. If there is any doubt of it remaining stationary when it is placed in the groove, the stem can be pierced and a round-headed bolt inserted, to jamb the arm, fig. 28; but this is really quite unnecessary.

Turners require a candlestick which can be raised or lowered, and turned in all directions, according to the requirement of the work in hand.

It is particularly essential that the foot of the candlestick should not occupy much space upon the work-bench; if it does the tools are sure to be constantly thrown off, and injure their edges by the fall.

Make, therefore, a wooden model of the shape shown in fig. 29, and another of that shown in fig. 30. That in fig. 29 ought to be about five inches long, at each end, and also at the place where it joins the foot, and beneath it must be a circular bellying part at least half an inch in diameter. The same circular part must be made in the pattern shaped after the drawing in fig. 30. A brass cast must be made of the first model, and two, at least, of the second.

When they are cast they should be slightly heated in the fire to remove the effect of the casting. Let them cool gently, and then temper their four sides. File them till they present a neat and accurate surface; then, in the centre of each circular bellying part, drill a hole about one-twelfth of an inch in diameter, and with a square cutting file deepen the perforation, on one side only, to a depth of about one-eighth of an inch. As for the holes in the joint, they can be left for the present of the diameter they have been made by the drill.

The cutting file, fig. 32, we have just spoken of, is round and projecting at the bottom. Its diameter varies. At its other extremity is a bobbin or ferrule. The end of the cutting file, of good steel, has a hole about three-eighths of an inch in diameter pierced in its centre.

Into this hole is fitted a piece of steel which fits tightly, and the outside of which is turned upon the lathe to suit the size of the hole. This piece of steel can be changed as often as required. The extremity of this cutting-file is, as may be seen in the plate, covered with little teeth, placed in a parallel direction and very sharp; it will easily be understood that by placing the piece of steel in the hole and turning the cutting-file with the bow, the latter cuts away the material and forms a hole concentric to the first and square at the bottom. To prevent it from becoming too firmly wedged in the hole, it should be made of a slightly conical shape towards the bottom. All these holes must be so treated only on one side. A small bolt must now be turned on the clockmaker's-lathe, or even on the lathe with the overhead-motion, the square head of which fits exactly into the rim and its body into the hole. Put it in its place, and insert the body of this bolt into the hole of the joining piece, the entrance of which must be beneath. Pierce a small piece of brass to fit the bolt; turn it to the size of the entrance, make its two pieces perfectly even, and make a conical indentation in one of them. Insert this head into its place, file the bolt so that it only projects as much as is necessary to fill, when it is rivetted, the conical indentation.

Rivet it neatly with a hammer, placing it on an even surface and frequently changing the direction of the blows given with the hammer, so that the conical indentation may everywhere be equally filled. The amateur must try from time to time if the movement is sufficiently easy, without either too great looseness or stiffness; there will then be a first joint to the piece. The second must then be adjusted at the end of the first, in the same manner. There will now be a couple of joints which can be extended or folded up at will.

The brass which works against the other brass part is subject to stick; that is to say that the homogenous particles adhere to one another, and it is impossible to turn the piece without these particles being forcibly removed, producing a jerky and uneven motion. It would be better to make the bolt and its appurtenances of well polished steel. This is done in all machines in which it is desirable to diminish the friction; but, in this case, as the part in question is not of much importance, it will be sufficient to interpose a thin iron collar between the two contiguous brass parts, and to insert, before introducing the bolt, a little wax into the hole.

This wax should be composed of virgin-wax and good oil. The composition should be dissolved over the flame of a candle, in a card turned up at the four edges.

We cannot give the proportions of the wax and oil; this must be regulated according to the power of the machine and the time of the year. In winter, more oil is required; in summer, a little less. Experience will be the best guide.

Enlarge the holes of the stay till they easily receive the small rod upon which it ought to turn. This piece must not be left upon its rod in this state; care must be taken that the latter is of equal thickness throughout its whole length. It is difficult to turn it on account of its small width in comparison with its length, which ought to be at least from eight to ten inches.



We have hit upon one very successful method. We passed the rod right through a double screw-plate, the thread of whose screw-dies was very fine; we then with a small file removed the thread, taking care not to cut more deeply in one place than in another, and in this way we succeeded in giving the rod the proper thickness and roundness. We then made a groove in two small wooden cramps, and seizing the rod between them in a vice, and adding some emery powder moistened with oil, we passed it up and down the groove, holding it at one end with a pair of pincers. This will give it the necessary smoothness, or the rod may be placed on the centre-lathe and polished by passing the wooden cramps against it while it turns.

A piece of brass about half an inch thick, and as wide as the thickness of the stay, must now be forged. This must then be cut to the proper length, held in a vice, and the shape given to it shown in fig. 33.

As in forging a piece of brass, it is seldome asy to sufficiently cold-hammer it in the middle of its thickness, it will be well before reducing it to its proper size to cold-hammer it afresh on an anvil with a smooth hammer. When it is sufficiently cold-hammered, which the operator can ascertain by bending it, and observing whether it has acquired sufficient elasticity to regain its shape, it must be finished with a file, and reduced to a thickness of an eighth of an inch, to a proper width, and to such a length that it will easily fit into its place.

A semi-circular notch must be cut in it, above and below, for the rod. This spring must then be placed on a wooden block, and a few blows with a large and smooth hammer be given it, in order to bend it without leaving any marks upon it. It must then be placed in its proper position.

All that now remains to be done is to finish the end which is to receive the candle. A hole similar to that just spoken of, but larger, must be made in it. A small piece of brass, about an inch long, must be added, with a hole of about an eighth of an inch pierced in it. This must be rivetted below, and a conical beading cut upon it to allow of the easy insertion of the stem. The piece of brass, indeed, may be soldered, but not with strong solder; as the heat necessary to melt the solder would take away the hardness the cold-hammering has given the piece. Tin solder must be used. The following is the way it should be applied:—

The hole must be enlarged with a punch till the piece of brass will fit tightly into it. The hole must then be moistened with some water in which salts of ammonia have been dissolved. The part to be soldered must be roughened with a file to allow greater grip to the solder, and rubbed with some moistened salt of ammonia. Then, reversing the piece, place close against the brass two or three pieces of cold tin. Moderately heat this part and the tin will melt and work its way into the joining; it will be well to add a little white rosin to hasten the fusion and the melting of the solder. Let the whole get cold, and all that will remain to be done will be to take a file and remove any unevenness that may be left, to level the top of the brass, and to restore the latter to the colour it may have lost. If, however, proper care has been taken, this last ought not to have taken place. A long conical beading must then be cut above the hole, and all will be finished. The whole piece, however, may be polished; first with polishing-stone or with a piece of white wood and powdered pumice-stone, then with tripoli-powder. Care must be taken not to round the salient faces nor to blunt the angles; these are the dangers of polishing. The whole may now be given a final lustre by rubbing it with a piece of wood covered with soft felt sprinkled with some very finely ground tripoli-powder.

The part to receive the candle must now be made. This ought to be fixed to the foot. In a workshop, where only one light is used, it is often necessary to go here to look for a tool, there to

the grindstone, or in another direction to use the carpenter's bench. It is very disagreeable to have to take the candle in one's fingers, and even if one does, where can it be set down when it is necessary to use both hands? We will show the amateur, therefore, how to obviate this inconvenience.

Take a piece of brass about the sixteenth of an inch in thickness, and trace on it a circle of a diameter of four inches. From the same centre turn a second circle of a diameter of about an inch. Divide the large circle into three parts, and from the points of division on the circumference draw lines to the centre. Take a tracing point and draw the claw shown in fig. 34, and then cut out as carefully as possible the matter between the claws. The amateur can, if he chooses, cut out a cardboard pattern of one of these claws, and placing it on the brass, trace its outline. File away the metal, following the lines, and whiten and polish what is left of the brass. Give each claw the shape shown in fig. 35, taking care to keep the small circle perfectly straight and horizontal.

Round a piece of steel with a file, or take a piece of round steel about an inch and a half long. Cut a screw in it lengthways, and then with a file remove all the threads except for a length of half an inch. Reduce the smooth part to the size of the hole in the piece of brass spoken of, so that it fits into it easily but not too loosely. Give a long point, cut with a blunt apex, to the end; and soften the smooth part with a file and some oil.

Send a model of the part that holds the candle, such as shown in *a*, fig. 35, to the founder. Turn both its interior and its exterior so that the kind of candle used in the workshop fits easily into it. As it is the exterior that ought to be turned last, the candle-holder must be firmly fixed in a chuck, its under surface dressed with a point-tool, and a centre marked upon it. At this point make a hole rather smaller than the screw first made, and without taking the piece off the lathe introduce the screw-tap, which must be held in a pair of screw-pincers, and a little wax, as has been already recommended in cutting brass-screws. This hole ought not to quite penetrate into the inside of the candle-holder, as the grease of the candle in melting might pass through the hole and fall upon the operator; but it ought to be deep enough to allow the steel-stem to be fixed firmly into it, and not to project beyond it more than about three sixteenths of an inch. Care must be taken that the stem is fixed tightly. The piece might if necessary be bored into a screw of three feet in length, but in any case a nut of rather more than half an inch in diameter must be fastened below. This acting as a counter-screw will securely fasten the whole.

This kind of candlestick is a very convenient one, as its candle-holder can be removed and carried about anywhere; it can also be lengthened or shortened as may be necessary. Indeed, as we shall presently see, the candle-holder can be placed in other candlesticks, as the small stem can be made to fit into other similar sockets. One of the ends of the rod must be filed to a point to enable it to be placed into a hole made in the work bench, near the lathe with the overhead motion, and as far as possible from the other side of the turner, so as to be out of his way. The end of the rod may even be cut into a screw, to allow of its being screwed into a nut let into the work bench.

It is highly necessary to be able to place the candle-holder close to the grindstone when a tool requires to be sharpened. For this purpose a piece of brass should be fastened to the top of the grindstone, with a socket similar to that already spoken of; but care must be taken that it is not too close, as the water which flies about as the stone turns might put out the light.

If the amateur is desirous of possessing a more highly finished candlestick, he may add a shade,

which protects the eyes, and throws a stronger light upon his work. That which we are about to describe is equally adapted for the library or the workshop.

Turn a wooden model of a candlestick with a very simple outline. Those with simple outlines are not only more easily cleansed, but are always the most effective. Instead of making the rim of the foot thin, as is usual, leave it of a considerable thickness, in order to give it weight and stability. Half the profile of such a foot is shown in fig. 38.

When the piece comes back from the foundry, put it on the lathe either with some glue or in a suitably sized chuck, by the assistance of which different mouldings may be given it, according to taste. If there are to be beadings in the profile, a row of beads can be cut with a milling-wheel, an ingenious tool with which this kind of moulding is made, which we shall speak of hereafter, and several patterns of which are shown in Plate XXVI. Above the foot make a hole of moderate size, which can be enlarged according to the dimensions of the part to be fitted into it.

Beneath, and in the thick part, cut a couple of openings exactly opposite each other; these openings must not show on the upper surface, or they would spoil the symmetry of the foot. Cut them with a small chisel, and make them about nine-sixteenths of an inch broad, and three-eighths of an inch deep. Adjust upon them a brass cross-piece three-eighths of an inch thick, and solder it on with tin-solder.

Clean thoroughly the male and female-screws so as to remove all the oil from both; pour over them a little water in which some salts of ammonia have been dissolved, and at the end of an hour or thereabouts rust will be seen slowly forming. Pour some more water over them and screw up the nut very tightly against the four squares which serve as shoulders. Take a file and round off the female-screw to a diameter of from five-eighths to three-fourths of an inch, and remount the piece upon the lathe in the manner above indicated.

Turn the two faces and the circumference of this screw to serve as a base for the rod and to fit on to the upper surface of the foot. Mouldings may, if desired, be formed upon it, such as a bead, and underneath a square. A beading may also be cut with the milling-wheel.

We shall soon see that there are many kinds of these mouldings. Finally, dress and polish all the faces with the greatest care.

Enlarge the hole of the top of the foot until the rod turns freely in it without wobbling, and also the hole of the under cross-piece. Insert the rod into this, then mark on the rod the spot which corresponds to the level of the cross-piece; remount the piece upon the lathe, and with a graver make a circular line at the spot already marked.

Fasten the rod between the leaden jaws of the vice and mark off from the circular groove a square space, or better still a space with six corners, as exactly as possible, so that the angles may rest on the circumference of the circle which will have been destroyed. Next take a strip of steel and make a chuck of the same dimensions, but so that it shall be sufficiently wide at the bottom, and diminished a little at the top, the upper angles of which will become blunted by making it round. Bore a strip of brass, and with a file make corners in the inside; then make it fit exactly into a chuck which has been slightly oiled, and force the hole to exactly take its form. If the chuck has been well made, the piece ought to fit exactly upon the edged part of the rod. Turn it, while still keeping its position, upon its circumference, until it enters freely into the opening which has been cut in the small cross-piece, and upon its two faces, until it rests evenly at the bottom without exceeding its lower surface. And as it is not always possible that a piece which turns upon its edges can be replaced indifferently in other positions;

give one of the faces of the square part of the rod a touch with a punch, and give another touch on the flat side of the strip of brass, right opposite the square point, so that it may always be replaced in the position in which it has been turned. Again with a sharpening file mark upon the square part of the rod, the place which corresponds to the upper surface of this plate, and from this point round off the surplus of the rod by cautiously cutting away the angles. Bore a very fine thread in this small channel; add a nut to it, and finally turn this hole to the same diameter and dress it upon its two faces.

It is not easy to screw and unscrew a round nut; a key must be procured to fulfil both functions. Divide the circumference of the nut-screw in the direction of its diameter and the two opposite points with a square opening, or, better still, bore upon the side of the screw, at an equal distance from the edge, two holes of a moderate diameter.

Afterwards, make with a piece of steel a wrench of the kind already alluded to, and represented in Plate XVII., figs 43, and 44. Thus, when the rod is in its proper place, it will turn without leaving the foot.

It is easy to see the purpose of the plate of copper we have added to the rod. As it is square, it turns with it without leaving its place, being kept there by the nut. If the nut were by itself, at the bottom of the opening, it would screw, when the stem was turned in one sense, and unscrew when it was turned in the other. With the above precaution, all it can do is to vibrate. A similar method is pursued in all machinery, the parts of which are held together by screws, and which can be moved upon themselves.

We must now occupy ourselves with the shade *a*, fig. 2, Plate XXVI., which slides both up and down the stem *c*, by means of a bolt, *d*, which contains a spring to fasten it at the required height.

In order to make this socket, roll a piece of brass around a chuck of the same shape as the square stem, but as there ought to be a spring between the stem and the back of the box, the chuck must be rather broad than thick.

If the amateur is content to leave an empty space in one of the inner faces of the box for the pressure-spring, this opening will have to be fixed in its place either with a screw or by keeping at its two extremities a small shoulder-piece. Unless this be done, in raising and lowering it it will be sure to fall. But these are not the best methods. There is another which answers the purpose equally well, and which is much neater. Instead of folding the piece of brass on the four faces of the chuck, as has been directed, fold it only on three; but make the two folds that are opposite wider than is necessary for the bar; dress them with the file, and make them equal above and below. Then take a piece of brass about three sixteenths of an inch in thickness, and give it the same length as that of the box, and cut on each side of it a mortice, by means of which this side can fit into those of the box. The amateur should endeavour to make these two mortices parallel, and in the same plane. Then trace a couple of lines, the distance between which is such that when the box is filed, and its right length given to it, each of them is about three-sixteenths of an inch from either end. Take a new file and remove the matter between these two lines until the depth of the mortice is reached.

Then having inserted the foot in a chuck in which it may be held firmly and turned perfectly correctly, replace it on the lathe. To satisfy yourself that it is so held, insert any tool quite closely along the bottom and the sides. Having assured yourself that it is firmly fixed on the lathe, bore a hole of a diameter of three-sixteenths of an inch in the cross-piece which has just been soldered, and hollow out afterwards an opening, having a diameter of at least one-fourth of

an inch, so that its bottom is perfectly square. In this state the foot is finished. Nothing further remains to be done but to polish its upper surface.

The brass is much more easily polished upon the lathe than by the hand; but as all the cuttings are circular, it is advisable to make the polishers traverse in all directions in order to cross the strokes, to make them disappear by increasing their number and so to obtain a much more beautiful polish. As to the row of pearls or other ornaments if there be any, use a very rough brush upon which a little oil and some finely-powered chalk has been sprinkled.

Having in this way polished and finished the foot, we must now occupy ourselves with making the shaft, (fig. 51), which is intended to carry the candle-holder (A) and the eye-shade (fig. 2 Plate XXVI.). Choose a bar of steel from 15 to 16 inches long and about three-eighths of an inch square. File it perfectly upon the surface, removing as little as possible, and dress it with a correct rule. This operation is long and tedious. For this purpose use a smooth file rather than a coarse one, and file obliquely along the length of the bar. There are several reasons for filing in this way. First, the dust does not fill the teeth of the file, and falls more easily; whereas by filing it on the surface, that is to say, by moving the file perpendicularly to the piece, the grains of dust lodge more firmly between the teeth. In the second place by filing obliquely, the marks upon the piece may be seen, and when they are crossed the amateur will be better able to see where it is necessary to apply the file. In a laboratory a marble bench for polishing cannot be dispensed with. This is how makers of mathematical instruments dress all their pieces. A rule is never as sure; but the marble itself is very difficult to dress perfectly. If there is no opportunity of getting marble you must act in the following way.

Get a marble-cutter to make three square pieces of black Italian marble eighteen inches square. Then dress two of them, one upon the other, then each of the two upon the third, and so on, alternating them continually. This is done by fixing one of the two marble pieces and moving the other over it, after having covered their surfaces with sand, passed through a screen, and moistened with water. Nothing is so long and wearisome as work of this sort. But it is indispensable. When the marbles are applied exactly one upon the other you will be able to ascertain if they are perfectly equal. When you want to use them for dressing, take with the finger a little of the black slime which is upon the oil-stone, and rub it evenly over the marble.

Having dressed one of the faces of the box with a rule as well as you can, rub it over the marble; you will then see where you must use the file. Remove a little of the material at a time, for all that has been done has frequently been spoiled by doing otherwise. When it fits evenly at all points, dress one of the faces by the side of the first, and apply a correct square frequently to it. It is scarcely necessary to say leaden jaws must be used to grip this bar in the vice. Finish this face like the first, by applying it to the marble, and with an iron shifting-gauge, the point of which has been hardened, trace a mark parallel to one of the faces. Dress this side with a file and rule, then place it upon the marble and trace in the same way two parallels upon the fourth side. The piece being perfectly dressed, join all the marks by passing a very smooth file crosswise over its length; this operation which we have described in a line or two is exceedingly wearisome, but each piece, so dressed, does honour to the artist, and contributes to the perfection of the machine or tool for which it is destined. Polish it afterwards, but cautiously, so as not to round the surfaces or blunt the sharp edges. For this purpose take some pieces of willow, or other white wood, without knobs, commonly called polishing wood, bulging out towards the middle of their length. Sprinkle some fine emery and oil upon them, and move them in the same direction as the file, taking care not to catch the angles. Next take two pieces of this wood,

vice, sprinkle them over with very fine emery powder and oil, and give them the last lustre by rubbing them together between the hands. In this way two surfaces may be polished at the same time. Replace the piece and polish the two other faces in the same way.

One of the ends of the rod must now be rounded so that it may enter and turn in the foot of the candlestick. Take the total height of the foot and a few twelfths of an inch over. Cut carefully the angles of the bar to a height equal to that which has just been measured. Take the four new faces resulting from the cutting of the angles, and dress them with a rule so that this part may present eight equal sides. Cut away again the eight angles and there will be sixteen faces. This precaution tends to produce a cylinder which will be at the centre of the square of the bar. It will be now advisable to finish it on the lathe, but the length of the bar and still more its square form render this operation difficult. This, however, may be done by the several means which ingenuity suggests. You may, for example, fix almost at its centre a strip of brass pierced with a square hole in which the rod may fit exactly, and which may be turned by placing one of the ends of the rod in a chuck mounted on an overhead-lathe, and the other, well centered, at the moveable point. When the copper strip has been made perfectly round and of the shape of a sphere, place it between two collars fastened to a supporting poppit. By this means the noise or vibration which the length of the rod would otherwise inevitably involve is avoided. If the mandrel of the lathe is pierced it would be more simple to place the rod in the hole, leaving the part to be turned projecting. This last is turned by centering it on a chuck with eight screws or screw-dies. It will easily be conceived how important it is to firmly centre this bar upon the lathe at both ends. As to the square end, it suffices to hollow out a chuck in such a way that the square end fits into it exactly. The angles will suffice to hold it in position. But as the other end is to be pierced with a centre-punch, you must try to direct the piercing of the hole from one side to the other according as the piece is seen to turn more or less roundly. Of this you may feel assured when on turning the four angles are seen to equally approach a tool which is presented to them. It would be still better to determine the centre before cutting away the angles. Fig. 12, Plate III., Vol II. shows a very useful tool for performing this operation.

This part must be turned with a graver, which is more suitable to persons not well practised than the ordinary tool. Measure it frequently, so as to ensure its being perfectly cylindrical. But before doing so it is well to bore a hole, having a very fine thread, in the top of the part that has been rounded, to a depth of from three-sixteenths to a quarter of an inch. This is to receive the shoulder we are about to mention. Then turn the end which is to fit into the foot of the candlestick, and reduce it to such a thickness that it may freely pass into the female-screw of the shoulder without damaging the threads. As the shoulder once in position can no longer be removed, it will be well to fix it therein in a permanent manner. Rust is usually employed in this sort of case. Wipe the screw and the nut carefully in order to get rid of the oil. Wet both of them with some water in which salts of ammonia have been dissolved, and in about one hour rust will be seen forming. Add a little more water, and screw the nut tightly against the four squares that act as a shoulder to it. Round this nut with a file, and replace the pieces upon the lathe as above indicated.

Turn this nut upon its two faces and upon its circumference, to fit it to serve as a base to the stem, and to rest against the upper part of the foot. Mouldings may be added to it, such as a beading, and underneath that a square; the beading may be cut with a milling-wheel if the amateur thinks proper. Finally, all the faces must be dressed and polished with the greatest care.

The hole in the upper part of the foot must be widened till the stem turns freely in it, and without wobbling. The hole in the lower cross-piece must be similarly enlarged, and the stem inserted in it; then mark upon this stem, at the level of the bottom of the cutting in the cross-piece, its corresponding place; replace the piece on the lathe, and, with a graver, trace a circular line at the spot marked.

Place the stem in a vice with leaden-jaws, and beginning at the circular line, cut a square part, or better still, a six-sided one, in such a way that all the angles be at the circumference of the circle destroyed. File a piece of steel and make a chuck of the same dimensions, but with plenty of room at the bottom, and rather smaller at the top, the angles of which must be rounded off. Pierce a piece of brass, and force the chuck, which should be slightly oiled, into it, and cause the hole to take the shape of the chuck. If the chuck is a well made one, the piece ought to fit exactly. Keep it in its place and turn its circumference till it easily fits into the cutting made in the small cross-piece, and its two faces, till it rests completely and evenly against the bottom, and does not project beyond its inner surface. As it is almost impossible for a piece with sides to change its position with impunity, make a punch mark upon one of the faces of the square of the stem, and another upon the flat part of the piece of brass, opposite the point of the square, so that it may always be replaced in the direction in which it was turned. Further, take a file and mark upon the square of the stem the place which corresponds to the upper face of this plate, and from this point round off the surplus stem, carefully cutting away its angles. Cut a fine thread in this part, and insert it into a nut; turn the nut to the same diameter, and dress both of its surfaces.

It is not easy to screw and unscrew a round nut. The amateur requires a key to achieve this double feat. Cut square mortises in the circumference of the nut, at two opposite ends of one of its diameters; or better still, drill a couple of holes of medium size in the flat part of the nut, at an equal distance from the two edges and the diameter.

Then take a piece of steel and make a key, such as we have already spoken of, and which is represented in Plate XVII., figs. 43 and 44; then when the stem is in its place, it will be able to turn without getting out of its place.

It is easy to guess the purpose of the brass-plate placed upon the stem. As it is square it turns with it without shifting its position, being kept back by the nut. If the nut rested by itself at the bottom of the cutting, it would screw when the stem turned in one direction, and unscrew when it turned in the opposite one; but if the above precaution be taken it will not even move. This is what is done in all machines when parts are screwed together.

We must now turn to the shade (A, fig. 2, Plate XXVI.) which slips up and down the stem c, by means of a bolt, D, that contains a spring by which it is fixed at any required height.

In order to make this bolt, a piece of brass must be rolled round a chuck that is about the same shape as the square stem, but as there must be a spring between the stem and the back of the box, the chuck should be made rather broad than thick.

If the amateur is content to leave an empty space in one of the inner faces of the box, in which to place the pressing-screw, this latter must be fixed in position, either by a screw, or by reserving a small shoulder at its two extremities; unless this be done as it was raised or lowered, it would fall to the ground. But these are not the best methods; the following is equally efficacious and much neater.

Instead of bending the piece of brass round the four faces of the chuck, only bend it round three; but the two which are opposite to each other must be made wider than is necessary for the bar; they must be perfectly dressed with the file, so as to be equal, above and below.

Then take a piece of brass about a quarter of an inch thick, give it the length of the box, and make a mortise in each of its sides, by means of which these may fit into those of the box. These mortises should be parallel and in the same plane.

Then trace a couple of lines, the distance between which is such that when the box is filed and has been given its proper length, these lines are each about a sixth of an inch from either end. Take a new file and remove all the material between these two marks, until the bottom of the mortises is reached. In this state the piece will resemble a part of the thickness of the rest of the box, at the end of which has been fixed an elevation as wide as one of the faces of the rod.

Finally, the two sides must be filed until the piece added, when tightly fixed in its place, leans closely against the fourth side of the stem; care, however, must be taken to leave between the two sides sufficient space for the spring, which once in its place cannot leave it, being kept there by the two shoulders. The operator must also see that the two sides of the added piece project beyond the sides of the box, so as to retain the solder. A few strokes of a file must now be given crosswise, as we have already recommended, to give grip to the solder.

There is still something to be done before soldering the piece. The box must have on its front face another box, in which is fixed the stem to carry the shade; and the whole must be soldered at one blast. Now make another steel chuck, about three-sixteenths of an inch square, and rather longer than the box; it must taper a little at one of its ends. Adapt to three of its faces a piece of brass about one-twelfth of an inch thick. Carefully finish off the two extremities of the cheek-pieces which must lie closely against the box; and also finish the face of the box, against which must be adjusted the piece just prepared. As this face must project at each side beyond the small box just made, the latter must be placed exactly in the middle of the width, the narrowest part beneath. Nothing now remains to be done but to solder these three pieces, but as the solder might run and stop up the apex of the angle made by the file close against the small elevations and between the two, which would prevent the proper insertion of the spring, a little flake-white, in paste, must be rubbed into these angles. It will be well to re-touch the ends which impinge upon the sides of the box, as if they touched, the flake-white might prevent the solder from biting in this particular spot. It is thus that when a piece is being soldered, and that it is not intended that the solder should effect any two parts, the surfaces are covered with flake-white, the borax placed upon the joinings having been first calcined.

Fix these three pieces with some wire; then put a little borax-water on all the joinings, together with some solder; place the piece in an earthen-oven or in a clay-stove upon a tripod. Cover it with charcoal, leaving interstices to allow of the piece being watched, and to be able to notice if the solder runs. We have already explained the details of this operation.

The operation is somewhat difficult on account of their being two pieces to solder at once. The fire must be fanned with a medium sized bellows, or better still with a fan, when, that is to say, this is necessary to make the two solderings run simultaneously; for if one is a little behind the other, and the fire is tolerably hot, the first will be quite melted before the second begins to run.

Brass may be soldered with the same solder as that used for silver. It is expensive, but although workmen say that it is not so strong as zinc-solder, and that it leaves a white mark upon the brass, we remain of opinion that it possesses several advantages which the other does not.

It runs more easily, and, as a consequence, less heat is required, and there is less danger of melting the pieces. In the second place, as there are silver solders of different degrees of strength,



and which melt at different degrees of heat, the piece, if silver solder be used, can be soldered by degrees, without any risk of affecting the solder already employed. And, thirdly, if the silver solder leaves a white mark upon the brass, zinc-solder leaves one, not as white, perhaps, but that is still easily perceived.

The piece being soldered can be so nicely adjusted that the joining is imperceptible; and as we have already explained, this is a proof of the strength of the piece. For instance, in the present case, the back of the box can be soldered first, and the small box can then be soldered in front, but not with the same solder. There are five kinds of solder. The first strength is so weak that it is seldom used. The solder of the second strength is that most generally employed. Elsewhere we intend to give the compositions of the different kinds of solder.

Let us suppose now that the piece has come successfully out of the above operation. It must be put into a vase and covered with diluted aquafortis. After a short time it must be removed, carefully wiped, and examined to see if its interior is in perfect order. A small piece of sheet-iron must be fitted tightly into the groove, so that it is just flush with the two elevations. The chuck slightly oiled, must be tightly fitted into it, and placing the piece upon a smooth anvil, a few gentle blows must be struck all over it with a hammer.

When the chuck has quite entered, the box ought to fit tightly on the stem, since the chuck should be equal in size to the stem. Here, by the way, we must correct any error that we ourselves, perhaps, have helped to cause. The chuck upon which the brass parallelogram is adapted in cases similar to this, is not the same as that which is used to give the shape of the stem which will fit into the box. The first is made smaller.

The box, with the small piece of sheet iron, must be replaced upon the chuck, for fear that the pressure of the vice might cause it to lose its shape. File it carefully on three sides, making its thicknesses everywhere equal. As for the fourth side, upon which the second box is soldered, it must be finished with a peculiar kind of file, which sharply accentuates the angles of the box.

The box can be left as it now is, the inner surface being smoothed, or the top can be removed with a file, and only the sides left, which can afterwards be made to receive the stem of the shade. This last method is the best, as this box being soldered on to the first, the latter might be injured if the chuck was forced into the smaller one. The box must now be finished and polished.

In order to make the spring, take a piece of brass, and cut it down to a thickness of one-twenty-fourth part of an inch. It must be cut with a pair of shears, and its two surfaces filed. A thickness equal to that of the inside of the box must be given it, and a length proportionate to the place reserved for it. It must then be placed upon a wooden block, and a slight curve given it with a wood-hammer; its back must be polished to allow it to slip easily. Now put it in its place, its back turned to the stem or steel-bar; in this manner the box can be either raised or lowered without any fear of its falling.

The part to hold the shade must now be prepared; but first, it will be well to settle the latter's shape.

*In every shop front shades are to be seen used to throw down the light upon the shopman's goods. Most of them, however, are made in defiance of proper optical principles, and with the sole aim of throwing the light downwards. The object of the shade is first to prevent the rays of light from affecting the eye of the workman; and, secondly, to collect them and direct them upon the object at which he is at work.*

*Such, for example, was once the purpose of the reflecting mirrors that used to be attached to the old oil lamps. Scientific men have endeavoured to discover the best shape that could be given*

to these mirrors, and they came to the conclusion that the form of the parabola was the best. In practice, however, it was found difficult to construct parabolic mirrors, and people contented themselves with spherical ones. The conical form is that now adopted for shades, and providing that the work in hand forms the base of the cone, it suffices. Its sides, therefore, should not be made too slanting, as some of the light will escape, but just such an angle be given them as will concentrate all the rays of the lamp upon the work. The following is the way to make it:—

The best method is to give its base a diameter of about seven inches, its upper section one of about three inches, and its height should be about three inches and a half. Upon the line A, B, fig. 24, Plate XXVI, drop a perpendicular C, D; about three inches and a half from it draw a parallel to the first line E, F. Measure off right and left of the point where the perpendicular intersects the base, half the length of the diameter it is intended to give to the base of the cone; in this case this is three and a half inches. On the parallel mark off, right and left of the point where it is intersected by the perpendicular, half the diameter at I and K; in this case, one inch and three-quarters, the half of three inches and a half. From the two points G, H, the extremities of the diameters to the right and left, draw two lines passing through the point I and K, which will intersect the perpendicular at L; this section will be the top of the required cone.

From this top with a radius equal to L, C, trace a circle P, C, Q, and with another radius equal to L, R describe another circle concentric to the first. Measure off on the large circle six times the radius of the base of the cone, and through the points thus obtained, and the centre of the circles, draw lines cutting the circles. If the material is tin, as is usually the case, cut it out along the line of the two circles. Join the two ends together with solder, and the result will be the truncated cone required.

In order to give this shade a greater degree of solidity, and at the same time neatness of shape, make a groove along the edges of the two circles in which place a piece of wire and double up the grooved part against the surface of the cone.

Round the cone upon a beak-iron, with a wooden mallet, and smooth its surface as much as possible. All that now remains to be done is to paint the cone within and without.

The outside can be painted green or black, according to taste; green is the most usual colour, but black is perhaps the best. The operation of painting it has nothing to do with the purport of this work, but for once we will go out of our way in order to show that an amateur ought to learn something of all kinds of art.

Begin by giving the outside a coat of salts of ammonia, for the purpose of scouring the surface and preparing it for the reception of the paint. Then give it a first layer of black paint dissolved in linseed oil. When this is quite dry, give it a second coat, and let this dry also. Then cover it with a lace tracing, marking each thread with a very fine brush. Then cover these lines with gold-leaf, and the lace-design will come out in gold lines.

When the whole is perfectly dry, give it a coat of good varnish, let it get dry, and repeat this operation five or six times. If the weather is not warm and dry, it will be well to place the shade in a cupboard from which all the shelves have been removed, hanging the shade from the top by a string.

Hang the shade in the cupboard, and place a lighted brazier under it, then shut up the cupboard. This is called a drying-stove.

This heat has two advantages. It causes the varnish to extend itself equally all over the shade, and it makes it dry more quickly. When the whole is quite dry, take some pumice-stone and rub the cone all over, in order to remove the roughness necessarily left by the varnish.

Finish with some fine tripoli powder dissolved in water, and put the last touch with some dry tripoli rubbed in with the palm of the hand, or with some felt stretched upon a piece of wood. After this the varnish will be found to be very evenly and equally applied.

Make the inside white; any other colour is worthless. White reflects all the rays and gives the strongest light, but it ought not to be too brilliant, and for this reason no oil should be mixed with the paint.

The inner-surface must be smoothed similarly as was done with the outer-one, and a thin coating of white-lead mixed with a little gum given to it. Two or three similar coats of this may be given to it. They easily dry. When they are dry the effect produced is a dead-white particularly suited to the inside of a shade.

There is now the stem that carries the candle-holder to make.

When the shade is fastened to the stem it is of course impossible to lengthen or shorten the arm that carries the light. The amateur must content himself with making it of one piece.

It is often necessary to have the light very close indeed to the work in hand, and for this purpose the candle must be scarcely higher than the level of the workbench or desk. Trace upon a piece of paper the whole of the outline of the candlestick. It is shown in diminished proportions in fig. 2, Plate XXVI. Make a wooden model of the arm that carries the candle-holder. When this is finished and polished it ought to be at the outside about a third of an inch square. To allow of this the wooden model must be made a little longer, so that any defect in the casting may be able to be removed. The parts through which the stem passes must be made considerably thicker, but they must not be pierced till after the casting.

The curves seen in the plate are intended to match the outline of the foot; at the place where the candle-holder is to be fitted, the outline, for the sake of elegance, must be circular.

In the same way a model of the candle-holder must be made. These models must be finished with the file and varnished.

Now take a piece of wood about a third of an inch thick, and cut it into a square, as in the plate, and after determining the length it ought to have, in order that the axis of the cone or shade be within that of the candle itself, which may be easily done with the help of the drawing, measure off the angle of the side which supports the cone.

Trace the outline of the cross-piece and the S-shaped piece, on the piece of wood, and with a narrow saw, (fig. 3), cut out the material that has to be removed.

For this purpose unscrew one of the screws that fastens the blade. When all the parts have been cut out, finish it neatly with a file, and as the portion which is to rest against the cone would be too narrow if it were left of a width of only a third of an inch, nail a small rod to each side of it. Then varnish the piece and give it to the caster.

The amateur may, if he chooses, turn a model of the cup that is to be placed at the top of the stem. In order to fix it in its place, take a file and make a tenon at the top of the stem. Cut a screw in this tenon, which must be screwed into the bottom of the cup. Give all these pieces to the caster.

When he sends them back, file all their four faces, taking care to make them all perfectly square, and to give them all the same thickness and width. As for the thick parts, through which the stem is to pass, take a punch and make a hole as exactly in the middle as possible. From this point, as a centre, describe as large a circle as the material admits of, and carefully finish it beneath. To execute this, dress one of the sides with a square, and draw a line through the centre above, from the end to the side, and then beneath; then, with a carpenter's gauge draw a line through the centre

of the upper and under faces; but as the thick part prevents this line from being continued throughout the whole length, prolong it by means of a correct ruler carefully laid against the line; the under section will now give the central point required.

Next, describe a circle beneath like that which has been already described above; the parts will be easily rounded; but first, however, make the hole intended for the passage of the stem.

Begin by drilling a hole above and below, and cut them both into a square shape with a four-sided file, making them rather smaller than the size of the stem, and taking care that the arm which is to support the candle-holder, is quite perpendicular to the front face of the stem, so that this arm and that supporting the shade be exactly in the same line.

Make a chuck of the same thickness as the stem, and rather longer than the distance between the holes. In order to better succeed in this, dress each of its faces on the marble. Diminish towards the extremity, the thickness of the chuck.

Treat the top in the same manner, and force it to enter one of the holes, then with the assistance of a little oil insert it into the other. If there is any difficulty in forcing it into these holes, if, that is to say, it is necessary to strike it with some violence, turn a wooden cylinder, well finished at its two ends, and as long as the exact distance between the larger and the small arms. Then, having made a sufficiently large hole in its axis, place it between the two arms, and resting the whole upon the jaws of an open-vice, the chuck may be struck without any danger of injuring the piece. When the chuck has once passed into the two holes, the stem ought to fit into them easily.

If not, the chuck must not be made to enter the hole by reversing it, as the four faces of a piece are seldom all exactly equal. On the contrary, the holes should be carefully eased with a suitably sized file until the stem easily enters and fits without wobbling.

The next thing to do is to make the spring. We have already explained the way to make one; we will not repeat the explanation, we will merely say that a piece of sufficiently thick brass must be bent at right angles, above and below, in the vice. It must be rather shorter than is required, and must be lengthened by continual hammering; in this way when it is thoroughly filed and polished, it will easily enter. There are two ways of keeping this spring in its place. It may be screwed into the part against which it rests, or a mortise may be cut in it, above and below and the stem passed through them.

The amateur must now turn the candle-holder. First, a hole must be made in the arm which is to support it. Then turn a stem, one end of which will tightly fit into the hole just made. Then make a portion of it, which may be either cylindrical or ball-shaped, of a thicker diameter, and about half an inch high, and then an even part about an inch long. Cut a screw in this last portion, and after having turned and pierced the socket to the thickness of the part cut into a screw, turn and cut a screw in the candle-holder, taking care that the hole does not quite transfix it. Put the stem in its place, rivet it beneath the arms, and file the whole level with the surface.

The part supporting the shade requires a good deal of care. Files of all shapes will have to be used, according to the intricacies of the outline. First use a smooth file, then a half-smooth file, then ordinary ones. Great care must be particularly taken not to injure the edges; to insure this rounding files must be employed, the angles only must be filed, and the outlines left intact. Then file the thickness until the angle is a very acute one. All the angles, both the re-entering and the projecting ones, must be made very sharp. Finally, lay the piece upon some wood held in a vice, and finish it accurately with files of different kinds and sizes. Polish the two faces, as well as the thickness, using polishing stones and a little water; the stones being straight or round according

to the outlines of the part being polished. Lastly, we may add that the method we recommended in treating of the polishing of brass, may be employed in giving a final lustre to this piece.

The amateur will remember that he made the part which is to rest against the shade, wider than the thickness of the rest of the piece. He must now, therefore, fix it in a wooden vice with a piece of rag between it and the jaws of the vice. Take a large file and make a circular groove in it rather smaller than the width of the shade, so that the two edges may exactly meet. It is not worth while to polish the inside of this groove which will not be visible; it will be enough to pass a smooth file round it. Then decide upon the best places in which to pierce the holes, two in the upper part, and other two in the part supporting it, to receive the screws that are to unite these two pieces.

Then pierce the two holes in the upper part, at an equal distance from the top and the bottom; turn upon the watchmaker's-lathe, two small steel screws with a round head and four-sided below; cut a thread in this whole length, and then dividing them on the lathe with the edge of a graver, separate them from the metal they have been made out of.

Split their heads with a splitting-file proportioned to their size; but as this kind of file makes an angle at the bottom of the split, and this is for the most part a bad way of splitting screw-heads for the reason that the turnscrew is apt to slip, it will be well to pass a very thin equalising file two or three times through the split.

These screw-heads can also be split with a metal-saw. This is a better method; the split thus produced is made at one stroke and is more correct. It is always imprudent to place a screw in a vice for the purpose of splitting its head; the best way is to hold it in a wooden pair of pincers or in a brass-hand vice.

If it is desired to colour the head of the screw, it must be polished, or at any rate burnished. For this purpose it must be grasped in a pair of pincers, held against a grooved piece of wood and rapidly turned in every direction; the head can thus be smoothed with a rather worn fine file. It must be subsequently burnished with a tool termed a burnisher.

We will not here repeat the explanations with regard to colouring small pieces of steel which we have already given in our chapter on tempering.

The holes made in the shade should give an easy passage to the screws opposite to them. Another smaller hole must be pierced in the cross-piece, and a thread must be cut in it perpendicularly to the side of the cone. The screws must now be inserted into the shade, and the latter then fastened to the part that supports it.

It is scarcely necessary to observe that the swallow-tailed groove in front of the box ought to be made with care, it is equally necessary to be careful in making the stem that is to fit into it, in order that it may exactly reach the point desired.

The candlestick is now almost finished; all that remains to be done is to turn the cup that is to be placed at the top of everything.

Begin by cutting a thread beneath it to receive the screw that has been made at the top of the stem. Place a piece of round iron in a boxwood chuck, and cut a thread in it exactly equal to that in the bottom of the cup. Put the cup upon this iron screw and press it home against the chuck. Then carefully turn and polish it. For the present we do not give any model of the cup or the plate; but later on we intend to give a selection of these models in a special chapter.

When the cup is fastened in the way we have just described it will project beyond the whole of the chuck, and it can be turned without any danger that the strain of the tool will throw it off the lathe.

Before finishing this chapter it will be well to observe that only small screws are usually made of steel. The larger ones can be made of iron, and in this case, as in that of wooden screws, the head is split with a splitting-file, or with a portion of saw held in a special kind of holder. This holder (fig. 4) is composed of two pieces which are adjusted one above the other by means of three screws. The file or the portion of saw is held between these two pieces.

Fig. 21 represents a kind of saw by which iron can be cut or screw-heads split. It gives a flat surface to the bottom of the split, as we have already recommended.

Our readers will possibly think that this chapter has dealt very largely in details that do not seem of the first importance. But in describing the manufacture of the candlestick, we have seized an opportunity, that might not again present itself, of speaking of a variety of interesting collateral topics.

## CHAPTER VIII.

*Milling-Wheels.*

**A** Milling-wheel is a small steel cylinder used in the manufacture of beadings, filets, and other mouldings, as well as ornaments of different kinds, such as pearls, leaves, etc.

The beginning of this instrument was a very simple one. It was the English who first cut on the heads of endless-screws and the handles of optical and astronomical instruments egged-mouldings representing the strands of a tolerably thick rope.

Canivet, a skilful engineer, belonging to the French Academy of Sciences, was struck with the advantages of this kind of ornament, and long endeavoured to discover how it was produced. He was at first inclined to think that it was done with a small wheel; but he reflected that it seemed indispensable that the wheel should have exactly the same number of the grooves as the screw-head upon which they were to be marked, and that in that case it would be necessary to have as many different wheels, or mills, as there were screws of various sizes to be marked. This appeared an insuperable obstacle. However he tried the experiment and found that his doubts had no foundation. At first the invention was kept secret, but it soon became generally known, and the apparently impossible was at once explained. Let us suppose, it had been said, that a milling-wheel contains 60, 73, or 86 grooves, and that the circumference of the head of the screw admits more, but not a whole one, what will become of the fraction? And will not the grooves, no longer falling on similar ones, be all spoilt?

It was observed, however, that the error existing between the first and the last, being equally shared by all the grooves, became absorbed, and a little experience showed that whatever the relation between the diameters the egged-mouldings were always equally exact.

Experiments were also made in other kinds of ornaments; hollow-beads were cut upon the milling-wheel, and came out in perfect relief on the work. Hence the fashion for adding beads to all turned work, such as a candlesticks, candle-holders, etc. And so little by little designs of all sorts were gradually introduced, which to the unskilled would have seemed utterly impossible of production. As in lathe work many opportunities offer of employing this kind of ornament, we have thought it worth while to enter into a few details.

The first milling-wheels were made with round screws of different widths, which did not afford any great degree of pitch. Afterwards screws with a thread of three or four turns were used, and the egged-mouldings immediately became more distinct. Lastly came the turn of beads which were made with an instrument like that used by watchmakers to split wheels, and employed at present in the manufacture of milling-wheels.

Fig. 8 represents a tolerably bold kind of moulding; it is used of different thicknesses according to the position intended for it. It is very useful for the heads of round-screws, female-screws, &c. In order to cut it upon the object in hand, all that is required is to place the rest so that there is room for the milling-wheel between the wedge and the work. The tool is applied directly to the latter, and pressed home with some force, and the piece is rapidly turned with a drill-bow, on the lathe with overhead-motion, or on the centre-lathe. The operator will soon see mouldings faintly grow into life under his hands, and presently become perfectly distinct. In this operation it must be particularly noted that pressure is applied to the tool during the whole revolution. A little oil should be applied to both sides of the milling-wheel, which must be inclined to the right or to the left, according to the shape of the work.

Fig. 9 represents a row of beads, made in the same way. As, however, there is in this case a great deal of material to be cut away, a good deal of pressure must be exerted, and the operator must patiently wait till the beads are thoroughly formed. These can be of all sizes and of more or less projection according to taste.

Fig. 10 represents a kind of wheat-ear, in which the grains are attached in couples to a rather thin stalk. Two rows of this kind of ornament can be cut upon a beading, side by side; the stalk will then show four grains, while the rest will seem to be concealed by the piece on which the moulding is fashioned.

Fig. 11 is a myrtle leaf, fastened to a cord shaped stem.

Fig. 12 represents a wheat-ear like that in fig. 10, except that it is enclosed between two cords, the strands of which are in considerable relief; this in certain cases produces a very agreeable effect.

Fig. 13 shows a piece of twisted wicker-work. The interlacings of the wicker are plainly visible around the uprights.

Fig. 14 represents an acanthus leaf upon an indented background. Between each leaf is a stalk bearing three berries.

Fig. 15 represents a watered-leaf with stalks similar to that in figs. 12-14 by the side of the others; this sometimes produces a good effect.

Fig. 16 represents a plain leaf, upon an indented background, with a pistil between each leaf.

Fig. 17 shows a piece of wicker-work different from that in fig. 13.

Fig. 18 represents a garland of laurel leaves, with some small berries.

Fig. 34 represents a section of a palm leaf upon an indented background.

Fig. 35 represents an entire palm leaf.

Fig. 36 is another palm leaf, encircled.

Fig. 37 represents a pomegranate surrounded with leaves.

Fig. 38 is a frieze with shells.

Fig. 39 is a four-sided beading with pointed extremities.

Fig. 40 is an architectural ornament.

Fig. 41 represents a trellised interlacing of leaves with fruit.

Fig. 42 is an oak-leaf and acorns.

Fig. 43 is a vine leaf with grapes.

Fig. 44 is a star upon an indented background.

To undertake to describe all the different kinds of milling-wheels that have been and are still invented would be too laborious; we have contented ourselves with mentioning the most popular



and the most pleasing designs. But to give a general idea of how the other kinds are made a very complete one is shown in fig. 19.

The amateur at first will find considerable difficulty in perfecting the particular kind of beading he has chosen. It is a good precaution to take to cut these mouldings before finishing the other parts of a piece of work; this will prevent the spoiling of that on which much labour has already been spent.

It would be well, too, that he should exercise himself in making the various mouldings, for which he possesses the necessary milling-wheels. It will further be advisable to experiment with the latter upon tin or lead so as to be able to give the real mouldings the sharp relief necessary to produce a good effect.

Beads, particularly the larger ones, demand much time and continual labour. In making a bead, in fact, it is not so much a question of cutting away material as of displacing it, and forcing it to assimilate itself elsewhere in the shape demanded by the milling-wheel. In order to rid themselves of as much as possible of the effort required for this, in order, that is to say to avoid being forced to expend their strength in pushing against the piece that is turning, a task that if long continued would prove very exhausting, workmen, particularly those who have to make candlesticks, in the ornamentation of which a quantity of beads are used, make use of a mounting for the milling-wheel that lessens their task by three-quarters.

The amateur will find in fig. 20, a heel piece which is joined to the mounting, and at the bottom of which are a few hooks. This heel piece is applied to the inside of the rest, and in order to exert a greater or a less pressure against the work, it will be found sufficient to raise or lower the handle which acts as lever and whose fulcrum is supplied by the rest. This method, however, can only be used when the surface to which the milling-wheel is to be applied is soft and smooth; for mouldings and beadings care must be taken to describe, with the hand holding the handle, a portion of a circle the centre of which is the beading being cut; by this means the angle of the milling-wheel falls close against the commencement of the beading, and the cord, egged-moulding, or other ornaments will turn round this beading. If beads are being made they will be hollow below and will only hold to the piece by a single point; this will give them a very light and graceful appearance.

In order to avoid the necessity of having a separate frame for each milling-wheel, a universal frame has been invented, in which any milling-wheel, whatever its thickness or its diameter, can be fitted.

This frame is composed of two cheeks *a, a*, one of which is fixed and the other moveable; a screw, *b*, brings them together more or less, according to the thickness of the milling-wheel. There is usually a pocket in the thick part of the handle in which the milling-wheel is kept.

Since it was found that the most delicate and varied ornaments could be made with the milling-wheel, jewellers and bronze manufacturers have had much recourse to it; it must not, however, be supposed that its use is confined to metals. The milling-wheel can be advantageously used with wood, particularly for edgings. It is also employed in the production of the various ornaments on vases, and other porcelain and earthenware objects.

Shoemakers make use of a kind of milling-wheel whose surface is flat, to add ornamentation to the edge of soles and heels. Finally, the brass-rollers used by bookbinders may be considered a species of milling-wheel. These, however, are made of brass, and have a flat surface, and must be heated before being used for gilding.

If the amateur should wish to give an appearance of having been rose-turned to the chessmen, whose outline only we have already indicated, and he does not happen to possess a rose-turning engine, milling-wheels may be made use of, and will be found to sufficiently answer the purpose provided that the work be very neatly done. But let us once again repeat that chessmen look much better when they are quite plain, provided only that their mouldings are well made, their and their shape graceful. In the plate they are represented on too small a scale to angles fine, show their exact proportions; but we should have had to double the number of our plates to represent their natural size. Moreover, the further we advance in this work, the more capable we are bound to suppose the amateur of carrying out a design from a mere indication, particularly when the exact proportions of the design are more or less a matter of taste.

When, however, architectural rules are concerned, it is different; columns, capitals, bases, balusters, and pedestals, demand great precision. We propose to give several examples of pieces, whose outlines demand a great deal of exactness. We will begin with balusters; those we spoke of in connection with the winder had nothing to do with the laws of architecture, but it will be well, now that the amateur has acquired considerable experience in cutting correctly, for him to understand the fundamental principles of ornaments and mouldings.

## CHAPTER IX.

**On Mouldings, and their Fundamental Principles.****PART I.**

## NAMES AND FIGURES OF THE PRINCIPLE MOULDINGS.

**M**OULDINGS are imitations of nature, but it must be acknowledged that fashion and taste have made them very incorrect ones. Everybody is aware of the origin of the Corinthian capital. A young girl one day laid a basket upon a stone and covered it with a tile; chance caused some acanthus leaves to spring up around it. The basket was hid by the leaves, and the tile forced the latter to take a certain direction and shape, which have since been applied to architecture. Our Corinthian capitals do not, however, altogether present us with a faithful picture of their origin. The same departure from their first patterns is characteristic of many other kinds of ornament. The modillions which add so much to the beauty of our cornices were originally nothing but the ends of the joists that supported the roofs of rustic dwellings.

Nature was then the origin of many of our architectural mouldings and ornaments; and it must be admitted that art, if it has not scrupulously adhered to its model, has at any rate departed not ungracefully from it.

These mouldings and ornaments are nevertheless governed by no arbitrary rule; they have to obey strict precepts and are pleasing to the eye according as they are obedient or the reverse. We will classify mouldings as large and small. The large present large masses to the eye, separated from one another by the small; and it is from these skilful combinations that beauty of form results.

Among the large are the plinth, the larger quarter-round, the cavetto, the straight or reversed ogee, the bowtell, the hollow, and the large fluting.

Among the small are reckoned the listel, the square, the facet, the astragal, the beading, the small cavetto, the small fluting, and the small hollow.

Sometimes the larger mouldings are made of a very small size, the cavetto and quarter-round, for instance, according to the necessities of the work. The bowtell is a large beading, such as is often seen at the base of the column. The hollow is the reverse of what the bowtell is in relief, as may be seen at the bottom of the Corinthian column. The cavetto is a hollow-round, with but one centre; the quarter-round is exactly the reverse in relief.

We have no intention, however, of entering upon an architectural treatise. But as each art has its own principles, and as manuals of architecture are not within the reach of all, we will venture on a few examples.

It may be taken as a general rule, that a moulding ought rarely to have a projection greater than its height. It is for particular taste to select those most suited to whatever may happen to be the work in hand.

## PART II.

### HOW TO TRACE MOULDINGS GEOMETRICALLY.

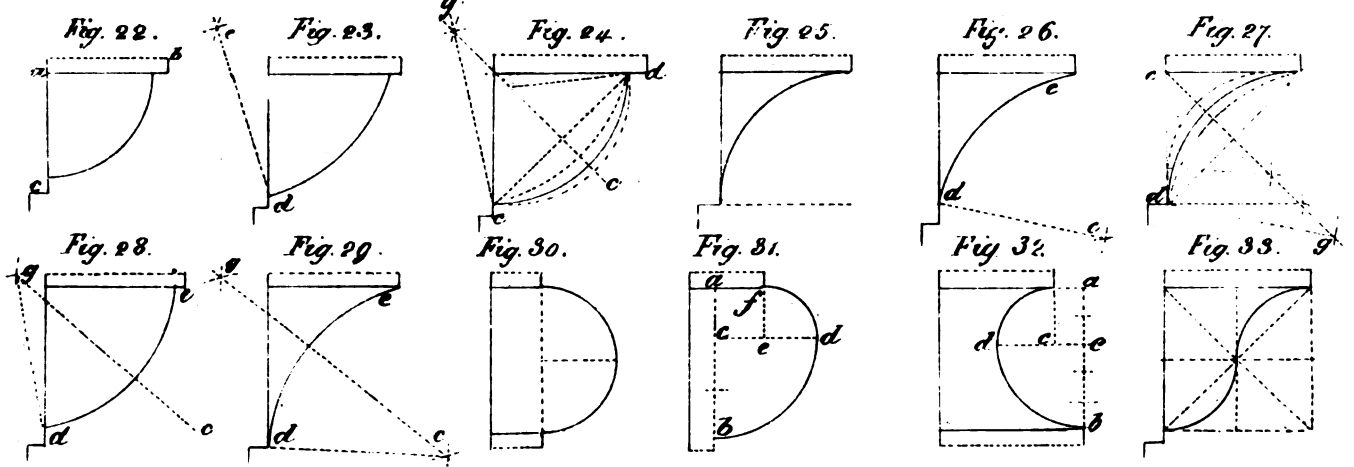
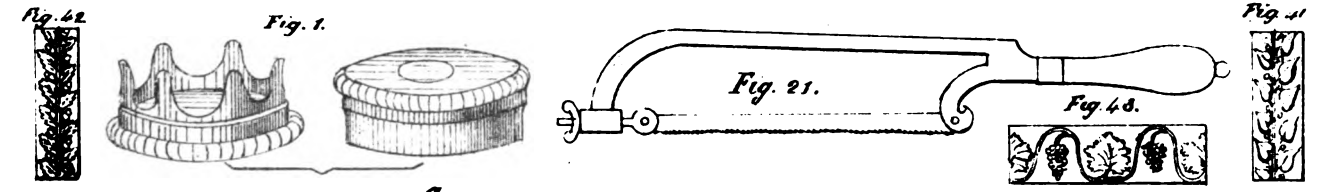
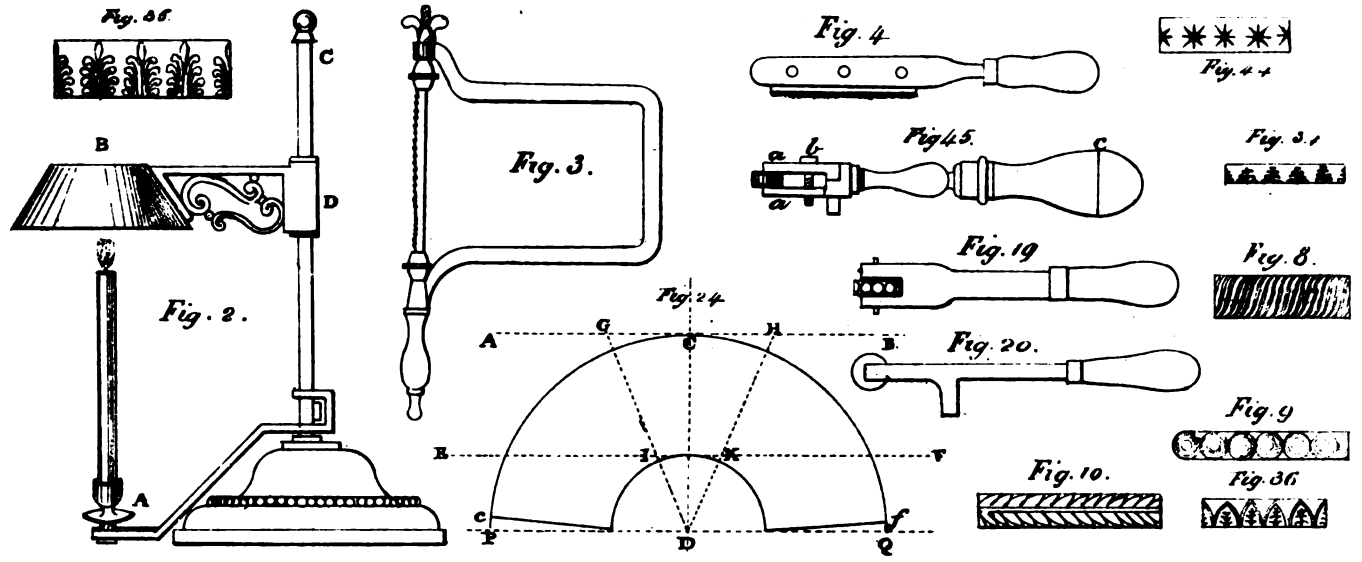
**M**OULDINGS are traced according to the following principle. Either they are given a projection equal to their height, in which case both start from one point, which is that of the intersection of the two perpendiculars, as in the quarter-round (fig. 22), or from the point *a* given by the intersection of the parallels *a, b*, and *a, c*, as in the cavetto (fig. 25); or else by taking with the compass the distance between the two angles, *d*, of the height, and *e*, of the projection, and by carrying this measurement from both points, either behind the figure to find the intersection, as at *c*, (fig. 23), and from this latter point tracing the arc *d, e*, which, as may be seen, is less than a quarter a circle, or else from the outside, as at *c* (fig. 26), and tracing the cavetto *d e*, which is itself less than a quarter of a circle.

The projection of this moulding may be infinitely varied. It may follow the figures 24 and 27, formed by two perpendiculars of equal height meeting at right angles; in this case, from the two extremities of these lines draw a perpendicular *d e*, and bisect it at *c*; then draw the line *g c*, at right angles to *d e*, and which will pass through the point of intersection and the point *c*. It is evident that between the points *d, e*, as many arcs could be drawn as there are room for different openings of the compass, when one of its points is placed at *e* or *d*, and the other on the line *g c*, at any point that may be considered desirable; if the amateur wishes the moulding to have a lesser curve than a quarter of a circle, the end of the compass must be placed beyond the point of intersection; if it is placed within this point the moulding will, on the contrary, have a greater projection than a quarter of a circle. But this latter shape is not a pleasing one, and is seldom made use of.

If the projecting of the moulding is not so great as its height, (fig. 28, and 29), or if its height be less than its projection, the perpendicular *g c*, drawn from the middle of the line *d e*, will pass in the first case beneath, and in the second above the point of intersection of the two right lines. The centre of the moulding must, as in the preceding case, be taken in this line *g c*, by placing one end of the compass at *d* or *e*, and the other on the line *g c*, at a greater or less distance, according to the projection it is intended to give the moulding.

It is the custom in moulding to place a square, small or large, according to circumstances, next quarter-rounds and cavettos, as it gives them a graceful relief; but this must be left to individual taste.

The bowtell (fig. 30), is a half-circle, whose diameter is the line drawn from one square to the other; as a consequence half the diameter or the radius is the measure of its projection. The same measurement, but in an inverse direction, applies to the hollow.





The false bowtell is a composite curve, fig. 31. It is not a semi-circle, but two arcs of two different circles. This kind of curve is termed a curve with two, three, or four centres. We will explain this. If it is with two centres, its height  $ab$ , must be divided into three equal parts, and from  $c$ , the first point of division, a perpendicular  $cd$ , must be drawn. Measure off on this perpendicular a part  $ce$ , equal to  $ac$ , and from the point  $e$ , as a centre trace a quarter of a circle  $db$ ; this will give the curve with two centres,  $fdb$ . This, we may say in passing, is the principle on which are traced the scrolls of Ionic capitals, as well as the astragal at the top of columns.

The same process pursued in an inverse direction will give the fluting in fig. 32.

This rule is the fundamental principle of all curves, converse or concave. All the above methods are purely mechanical, but those acquainted with higher mathematics are conversant with the way to form all kinds of curves.

The ogee, figs. 1, 2, and 5, Plate XXVII. and the cyma reversa, figs. 3, 4, and 6, differ only in this; in the ogee the projecting part is above and the hollow below, while in the cyma reversa the projecting part is below and the hollow above. This moulding is composed, as is seen in the plate, of two portions of a circle. An inspection of the plate will show that the projection of this moulding may be varied by widening the opening of the compass. Those to which the preference is now given are those which are but slightly curved and nearly flat, as in fig. 3.

If these principles are carried out in practice, it will be easy to give every kind of moulding the proportions and the shape that will render them pleasing to the eye. They will enable the amateur to give a graceful outline to his curves, a well balanced shape to his balusters, etc. In short they will enable him to copy all the shapes shown in fig. 11 and the following ones.

As, however, it is not sufficient to trace a figure, but it is necessary to know how to use the tool to cut it out, we will enter into a few details as to the method of making some of the most difficult mouldings.

We shall not speak of figs. 7, 8, 9, and 10. The mouldings in figs. 7 and 8 are merely squares and listels whose proportion vary according to the larger mouldings with which they happen to be associated. They are what writers on architecture term reglets.

The same remark applies to the smaller beadings which are nothing but portions of circles it is customary to detach from the main moulding with a sharp blow of the corner of the chisel. The bowtell between two squares, fig. 11, is also a portion of a circle, by the side of which are a couple of squares which are not to be detached like the beadings; in architecture it is known as the astragal.

Fig. 12 is a fluting or a portion of a hollow circle. The two squares next to it are of equal dimensions; but their size may vary according to the nature of the piece, the proportions of the fluting, and the taste of the artist. This figure is known in architecture as the trochilus. It is cut with a long gouge; the two sides of the curve must be made by using the gouge slightly on one side. As the tool cuts more deeply, it must be turned so as to make the two portions of the circle meet in the centre. One of these two portions must be commenced at the right, the other at the left, and they must join exactly in the middle. This is rather a difficult operation and demands great skill in this particular way of handling the gouge.

The curve represented in fig. 13, is that we have already explained in fig. 32, Plate XXVI. The amateur must bear in mind that the lines marked in the plate are only for the sake of explanation, it being utterly impossible to trace upon wood or any other material the divisions shown in the plate, or to place centre points outside the figure.



This curve is one that it is difficult to make upon the lathe. It will be well, indeed, to cut a pattern out of an ordinary card, or better still out of a thin piece of brass, and to try it from time to time upon the curve. This curve is much used in a great variety of objects made upon the lathe. It is a very graceful one, and is particularly desirable in joining a piece to its foot. The amateur, therefore, will do well to practice it assiduously, and to make himself master of the necessary way of handling the gouge.

Gouges of different size should be used. One of the greatest difficulties is in beginning the curve to the right and to the left, in which operation it is difficult not to be led astray by the grain of the wood. The tool must be presented quite upon its side, and rather inclined towards the hollow part. As soon as the gouge cuts freely, the amateur may apply the necessary pressure and fearlessly proceed to cut the outline of the curve.

Fig. 14 is composed of two quarter circles, the centres of which are at  $a a$ ; the principles of this figure have been given in explaining fig. 12, Plate XXVI. These quarter circles, however, are separated by a square, large or small, according to taste. It is extremely difficult to cut this round part with the gouge. The amateur will require great skill and mastery of the tool, particularly in finishing roundly close up against the angles of the square. It will be best to cut these angles with the obtuse corner of a sharp chisel, as the square ought to meet the round part perpendicularly to the axis of the piece.

Fig. 15 is a cyma reversa between two squares, the principles of which are shown in figs. 1, 2, and 3. In the plate we have distinctly marked the two centres, internal and external, of each curve, so that they may easily be discovered. This curve must be cut altogether with the gouge, unless it happens that the small square, close to the centre of the figure is too near to some other moulding to allow the gouge to approach it with sufficient closeness. Nor can the square, in this case, be cut with the ordinary chisel, it is too narrow. The amateur must take a mortice-chisel with a very long sharp edge and present it obliquely to the wood.

Figs. 16 and 17 are much the same, with the exception that their curves are portions of different circles. They are called shafferoons.

Fig. 18 is particularly pleasing in an upright. It is an egg-shaped ball composed of two portions of a circle which join at the top at a sharp angle. A perpendicular dropped from this angle ought to divide the total thickness of the moulding into two equal parts.

Fig. 19 is a band with a cavetto. It is known as a small quarter-round upon a shafferon. In order to give this moulding all the grace of which it is capable, the converse part should form a very acute angle with the concave part; the angle being exactly in the middle of the thickness.

Fig. 20 is the most difficult of all. It is a ball or sphere surmounted by another sphere. The dotted lines which form the square in which this figure is enclosed show that this sphere must be cut out of a cylinder the diameter of which must be equal to its height. The amateur will do well to accustom himself to make this figure, and all the following ones, with the gouge only. When he finds that he can make them as well with the gouge as with the chisel, he may flatter himself that he knows how to turn and is master of his tools. It is with the purpose of showing the entire shape of this figure that we have represented it as it is in the plate. If it is to be joined to other mouldings, a listel or a beading should be placed between the two, but the curve must always be as carefully finished as if it were to be quite detached.

Fig. 21 is a spheroid, surmounted by a small ball. A spheroid is a sphere flattened at its two poles. Mathematicians define it as the figure produced by the revolution of a regular oval upon its lesser axis. It follows from this definition, since an oval is composed of two smaller and two

larger circles, that a spheroid is composed of two spherical parts and of two curves uniting them. At least this is the most regular shape, but the two spherical parts can, as in the plate, be joined by two straight lines. The figure is connected with the main piece at this junction. It can also be made in the opposite direction, supposing, that is to say, that it is joined to the neighbouring mouldings by its larger axis.

Fig. 22 is an ellipsoid, a solid formed by the revolution of a semi-ellipse round its major axis.

We spoke of this curve when treating of conic sections, and explained the way to obtain it by cutting a cone obliquely to its base. The following is a method of tracing it on a plane by a continuous movement known as the gardeners' oval.

Draw a straight line, *A B*, fig. 46, and give it the same length as will be that of the major axis of the ellipse. In the centre of this straight line cut two equal perpendiculars, *C D* and *C E*, one to the right, the other to the left; the sum of their length should be equal to the length of the minor axis. From one of the extremities of the minor axis, *D*, and with a radius, *A C*, equal to half of the major axis, trace two arcs of a circle which will intersect the major axis at the points *f F* of the ellipse.

Insert a couple of pins at these points. Take a double-thread, the ends of which are fastened together, and whose length is equal to *F f*; stretch this thread by means of a pencil, and turn it round the points *F f*. The curve *A D B E*, described by the pencil, will be the required ellipse. This method is founded on the following well-known property of the ellipse. If from any point *M* in this curve two chords *M F*, *M f* are drawn to the points *F f*, their sum will always be equal to the portion *A f* of the great axis, or to its equal *B F*. The construction of the compass for tracing ovals, which is described in the second volume, is based upon this principle.

Fig. 23 is a collection of curves which end in a point. It is often very effective.

Fig. 24 is a pear-shaped figure intersected by a square and finished in the usual manner.

Fig. 25 is a spheroid, with a groove running round its diameter.

Fig. 26 is a egg-shaped figure girdled with a belt.

Fig. 27 is an egg-shaped figure divided by a groove.

Fig. 28 is a half-globe.

Fig. 29 is half an oval, cut upon its major axis.

Fig. 30 is a lamp-foot terminating in a half-round of a less diameter.

Fig. 31 is another lamp-foot terminating in a small globe. This moulding can be used the reverse way, and, by varying its outline, be applied to several different kinds of work.

Fig. 32 is the bell of a trumpet.

Fig. 33 is a kind of pestle. Its shape shows that it is used in the composition of balusters. It is also, however, used in other kinds of work.

Fig. 34 is an acorn. Tastefully used this is very effective.

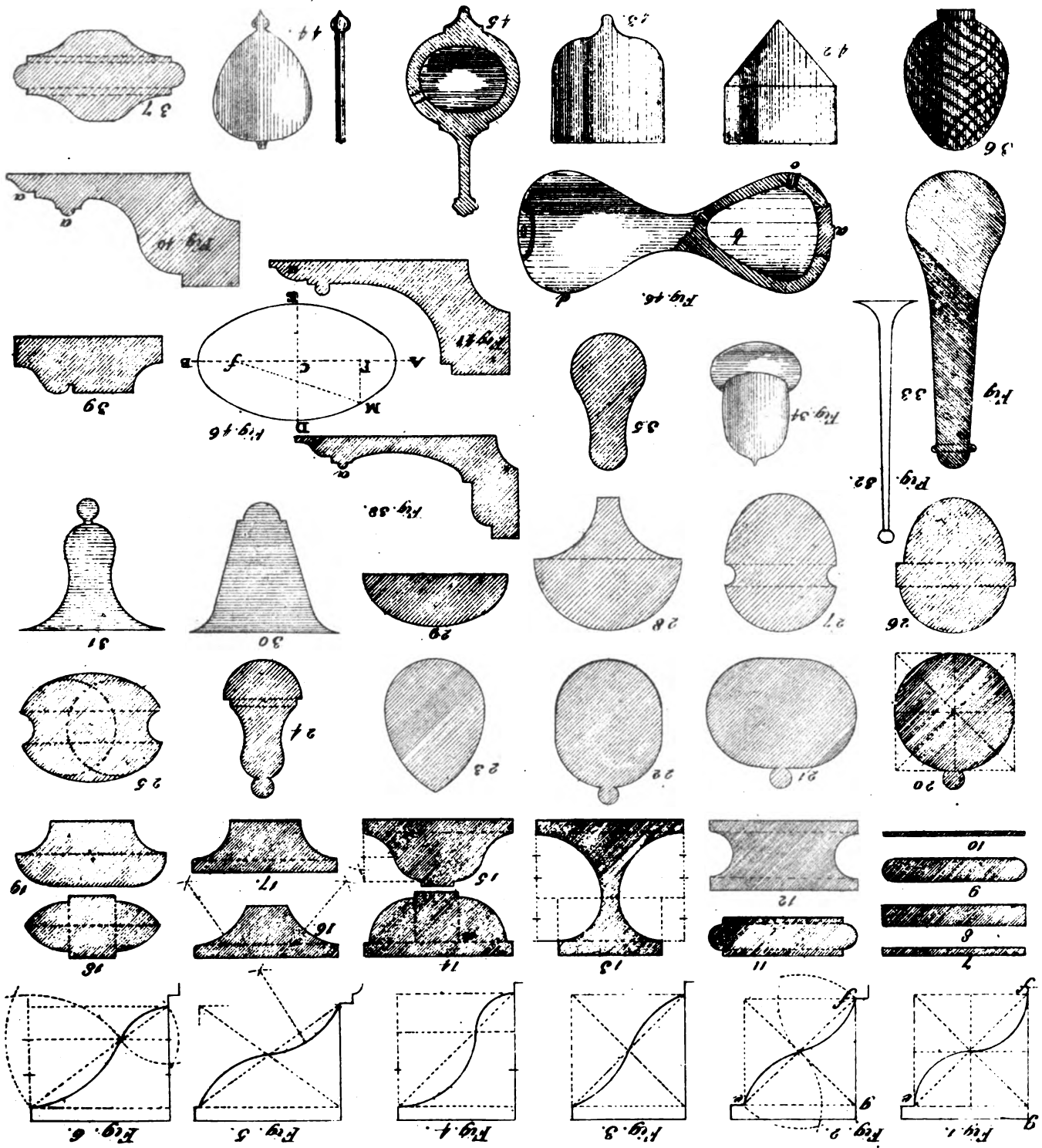
Fig. 35 is a pear, which is made to vary in shape according to the object for which it is wanted. It can be used for the end of tool-handles, but in that case the bellying part must be slighter than is shown in the plate. As the proportions of all the above mouldings, as well as of the following ones, are arbitrary, we have not attempted to give any measurements for them.

Fig. 36 is made on the lathe, and is finished by cutting out all over its surface grooves in the shape of a screw, which all tend to the top, and which crossed, as is shown in the plate, have some resemblance to a pine-apple. These grooves, which are cut with a three-sided rasp-file, ought to be farther apart towards the bottom and come closer together as they approach the top, so as to

terminate in a point. Each groove, however, ought to be composed of two inclined planes, which will give each small grain the form of an obtuse but pointed pyramid.

Fig. 37 is a bowtell between two ogees. When this moulding is well cut, and its curves properly proportioned, it has a very agreeable effect.

Figs. 38, 39, and 40 are outlines suitable for the frames of medallions or miniatures. The beadings *a, a, a, a, a* of all these mouldings can be ornamented with pearl or beads, models of which are shown in Plate XXVI. But these must be carefully placed and of different sizes. Models may even be turned of these shapes in hard wood and sent to the founder. They can afterwards be turned to suit the frames of valuable objects, but as brass, when it is not gilt, easily becomes black by the action of the atmosphere, it must be varnished in the way explained in the appendix.





## CHAPTER X.

**Wheel used with Lathe with Overhead-Motion.**

**N**OTHING is so convenient as to be able to turn with a continuous rotatory motion. If the piece being turned is of considerable size, the large wheel we have already spoken of is adapted to the lathe with the overhead-motion; but besides the fact that it requires a man to turn it, and that it may be only occasionally required, the movement thus obtained may be too strong and prove embarrassing.

The plan has therefore been adopted of adding a wheel to the lathe-bench. This wheel is turned with the foot, much in the same way as the treadle is worked. These wheels are often placed above the bench. It is thus that are fixed the wheels used with rose-turning lathes and others. But as we intend in the second volume to describe all the composite lathes, we will confine ourselves at present to the lathes with overhead-motion where the wheel is beneath the bench.

All lathe-wheels are mounted upon a shaft which revolves upon collars or between two points. These shafts are bent at right angles in the centre, or are armed at one of their extremities with a crank, which sometimes catches in the pulley which corresponds to the lathe. But there are cases in which the wheel carries both pulley and crank. The diameter of these wheels varies but little. It is usually from twenty-four to twenty-six inches; they are heavy enough to keep moving while the treadle ascends.

Various kinds of frames are constructed which are placed beneath the bench, and which are fastened between it and the floor; but as there is nothing but its own weight to keep the bench firm, much force cannot be applied to the frame without moving the bench.

Iron frames have also been inserted beneath the lathe-bench. These frames are composed of four uprights, fixed in couples, between which are the cheek-pieces to receive the shaft with the wheel and pulleys. The movement is given in the same manner. In any case the treadle starts the wheel, and an endless cord imparts the latter's motion to the lathe, and so supplies a continuous rotatory movement.

The wheels are often made of wood, very thick or weighted with lead, applied either in a groove on their circumference or against the surface. But this method takes up a great deal of room, and prevents the operator from having the full use of the whole length of his lathe. Leaden wheels, although much heavier, take up far less room and are much less embarrassing, but up till now it has always been necessary to reserve a space upon the length of the bench for a frame of some kind of shape to support a shaft, bearing two wheels, one the wheel of motion, the other the

fly-wheel. If the shaft is bent at the centre, as we have already said, it must rest, by two points made at its extremities, in a screw which can be tightened or loosened at will, or between cheek-pieces. This is always so much space lost from the length of the lathe-bench, which it is often necessary to have as long as possible.

The manner in which the wheel we are about to describe is mounted, has this great advantage, it occupies but little space. This wheel has a brass nave in its centre, the hole of which is pierced to receive the shaft (fig. 5, Plate XXIV.), upon which it is to turn. As the plate shows, this shaft has towards its centre a shoulder B, which helps to fix it on the uprights placed on the left cross-pieces, by means of a strong nut A. Upon this upright, shown on a large scale in fig. 7, a groove is cut in which the shaft ascends and descends when the cord is tightened. Between the nut and the upright is placed a brass collar, of about the same diameter as the shoulder. The other part of the bolt is turned to a cylindrical shape, and of the width of the hole made in the nave. At its extremity is a six-sided part having a cone, *e*, terminating in a portion cut into a screw to enter the nut that fastens the whole. Upon the spokes of the wheel are fastened brass circles of various diameters to receive the endless cord, and impart more or less speed to the motion of the lathe. In one of the four spokes is a groove to receive a bolt that acts as a winch-pin. This bolt ought to be about three or three and a half inches from the centre. It must be placed further away if it is desired to increase the motive power, and nearer to increase the speed. These wheels may, like the others, be made of wood or of wood weighted with lead. Fig. 1, Plate XXXVI. shows one completely finished.

Fig. 1, Plate XXIV represents another method of fixing the wheels beneath. Arranged in this way they take up less room, and it is easier to stretch the cord. The plate shows the disposition of this arrangement as regards the feet to the left of the bench, seen from the inside (we suppose the feet to be about three inches from the end of the bench. Two cheek-pieces F, F, secure the two feet and are fastened at G on the hinder foot by a bolt. At the other end of the cheek piece is a handle H, which is just as long as the width of the foot of the bench; it is pierced, like the cheek piece, with a hole to receive the bolt K. It will be seen that in spite of this mobility the cheek pieces firmly secure the feet of the bench and do not give.

A thread is cut between the bolt K and the front foot to receive the screw L, which fixes the wheel at the height required, according as it is desired to stretch the cord more or less tightly. This screw rests upon a bracket which is fixed to the foot of the bench. On the sides of the cheek pieces, and perpendicularly to the foot of the bench are some tin or sometimes brass collars supporting a shaft N, with two shoulders, for the purpose of receiving on its outer side the fly-wheel and the circles for the endless cord. On the inner end is the crank P, which is moved by the treadle.

Figs. 6, 8, and 9, represent on a larger scale the fittings of this wheel. The different parts are marked with the same letters as in fig. 1.

It will be seen that with this arrangement the whole length of the bench is left free for the amateur. If the bench is a valuable one it will be unnecessary to pierce it for the cord. The latter, when it can be very easily withdrawn, allows the continuous movement produced by the wheel to be instantaneously changed for the come-and-go one that is absolutely necessary in order to cut the thread of the screw.

We have hitherto assumed that the lathe was placed in such a way that the pulleys placed behind the shaft are outside the bed and level with the pulleys on the fly-wheel.

If the end of the shaft is not suitable for the reception of a pulley, a pulley with several grooves must be placed on the square of the crank; on this pulley a bolt *e* must be fixed, similar

to that we have already spoke of, and which will take the place of the crank. If the connection between the pulleys of the wheel and those of the lathe has been well calculated, the cord will pass into the groove of the bench. The inner angles of the groove must be rounded in this place; if they are not they will soon cut the cord.

The wheels used in this kind of arrangement must not be constructed in the same way as those we have just been describing, which are composed of fellies and spokes, made either of wood or of lead.

They must be solid, of from an inch to an inch and a third in thickness, and with a diameter of about twenty-four or twenty-six inches.

They are made of four pieces of oak or walnut-wood, each of which is a quarter of a circle, and the grain of which should run in the direction of the chord of the arc. The angle at the apex of each of these pieces of wood is cut away to the extent of about three inches, in order to leave room for a nave, which is made out of a piece of wood of the same kind as that used for the body of the wheel, and is about six inches square. If the wheels were all composed of one piece, the grain would end at the circumference and the wood would soon warp and split.

In order to join the pieces a tongue is cut on each of the four sides of the nave, and a groove at the top of each of the other four pieces; these are then joined together by cutting a groove in their edges, and placing in them false tongue-pieces, as we have already described in our chapter on joiners' work.

To insure greater solidity, these false-tongues are made of two pieces, and a false tenon is inserted into two mortises cut at about five inches from the circumference. A couple of pins keep the tenon in its place, and impart great solidity to the wheel.

The amateur may, however, dispense with the nave, and content himself with joining the four pieces of wood together at their apex; in either case it will be well to strengthen the centre of the wheel with a brass plate of about three inches in diameter, which is screwed on to the wood. This increases the general solidity, and prevents the shaft from shifting.

In order to give power to the wheel a leaden circlet as wide as the thickness of the wood is added to the circumference. This should be nearly an inch thick. It is composed of four leaden bands cast in a wooden mould of the proper shape and dimensions, and which are applied on the wheel and adjusted to the proper curves with a mallet. The precaution must be taken of not placing the leaden joints exactly above the wooden ones. They are then fastened with strong screws, inserted at every five or six inches, and driven home till their heads are below the surface of the lead.

Nothing is more fatiguing, in turning the wheel, than to be obliged to place the hand on it every time one wishes to put it in motion. To avoid this trouble the wheel must be weighted so that wherever it stops the treadle will be raised. This is done by placing a piece of lead in a recess about four inches square cut in the circumference close to the square in which rests the crank. This weight is screwed to the leaden rim; but as the weight is beneath, it must be put in its place before the rim is adjusted.

When the wheel has been thus fixed, it may with advantage be left to itself for a few days, to give the wood time to settle down. After this interval add the mandril, and place it on the lathe; ascertain if it turns truly and remove any inequalities it may possess.

If the amateur wishes to give this wheel a highly finished appearance, he may cover it with a veneer of precious wood; this must be continued as far as the edge of the circumference.



Upon this veneer, or upon the body of the wheel itself, if the amateur has preferred to leave it in its original state, are placed two circles of different diameters for the endless cord of the lathe.

We have now to speak of a new kind of treadle peculiar to this wheel which is as solid as it is convenient. It is shown in fig. 1. We will describe its shape and its advantages. Along the whole length of the lathe-bench is a cross piece, *q*, fastened by its two ends by pivots that work in small collars let into the hind foot and kept in place by screws. Two arms, *r*, *r*, are added to this cross piece; the first opposite the winch-handle of the wheel, the second at a distance determined by the length of the lathe-bench.

On the two ends of these arms are a couple of squares, to which are attached bolt-pins turned to receive the loops of the foot-board *s*, which by this means lends itself to the movement of the foot. The first arm is furnished with a hook for the double strap of the wheel.

The advantage of this treadle is that on whatever part of it the weight of the foot is applied the effect is always the same, while with others the nearer the foot is placed to the joint the less is the power generated. Still when a long and thick piece is being turned it is impossible to apply the foot at the upper part of the treadle, and the foot-board, which then bends beneath the foot, imparts but little motion to the wheel, thus uselessly exhausting the turner.

Every amateur fixes the wheel of his lathe according to his taste and the space he has to dispose of. Those upon the lathe may be looked upon as an additional ornament, but they often interfere with the light in a not too well lighted workshop, or in one in which the lathe-benches are crowded together one behind the other. We will not at present speak of the lathes whose wheels are adjusted to uprights fixed above the bench, as this is the method adopted with composite-lathes which will be treated of in our second volume.

Just now we are confining ourselves to the ordinary lathe with overhead-motion, and we can assure our readers that the wheels just described unites almost every advantage.

One of the principle of these advantages is that a rotatory movement, the centre of which is some six or seven feet from the floor, imparts a series of violent jerks to the pieces being turned, unless the lathe-bed be very heavy or firmly fastened to the wall; while when the wheel is below the bench there is very little vibration.

If the amateur does not possess such a lathe, and does not care to go to the expense of purchasing one, he can remedy the want by several expedients, which to tell the truth, however, give a great deal of trouble, take up space that can ill be spared, and that cannot be had recourse to in many workshops.

We may, however, say that we have seen turners of much experience take advantage of circumstances to place the wheels of their lathes in a highly ingenious manner.

We shall not attempt to describe all their expedients, but we will give an example of one, which may serve as a general hint.

The room was a tolerably lofty one, and the turner had placed his lathe close against a window hard by one of the corners of the workshop. He had fastened against the wall, opposite to him and just above the lathe, two large oaken cross-pieces, kept in a horizontal position by a couple of iron bars bent at right angles so as to clamp the cross-pieces, and firmly fixed to the flooring. Upon these cross-pieces was a second frame of the same size, which fastened to the first by couple a of strong pivots, could only be raised or lowered at its end nearest to the wall. These two pieces thus formed an angle which could be increased at will by raising the upper frame.

Upon this frame, and nearer its raised end than the other were placed some strong cushions which were kept in their position by means of a box attached to the frame. Upon these cushions rested the spindle which supported the two wheels, viz. the fly-wheel and the wheel which guided the lathe (the fly-wheel passed between the arms of the two frames which appeared to be only one as they lay close to each other. Its diameter was about three feet, and its circumference, which was formed by the union of the ribs, which are called fellies by wheelwrights, was very massive in order to make it heavy. By this means the spindle turned upon its two ends and worked more easily. To the left end of the spindle, and kept in its place by means of a screw, was attached a square crank which guided the whole machine.

One may easily perceive that a continuous motion may be imparted to the spindle by means of an endless cord passing over a pulley. The tension of this cord may be easily increased by elevating the upper frame as the occasion may require. This is done very readily by placing at the end of each transom of the frame a wooden-screw which procures the inclination necessary for stretching the cord. To the crank there is attached a cord which reaches the treadle of the lathe. In this way a very great force and a gentle motion may be obtained, and the motion of the wheel will leave no perceptible impression either on the bench or the work. This mechanism, very simple in itself, sufficed to set going a very powerful lathe with overhead-motion. To it was attached a very powerful *oval* upon which we have turned a piece of mahogany eighteen inches long, eleven to twelve inches broad, and two inches thick, with as much ease as an ordinary draughtsman is turned.

This way of placing the wheel, though good in itself, is suitable only for a workman or an amateur who is occupied in executing works on a large scale. It is seldom possible to make these insertions into the wall, nor do we always wish to do so. Besides the lathe once in this position can no longer be moved elsewhere. It is not for us to give advice. We merely feel bound to enumerate the various methods, leaving it to the amateur to choose that which best suits him.

## CHAPTER XI.

*Different Pieces of Architecture.*

## PART I.

## TURNING A BALUSTER.

**W**E shall assume, henceforth, that the pieces we are about to describe are worked upon the lathe with the overhead-motion. Pieces of a certain size and length may be turned between two points. But we shall not refer to this matter now, as we have already said enough. Although the making of a baluster involves some difficulties even for those who pretend to make them well, yet it is the simplest of the pieces that we shall describe. Trace with the greatest accuracy a baluster with its proper proportions upon a somewhat thick piece of paper. If the amateur is anxious to know the principles of their construction he will find them in any good treatise on architecture. We shall content ourselves with the outlines as represented in Plate XXVIII.

The best way to secure the proportions is to extend all the other lines which determine each part of the moulding to a line drawn parallel to the axis of the baluster. In this way the distance between each of them may be determined with the greatest accuracy.

Take a piece of well-seasoned wood and place it on the lathe in a suitable chuck, and turn it into a cylinder. As the narrow fillet at the top of the baluster (fig. 1, Plate XXVIII.) is the thickest part of it next to the body and the plinth, then measure its thickness very carefully with the callipers and reduce the piece to the same size. Then mark the length of the fillet with a finely-pointed chisel, taking care to cut the wood very freely, neatly, and at right angles. Deepen this cutting as much as may be necessary, reduce the cylinder to the size of the resulting square, and cut the wood right opposite to the already deepened mark, in such a way that the side of the fillet and the surface of the square shall be polished by the first cut. This result may always be obtained if the chisel is sharp, and one understands thoroughly its manipulation. Then (with the corner of a sharp chisel) mark the size of the square and deepen it sufficiently. Nothing is so difficult as to cut the wood at right angles, so as not to leave any marks of the chisel perceptible.

To insure success in this operation, the tool must always be applied to the piece with the same angle of inclination, although it must be insensibly withdrawn each time that the treadle ascends, in order that the bottom of the tool which presents the appearance of a long point-tool may not mark the wood. Make the size of the piece suitable to the height of the resulting quarter-round, deepen the cutting with a chisel until the diameter of the fillet at the head of the piece has been reached to cut the wood very clearly and finely. This operation will soon produce the fillet. Then take a narrow gouge and make the quarter-round, which, according to the principle laid down in Chapter IX. must have its centre opposite the bottom of the square whence it proceeds. These curves are very difficult to execute well. Use only the side of the gouge and apply it only when the treadle descends, lest you leave a little mark upon the piece with each motion of the treadle. If the moulding is so small that one cannot attain the required perfection with an ordinary gouge, a bevelled-chisel must be used, or a cross-cutting chisel applied with an inclination in the direction of a tangent. Care must be taken not to scratch the wood, but merely to make a clean cut.

After the fillet comes the collar of the baluster, then an astragal and a small moulding, the height of which must have been previously determined with accuracy. Deepen the cutting with a chisel until the exact diameter of the same has been reached. But as the edge following must be joined under a very slight mark need only be made, in order to be able to resume it with the gouge. Next, determine the size of the edge or collar between the final mouldings of the baluster and the astragal with a small chisel, or by the means already pointed out, inclined towards the piece, cut it very quickly and evenly. Reduce the edge to the required diameter, and make the astragal round. This is a difficult operation, inasmuch as the rod being very narrow, one has no support for the tool.

The body of the baluster involves some difficulty in the making. First, with a gouge reduce the neck to almost the required thickness, then from the bottom of the small moulding mark the total height as far as the small square which lies at the bottom of the round piece. Prepare in like manner the part that has been rounded at the top, and if you carry accuracy to the furthest limit, take several points upon the pattern and as many upon the piece. The more points there are the greater is the certainty of success. Reduce them to the required diameter, and with a finely cutting chisel remove the wood which exceeds the parts which have already been reduced to their proper size, and finish by giving it all the necessary grace and elegance of outline. It must be observed that the body, properly speaking, is of a spherical shape, make the small square underneath carefully, then the ogee and the other square. Next make the scolia, which may be seen to be one of the kind we have already described, as having two centres; but owing to its smallness the compass cannot be applied to it. Practice and the eye will suffice to give it the form it ought to possess. It is well to remark that these curves are made with a gouge which cuts perfectly, and has been sharpened on an oilstone. In order to cut without leaving the marks of the tool in the same way as the chisel, besides the precaution of taking one smaller than the groove, cut the wood by drawing the point of the gouge down from right to left, and reversing it slightly. By this means the gouge in presenting an oblique-cutting will do the work of a chisel and will polish also. Nothing more remains but a square, the ogee and the large square or plinth which terminates the bore.

To give more grace to the baluster the bottom of the body should appear to be like a ball posed on a flat surface. To do this, it is enough to make a slight hollow with the corner of the chisel between this ball and the small square, thus detaching one from the other.

If the baluster is to form a part of a piece of architecture, a tenon to fix it in its place must be made at each end. If several are worked, they must be all made exactly alike. This, of course, is a difficult thing to do. A well-trained hand, and an accurately-seeing eye, are required, despite the constant care taken in measuring, in order that all the pieces should resemble each other. In this case, we would advise the amateur to use an expedient which we have tried, and with great success, in order to determine the respective distances of the mouldings from each other. Make a gauge out of a strip of iron, and mark upon it all the parts which the mouldings are to occupy. Bring them to a point with a file, before placing it in contact with the work when the several positions will be fairly determined. It would be very useful also that one of the ends should have an ogee, which should rest on the point of departure, and that the other should have a point to determine the height of the baluster (which should be the same in all). Fig. 2 represents the most common baluster after the one the making of which we have just described. All the parts of the former are plain and prominent. A simple inspection of the figure proves this. After what we have said by way of teaching the amateur how to make a baluster, we do not think we ought to say any more. It is enough to trace the outlines to extend or carry them, as we have already said, to a line drawn parallel to the height of the piece to be turned, and to carefully follow the proportions.

Fig. 3 represents a baluster for a long time used only in ancient staircases. This kind of baluster, however, is employed in very elegant constructions, such as the pulpit of St. Sulpice in Paris. This is a charming work. This form is repeated in fig. 4, only that it consists of two balusters in conjunction with the ends opposed to each other.

Fig. 5 is more like what is called a *sheath* than a baluster, although it is ranked in the latter class. But whatever it be used for, its shape is very rich, and when used as a pedestal it produces a very good effect. When so used its surface must be very even so that it may hold a small statue of bronze, porcelain, or anything else.

Those represented by fig. 6 and 7 are but little used. We have merely referred to them to satisfy our readers. Fig. 7 in particular is nothing but a baluster very much like those represented by figs. 1 and 2, only reversed.

Of the three pedestals represented by figs. 8, 9, and 10, that represented by fig. 8 is without any doubt most in consonance with the principles of architecture. It will be sufficient if we enumerate its mouldings. The part at the bottom is called the *Plinth*, next comes a large ogee or head, then a reversed ogee, then a square and a conge which ends in the plain part of the pedestal. Its height is determined by the number of mouldings which the order, to which it belongs, demands. The principles are to be found in works on architecture. And, lastly, there come a square, an ogee, another square, then a corona, which could not be represented here on account of the fineness of the mouldings, but the details of which we shall hereafter give when we proceed to give instructions for the making of an entire column. Then come a reserved ogee and a square. These two last parts form what is called a *Cyma*. At the top there is a square equal to the plain part of the pedestal upon which may be placed anything that one likes. But as a pedestal is from its nature destined to be exposed to the air and consequently to the rain the top of it inclines slightly towards the sides of the cyma.

It is very difficult to make this piece and those similar to it well. The moulding must be cut very finely, the angles must be very acute, the hollows well defined and the smooth parts in particular must be very even and without any swellings. Pieces of this sort are very difficult to be polished as it very frequently happens that the angles are blunted in polishing them, the outlines

of the curves are altered and the marks most difficult to be effaced are left in the hollows. We will always maintain that the only plan to be adopted with advantage is to use small wooden reglets trimmed according to the shape of the places they are to occupy. This operation, however, is very long and laborious. The pedestal represented by fig 9. is not quite so beautiful as the preceding one but for the sake of variety we felt bound to mention it. Fig. 10 represents a pedestal more like a baluster without any proportions than a pedestal. One may remark that the points *a a* represent the centres of two curves which form the body. We shall have occasion to give models of other pedestals when we come to speak of the different columns, the bases of which together with a portion of the trunk, are often used to form very beautiful pedestals called Cippi or truncated columns.

It may happen that the design selected has not the proportions intended to be given to the piece that is to be worked and that consequently one is obliged to enlarge or reduce it. This may easily be done by means of two scales divided into the same number of equal parts. The first should be proportional to the design that is to be reduced, and the second to that which is to be worked. If, for example, you wish to reduce the design to one-half, the first scale must be double that of the second. Measure how many parts of the first scale each moulding of the first design contains and give to the design intended to be executed the same number parts of the second scale.

## PART II.

### METHOD OF TRACING AND WORKING A COLUMN OF THE DORIC ORDER UPON THE LATHE.

**N**OTHING is so great an ornament to a cabinet as models of different machines, vases, and other objects, worked either with the lathe or a plane. Of all these the most valuable is a collection of the fine orders of architecture. It is one of the most difficult enterprises that an amateur can possibly undertake. It is extremely rare that one succeeds perfectly in the attempt, especially when dealing with the Ionic, the Corinthian, and the Composite orders, on account of the difficulty of executing their chapters on a small scale. We shall not attempt to give a description of working them. There are very few amateurs who would take pleasure in it, and besides it would carry us too far from our main object. However, after the satisfaction we have felt in executing a portion of them, we think we ought, for the benefit of the small number of readers who may be tempted to undertake the matter, to describe the Doric and Tuscan orders, the bases and capitals of which can be wrought upon the lathe. The following is the method we adopted, in order to secure accurate work.

We took from Vitruvius the proportions which he gives of this order. We determined the exact height which we intended to give to the column upon its pedestal, and surrounded with its entablature. The height determines the diameter of the base of the column, and the diameter serves in its turn to fix the proportions of all the other parts of the column and the pieces that accompany it, such as the pedestal and the entablature.

The half of this diameter is called a modulus, and in all the orders is divided into twelve equal parts.

We have traced with the greatest accuracy all the parts of the order we adapted, in Plates XXIX., XXX., XXXI., and XXXII., and we have marked right opposite in numbers upon another design, Plate XXIX., the measure of each portion.

Upon a stiff sheet of paper begin by drawing an indefinite line A B, which represents the axis of the column fig. 1, Plate XXIX., and determine the diameter which the column ought to have close to its base, according to the height intended to be given to it. Take exactly one half of this diameter. This is what we call the modulus, and is the measure to which are referred all those of the order which we wish to execute. Divide this modulus into twelve equal parts (fig. 5) and starting from a horizontal line perpendicular to the one already drawn, one at another line already drawn parallel to (and at some distance from) the first, E F. To this line we shall refer all the measures we are now about to speak of. Take a compass and mark out five moduli, and

four parts or twelfths of a modulus, starting from the horizontal line *c d*. This will be the height of the pedestal. From this point mark out upon the same line five moduli, which will give the height of the column as far as the top of the astragal. Mark out a seventh modulus, which will give the total height of the capital. Lastly, mark out four more moduli, so as to contain all the mouldings of the entablature. The only thing now remaining is to fix the proportions of each number of the mouldings. To do this, draw from each of the points of division upon the line *e f*, lines parallel to the line *c d*, according to the following proportions.

Take four parts or twelfths of a modulus, which will form the height of the plinth, two and a half for the square which follows, and two for the talon. Place one more for the small tore, and one-half for the square following. Starting from the six parts which form the bore of the pedestal place four moduli, which will form the height between the cornice and the base. The cornice of the pedestal must have six parts, viz. a part and a half for the fluting, two and a half for the corona, one-half for the square that follows, one part for the quarter-round, and a half for the square which terminates the pedestal.

The base of the column will have one modulus, and this modulus, or the twelve parts into which it is divided, will be thus apportioned—six for the socia, four for the ogee, one and a quarter for the beading, and three-fourths for the square. The total height of the column from the top of the pedestal to the bottom of the entablature should have sixteen moduli, the capital and bore included. The fifteenth moduli of this height will terminate exactly at the bottom top of the astragal. The astragal is composed of a beading and a square at the bottom. Their dimensions are taken according to the fifteenth modulus, namely, one part for the beading and a half for the square. One modulus remains for the capital and is divided in the following manner:—Four parts for the collar; thirteen halves for the three small squares surmounting it (the two last squares are replaced by a beading in the Doric capital of Vignole), two and a half for the quarter round, two and a half for the square, one for the fluting, and one half for the little square.

The entablature is composed of four moduli distributed as follows:—Five parts to the plain at the top of the column, and from that point down to the bottom, four parts. The height will be two parts, including the fillet at the top, then comes the reglet, which has two parts. The triglyph is one and a half parts in height, but of this height two parts are reserved for the top of the flutings, which, therefore, are one modulus and four parts in height. At the top of the triglyph there is an edge two parts in width, then a square half a part in width, and next, a quarter-round, two parts in width. The edge that follows, and into which the brackets are let, are three and a half parts, but the bracket itself is only three parts in thickness. The fluting attached to the bracket is one part thick. After this fluting there comes a square three and a half parts, then a fluting one part, then a cyma having two parts, and lastly, a small square half a part.

In all these proportions as many parallel lines must have been drawn with a pencil as there are divisions. Now we must determine the projection. To do this we must always reckon from the line which passes through the axis of the column.

Take a modulus and extend it to the right and left at the middle point in the height of the pedestal, and draw two perpendicular lines to the base on two parallel to the axis of the column. This line will determine the size of the panel, and the two latter lines ought to unite exactly with the modulus which served as the measure, and which is one-half the diameter of the column at its base.

The border which surrounds the panel will have one and half parts, then comes an edge



which has four parts. The projection of the moulding of the base of the pedestal is in all four parts for the fluting and the plinth, and the total projections of the cornice of the same pedestal is six parts. It will be easy to determine the projection of each since we have the size of each.

The diameter of the column being two moduli, its base which is as we have already stated, one modulus in height, will have in all a projection of five and half parts at the large square which must be perpendicular to the pedestal. The ogee is the same size as the square. The beading has a projection of two and half parts, the square half part, and lastly the bottom of the column, has five and half parts less than the ogee.

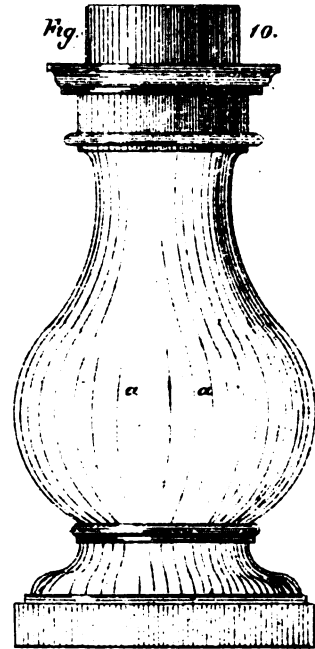
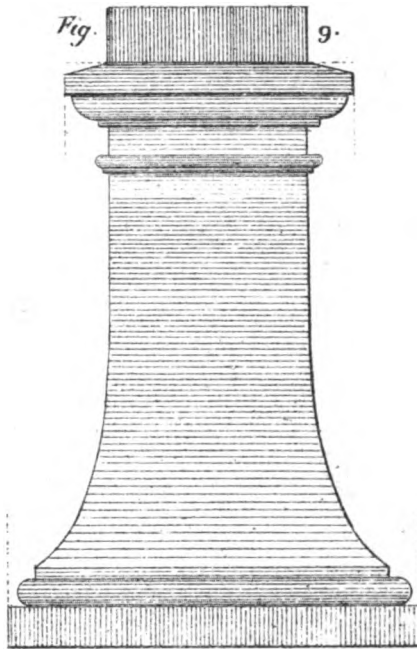
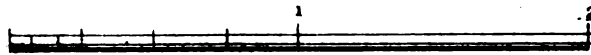
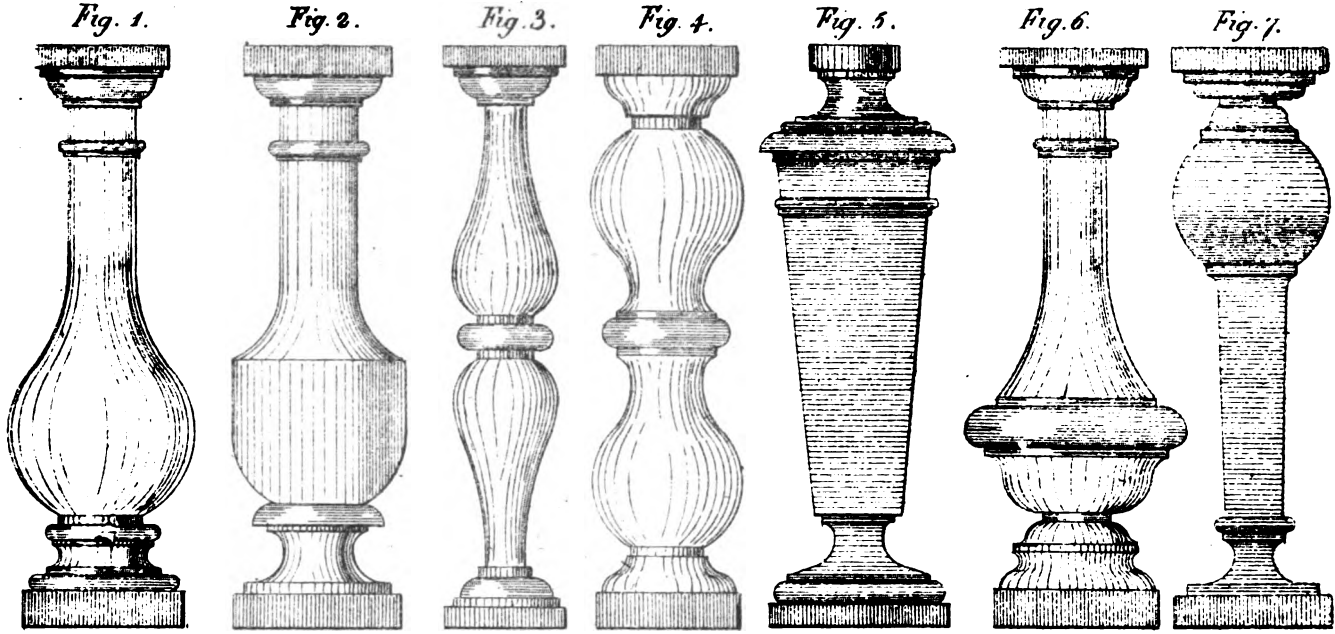
For the present we take it for granted that it is composed of two lines, determined by the diameter of the base and the latter by that of the height which as we have seen contains twenty parts, whilst the base has twenty-four. The astragal has a projection of one part and a half, and the capital five parts, in the manner described in the figure.

The first portion of the entablature is a square which ought to be perpendicular to the neck of the column, as indicated by the number ten. The height of the column contains twenty parts. The portion following which supports the gates ought to exceed by a half-part. The gates project one part, the reglet at the top projects a half-part beyond the gutter, whilst the portion which comes next retreats by two parts, and the triglyphs which rest thereon project by only two parts. The size of the triglyph is one modulus or twelve parts, and the distance is eighteen parts. The space between the angle of the entablature and the triglyph contains four parts which added to the six which form half its length give ten parts, which number agrees with that of the half-diameter of the upper part of the column. The projection of the moulding beyond the triglyph contains four and half parts. This moulding is composed of a square which joins on in the same line to the upper part of the triglyph, a beading which is not attached to the triglyph a quarter-round, and lastly a square on which rest the brackets. The length of the brackets is twelve and half parts, the waved moulding is one part and a half, and finally the cyma is four parts. The numbers placed at the top of the figure denotes the respective projections.

As this is the method which we employed with such perfect success in working columns we thought that we could not do better than give a full sketch of all the dimensions we adopted. By so doing we are convinced that there is not one of our readers who could not execute it as well as we did provided only he brings to his work great pains, attention and patience. We have now to trace the swelling of the column. Divide the total height of the axis ( $\varepsilon f$ , fig. 1, Plate XXXII.) into three equal parts. From the point  $f$ , at a third of this height erect the perpendicular line  $u$ , of indefinite length to the axis  $f$ , and from the point  $d$ , as centre, and with a compass extend to a distance equal to the total height of the axis, make a segment at  $u$ , upon the line  $u f$ , and draw the line  $d u$ . Next divide the total height of the axis into eighteen equal parts, and from the points of these divisions draw straight lines terminating at the point  $u$ . Then take the length  $t d$ , which ought to be equal to the modulus, apply it to the lines from  $\alpha$  to  $i$ , and so on. In this way we shall get the points  $d i$ , &c, through which the curves of the swelling are to pass.

If this operation be continued to the base it is easy to see from a simple inspection of the figure that the lower part of the column will be diminished in the same degree. But this method is not pleasing to the eye and is seldom used; it being thought sufficient to diminish the upper part leaving the lower third cylindrical.

The following is another method of tracing the diminution. From the point  $s$  (fig. 4, Plate XXIX.) as centre, draw the semicircle  $a, q, b$ , and from the point  $c$  one of the ends of the upper





diameter of the column let fall a line parallel to the axis cutting the semicircle in  $b$ . Divide the part of the semicircle  $a b$  into as many equal parts as the line  $s s$ , which is equal to two-thirds of the axis, and from each point of division in the line  $s s$  draw lines parallel to  $a b$ . Then from each point of division in the semicircle erect lines parallel to the axis. The points of section  $o, m, t, g, e$ , and  $c$  will be the points through which the curves of the swelling must pass.

The only thing now to do is practically to execute the principles here laid down.

All woods are liable to warp, and to obviate this inconvenience we have taken all the precautions which experience has suggested. The column considered as a piece for the lathe, having a great height compared with its diameter might dry unequally, and so become oval or curved. We took a piece of mahogany that had been well dried and seasoned, as this wood is, in our opinion, the best fitted for being worked on the lathe or plane. We turned it between two points much larger than was necessary, and having placed it in a boring collar, pierced its whole length with a hole of three-twelfths in diameter, or thereabouts. Although it was turned tolerably round and with a gouge only, yet when left on the bench for a fortnight, we found on replacing it on the lathe that it had lost its roundness, and was no longer true. Having then redressed and made it round again, we laid it aside, for some time, once more.

During this interval we prepared the capital on the lathe, and when, at the end of a few days, during which we were preparing some other pieces, the warping had produced its full effect, we replaced it on the lathe as on the first occasion, bestowing the greatest care in giving it the proper proportions, dressing the coping-plate top and bottom, and reducing it to the proper thickness. After which we smoothed its upper surface with bastard-files, and polished it with sand paper.

We then made its four sides perfectly square, and afterwards with a gouge which makes wavy lines, by means of a sharp point, we traced on the board the thickness and size of the mouldings which it was to bear. It is well understood that there is no joiner's tool that can make mouldings so fine, also that the smallness of the object and the short length of its sides do not allow us to have recourse to the method. We then made at the forge, and afterwards with a file, as many kinds of templates, as we had mouldings to make. We shall shortly explain the manner in which are made those tools, by the aid of which we completed and almost polished all these mouldings, after having prepared them with small gouges and very fine chisels. In all these operations attention must be paid to preserving the forms, to make the outlines of the mouldings such that at their junction in an angle they should be vertical with respect to each other, to make them all form but one straight line, and to cutting the wood freely and neatly. But this is a very long process.

It is easier to make the board of the capital from a separate piece, but if it is made of wood laid crosswise, wooden mouldings with wire-joints must be fastened to the two faces. They are used to give the board a colour like the rest of the piece. Every one knows that wood standing has not the same colour as its fibre, and is polished with more difficulty. Immediately after the collar of the cincture of the capital comes the astragal and its square. The junction, which workmen call the joint of the capital with the column ought to be made between the collar and the astragal, and should be scarcely perceptible.

It remains now to complete the shaft of the column, which should have been prepared in the manner indicated, and some days beforehand, so that the full effect of the warping of the wood may be seen. It will be then advisable to reduce it almost to the dimensions intended to be given to it, so that there may be as little wood as possible to be removed when completing it. It is easy

to understand that the less wood to be removed the less will be the effect of the air upon it. To hide the joints as much as possible one ought to unite over the whole length of the shaft the arch, and the square at the bottom terminating the column. Turn, firstly, the largest and the large tore, which, with the small square, form the whole base of this order of architecture, and dress and square the socket perfectly after having pierced its centre with a hole similar to that of the column. This piece may be made, like the capping-plate, of cross-pieces of wood, by re-covering.

We must now concern ourselves with the pedestal suitable to this order. Take a plane and dress a parallelipid, so that all its sides shall be square and equal to the thickness of the plain of the pedestal, though not quite so, seeing that the wood shrinks. Allow it to dry long enough to allow the full effects of its tendency to warp to develop themselves before it is finished. During this we shall occupy ourselves with the mouldings which are to ornament the pedestal. To execute them small rods of wood should be carefully prepared, to the total height and length of the proposed mouldings, and here we must not lose sight of the fact that, considering the extreme smallness of the objects an error of a quarter of the twelfth part of an inch becomes considerable. Apply the gouge gently lest the thickness of the mark should produce uncertainty as to its true dimensions, allow these rods to dry, and then give them the last touch with a hollow-plane, the iron plate of which is upright, so as to remove very small pieces of the wood.

But the parallelipid ought to have the body of the pedestal to the required height. To do this, trace with a square upon such face some marks which must unite, dress the upper and lower surfaces with great care, although neither the one nor the other is visible when the column is finished. The upper surface will be concealed by the socket, which has the same dimensions as the body of the pedestal, and the lower will rest on the block on which the column is placed. The least inequality in either one or the other will derange the equilibrium of the column. Mark the height of the mouldings on the parallelipid from the top to the bottom, make a few uneven spots in this place, so that the glue may hold well, to make as many for the rods upon the face which is to be glued by means of a mitre-square the triangles to the length required so that the interior angles should abut exactly on those of the parallelipid; but before irrevocably fixing these pieces in their places, make certain that they are angles of quite 45 degrees, number. This ought to be the size of each supposing the triangle to be correct. Place the triangles in position and (by means of a smooth file), make the angle or angles fit exactly, and on them as well as upon the parallelipid make marks for the purpose of distinction and glue them in their places. Fit them lightly and carefully glue three of them in this way. As to the fourth, adjust and glue it in its place like the others.

One may now conceive how important it is that the parallelipid should be perfectly dry and exhibit no signs of further change before glueing the triangles thereto. If the body of the piece should shrink it follows of necessity that the triangles, as they do not change, must give way. This observation applies to all similar cones.

Treat the cone of the pedestal in like manner with the top. When this is done it only remains to make the mouldings. Now this is a very difficult operation. We strongly urge the amateur to provide himself with a good compass, (or gauge). An iron one if well made is the best. There are some in which the cutting-bit may be removed from the place in which it is held by means of a screw. They are very convenient when very fine lines are to be traced as in the present case. As we shall frequently have to make small rabbets, whether to form squares or rods, and as it is a long and difficult operation to make them, especially with the hand, a compass or gauge (with a very fine blade sharpened like a knife instead of a point), may be very carefully

employed for the purpose. In Plate III. of the second volume may be seen a model of the compass in leather. It is called a cutting compass-gauge. One may perceive that in tracing with this tool two lines somewhat deep upon two sides at right angles to each other, their joining will detach a small piece of wood, thus forming the square desired, and if you desire to make a rod, nothing is easier than to make it round afterwards. At all events you will be satisfied that its edges are parallel.

Now we come to a stage of the operations at which the amateur must arm himself with patience. He must know how to make a great number of tools which can be nowhere obtained and which he must make for himself. He will require rasps or very fine templates, round as well as square, to make the several mouldings or beadings, etc. We shall now give a sketch of the shape of those we used and with perfect success.

We took a small strip of steel, whose thickness was suitable to the object we had in view and whose breadth was three-twelfths, or thereabouts, and dressed it evenly on both sides. Then having given another piece of steel (fig. 7) a double curvature we soldered it firmly. This enabled us to work a very fine pitch on the side for the purpose of making recesses or rabbets. We have even remarked that the teeth, being inclined to the length of the tool, do not present themselves to the wood so much in front and cut in such a way as to produce small curled shavings thus forming a very united rabbet; whereas the wood if the tool be presented to it perpendicularly, more jagged and becomes less solid. But despite this disadvantage one must know how to treat the wood and handle the tool, and to take great care that it neither flies off nor injures the next moulding, which has been already finished. There is one more observation to be made, and that is to indent the tool in such a way that the shavings should fly off from the top of the piece and not in the opposite direction. For this purpose it is well to have tools inclined both towards the right and left. Lastly, the dentation must be quite even and perfectly dressed so that the teeth may catch the wood at the same time thereby removing less and working more evenly than if three or four, only that projected were at work. From these observations it necessarily follows that the teeth should be made and finished with a file in order that the mouldings should not present marks as though a toothed iron plane had been used.

Whoever has worked in this way will easily perceive the convenience and usefulness of such a tool in an infinite variety of circumstances. Having once obtained templates of this sort, ranging from one-twelfth to five or six-twelfths, it is easy to make any kind of mouldings. And if the amateur should desire to make mouldings having a curve which forms part of a circle, the following method may be adopted. We have soldered a tail-piece, like the preceding one, upon the flat side of a piece of steel thick enough to receive the curve. This curve may also be slightly prepared by placing the sheet edgewise between the two cheeks of a vice, not far apart from each other and striking the middle of the small sheet, which has been made red hot in the fire, with the flat-side of a hammer. This operation causes it to assume the form of a groove which may be hollowed out at will. This done, solder the tail-piece in the groove, and then make the dentation upon a machine for indenting clock wheels, by means of a circular cutting file.

If the substance to be operated upon is somewhat hard as ivory or copper, the tool must be hardened, an operation which does not injure the solder, as it does not melt at the cherry red heat to which steel must be raised. The operation might be rendered still safer if copper were used as a solder.

In cases where metals are being operated upon, we strongly advise the amateur to adapt tail-

pieces of this sort to all files that are made. The degree of heat, however, necessary to make the solder melt would absolutely destroy the dentation. To avoid this inconvenience, the universal handle bent at right angles (fig. 23, Plate *a* I.), has been invented. A skilful and practical worker can, instead of the dentation of these small templates, cut them with a chisel as cross-stroked files are made. This operation, however, is rather difficult, and there is no sufficient reason why we should now enter into its details. Besides, these templates may be replaced by small, half-smooth (second-cut) or smooth files of every shape and size. For working metals (as well as wood) other special tools may be profitably used.

With great skill small polishers may be made for all these mouldings, however fine they may be. Sufficient patience must be had to gum with strong gum some very fine polishing paper upon some small slips of wood which have the form of the moulding, and one of a certain length, so that when placed in a straight line they may not show any swellings. It must be remembered, if it be a question of the curve of a neck, or a curved piece, that the thickness of the paper changes the nature of the curve, so that when polished, considerable surprise is felt that the curve is no longer that intended to be given to it. The paper may be softened by saturating the small strips of wood with very warm and clear gum, and by sprinkling it over with powdered glass or very fine emery, which is preferable to glass, inasmuch as it does not alter the form. It may be objected to that what we have just said is in no way connected with the art of turning on the lathe, and fault perhaps may be found with us for enlarging upon subjects foreign to the end we had proposed to ourselves. We answer that we announced in the very first pages which treat especially of the art of turning on the lathe, that we intended to treat in like manner several other subjects which stand in a well-defined relation to it. Besides, to what shifts a turner would be reduced if he knew how to turn only. By the course we have adopted, we imagined that we should have earned the thanks of our readers, and keeping this object in view, we shall omit no opportunity of describing useful tools and convenient expedients. Let us now return to our column.

If the time that has elapsed since it was last touched is considered long enough for it to have dried, finish it. In doing so, every precaution must be taken to ensure its having both the proper proportions and the rivetting prescribed by the rules as well as to have it well threaded. Mark each modulus with a pencil in a circular direction, then with callipers placed on the design, and having a diameter equal to that which each of the moduli of the column is to have, place it exactly on each of them without touching the intervals. To ensure greater regularity, one may even use a levelling chisel which cuts sharply, removing very little wood at a time, so as not to raise any pores or injure the surface. Having determined the diameters in all directions, make every part of the whole of the column of equal size by means of a similar chisel by reducing the inclination to nothing at the places which have the proper proportions, and then, with a very finely sharpened chisel, you may amuse yourself by slightly grazing the whole length of the column, removing the dust produced by the pores, or an imperceptible thread, which may have been raised, and trimming it with great skill. The eye is often unable to perceive whether the column has any undulations resulting from the manner in which the different diameters have been determined. To aid the sight, then, take hold of the column between the index finger and the thumb, and move the hand upon its length, and if no irregularities are felt, you may be assured of the perfect regularity of the column.

In the course of this operation, the arch and its small square must be finished from below. It must be made with great precaution, so that it may correspond with the shaft of the column.

And that it may spring up cleanly from the bottom use a gouge and present it sideways—that is to say, the end must not injure the wood, but only the part between the end and its sides. By this means it may be bevelled circularly, so that the cutting becomes smooth and even as may be seen from the shape of the shaving which comes off.

Some architects form upon each face of the pedestal worked in the same piece—that is to say, it does not project, but is flush with the surrounding surface.

This effect may be produced by means of a flat moulding, the outline of which may be seen in works treating of it. We shall only describe the process of making this ornament. Having then decided upon having it, make it before joining (top and bottom) of the mouldings, both on account of the facility of seizing the piece in a vice, and of tracing all the lines with a cutting-gouge in the shape of a knife, and after working the cross-piece. Remove carefully the wood which the recess discovers with a small chisel of sufficient size, which is represented in fig. 41, Plate XVII. Hereafter it will be seen how useful are these kinds of tools, especially when one operates on a surface whose edges are relieved by means of some mouldings, as though the groove was made after the top and bottom of the mouldings. To make the bottom equal in depth to the sides, use a plough-plane represented in fig. 53, Plate IX. In this operation as well as in all those which remain to be described, one should always remember a proverb, which contains a great truth “so quickly but gently;” since in going recklessly you run the risk of spoiling everything, and of being obliged to begin over again.

We have now arrived at the most irksome and difficult stage in the process, the making of the entablature or cornice. Care must be taken to mark upon the design not only the height of each moulding, but also the projection from the surface of the column; for it is from this upright part only that the cornice, and consequently the whole of the structure rests upon the column; otherwise it would have a very unpleasant effect, and the coping stone as well as the mouldings underneath, would be inevitably broken by a weight which nothing could support. This is the reason why the four sides of the coping-stone taper towards the edges, beginning from the spot on which the cornice rests.

It would be too difficult to make the cornice of one single piece. Advantage must be taken of all those places most recessed, in order to make its height of separate pieces. Unite these pieces, either by glue, or, which appears to us better, by wooden screws which are concealed. In this way, the mouldings which are not correctly made may be retouched, or other pieces may be substituted. The first piece will extend right under the projecting reglet, under which are the gutters of the triglyph. As to that part of the triglyph which must be visible, it is usual to choose the square whose angle is that of a pediment, in order that the mouldings may be outlined, and that both sides of the entablature may be seen. In this way all the pieces composing it may be conveniently united at right angles in the manner we are about to describe.

Begin, then, by dressing with a hollow-plane, as accurately as possible, a piece of wood, whose length is at least double that which is required. The gutters need not be considered for the present. This piece must have one smooth part. When the piece is of the proper thickness and perfectly dressed, cut it with a mitre, and join it in the following manner.

Trace with a gouge upon one of the faces of each, in the direction of their thickness, two marks distant from each other three-twelfths or thereabouts.

Deepen them from eight to ten-twelfths, and into this double groove glue a false-tongue which



fits tightly. By this means the piece becomes very firmly joined, and the grain of the wood will be at right angles.

At the top of this piece stands a reglet, the thickness of which must be taken with great care. Plane it and cut it as in the former instance at an angle of 48 degrees. Wedge up and glue this angle according to the projection which each side ought to have. The length of the piece may be extended at will, although it ought not greatly to exceed the coping of each side, when fixing the soffit upon the coping it ought to fall perpendicularly from the surface of the column on to the top of the astragal.

The piece which follows the reglet should be made by using the same methods and precautions. Join it and make it smooth, leaving the triglyphs and other ornaments which are to be placed between them to some other occasion. This piece must not be glued to the preceding one. It is better to fix it thereto by means of a wooden-screw, with a beaded (or countersunk), head, which is let in somewhat below the surface to prevent injury. When the piece has been placed in position remove the screws, mark them as also their holes so as to prevent confusion, and upon both sides of each piece mark lightly, with a tracing-point, the position of each triglyph as well as the size of the piece it is to occupy.

It is not necessary to concern ourselves with their respective distances, unless it be for the sake of suitably placing the pattern, which will be described hereafter.

At this stage, small strips of wood, whose thickness and breadth would have been determined by the rules of architecture, may be joined, and their height must be such that they stand upon a reglet, and are level with the upper surface of the piece, upon which they are firmly glued.

On the top place a piece of wood whose size is sufficient to form the square which is to crown the triglyph, give it the projection traced upon the design, and mark exactly the projecting points at the triglyph. When the angle of this piece has been well wedged in, glue it to the preceding one, after having marked and made the hole for receiving the same.

The piece which stands at the top should have a round portion between two squares, a smooth face, and lastly a neck between two squares.

The modillion must be outlined with a part of the two mouldings, and that all its faces should present an even grain, plane with the utmost care a piece of wood whose height is determined by the design, whose breadth is such as to admit a moulding, and whose length is sufficient to support the modillions.

Cut both ends at right angles, then form each angle, draw a line towards the middle, making an angle of forty-five degrees. The meeting intersection of these two lines will produce a right angle. Groove very exactly one of its faces, both top and bottom, and into each fit a piece of similar wood of the same shape. When these two pieces, placed end against end fit perfectly, glue them together and place them length ways in a press until the whole piece is quite dry. For the under-surface take that where the joining is firmest, and then (if the pieces when joined are not exactly level with each other) smooth both faces with a fine bastard-file, and afterwards with a gouge trace the moulding, which ought to be flush with or form an outline with that of the cornice. Mark the place which the modillion is to occupy, and having watched the small moulding at right angles, place the modillion therein, so that this moulding should be a continuation of that of the modillion. In this state lay aside both modillions until it is time to glue them in their places. The part to which the modillion is to be attached is the corona on the top of which stands the cyma.

Although these two pieces project very much beyond the surface of the column, it is not always necessary to follow exactly the rules laid down with regard to projections. In a model, however,

where the rule should be carried out with the greatest accuracy, this part must have the whole projection intended to be given to it. Then make a rod of a thick piece of wood, so that the perpendicular part may be equal to that which projects, and join the two pieces at right angles as was done in in the preceding cases. We must observe, firstly, that the upper part of the cyma presents an inclined plane to allow the rain to flow off; and secondly, that this incline begins from the surface of the column. This forms the standing point whereon to meet that which the entablature is intended to support. Trace and finish each moulding carefully, and carve the corona. To insure accuracy in this respect, it is advisable to operate on the entire rod, before it is cut, and joined at right angles. It is, perhaps, right to advise the amateur to make the rod which is to be cut at right angles somewhat longer than the two pieces when reunited would seem to demand. Having joined these two pieces and glued the false tongues, fix this piece upon the preceding one, seeing that it is the latter which is to support the modillion, which should be firmly glued on to the place where the mouldings outline themselves.

We must now make the grooves of the triglyph. Divide it into twelve equal parts, and from each of which draw as many parallel lines. One part should be bevelled, two plain, two bevelled and united; two plain, two bevelled; two plain and one bevelled. This operation demands the greatest attention and patience. Very fine and evenly sharpened chisels must be used, from four to five inches long.

Lastly, the gutter under the triglyph, and under the square on which it stands remain to be made. It is difficult to make them well, or to carve them on account of their extreme smallness. If you undertake to carve them with a tool, you cannot be certain that the bottom is even and smooth. The small reglet at their top is also difficult to make. After having tried several methods, the following is the one in which we have best succeeded.

First glue the small reglet in the proportions indicated in the outline, than take a small piece of wood of the size of the triglyph and equal in thickness to the projection which the gutters ought to have according to the design and divide its length into twelve equal parts, taking two of them for each gutter. From the 2nd, 4th, 8th, and 10th divisions make, with a triangular-file, angles equal to each other in depth, which give the distance and the inclination of the gutter. Having made them as nearly as possible equal, cut the whole of them somewhat longer than is needful and glue them in their place. When they are dry, care having been taken that the glue does not show at the intervals, place them out in full length and wedge them up or else a small space between them at the bottom will be found.

The Doric column, like several others, may be fluted if desired. In this case a very ingenious machine is used which we shall describe in the second volume, giving at the same time the proportions of the flutings for all the orders which this sort of ornament suits.

When the column is placed on its pedestal it will wobble slightly and is liable to fall. To prevent this it is advisable to stand it upon a board of six or eight inches square, on which are placed black and white tiles to imitate the manner in which a temple or other edifice is formed. A large base is formed and a most agreeable effect is produced.

## PART III.

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### TUSCAN ORDER.

**F**IG. 2, Plate XXIX. represents a Tuscan column. Its total height, base, and capital included is fourteen moduli or seven diameters. At the lower extremity *a*, of the line *a b*, representing the axis of the column draw a perpendicular. This is the starting point in assigning to all the parts their different proportions. Take one diameter or two moduli and place seven of the former or fourteen of the latter upon this line. This gives the total height of the column, including the base and capital. Then measure the parts on the scale, and starting from the lower point of the line, mark an equal number off on the axis of the column. This gives the height of the plinth, and starting from the plinth mark five more upon the same axis. This produces the bonus. Mark one more for the square. From the upper point which fixes the height of the column mark one part for the square, three for the coping-plate, four for the quarter-round which follows, one for the next square, four for the space between this space and the astragal. This space is called a cincture. Then verify the operation by trying whether the sum of the parts, as far as regards the capital, forms a modulus, otherwise it may not turn out correct, since small errors when multiplied produce a serious discrepancy. The astragal is made up of a rod and a square. The rod containing one part and the square a half-part.

To determine the swelling of the column, one of the methods we have just indicated, when treating of the Doric order must be adopted. On the capital may be seen the proportions of the projections of each member, starting from the surface of the column. The fillet projects five parts, starting from the base of the column, thus giving fourteen and a half parts reckoning from the axis. The abacus has a projection one half part less than the former.

The egg springs from the abacus and joins on to the fillet, which projects one part only. The tincture or space comprised between the fillet and the astragal has the same diameter as the column. Now as to the base. The fillet projects one and a half parts on each side. This gives three and a half parts for each starting from the axis. The arch projects four and a half parts, giving sixteen and a half parts measuring from the axis. The plinth has the same projection as the arch.

The Tuscan pedestal contains four moduli and eight parts, namely, five parts for the plinth, one for the square following, three moduli and eight parts for the bottom of the pedestal, as far as the talon, ogee, four parts for the ogee and two for the square which follows.

The plinth is one modulus and eight and a half parts in height, reckoning from the axis, making in all two moduli and seventeen parts.

The small square has a projection of two parts less.

The bare bottom is six modulus and four and a half parts in height, and the ogee eight and a half parts, being equal to the plinth.

The entablature contains three and a half moduli, namely, the architrave and its square contain one modulus, the freize one, and the cornice one modulus and six parts.

The architrave and the freize are at the base of the column, and the cornice projects one modulus and a half beyond the frieze.

The fillet and the abacus which constitute the part called in architecture the coping-stone have one square surface as may be seen in fig. 2, Plate XXXII.

If it is desired to make the whole of the capital from one single piece, it must be observed that the square cannot be obtained by turning it to the diameter of the egg. In this case the part which is to form the coping is to be turned to a diameter of forty-one parts.

The same remark applies to the plinth of the base, which must also be square, and turned to a diameter of forty-six parts and six-tenths of a part, as may be seen by referring to the plan of the base, fig. 3, Plate XXXII.

The reason why the diameter has been thus separated from the diagonals of those parts which are to be made square, will shortly be made plain.

When they have been carefully turned, divide their circumference into exactly four equal parts, and by means of rasps and bastard files, reduce them to the form of a square, using a correct compass for the purpose.

The remarks we have just made with reference to the Tuscan order may be applied to the Doric order. And to prevent the amateur from making any mistakes we have had engraved, on Plate XXXII., the proportions applicable to each capital or base.

However practical the amateur may be in executing with precision upon the lathe all sorts of objects, it is extremely difficult for him to make pieces which shall exactly be like each other.

From the one piece a mark may have been removed, in the other it may be left. In the one case the compass may fit exactly; in the other it has been strained. The material may vary in hardness or softness, the tool has not been used with the same skill, in short a number of causes which cannot be always controlled prevent our giving the pieces that equality in every respect which constitute their merit. The difficulty becomes considerably increased, if the piece operated upon is intended to have a number of balusters or columns of the same order and dimensions. The greatest pains and precautions without number may be taken, and yet the eye is offended by those irregularities which only a skilful artist can excuse, because he is aware of his own shortcomings, but which nevertheless detract from the perfection we had proposed as our great object.

## CHAPTER XI.

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### TUSCAN ORDER.

**I**T was in order to avoid these inconveniences that we had caused to be made steel tools, well hardened and capable of forming by a single movement the bases and capitals of the Tuscan and Doric orders, as well as the Attic-base which produces a very agreeable effect to the eye. This base is not solely intended for columns. It may very conveniently be made to serve as a pedestal for any small objects intended as ornaments for a cabinet.

We should but very imperfectly gratify the natural curiosity of amateurs if we described only tools of such and such a size. One often wishes or needs to make a very large or a very small tool for columns of 4, 8, or 10 inches in height, including base and capital. And such is the convenience and advantage of this method of dividing the modulus into twelve equal parts, that, no matter what dimensions the amateur may wish to give his columns, is sufficiently to send the modulus appropriate to them in order to have tools made which should perfectly agree with the design which has been traced.

A simple inspection of Plate XXXIII., will show the shape and outlines of the tools suitable adapted to each of the two orders represented in Plate XXXII. The following is the method of using them. Prepare on the centre-lathe or the lathe with overhead-motion, a piece of wood whose size is such as to allow a clean and complete circle to be inscribed thereon, of which the diameters are A, C, T the plane of the Tuscan capital, and B, C, T the plane of the base.

Reduce the piece to the exact length of the column, including base and capital, dress both ends and bring them to the diameters required, viz., B, T (fig. 3) for the base, and A, T (fig 2) for the capital. Bring the shaft of the column to almost its proper size so that one end of it shall have twenty-one divisions on the size of the astragal and the other twenty-five divisions on the side of the base. Then by means of a gouge and chisel make the mouldings with their proper diameters, and keeping the base on the left, present the tool which has been adapted to the Tuscan base so that the interior of the point *a*, shall rest on the end of the piece. Remove very little wood and at once a very large space will be seen forming, which will turn out to contain the plinth, the toras, the fillet and the hollow part joining on the base of the column. Care must be taken to hold the tool perpendicularly to the axis of the piece, and to remove it as soon as the point *b* of the tool begins to cut it, to stop the operation. Thus by a single operation, and the adoption of the necessary precautions, a part will be completed in a short time, which would have

cost a great deal of trouble, attention, and skill. As this tool does not cut but only scrapes the wood, very little of it must be removed at a time so as not to produce any abrasions or splinters.

Independently of the rules just given, and the proportions marked in the plates, we have adapted the plan of marking on each tool the proportions of the diameter of the square of the plinth and of the coping-plate of the capital, so that the amateur may make no mistakes.

In Plate XXX. fig. 6, there may be seen a column of the Doric order, after Vignole, and the same plate, fig. 2 represents an Attic base which produces a very agreeable effect when employed in this order, or as we have already said, under a truncated column to serve as a base for a vase or other object. Plate XXXIII contains the shapes of the tools which produce in a simple operation this capital and base, all the dimensions of which may be found in Plate XXX. fig. 2. But though the plans of the base and capital could not be represented in Plate XXXII. yet a sufficient guide for making them will be found by means of the marks made in the tools which are marked so that the diagonal of the plinth of the Attic-base, or as we have just observed, the diameter of the circle which is to contain the square of this plinth, shall have seventy-three-tenth parts, and three-tenths of a part and the half of the coping-plate, or half of the diameter of the diagonal circle which it is to contain shall have twenty-one two-tenths parts. The smallest measure marked on each tool is the diameter of the base of the column.

One must not imagine that the tools when applied directly to a piece in which the shape and the diameters of the mouldings have not been previously traced, can produce correct mouldings. For suppose a rod to be of the proper size and the toras not to be so, the moment one begins to cut the wood the rod cracks and becomes covered with abrasions. When, therefore, it is noticed that the tool touches in some points and not in others, the points where it touches must be removed until it touches all parts equally. This is the only way to execute neat mouldings. The same remark applies to the making of screws on the lathe. If it be too large and a chasing-tool be used in diminishing it, remove all the wood. It is even advisable to raise the hand slightly and to cut away the wood from below. In sharpening this kind of tool one must not think of touching the mouldings with any whetstones. It is quite sufficient to pass them smoothly over an oil-stone.

In order to give our readers as great a number of models of pieces which he may amuse himself in imitating, we have had represented in Plate XXXVIII, fig. 1, 2 and 3. Etruscan columns of different shapes, which produce an agreeable effect.

Fig. 4, Plate XXX. represents a martial column the shaft of which is a fairly good imitation of a cannon which appears to rest upon a pedestal hollowed out in front so as to make the breech visible.

Fig. 5, in the same plate, is a kind of triumphal column surmounted by a ball which stands upon a small stand. If a point were placed upon this ball it would convert it into a military column like those which may be seen through the railings of the .

Fig. 1, Plate XXX. represents a small pedestal capable of holding a small bust or other work of art. If the object which one wishes to keep is valuable, dispose the upper surface of the pedestal so as to admit a groove in which a glass-bell fits to secure the object from dust and flies.

If the amateur has been induced to study the angles of the five orders of architecture, and to execute specimens of any dimensions he pleases to give them, we think he cannot do better than to procure at a picture dealers engravings representing the dimensions of the five orders on a large scale.

## CHAPTER IV.

### THE TURNING OF VASES.

**W**E may easily add to the pleasure of the amateur by offering him objects possessing graceful outlines for imitation. He very often finds it difficult to procure designs of objects suited to the lathe. It is with a view to supplying this want that we are about to propose different kinds of vases suitable for the decoration of a cabinet, or a mantelpiece. Some may be made useful by making them large enough to be hallowed out for the admission of glass globes or leaden basins, in which flowers may be placed in spring or summer; and bulbs in winter, vases of of this kind are very agreeable ornaments to a pier-table or mantel piece.

Fig. 5, Plate XXXIV is a model very well adapted for this purpose. Choose a pretty piece of any piece of wood you may fancy, of sufficient height and thickness, and turn it carefully. And as the amateur is supposed to have by this time sufficient skill in using all the tools relating to the lathe, he might now try to perfect himself in their use. The belly of the vase must be turned with a gouge, and not with a chisel. But in this case, the method of using it hitherto employed in diminishing the wood, is not adopted. Begin by turning a cylinder, upon which mark by means of the sharp point of a chisel, as many divisions as the vase contains, and then model it roughly by means of gouges of different sizes. And to feel certain that no change has taken place in their various divisions, when reducing them to their proper diameters, make use of the following expedient. The total length should be marked off on the piece by means of two deep grooves which determine each end. Having diminished the thicker parts and prepared the mouldings, bring the square which forms the base to the required diameter, or nearly so. Next make the listel, as shown in the figure already referred to. Starting thence, we may find the point which constitutes the end of the egg, and which has doubtless disappeared whilst diminishing. It must not be reduced to the size it ought to have when completed. Form the square, then reduce the reglet to the depth indicated by the profile, and from this point commence making the doucine which extends to the sort of lid indicated in the design. Prepare with tolerable accuracy all the outer mouldings, carefully measuring them all the while lest their proportions vary. We will not repeat what we have said elsewhere, but content ourselves with saying that all the carved points can be made with a gouge quite as well as with a chisel. This is what the amateur should try to do. The convex parts are made not by gently using the gouge, as in the case when diminishing the piece, but by presenting the end of the gouge sideways, and resting the bottom of it on the

piece without packing it, although the interruption caused by the rise of the treadle may seem of necessity to produce hacks in the work, if the front of the tool is not changed, yet none will be found ; and if the gouge be firmly kept in its place the shavings will come off easily and the surface be nearly smooth. We shall try to make this result intelligible to those who are accustomed to analyse and reflect upon everything.

We have already said that a gouge, when presented sideways to a piece of wood, that is when the cutting it makes, instead of being on the top, as is usually the case, is oblique to the curved part which tapers, has the effect of a bevelled chisel. When this is the case, the wood when the tool is presented obliquely to its fibres, is cut much more easily than when its face is presented. Hence it is that this part is turned out smooth. And if a tool be used in producing an infinite number of circular parts, one after another, and its direction be not altered, but on the contrary, kept in the course prescribed by the groove, there is no reason why the curve should not come out smooth and even from the bottom of the tool.

By this means the hollow parts are the easiest to make, the nearer their form approaches that of the gouge. The gouge must always be presented sideways and gradually, but insensibly turned as it descends. By taking these precautions the hollow moulding will be cut as neatly as a cylinder cut with a chisel.

If the vase is intended to hold flowers it must be cut between the list, which may be seen on the lid, with which it is surmounted, and the little square in which the curve has its origin. Procure a vase made of glass, earthenware, or porcelain long and large enough to hold sufficient water. In hollowing it out care must be taken that it be not made too thin as it would be liable to break in a short time. A goblet, phial, or any other glass object may be inserted and cemented in the interior of the vase to hold the water and prevent the nose from more readily breaking. The whole of this operation may be done with the nose on the lathe. The rims of the glass and goblet, or whatever object be used, must be made flush, and a lid may be fitted on to it when no longer required for its original purpose.



## CHAPTER V.

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### HOW TO SOLDER THE LEAD USED IN LINLING VASES.

**T**HE interior nose may be formed of lead only in this case. It must not be cast from one piece of metal. We will not describe the process of making it here as it would be too tedious. It suffices to say that it is made from lead that has been rolled, one-twelfth of an inch in thickness, whose ends have been soldered.

On this occasion our readers will, perhaps, be content with a description of the methods of soldering leaden troughs (whether they be intended to form small basins in cages or conduit pipes for jets of water, or for any other object in which lead is used).

Flattened-lead of all degrees of thickness may easily be obtained, but if the amateur cannot conveniently get any, we imagine that we shall gratify his wishes if we put him in a position of doing so.

Take an oak-board of any length to form the casting table, and upon its edges fasten two pieces of wood for guides, whose height is equal to the thickness of the leaden-plate. Cover the table with one or two layers of woollen stuff, and on top place a piece of tick which should be tacked on to the under layers and properly stretched before fastening the strips of wood just mentioned.

Incline this table at an angle of 20 degrees or 25 degrees to the horizon. Form a sort of small trough like an inverted box, having neither top nor bottom, but only its four sides, of which the front, that is the smallest, is not flush at the bottom with the other sides, but which has the thickness of the required plate or table of lead. Cast the whole of the inside of this trough with a layer of whitening moistened with water, containing some strong glue dissolved therein. Incline it so that when placed upon the tick its upper surface shall be perfectly level. Before placing it upon the tick place underneath a sheet of white paper to prevent the lead from burning it. Place the trough upon the table so that the molten lead shall not escape, sufficient lead being melted to fill the trough. And in order to prevent the lead from burning the paper or the tick, try whether the lead is too hot in the manner following.

Steep a piece of white paper in the hot lead. If it blackens, or turns yellow, the lead is too hot. If it does not change its colour, the lead is of the right temperature. Pour out all the lead into the trough, which should be firmly held, and at once cause it to flow by inclining the table, thus forming a sheet of lead more or less long, and having the thickness which the slight opening at the cross bar allows.

This sheet may not always have a uniform thickness or continuity owing to the small quantity of matter and the want of experience in dealing with this kind of material. Manufacturers cast sheets of eighteen to twenty inches broad, and from six to eight or ten feet long. The consequence is there is no need of astonishment in finding a large quantity of material retaining its heat. As one of the surfaces of the sheet is granulated, and the other bears the impression of the tick, they must be beaten out with a smooth hammer upon an anvil in those parts which require it. By this means they may be made sufficiently smooth if moistened with some soap and water, so that the tool may move easily, they may even be polished with an iron plane.

In order to have as few joints as possible, bend as well as you can all the sides of the cask. If it is to be of a cylindrical shape, solder the two sides together, and fit a bottom on to it. This is done in the following way.

Get a soldering-iron made, the shape of which is represented in fig. 9, Plate XXXIV., and provide yourself with a brick, or burnt earthen tile, in order to be able to tin the iron in the manner about to be described.

Bring all the parts to be soldered near each other, dress them very exactly, and see that their distance from each other is about the thickness of a playing card. Dilute some flake white with a little water, moderately mixed with some strong glue, and coat each end that is to be soldered inside and outside with a layer of from six to eight-twelfths in thickness. And in order to make the flake still better, it may be spread with the finger if the fire of the piece permits, if not, with a brush. When the flake is dry it ought to stick to the lead and not peel off. If it does peel off it is because there is too much gum. Add a little more water in that case. Rub the joint with a point-tool, so as to level each end, and pass the end of a candle on the outside, over its whole height, in order to grease the part that has been rubbed.

It does not much matter whether the rest, which is covered with flake, is rubbed over with grease. Heat the soldering iron, and grasp it with a handle made of two semi-circular wooden cylinders, having a groove in the middle and united by a piece of skin glued on to one of their edges by means that they may be opened at pleasure. Upon a fresh tile place some solder (the lead being of any quantity, and the tin being one-fourth the weight of the lead, and both being fused together) and some powdered resin.

To facilitate the plating of the iron, first rub it over with salammonia, and then see that all its sides are dried before soldering, as dust and cinders mar the operation.

When the iron has been plated, it will be found to have acquired the property of seizing and raising small drops of the solder. Take several drops, one after another, and holding the piece horizontally with the left hand, and let fall into the cleft as many drops, at very short distances from each other, as it will contain. If the iron is no longer hot enough, put in the iron again, taking care that it must be red hot, lest the process of plating should be checked. Clean it well on each occasion, and starting from one end, begin by drawing the iron over the piece until the solder has perfectly melted and filled the cleft. To complete the operation, and make the soldering perfect, give it a few more touches, so as to feel assured that the solder penetrated, and that it presents to the eye a smooth list.

The difficulty of this last operation consists in inclining the iron upon the piece neither too much nor too little, and in not moving it too fast, so as to allow the link to set firmly and the solder to penetrate well into both ends of the piece. If one joint is soldered on to another already made, or the two ends of a circular joint, the iron must be drawn off at an inclination to the joint, and somewhat quickly, so that the list may not lose its shape.

It may be perceived that the layer of whiting prevents the solder from spreading unequally over the two ends which are to be united, and as the two edges have been made into the shape of a chamfer, it is evident that the solder can only take in this place. Then wash the piece in some tepid water to remove the whiting, and it will be ready for use.

This operation, which we have applied only to the making of small troughs, may also be employed in a great number of other works.

We will not give the details of making any other vase as we would only repeat ourselves. It is sufficient that we give the profiles of those which can be most easily executed upon the lathe. We have given designs in Plate XXXIV. and XXXV. of vases, urns, and among other things, of a vase which is called the Vase de Medici, and represented in fig. 6. These vases are arranged in such a manner that the most of them may have their taps finished, so as to have the form of a lid, or they may be cut at right angles to their upper surface as suits the taste of the worker.





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## PART VI.

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### LARGE VASES, AND PEDESTALS OF WOOD, STONE, OR PLASTER.

**I**F the amateur desired to execute any of the vases just referred to, he may make them of several pieces, bearing in mind the nature of the place they are destined to occupy. Suppose you want to make a very large wooden vase to place on the posts of a gate in the country or elsewhere. You must begin by tracing the natural size upon a wall or table, and, for the sake of greater convenience, you may gum several pieces of white paper upon the table. Having determined and traced the outlines with a pencil, make yourself, or get a carpenter to make, a square piece of wood, upon the four sides of which as many other pieces of wood are placed as evenly as possible; nail them on to it, and pour glue over the whole surface and the nails as well. This serves to keep them in the place marked out for them in the design.

Supposing the whole block to be thoroughly dry enough, hew it with a hatchet, then place it on the centre-lathe, adapted for turning a large wheel. Next make a groove for the cord, which may be done by placing it upright and holding it with the left hand for a few turns, to prevent it from scraping, whilst the right hand holds the gouge for making the groove. If the vase is to be exposed to the air, it may be imagined that the pieces which are patched together may become unglued at the end of a short time, and that the rain insinuating itself into the joints may cause the whole to rot. To diminish these inconveniences, select in the profile a few places adapted to receive some iron hoops, which may be driven in by means of a peculiar kind of hammer (represented in fig. 20, Plate X.), which we have already described. When the piece is finished paint it with oil, allowing it to imbibe as much as it can. It would be better to heat some nut-oil, and put on thick layers of it quite boiling, as long as the wood continues to absorb it. It is advisable to give a fresh caking every year, seeing that the rain which falls drop after drop upon the wood when standing upright will in a short time penetrate it. By this means a vase of this sort may last eight or ten years.

The amateur may possibly wish to make himself a vase, a truncated column, or other piece fit to support a sun-dial or statue or some object to adorn a garden or a cabinet. For this purpose choose some white and soft stone of a fine grain, and saw and carve it so as to have a sufficient face to make it tolerably round. Mark the centres top and bottom, and, if the piece is rather hard, deepen them by means of a square jag, and force a piece of wood of the same shape into



the hole. If the piece is too hard, the hole may be made with a borer whose diameter is of eight to ten-twelfths of an inch, and a wooden peg driven into it. Place on the piece, and in the direction of its diameter, a block of wood hollowed out in the centre (figs. 4 and 6, Plate XXI.) and fix it thereon by means of screws inserted through the thick part of the block. Turn it at first with a heel-tool, and then finish it with bevelling chisels. But as these stones are rather soft care must be taken not to remove too much at a time for fear of splitting it. And, lastly, the mouldings and angles must be accurately made.

These pieces can only be turned by means of a wheel, on account of their great weight, and the lathe employed must be very solid. If any splits or holes be observed while turning they must be repaired by means of plaster mixed with similar stone, in a state of powder, that has been passed through a sieve and then tempered with water containing a small quantity of strong glue. In order to make the mastic adhere better, some similar glued-water must first be poured into the hole or the split. Allow it to dry for several days and then finish it on the lathe. These stones have the property of hardening in the air. Hence they are well adapted for the purpose just mentioned.

These same pieces may be made in plaster. But wood is better as, then the piece may be more firmly fixed on the lathe, and the strong parts are less likely to tear the weak ones. If plaster be used it must be well dried and passed through a very fine sieve. If several pedestals are required to be made all alike, and at less expense, for holding vases, figures, or sun-dials they must be made in a mould. This is how it is to be done. Make a model in stone or plaster, and coat it with one or two layers of nut-oil. When the oil is quite dry make upon the model a mould for those which are required. Place the model upon a table, mix some very fine plaster, and then place on one of the parts a handle large enough for two hands, taking care that it insinuates itself exactly into the mouldings. When the handle is firmly set remove it from its place and cut it perpendicularly to the model, and in the cutting make with the curved blade of a knife one or two notches, each formed by the meeting of two curves of six to eight-twelfths of an inch deep and one inch long. The piece that has been sharply cut must be coated with a strong solution of soap and water, which should be kept in a basin close at hand. Replace it accurately in its position, and over the section place another handle similar to the former one. Cut both sides in the same manner, and make guiding-points while cutting them. It will be seen that we shall gradually cover the whole figure with pieces corresponding to each other, and that the guiding-points will serve to prevent their losing the respective positions they ought to occupy. Cut externally each one of these pieces so that they should possess a surface almost smooth, and also the guiding-marks. When everything is made, coat the exterior with a layer of very thick soap and water, and envelop it with plaster on both sides, thus forming a very solid whole. The plaster having firmly set, remove the covering, and mark it with either a pencil or ink, so that all the pieces may be recognised when they are to be put together again. If we are using a vase or the base of a column, or any other object, which from its nature leaves in the model an opening through which the plaster may flow so as to fill up the parts in relief, all the pieces must be afterwards brought together. It may also be moulded by means of a single jet, by making an opening for the introduction of the plaster, and another smaller hole, called an air-hole, in order to facilitate the escape of air. In all these cases the amateur must exercise his ingenuity in taking advantage of circumstances.

The instructions just given for making a model in several pieces is eminently adapted to objects that are richly ornamented. If this operation is to be performed on a smooth vase, having

only a few mouldings, the model may be made in two pieces, the joining of which is in the plane passing through the diameter of the piece.

If the object is considerable, use some ordinary plaster, very white, and passed through a sieve. To have the plaster white it must be made in an oven, of plaster well dried and in cakes, without being mixed; if it is mixed the carbon which has been mixed up with it, and which will probably cause it to be streaked, cannot be separated from it.

The mortar must be sufficiently tempered to allow the piece to be made in a single operation. Take some very fine and very thinly tempered plaster in the hands, plaster the whole of the interior of the mould, which has already been covered with a thick solution of soap and water, work it into all the angles, recesses, and mouldings, then move the mould backwards and forwards until the plaster is well set, and plaster those parts of the base which are to sustain the mass.

Having assured yourself that the plaster is firmly set, cast off all the pieces of the mould. Handle them carefully, so as not to break the corners off which would spoil them. Trim the seams which the joinings must have produced with very great care so as not to injure the mouldings or profiles.

We have said enough to furnish the intelligent reader with the means of making models of pieces which he may wish to multiply or the type of which he may desire to preserve. The same remarks hold good should he have a copy in plaster of an object the original of which is in lead or copper. It is by the attention bestowed on making each of the small pieces of the mould neat and solid, and in replacing them exactly, that the purity of the relief depends



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FOURTH BOOK.

APPENDIX.

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## CHAPTER I.

## Various Tools Employed on the Lathe.

## PART I.

## METHOD OF INLAYING CIRCLES.

**W**E shall describe in the second volume a method of turning a piece to any excentricity desired by the help of an instrument adapted to the lathe with overhead-motion and which is commonly called an excentric instrument or simply an excentric. By means of this instrument a piece which has been turned round can have formed upon its surface different ornaments at distances more or less great from its centre.

For the satisfaction of our readers, and especially those who have not a composite lathe, but only a lathe with overhead-motion, we shall proceed to describe a simple method of engraving on a box or other smooth object concentric circles forming a kind of rose-work, and placed at equal distances from the centre.

Suppose then that it be wished to inlay the lid of a box with three or four roses formed of concentric circles of different colours at distances of four to five or six-twelfths of an inch from the edges. The box being turned round, but not quite finished, place it on the lathe and begin by describing with a fine pencil upon the lid a circle at any distance from the centre that may be desired. If it is only the lid that is to be inlaid the box may for greater safety be left on the lathe and the lid treated only. Divide this circle into as many equal parts as there are to be centres, and hollow out these circular grooves with a tool called a drill-tool.

A drill-tool is an instrument invented for piercing various objects which are fit to be used in the cases we are referring to. Fig. 1, Plate XXXVII, is a representation of a species of small iron lathe. A B, and C, represent species of iron stirrup, and H is a square tenon for holding it in a vice, or for enabling it to be inserted in a square hole made in a table or board which is fixed on a carpenter's bench by means of a hold fast or thumb-screw K, which fits on to the screw I.

The heads B and C are pierced, namely B with a conical-hole, the base of which is inside, and C with a screw-bore, for a reason we shall shortly state. Upon an iron, or better still a steel rod,

the head of which is conical so as to allow it to fit tightly into the hole of like shape in B, and which is square as to the rest of its length, there is mounted very accurately a double bobbin of hard wood, such as ebony or box, having two diameters  $D$  and  $d$ , and made upon the same rod. This rod exceeds the length of the bobbin just a little, and receives into the hole which served as a centre for turning it the bobbins as well as the pointed end of a screw E, which crosses the head C and keeps it in its place by pushing the conical-head into the hole adapted thereto. F is a thumb-screw which supports itself against the head C, and makes a counter-screw to prevent the screw F from giving way. The end of the rod which exceeds the head B is externally round and pierced in the direction of its axis with a square hole in which are placed drills of all sorts, files, and centre-bits. Such is the ordinary use of this drill-tool.

The peculiar fitness of this tool for the work in which we are now engaged, consists in its being furnished with the kind of bits or punchers which serve to form the circles of their positions

We begin then by providing ourselves with some wooden laths of not more than one-twelfth of an inch in thickness, of any colour we like, be it their natural colour or otherwise; it is well that they should be of many colours which contrast with each other and with the colour of the back-ground of the box.

Fig. 2 represents a kind of centre-bit of which the parts  $a$  and  $b$  are bevelled in opposite directions. In the middle of it there is a hole to hold the bit  $c$  which serves as a guide to the borer and enters a round hole made in the side of the borer, this serves to unfasten the bit by means of a punch.  $D$  and  $e$  are shoulders which determine the distance the borer shall enter the wood and the thickness of the roundel which is carved therein. If the first borer be used, a circular countersunk only is produced. It must afterwards be made an exact roundel.

Fig. 3 represents a borer which has an effect quite different to the preceding one. The bit is put in its own place as in the latter case. It serves to bore and keep the centre at the same time. The two teeth  $b$  and  $c$  are set with a bevel in opposite directions, and their distance from each other must be exactly the same as that between the shoulders  $d$  and  $e$ , fig. 2. The part  $d$ ,  $d$ , must be smooth and its angles somewhat rounded, as it should not cut but only mark the depth of the hollow. Thus, when a circle of wood or ivory has been detached a roundel results therefrom which fits securely into the place made by the borer represented in fig. 2. Glue it carefully thereto with some isinglass, which, though somewhat light, takes firmly and dries very quickly. If there are several such wheels to be made, it is advisable to make them one after the other, so that some may be drying while the others are being made. If the borer be applied to a thin lath of wood, which rests upon nothing, for the purpose of making a roundel, it would probably split it. It is therefore advisable to support it on a wooden ruler well dressed on its flat side for applying the borer a roundel very smooth and cleanly cut will be seen disengaging itself.

When the wheels are dry take a borer similar to that represented in fig. 2, but with a diameter one-twelfth of an inch less, and use it like the borer first described was used. Fill the hole thus made with the roundel produced by its corresponding borer. Glue it, as also the others. Then take a third, but much smaller borer, use it in the same way until there is no more space to work it. Enlarge the hole at the centre with a rest-drill of a suitable size and then fill it with a plug of wood or ivory of any colour you please. This tool, thin strips of wood of various colours, well assorted plugs, and isinglass saturated with spirits of wine may be obtained at any of the shops dealing in articles of this nature.

You may easily conceive that the result of all these successive operations is the production of

concentric circles of different colours, as fine as you please, or as the graduated series of borers will permit. When they are all finished place the lid upon the box and polish it on the lathe, thus producing a very smooth surface and figures regular and symmetrically placed.

The position of these circles, if it be so desired, may be varied in an infinite number of ways, and the ornaments also which one may wish to work upon the box or other objects may be multiplied in like manner. All the circles, too, may be interlaced the one with the other, as represented in fig. 4. To do this the circumferences of the circles must be divided in such a manner that an exact number of circles may be formed on the lines uniting the different centres. The following is the method we advise the amateur to adopt. Upon the box glue a paper circle and remount it upon the lathe. From the centre draw, with a black-lead pencil, only a circle at a convenient distance from the edge, so that those parts of the circles which reach close to the edge of the box may lie wholly on the side and not touch the great circle which we imagine to be described thereon.

Trace, with the greatest accuracy, upon another piece of paper only two sets of the required circles. Find the distance between the two centres and use it as a measure for dividing the circle which has been traced upon the box. It rarely happens that the compass will be contained an exact number of times in the circumference of the circle. In that case diminish the large circle until you find by actual trial that it is evenly divided. Having done so, use all these points of division as centres of the concentric circles whereon is placed the drill of each borer. But, in this operation, take care not to injure the corresponding roundels, and therefore to proceed gently.

These circles may also be placed in such a manner that the greatest should only touch each other, as in fig. 5. This, of course, depends on the division of the circle upon the box. Again, you make the circle, and passing each through the centre of its neighbour as in fig. 6. To do that all that suffices is to place the drill upon the circumference of each circle.

Lastly, you may arrange these circles as in fig. 7, and the only question in these cases is that there shall be an exact number of centres equally distant in the circle to be divided. We recommend some paper to be glued on to the box, so that in case many attempts may have to be made in dividing the circle exactly it should sustain no injury from the frequent use of the compass. When this operation is completed, remove the excess of wood and paper from the box and polish it carefully.

It may have been observed that the borer in fig. 3, is of use only to detach upon small and very thin boards the roundels which should fit exactly into the hollow marked in fig. 2. The borer in fig. 3, may be used for hollowing out upon the box plain circles to be filled with ivory or shell. This operation, though long and laborious, yet when performed with care, produces an agreeable effect. Similar circles may be connected according to the last method by making only one at first and leaving its roundel wholly aside. But of course it is necessary that the roundel should be of the same wood and colour, and should have the same veins, so that the piece might not appear to be joined, a thing which is undoubtedly impossible. It is advisable that the outlines represented in fig. 7 should be made in this manner. But the utmost attention must be bestowed on this part of the work, as the places intended to receive the circles must first be made and as the wood at the points of contact is liable to give away. Lastly fill the holes made by the drills with plugs of ivory or shell.

As the method of inlaying with shell is quite peculiar we believe we are bound to state the means of procuring small strips adapted for the grooves which will have been made according to the preceding method. One may make upon the neck of the box the diameter of which is equal

to that of the required circle some small circles which shall fit exactly, or upon a neck whose diameter is much greater than it need be. In reference to the design represented in fig. 7, you may make from one single piece the part *a*, *b*, and *c*, and from another separate piece the semi-circles *d*, *e*, *f*, etc. Make the angles agree so that the joining should be seen as little as possible. Strips, too, each of which is of the length of *a*, *c*, may be used. It need not be feared that they will break if they are rather fine, as they ought to be, if a good effect is aimed at. If they are too thick, and the shell is somewhat dry and liable to crack, plunge them into boiling water, dry them immediately after with a cloth which should not be too coarse and glue them with isinglass. These strips are made in a very simple way. Place in a suitable chuck a neck the diameter of which is sufficiently great to admit the required length. Take a piece of brass and form a kind of backboard like the one we have described for cutting screws-heads, but much shorter, and grasp between the two pieces of which it is composed a very fine spring-blade, the end of which extends beyond them by two or three-twelfths of an inch. Sharpen it almost like a mortise-chisel and with this proceed to carve out small circles, removing very little material at a time. Fig. 8 is a representation of this tool which equally serves to cut shell upon tribolets, which are a species of chucks, upon which are placed the shell that is soldered in tubes.



## PART II.

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### AN INSTRUMENT FOR TRACING PARALLELS UPON A PLANE SURFACE.

**I**F the amateur should wish to inlay a box with a great number of coloured wheels or small circles, so as to completely cover it, he must mark upon its surface a certain number of points, equally distant, in order to indicate the centre of each wheel. This division, when made by the hand, is very tedious and seldom turns out to be exact or regular. We shall now describe a machine which shortens the operation and makes it surer.

Fig 9 is a division which serves for a variety of uses. A, B, C, and D, is a flat piece of wood twelve inches long, seven to eight inches broad, and one inch thick. Upon its two sides and on top, two dovetailed rods are fastened by means of wooden screws with their heads countersunk. These rods afford a passage to a slide which moves in the direction of its length. In the thickness of the sleeper there is a groove in which there is fixed an adjusting screw E, F, which guides the slide. At the bottom of this slide there is a piece which turns on a pivot and supports the piece to be divided. In front there is a piece of iron, the two slides of which are fixed upon the plate and make room for the head of the screw so that it can not advance nor recede but merely turn upon itself. At the end of this head there is a handle (*e*) which serves to turn the screw and send the slide forward. An index or a needle is attached to the screw and the dial (*d*) which is divided into a number of equal parts such as 12 or 24 which contain exactly 3, 4, 6, and 8, rests on a fixed piece of iron. The number twelve or any multiple thereof is selected because they contain a great number of measures. On the beam are fixed, by means of a head-screw, the two square ends of a brass guide, which, by this means, can be raised or lowered by a circular movement, the centre of which is in the two screws. Fasten the lid of the box upon the turning-plate which is also fixed so as not to be capable of any motion but what the slide imparts to it. Draw the lid back while turning the handle until the edge of the lid is right opposite the edge of the guide which lies below the diameter. Then, having determined upon the number of circles, mark the distances between them upon the diameter of the box. Push the slide and plate, which move together, forwards and consequently the lid which is fixed on them, and draw from each point of division parallel lines. When they have all been drawn, turn the plate until the guide is at right angles to the lines already traced. Make the same incision as before and draw parallel lines in the like manner. The points of section will give the centres of each circle. And it is at this point that the boring-bit is placed. Use it according to the instructions already given and the lid will be found covered with a great number of concentric circles. Sometimes the form of the box is such that it cannot be so easily divided. In this case make the required division on paper and gum it on to the box.

Fig 13 represents a clasp by means of which the division may be fastened on to a table or bench.

## PART III.

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### BOW OR ROD SPLITTING SAWS.

**I**N a laboratory the amateur is constantly in need of a screw for cutting wood into small boards or pieces of various dimensions. He will be sure to feel how fatiguing it is to saw a piece of wood lengthways even if it be only two feet long. To remedy this inconvenience in great measure we shall describe a saw which is made to move vertically by means of a treadle. It causes no fatigue and is very useful for cutting boards for veneering. It is mounted on the bed of a lathe or upon the peculiar bench with which the laboratory is usually furnished. It is better to use the latter inasmuch as it dispenses with the necessity of continually unmounting the poppits of the lathe. But as this latter arrangement requires more room we shall suppose it to be set up first upon the bench of the lathe.

A, A, fig. 10 represents two uprights on the inner face of which is a groove in which the saw glides. The tops of these uprights are fastened by means of a double crosspiece which allows the saw to move up and down and the separation at the base is regulated by a piece which serves also another purpose. It has the power of being raised to any height, whilst keeping at the same time its distance between the uprights, serves as a guide to the blade of the saw to prevent it from shifting about and so injuring the wood to be cut. Fix it at any height by means of the two screws *a, a*, which press externally against the uprights of the frame. In the middle of it there is a slit which is just large enough to allow the blade of the saw to pass through. It is drawn further back than the piece which regulates it in order to prevent the saw from shifting about. And in order that the line you wish to follow should be plainly visible, make upon the front of the guide just described a semi-circular groove.

The saw itself is mounted as an ordinary pit-saw, and as the strain which it endures is exerted upon the two arms, they should be firmly fastened to the uprights. The blade is stretched by means of the screw *b* which presses against the upper arm. It may easily be seen by simple inspection of the figure that the saw is able to move up and down and that if the blade be even, fine, and the teeth well sharpened, it must do its work thoroughly. At the bottom of the two uprights of the frame there are two socles ornamented with fancy mouldings which rest upon the frame. The tenons are pierced with two square mortises and fixed upon the frame by means of a screw key as represented in fig. 15, Plate XXIII.

Near the extremities of the upper arm of the saw there are two loops through which passes a cord the ends of which are held fast by knotted buckles. Upon this cord make a ring and fasten

it to the cord which is tied to the rod. On the lower arm there is a similiar cord which is fastened to the treadle of the lathe. Hence one may see that the foot causes the saw to descend and the draw of the rod causes it to ascend. Lay a plank on the bench and upon it place the piece that is to be cut. In this operation the two hands are free to direct the piece operated on according to the direction of the groove which lies towards the worker, as the teeth are in front of him and the saw cut while descending.

It is certain that if the piece is rather thick, the rod or the arc, as the case may be, will meet with considerable resistance or else the saw owing, to the increased friction, would obey the impulsive force of the treadle and ascend with difficulty. A little practice in this respect will teach the amateur better than anything we can say here. It will be found sufficient if two or three turns more are made on the barrel or to fasten the cord on to the rod a little higher up.

We must confess that it is very annoying to be obliged to have to remove the saw-bow from the bench of the lathe as often as the latter is to be used and that it is much more convenient to have it mounted on a special bench so as to be ready for use at any moment.

We have ourselves long been occupied in trying to bring the saw just described to perfection, and after repeated trials we at last succeeded in constructing a new arrangement which had more advantages than the preceding ones.

With this instrument one may cut not only a piece of wood of any thickness quite accurately without any need of tracing it beforehand, but mitre quoins of all sizes and circles of any diameter. This saw when in motion needs little or no friction so that the pressure of the foot upon the treadle is almost entirely exerted in overcoming the resistance encountered by the teeth when cutting.

As we proposed to treat in the first column of simple machines only, we shall reserve a fuller description of the machine just described to the second volume which deals with complex machines.

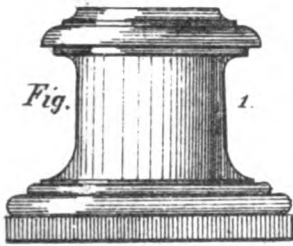
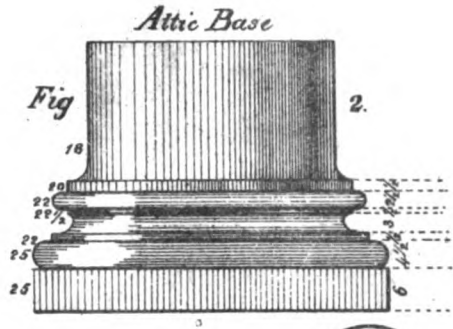


Fig.

1.



Attic Base

Fig

2.

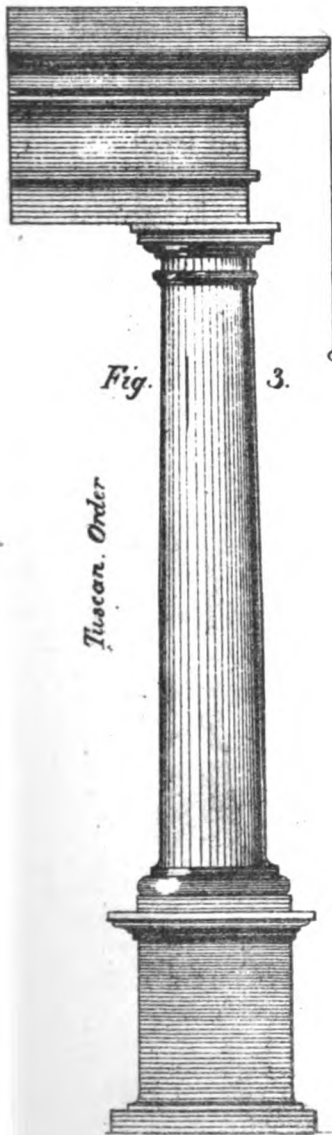


Fig.

3.

Tuscan. Order



2 Mod.

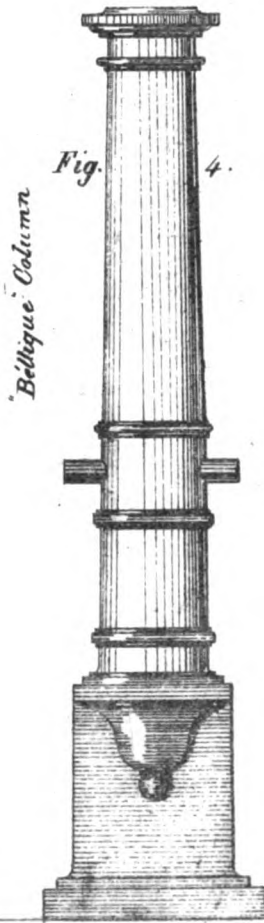


Fig.

4.

Bellique Column

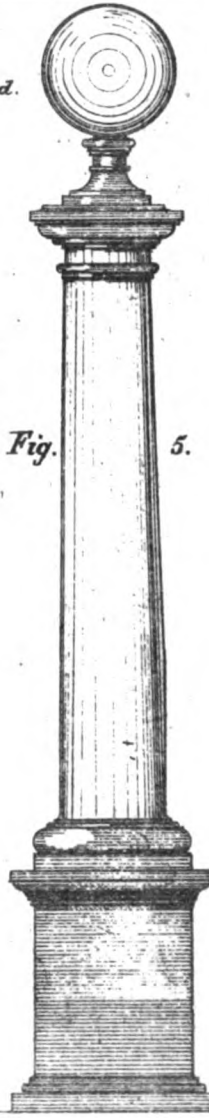


Fig.

5.

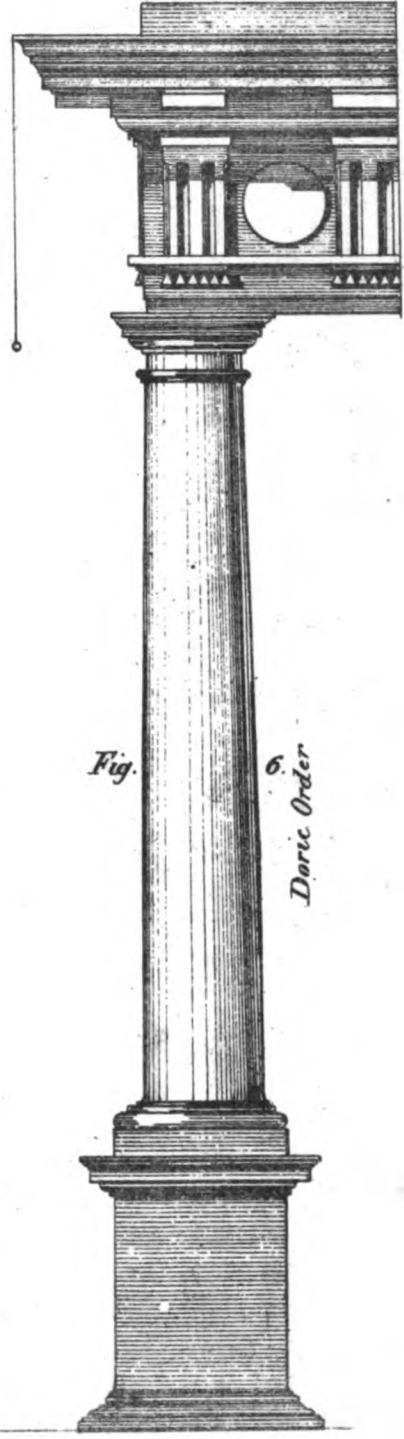
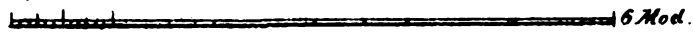


Fig.

6.

Doric Order



6 Mod.



## PART IV.

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### GENERAL REFLECTIONS ON THE DIFFERENT METHODS OF TURNING.

**W**HEN pieces of wood of small diameters, such as one or two inches, are turned between two points it is advisable to work the cord on a cylinder of a diameter smaller or at least equal to the piece that is being turned. If it be otherwise the piece does not go fast enough and no certainty can be felt that it will be round. Suppose, for example, that the treadle descends ten or twelve inches, the cylinder, being two inches in diameter, will make a little less than two turns and that is not enough. It may even be said that it will not make two turns for it very usually happens that the attention of the amateur when at work is directed almost entirely to his work, that he moves the treadle mechanically and that as a consequence he does not raise his foot high enough. In this case the treadle does not descend ten inches, and as a second consequence the cylinder scarcely makes more than a turn and a half, or if the cylinder be not quite round the chisel will naturally follow the defect; whereas if the piece made more turns it would most likely remove all the defects and insure its being round. It must not be imagined that the cylinder can be made to make more revolutions by simply moving the treadle with greater force. On the contrary the cylinder can only make a certain number of revolutions each time that the treadle descends; whereas if a smaller cylinder is used it will make in the same time a greater number of revolutions and consequently revolve with more speed. It follows from all this that, when a piece of any diameter somewhat great is to be turned a part of this piece must be reserved and not used, and which is afterwards reduced to a diameter much less than that of the piece. From this it will be seen that by a slight increase of the pressure applied to the treadle the inequalities will be removed by the chisel and the piece will turn out to be quite round.

However we must not carry this mode of reasoning too far as it would land us in absurdity. If the piece is only two inches and a half in diameter and the bobbin is reduced to a fifteenth the cord revolving as it must with great rapidity around so small a cylinder would ignite and soon become unfit for any further use.

In accordance with the principle above established it follows that when a board or other piece of any diameter is turned on a chuck with screws or claws, the bobbin cannot be more than two inches in diameter. It is true that in that case the arm of the lever in the direction of the power being not nearly as long as that in the direction of the resistance a considerable force must be applied to the treadle in order to be able to cut the piece, and in a very short time the amateur would feel very tired if he did not care to remove very little of the wood at each movement and to make three turns of the cord round the bobbin or else it would merely glide. It was this very consideration that led to the adoption of treadles which are not fixed to the frame and which are four or five feet in length. They may be placed where they are wanted and passed to the right or left as occasion requires. And as the lever is rather long less force is required to turn a large piece. Nevertheless it must be allowed that a treadle of this description is rather an inconvenience in a laboratory because of its length and, as it is suspended by the cord of the lathe only with nothing to regulate its motion up and down, it proves troublesome to beginners, who frequently feel inconvenience and pain in the ankles and feet. But if the amateur once acquires the habit of placing the treadle against the bench when he stops working and guides the foot which causes it to move, it will work without inconvenience.

In consequence of what has just been said as to the ratio of the diameter of the cylinder to the piece operated on, it is easy to see that in turning it with the great wheel the groove on its circumference is scarcely ever used. The reason is simple. The ratio of the great diameter to a piece weighing two pounds, for example, which is generally the heaviest weight of any piece that is turned, is as two to six. Hence the piece will make three turns for each turn of the wheel. If the wheel be made to go ever so little faster than before the piece will revolve much too fast. Therefore it is much better that the piece should have a very small diameter as is usually the case.

If the piece is made of iron and does not exceed three inches in diameter the ratio between the two diameters will be immense and the speed exceedingly high.

In this case it is true that the cord is placed on a pulley fixed upon the piece by means of screws, and having a diameter of about twelve inches.

It must not be supposed that we have said enough when we caution the amateur to go gently to work. Something further is required. He must work with a continuous and equal action, for he will derive no advantage from the increased speed which a wheel of great diameter would produce. The reason, which very probable is not evident to the turner for going as gently as possible to work is that the material cannot be operated on until the wheel is in motion and then it has to overcome the force of inertia as well as the resistance offered by the tool.

It is of no use to apply a large crank to the axletree of the wheel. It would only cause needless fatigue. Experience teaches us that a man working at a crank cannot without fatigue describe a circle greater than two feet in diameter.

If the piece operated on is turned too rapidly, the tool will polish only and not cut it. The best plan in such a case is to put the cord upon the greater of the two circles connected with the wheel, if wood be used, and upon the smaller, if iron.

If cast-iron be used, the speed must be diminished. This is done by placing on the wheel a pulley whose diameter is less than that of the pulley which is fastened to the piece. Without this precaution it would be impossible to operate on the piece on account of its hardness.

If the piece is so large that one man is not sufficient to turn it, two must be employed. As the axle is supposed to have a square at each of its ends, a crank may be fitted on each, so that

one person may work at each crank. The cranks must be placed in opposite directions; the reason for this is simple. The person who turns the wheel exercises the greatest force through the whole of the semicircle opposed to him starting from the highest point of elevation reached by the crank, but from the time when it descends to the lowest point until it returns to its highest point of elevation, scarcely any power is exerted except that which is used in causing the crank to ascend. If then the two cranks are placed in opposite directions, it is evident that the two persons turning will exert their force alternatively, each helping the other. By this means the rotatory movement becomes uniform.

If a large wheel is used for turning, a wooden circle having a groove in its circumference to admit a cord must be applied to its surface. The more the diameter of this circle exceeds that of the piece operated on, the greater is the force required.



## PART V.

### METHOD OF MAKING SCREWS ON THE WHEEL-LATHE, WITH OVERHEAD-MOTION.

**I**N order to make a screw on a piece which is fastened in a chuck mounted on the lathe with overhead-motion, the piece must be able to move backwards and forwards. It appears difficult to obtain this movement unless a pole-lathe or turn-bench is used, as the wheel does not produce a continuous motion.

It is probable that the amateur whether from necessity or choice has only a wheel-lathe. In that case he may profitably use the motion produced by the crank of the wheel, which must have been placed on the the bench of the lathe in the manner we shall describe in the second volume. It may also be placed underneath.

If the wheel is mounted on the top of the bench, remove the cord from the pulley. Take hold of the cord of the treadle, make three turns of it around the axletree and fasten it by means of a loop to the small rod or crank which turns the wheel. The mandrel will have the same motion as the bow if the rod be slightly distant from the centre and the crank rather large.

If the wheel is placed underneath, fasten the cord in like manner either to the crank or to the double elbow of the axletree of the wheel. Then make the three turns round the axle, bring it down under the bottom of the bench and fasten it to the treadle. By this means the desired movement may be obtained and the utmost possible use made of the means placed at our disposal.

Some turners make a turn and a half upon the wheel, thereby obtaining a see-saw motion. Others adapt screws having a continuous motion. This is an operation which requires great skill and experience.

## PART VI.

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### METHOD OF TURNING WITH CONTINUOUS MOTION BY MEANS OF A ROD-LATHE OR A BOW-LATHE.

**T**HIS operation can only be carried out upon a lathe adapted for the purpose. It, nevertheless, deserves mention here. Instead of the two collars which are attached to the bobbin of the mandrel of the lathe with overhead-motion, use one only, but it must be stationary. Fasten the other to a screw by means of a female-screw which has been made in its interior. Upon the first make a small square support to receive a ratchet-wheel. This is a wheel whose teeth are inclined to either side in order that the click should be able to move forward in one direction without going backwards in the other. Upon the smooth part, between the two collars, fit a moveable bobbin of iron or brass which is capable of moving freely. The rim of the bobbin contains a click which grips the ratchet just mentioned. Having adjusted the bobbin, screw on the other collar. By this means the bobbin, which has two rims, one of which carries the click, holds the cord of the lathe. At the left end of the lathe there is a wheel the diameter of which is greater than what the height of the poppits would permit, and whose circumference is weighted with lead in order to increase its momentum. This might also be effected if the poppits were pushed to the end of the bench so that the wheel should stand out beyond it.

Having arranged these parts of the machine in this way, adjust the cord in the usual manner. On turning the treadle the false bobbin will set the shaft and the wheel in motion since the clicks, inclined as they are on this side, will not allow one to turn without the other. The shaft then having acquired a rotating motion, imparted to it by the fly-wheel, raise the treadle, when it will be seen that the clicks will glide over the cogs because of their inclination, although in consequence of the impulse already given to it, the shaft will continue to move in the same direction. On applying the foot again to the treadle the rotatory motion will be continued. From this it will be seen that the shaft will acquire a continuous motion whether a rod or a bow be used.

In order to adopt this description of lathe to ordinary uses the bobbin may be so arranged that it may by means of a cogged-wheel placed opposite to the first be prevented from turning upon the shaft. When making the wheel care should be taken that the teeth are somewhat small so that they fit evenly and produce no noise.

## PART VII.

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### METHOD OF TURNING, MOULDINGS AND OTHER OBJECTS EXACTLY SIMILAR.

**I**T is very difficult to turn pieces that shall perfectly resemble each other, especially when they are somewhat large. In such a case the best plan to adopt is to turn them by means of well-made and well-tempered steel tools, which will simplify the operation very much.

This is by no means an easy thing to do, for it is very difficult to make the tools so that the mouldings should stand out clear and neat. But when they are well made and cut cleanly, the piece will, with very little trouble, come off finished, and if it be made of wood will only require a very slight dressing. Tools of this description may be readily obtained at shops which deal in these articles. If you want them to be of a particular size and shape, send a design of them traced out on a thin plate of iron or brass. They may be used not merely in similiar pieces but in repeating the same moulding on the same piece or on different pieces. Thus, in turning a frame, if a fluting simple or beaded, a quarter-round, a round between two squares, a congee, a hollow, or other moulding is to be worked on it, you have only to determine the kind and size of the moulding and procure the tools suitable to it. In composite mouldings as many tools may be used as there are separate pieces to be made. This helps to shorten the work very much and imparts to the objects an equality of outline which the hand alone could never give.

It is easy by means of tools of this description to make objects which though small are beautiful, such objects, for example, as vases of which the body and the mouldings of the base represent the outline of some figure.

If the amateur should desire to provide himself with tools which enable him to imitate any figure whatever, he ought to send to the tool manufacturer an exact copy of the figure he intends to imitate.

## PART VIII.

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### CONSTRUCTION AND USE OF THE DIVISION-PLATE.

**I**N a great number of instances it is necessary to divide the piece which is being worked on the lathe. As to do so with the compass is a rather tedious process we shall describe a very convenient instrument for dividing quickly and into any number of equal parts any piece which is capable of being so treated.

To make it we begin by casting a brass plate of about three-twelfths of an inch in diameter. Round it off by means of a saw, and afterwards with a file, until it has a diameter of ten to twelve inches. Complete the process of rounding it by fixing it on a chuck and mounting it on the lathe with overhead-motion, and make in the centre a hole of about an inch in diameter. Finish both surfaces, and upon that which presents the fewer defects trace several concentric circles, each of which must be divided into a certain number of equal parts.

The circle is generally divided into 360 parts as that number contains the greatest number of divisors. Divide the largest circle into the same number of parts, but in dividing the next circle use the decimal scale and divide the fourth part of the circle into 100 equal parts, in which case the whole circle will contain 400 equal parts. Divide the other circles into as many equal parts as may be convenient for the purpose for which they are intended to be used. Watchmakers use different numbers, sometimes 365, sometimes 366, on account of the varying number of days in the year. These divisions are made in the following manner.

Procure several beam-compasses, or if you like, spring callipers. It is better to use the former kind. Divide the largest circle into the usual number of degrees, that is to say 360. To do this we must begin by dividing it into eight equal parts, each of which will contain forty-five equal parts. Each of these latter parts must then be divided into five parts, each containing nine. Each of the latter are in turn divided into three equal parts; these latter again into three more, thus completing the operation.

It is essential that the circles upon which these divisions are made should be traced as finely as possible so that the point of the compass should not experience any variation. If the work has been well done the first and second divisions should exactly coincide. To insure greater accuracy in making the small subdivisions use a powerful magnifying glass, for it is very difficult to make them accurately with the naked eye.

All the points of division having been marked, hollow them out next so that the point of the cross-staff or index-peg (an instrument to be hereafter described) may be fixed in them. This again

is a very difficult operation, for if the point is not held quite perpendicularly to the plate, it is evident that however well placed it may have been at first, it will move from one side to the other, thus rendering the division inexact. It is still more important that the holes should all be equally deep

To obviate the first difficulty the worker must provide himself with punches which terminate in a point and are raised by means of a spring. This punch glides along the length of the perpendicular plane and never fails, as it always falls from the same height, to press the point to an equal depth in each case. Mathematical instrument makers adopt an ingenious method which also produces a very accurate result. Upon the beam of the compass they place a poppit which may be fastened to any point that may be desired, and which carries the rod of a small hammer which may be lengthened or shortened at will. This hammer can be elevated to any degree that may be thought necessary, but the degree of elevation once determined, it cannot exceed it; so that the amateur has nothing to do but to place the points of the compass in the divisions, raise the hammer with the right hand and allow it to drop. Falling always from an equal height it always strikes the points marking the division with equal force.

Such are the means employed by skilled workers. But these means are not always at the disposal of an amateur who could scarcely be induced to provide himself with tools so complicated and so costly. In that case the amateur must hold the point with his left hand and strike it with his right as perpendicularly as possible.

All the operations that have just been described are very difficult to execute, and if the amateur fears that he will not succeed in his attempt, he had better purchase a divider, which may be obtained of any degree of accuracy at the shop of any dealer in mathematical instruments.

The importance of insuring accuracy in operations of the nature just described, and which we have strongly insisted upon, will be at once acknowledged if we consider that it is by the aid of these division-plates that the wheels of clockmakers are indented, and thus the accuracy of a watch or clock depends on the accuracy of the divisions made in the wheels.

Having given the amateur instructions for making the division-plate we shall now proceed to describe the manner in which it is to be fixed upon the lathe.

Upon the thread at the back of the mandrel of the lathe mount by means of a screw a brass cylinder with a foot. Turn it until its exterior exactly fits the diameter of a hole bored in the centre of the division-plate which is fixed upon the foot by means of three screws.

This division-plate can be placed also on the middle of the mandrel at the place which is usually occupied by the pulley, and then fixed to it by means of a nut. In this case the hole should be larger and proportioned to the size of the mandrel.

Next place the point of the cross-staff, (*a*) figs. 7 and 8, Plate XXXVI., right opposite the figure indicating the number of divisions required. If the division-plate is attached to the pulley the rod *A* is fastened by means of the hinge *B* to the band of the lathe; if it is mounted on a left-handed screw, place it behind the poppit of the lathe. In this case the rod must be bent in order to secure the necessary distance.

The instrument being mounted in either of the ways above-mentioned, fit the piece to be divided on the nose of the mandrel, bring the support closer, the collar of which should be furnished with a rule made of brass perfectly dressed.

The cross-staff is then placed on one of the points of the circle which is divided into the number of parts required; draw the first line upon the piece with a pencil or a pointed

instrument directed along the length of the rule which is fastened to the support. Move the division-plate forwards with the left hand while holding the cross-staff with the right and count the number of necessary points. When the cross-staff comes right opposite the last of these points allow it to rest there and mark the second line upon the piece. Continue the operation in this way till it is finished; and if the work has been well done the last ought to cover the first exactly.

If the amateur does not wish to go to the expense of purchasing a division-plate he may content himself with placing upon the pulley a strip of brass which contains a certain number of divisions and is capable of being used in the same way. This plan is not as good as the former, because the wood of which the pulley is made always warps a little and thereby interferes with the accuracy of the divisions; but it is quite sufficient for operations which do not demand such accurate division.

The use of the division-plate is not solely confined to operations of the nature just described. We shall describe others, as occasions present themselves, in the second volume, which treats of different machines.

## PART IX.

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### METHOD OF CUTTING COMB-SCREWING TOOLS BY MEANS OF SCREW-THREADS WORKED UPON A MANDREL.

**I**T is probable that most amateurs have felt the need of replacing a comb-screwing tool which he has broken while at work. As it is very difficult to make it with the hand, we shall have much pleasure in describing for the satisfaction of our readers a method of making it upon the lathe, which has been communicated to us by a distinguished amateur. We ourselves have seen it at work and feel bound to say it was a perfect success.

Make a support of the form represented in fig. 4, Plate XXXVIII. A is a base similar to that of all supports which are fastened by means of a bolt. B, B, are two equal uprights fixed to the base by means of tenons and mortises. A groove (c, fig. 5) which descends as far as the centre of the lathe, is worked upon the upper ends of each of these uprights. Its size is determined by that of the back-plate, of which we shall speak hereafter.

Mount a triangular file (L, fig. 4) upon the back-plate E, which is somewhat thicker than the file and about three inches high. Fix it thereon by means of two copper belts, H H, which enter the back-plate crossways and are kept in their place by means of a screw fastened at the end of each.

On the upper part of the back-plate there is a movable cheek (F) fixed by means of two screws placed in the grooves *g g*, which enables it to move up and down readily at the will of the operator. The back-plate terminates in a handle by which it can be moved. Upon the nose of the mandrel mount a chuck of wood or copper on the front of which is cut a channel (*b*) whose depth is equal to the size of the longest comb tool. The upper cheek of this channel is pierced with a hole to receive the screw (*d*) which is used to fix the comb-tool during the operation. The lower cheek must not be parallel to the upper, but they should, if produced, form an angle of a little less than 45 degs. This gives the facility of inclining the comb tool more or less, so as to increase or diminish the slope of the teeth. Two screws (*c c*) are placed upon this cheek; one of them ends right opposite the screw (*d*).

Having thus prepared these three instruments, and before putting them into operation, he must assure himself that he possesses a method of determining an exact revolution of the mandrel. The simplest method is to use for this purpose a division-plate and a cross-staff. If you happen not to have them you may easily supply their place by piercing a hole in the pulley of the lathe, corresponding to that made in the poppit at the back. In these two holes place a pin

which keeps the mandrel in the position required ; this position should be such that the upper cheek of the channel cut upon the chuck should make with the lathe-bench an angle of 45 degs. When it is required to make a revolution on the mandrel remove the pin and turn the pulley until the two holes are exactly opposite to each other.

Having arranged everything in the manner just described place the strip of steel out of which the comb tool (*e*) is to be carved in the groove (*b*), and incline it more or less according to the purpose intended. The teeth of metal objects should have less inclination than those of objects made of wood. The end to be cut should project more or less beyond the circumference of the chuck, according to the intended depth of the teeth.

Place the support in a position exactly parallel to the face of the lathe (M fig. 5), and in such a manner that the file, when the back-piece is placed in the grooves should be on a level with the exterior edge of the comb-tool. Raise the cheek to the height which is necessary to give the teeth the depth required. First cut the edge which is to form the half of the first tooth, slightly pressing the back-piece, and causing it to advance in the groove in the same way as a file.

Then lower the catch-key, raise that part which corresponds to the thread of the screw which is intended to be traced and place the quoin underneath so as to support it.

Make one revolution in the mandrel, fix it again, cut the second tooth, and continue the operation in this manner until this part of the work is finished.

The comb-screw, the method of making which we have just described, is called a right comb-screw, and is represented in fig. 6. It is used to trace screw-threads upon the exterior surface of a cylinder. The comb-screw represented by fig. 7, which serves to bore the interior, is made in the same way, except that it is placed upon the circumference of the chuck instead of on its face. To fix it continue the groove (*b*) over the circumference for about an inch and give this continuation the same depth as the groove. The screw placed on the under part of the groove maintains in position the comb-screw, the handle of which extends to the right and does not embarrass the worker.


By following this plan the amateur can easily construct this instrument, which produces with the greatest regularity comb-screws corresponding to the threads of the mandrel, an operation which is very difficult if performed with the hand only.



## PART X.

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### METHOD OF UNITING THE TWO ENDS OF A CORD FOR THE PURPOSE OF MAKING AN ENDLESS-CORD.

 circular cord connecting the wheel of the lathe and the pulley attached to its axletree easily wears out. We shall now, for the benefit of our readers, describe the method of making one.

Take a cord of suitable length, and unite its two ends by means of a splice or two porters' knots. If the cords are made of catgut, the latter method is preferable, if they are made of hemp, the former. The following is the method of uniting them.

Take a cord about six or eight inches longer than that which is required to go round the wheel and the pulley of the lathe, and mark off three or four inches from each end to allow for the splicing. Separate the strands and point them finely by tearing and hacking them, but so as not to diminish their length. Then twist the cord as much as possible until it assumes a spiral form. This done unite the two ends by crossing the strands which are thus made to interlace and continue the operation until they commence to untwist. Fix them in this position by twisting some string several times round the point of union. An idea of this operation may be formed by an inspection of fig. 38, Plate VIII.

In this state fasten one of the ends in a vice under a claw, or in some other convenient way, and untwist the other until the part untwisted is equal to the ends that have been hacked. Roll each of these strands around the end corresponding to it in the part which has just been untwisted. While twisting moisten it slightly at each revolution it is made to take around the strand which corresponds to it.

Place the end thus finished in the vice and do the same with the other. Having done so untwist the part which has been twisted towards the middle. The twist thus given is distributed over the whole length of the cord, and especially over the splicing, and gives it the required solidity. If the splicing has been made with the precautions just mentioned, the part that has been spliced will scarcely be thicker than the rest of the cord. Even if it is thicker it will wear down by constant use.

The operation we have thus described serves equally well for joining the two ends of a piece of catgut, which, however, we advise the amateur not to use, as the two ends before being spliced must first be softened by placing them in water. When treated in this way they emit a

a most disagreeable odour. It is much better, as we have already said, to use steel hooks, a representation of which may be seen in fig. 6, Plate XXXVI., Vol. II. These hooks are pierced and bored through the whole length of their cylindrical part. One, A is entirely closed, and the other, B is open to receive the first, and thus to unite the two ends of the cord, which must be cut exactly to the length required. Diminish slightly the size of each end by means of a bastard-file, and make each end enter into a hook by screwing it therein with some force. If the end is too large to fit into the inside of the ring, heat a round piece of steel, insert it into the ring, warm each end, and the ring, like all animal matter, swells. By so doing the interior of the bored part may be tightly filled, thus forming at the end a kind of very solid riveting. When you wish to use the lathe it is sufficient to pass the cord over the pulley of the lathe, cross it, if necessary, by passing it over the axletree of the wheel, to fasten the hooks at the side, and to place the cord upon the corresponding pulleys; after which it must be properly stretched by means of the frame on which the motor-wheel is always mounted.

Similar hooks may always be adjusted at the two ends of a hempen cord, but in that case the hole of the hooks must be cut into a left-handed thread, because these cords are twisted from right to left in opposition to catgut cord which is twisted in the reverse direction.

## CHAPTER II.

## Tortoise-shell, Horn, Ivory, and Bone.

## PART I.

## TORTOISE-SHELL.

**S**HELL is the armour of the species of tortoise, called turtle, which is found in Africa, the Indies, but principally in the Antilles.

The shell of this species is composed of fifteen leaves, some of which are large and some small. The ordinary shell of the turtle weighs three or four pounds, but some have been found whose skin is so thick, and whose leaves are so long and wide that the whole weighs from six to eight pounds.

Boxes, snuff-boxes, combs, handles of razors and lancets, opera-glasses, and many other objects are made out of this shell.

In order to cut it up a vice must be fixed on a bench, and in a position parallel to its surface, as represented in fig. 1, Plate IV., Vol. II. Fix tightly the leaf which is to be cut into strips, and with a good inlaying-saw cut it into as many parallelograms as may be required. This is the only way of fixing it upon the bench. A holdfast or a pincer of any other description which might be applied to support it would break it into irregular pieces and thus entail a loss of material. Having determined upon the diameter of the circles, describe parallelograms whose diameter is three or four times as long and allow eight-twelfths of an inch more for the joining. This will be quite sufficient, seeing that the shell has the power of expanding so as to enlarge the circle if it be somewhat small. These parallelograms must be large enough to contain all the circles of the same magnitude which it is intended the box should have, taking care at the same time to allow something more for the loss which the cutting must necessarily entail.

Having detached the parallelogram take a new and coarse file and give to each of its sides a slope of six or eight inches in length. Dip this strip into water of the proper temperature. In a short time it will become soft. Give it the form of a oval which is somewhat flattened, and upon its major axis unite the two sloping edges. Hold them in this position with

the index finger and the thumb, and dip the whole into clear cold water in order that the shell may harden and keep the form it is intended to have.

During this operation, heat the soldering pincers. They are represented in fig. 14, Plate XXXVII. This instrument is a pair of fine pincers, the arms of which terminate in two square parts which are about an inch in thickness and breadth and three inches in length, or thereabouts. These two parts must be dressed by means of a file in order that they may be equal in all directions, and that they may fit each other exactly. The pincers when not pressed will of course open their arms.

Take a piece of new and clean linen, fold it into four parts, and turn up its two edges towards the middle so as almost to resemble a pocket-book. When thus folded, the linen presents a strip of three or four inches long, fifteen to eighteen-twelfths of an inch broad, and having four thicknesses. Fold this strip in two, in the direction of its length, and place the joined sloping edges within the fold. Now as the operations to which we have just submitted the shell may have somewhat greased and soiled the surfaces which are to be soldered, and as the solder may not in consequence thereof be able to catch as it ought, the two ends must first be passed over each other by pressing them at the side and not in the direction of their length, as in the latter case the edges would be left exposed, the one within the circle the other on the outside. Rub them well to make them sharp. They must now be finished off perfectly, and when this is done placed in the fold of the strip of linen.

Try whether the soldering iron is of the proper temperature. By way of testing this, fold a piece of white paper in two and press it against the iron. If the paper reddens the iron is too hot, but if it only makes a mark of a slightly yellowish colour it is suited for our purpose. Take the pincers and seize the circle enveloped as it is in the linen, which has been previously moistened with some warm water, and moderately tighten the part which grips the shell by placing it between the jaws of a vice. The shell will be felt to be gradually softening; to ascertain whether the solder is sufficiently soft move the circle from one side to the other. If the shell is not pliable enough, it proves that the iron is not sufficiently hot. Take the iron out of the fold without displacing the shell and heat it again. If the solder be not well set, it might dissolve during the rest of the process. To make certain of this remove the circle from the strip of linen and press the thumb against the solder so as to make it enter into the circle. See that the edges are held firmly together and try it also in the other direction, pressing the rest of the circle till it becomes oval. It is evident that this operation will determine the edges that must be removed if they are not firmly set. If it should turn out after doing so that the solder does not catch everywhere, but only in one place, the iron must be heated again. Lay hold of the circle with the pincers two or three times. The linen must be moistened every time that the iron is re-heated. The amateur must not be disheartened by this tedious operation.

We shall now proceed to give another method of soldering the shell which has been communicated to us by an amateur, and which has proved quite a success. Prepare the square piece of shell in the manner just described, and roll it upon a triboulet (a sort of chuck we shall shortly describe), by placing the two edges one upon the other. Upon the joint place a compress of linen, folded six or eight times, and fasten it on the top by means of a tie composed of several turns of string. In this state dip the triboulet in the hot water. Take it out after about ten minutes and allow it to cool. The triboulet and the string swollen by the water which they have absorbed afford a pressure sufficient to effect the soldering.

When the solder is well set, and if the linen sticks to it as it sometimes will do, it is a good sign that is so; dip the circle into the hot water to soften it and then place it upon the triboulet.

A triboulet is a truncated-cone of wood made on a lathe with overhead-motion, or a centre lathe, the slope of which is very gradual. Place the triboulet upon the lathe, take the circle out of the hot water and fix it upon it.

The manner of fixing it thereon is not a matter of indifference. Care must be taken while turning that the tool should neither catch the solder nor injure the end of the bevil. To obviate this, the circle must be placed upon the triboulet in such a manner that the bevil which is on the top should not collide with the tool while turning. This precaution is all the more essential inasmuch as the circle when once it is placed upon the triboulet cannot be changed on account of the latter's conical shape.

See that it turns round, and that the whole circumference rests evenly upon the triboulet. Force the circle on a little by passing a lathe-chisel over the triboulet and by tapping the circle lightly. Then in order that it may assume exactly the roundness of the triboulet keep some glowing cinders in a small warmer. Remove the triboulet from the lathe and present the circle to the fire while turning the triboulet round in both hands. Blow on it a little with the mouth until the circle has softened, tap it on its side and push it still further on ; while taking care to keep it turning round, guided by means of a light mark traced by means of a chisel or pencil upon the triboulet before fitting the circle on. If this precaution is neglected the amateur need not be surprised after removing the triboulet at finding that the circle has an oval shape.

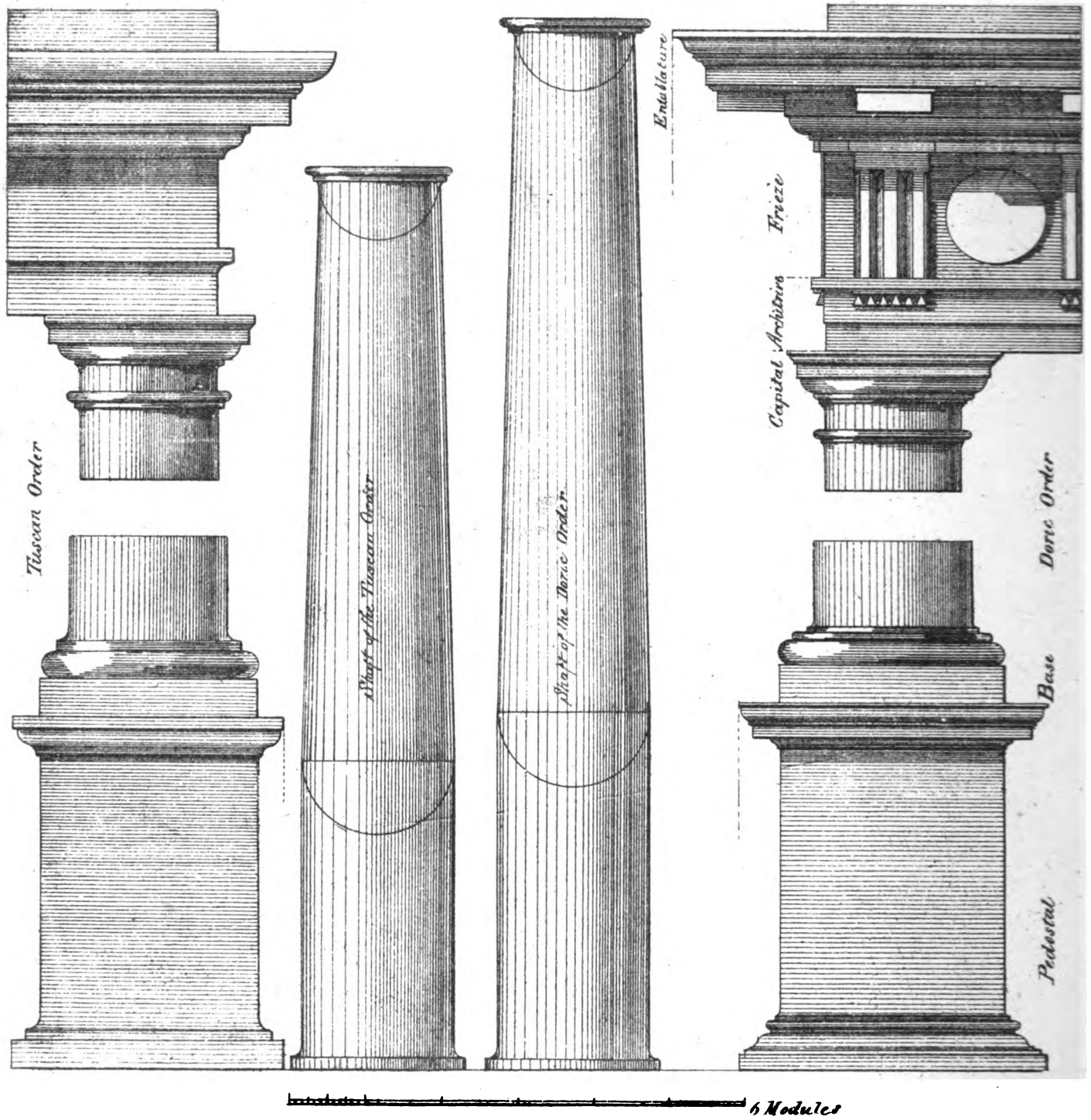
We have omitted to remark, that before dipping the circle when soldered into the hot water, in order to make it fit on the triboulet, the solder must first be pressed slightly outwards, in order to remove the edge of the bevel by means of a file, as it may not have set well, whatever the quantity, and may have left a bevelling or a seam. Treat the bevel on the inside in the same way by pressing the circle in the opposite direction.

Nothing further remains to be done but to finish the circles upon the lathe, according to the purpose for which they are intended.

We shall describe in the second volume, different methods of placing upon boxes circles of shells, which by exercising the ingenuity of the amateur, afford all the pleasure which the lathe is capable of giving.

It may often happen that the neck of a tortoise-shell snuff-box is too small for its lid, thus allowing it to be opened too easily. This defect may easily be remedied by dipping the neck only in boiling water. In a moment it expands and fits the lid exactly. It must be allowed to remain in the water only a short time, otherwise it would expand too much, and in that case would have to be made smaller upon the lathe. This is not always possible if the neck is not very thick. For the sake of greater safety a chuck must be made of the same diameter as that of the neck ; having placed the neck on the chuck allow it to cool there.





## PART II.

### ON HORN.

**H**ORN is very extensively used, and especially the horn of cattle. The best kinds come from Ireland. It may be substituted for tortoise-shell in objects which are not very costly.

It is worked and soldered in much the same way as tortoise-shell. The following is the method adopted.

Select a good piece of cow's horn and saw it about two to four inches from its solid end, and cut it in the direction of its length with a back-saw. Then hold it for some time in front of a moderate fire, seize it with a pincers and dress it until it takes the form of a flat-board. Next remove by means of a tool called a scraper, the surface which has been exposed to the fire, and finish the process by trimming it by means of a rasp-file. The plates now made in France are at least equal if not superior in transparency to those made in England.

It is of horn that are made extremely delicate plates of uniform colour and transparency, which are used in tinned sheet-iron lanterns, ships-lights, and especially in protractors which are mathematical instruments for indicating or measuring upon paper.

#### HOW TO MARBLE HORN SO AS TO MAKE IT RESEMBLE TORTOISE-SHELL.

Dissolve in a pint of boiling water about three ounces of potash. Allow this mixture to boil for about a quarter of an hour, and then pour it out into a vessel of double the capacity, and containing about half a pound of quick-lime. Stir the whole well up. When the lime has become thoroughly slacked and cool, add to it about three ounces of red lead, and one ounce of cinnabar or vermilion, and agitate the whole again until all the elements which compose it are perfectly united. When they are the mixture should have the consistency of thick soup and be of a soft red colour.



The mode of using this composition is very simple. Take a small portion of it on the end of a spatula and apply it to those parts of the horn which are to be coloured, avoiding those parts which are to remain transparent in order to imitate as much as possible the caprices which nature displays in distributing the colours of the tortoise-shell. The shell must remain covered with this paste till the whole has completely dried. Then wipe the piece of horn with a moist sponge ; it will be found to be so well coloured in some places and transparent in others that it might easily be taken for tortoise-shell. The thicker the patches of paste the richer will be the different colours. It is then very easy to vary the tints so as to increase still further the resemblance of the piece of horn to tortoise-shell.

A little artistic instinct in the amateur will be found of great assistance during the operation.

### PART III.

#### DIFFERENT RECEIPTS CONCERNING IVORY AND BONES.

##### HOW TO SOFTEN IVORY AND BONES.

**W**E find in several treatises on art, various receipts which some writers assert that they have tested, while others maintain that they are of no value. When we come to speak of them we shall consider it our duty to warn our readers beforehand of those which we have actually submitted to a test.

Take three ounces of nitric acid, which is commonly called aquafortis, and fifteen ounces of white wine or vinegar, or even of common water. Put the piece of ivory in it to soak until it has become sufficiently softened to assume the form it is intended to give it by placing it in a mould or otherwise. The same result may be obtained by dipping the ivory into a decoction of mandrake cut up into small pieces and well boiled.

##### ANOTHER METHOD OF SOFTENING IVORY.

Take a pound of black Alicant-soda, and three quarters of quick-lime. Put the whole into two pints of boiling water, and allow the mixture to remain for three days. If the water is tolerably red, the solution is well mixed and fit for use; but if not, add thereto a little soda or quick-lime as may be required.

Decant the water, that is to say, pour it out at an incline so that it may run off clear. Immerse the ivory or the bones in it, and leave them there for fifteen days. At the end of that period they will be sufficiently softened.

##### HOW TO RE-HARDEN IVORY WHEN SOFTENED.

Roll the piece of softened ivory up in some white paper after it has been made to assume the form required, and then cover it over with white salt which has been allowed to dry slowly before a fire, and has not regained any of its former humidity.

##### ANOTHER METHOD OF RE-HARDENING IVORY AND BONES.

Dissolve an ounce of alum in a sufficient quantity of water, and to the water add the same weight of powdered cuttle-fish as there is of alum. Boil the water until a film forms itself on the surface, and soak the piece of ivory or bone in it for one hour or thereabouts. Then put it into a cool place for a few days to dry.

We have referred to these different methods of softening and re-hardening ivory and bones merely to gratify the curiosity of the amateur. A large number of these so-called secrets are met with in all quarters, and although no person has been found who has tried them with success, they yet are re-produced constantly. We will not abuse the patience of our readers by giving them any more, but content ourselves with making some reflections on the subject.

Nature has in her operations methods of construction which it is in the power of man to counteract. Thus, for instance, the texture of wood, the fluid which serves as gluten to its fibres, that immaterial something which combined with its active principle contributes its essence, all these may be destroyed by means of fire or by other agencies. But if the piece of wood be once disorganized, is it in the power of man to build it up organically anew? How then can it be maintained by argument that ivory and bones, which are nothing but a bundle of material elements united by a kind of gluten, of which nature alone possesses the secret, and whose molecules are disposed in a manner peculiar to the nature of each, can be destroyed, modified, or disturbed, then constructed afresh, organized and restored in their proper order, when all their ingredients are in the greatest disorder? In the case of tincturing objects, it is easy to conceive how this may be so; for then an infinite number of coloured molecules are introduced into the pores of the substance of which they are composed, and which, considering their number, present to the eye a surface of uniform colour. Seeing then the absurdity of the attempt to do so, we believe it to be our duty to leave to those authors who write about such matters, all those pretended secrets which astonish their readers and excite in them a desire to reduce them to facts, but which experience almost always belies.

#### A PREPARATION FOR DYEING IVORY.

Boil the pieces which are to be tinted in a bath of clean water which contains some vitriol and nitre, or saltpetre. The acids of their salts penetrate the ivory and dispose it to receive the colouring particles of the dyeing fluid. Take them out of the bath while it is still warm and plunge them at once into the dye, where they should be left for such a length of time as may be deemed necessary for the dye to become firm and acquire a tint of the intensity required.

#### HOW TO DYE IVORY.

Dissolve in spirits of wine the colours which are soluble in it. If a red tint be required use Brazil wood cut up into thin shavings. When the colour of the liquid has acquired sufficient intensity dip the piece of ivory into it, and in a tolerably short time it will become penetrated with the colour to a sufficient depth.

#### HOW TO DYE IVORY AND BONE.

Infuse for eight days or thereabouts some copper filings, rock alum, and a little vitriol in strong vinegar. When the solution is complete, decant it into another vessel and dip the ivory and the bones into it. Add to the latter vessel the dye colour which is desired. If the colour required be red, use Brazil wood cut up very fine, or cochineal; if yellow, Avignon berries, and if blue, indigo. Boil the whole until the ivory and the bones have acquired a proper tint.

#### HOW TO DYE BONES AND IVORY RED.

Take some cloths of a scarlet hue and boil it in ordinary water. When the water begins to boil add to it some pearlsh to extract the colour from the wool. The water will soon become

intensely red. Add then to it some rock alum and pass the whole through a linen strainer, in order to separate the wool. Dip the ivory and the bone into some aquafortis diluted with water, and leave it for only one second lest the surface should be affected; then add the die. If the pieces of ivory or of bone are to be streaked with white veins, they must be covered with wax before this operation, leaving untouched those parts which are to be so streaked. In this way designs and marble-grainings may be executed at the will of the operator.

#### HOW TO BLACKEN IVORY.

Soak the piece of ivory for five or six hours in an infusion of walnuts, pearl-ash, and arsenic. When the pores of the ivory are sufficiently opened, coat it with a few layers of a composition which is used for giving wood an ebony colour. This composition we shall describe hereafter.

#### ANOTHER WAY TO DYE IVORY BLACK.

Take four ounces of gall-nuts, pound them, add four ounces of the husks of green-nuts, and boil the whole into a pint of strong vinegar until it is reduced by one half. After having soaked the ivory for some time in some alum water, boil it.

#### HOW TO DYE IVORY GREEN.

Make a strong decoction of vine-cinders. Take a pint and a half of this mixture, and add one ounce and a half of powdered verdigris, some rock alum and a handful of sea-salt. Boil the whole till it is reduced by one half. Then having taken the ivory out of the preparation which was described at the commencement of this section, dip it into the mixture, take the vessel off the fire and allow the ivory to remain in it until it has become sufficiently coloured.

#### HOW TO DYE IVORY BLUE.

Make a decoction of the same kind as that just described and take the same quantity. Dissolve some indigo and potash in a little water and pour the mixture into the decoction. Dip therein the pieces required to be dyed in the same manner and with the same precaution as were used in the case of dyeing ivory green. Equal parts of indigo and of oil of vitriol or sulphuric acid may also be used for the purpose; but as this acid is very powerful, care must be taken not to touch it or to allow it to fall on the clothes, furniture, or other objects, which would probably be instantaneously scorched.

#### ANOTHER METHOD OF DYEING IVORY BLUE.

Take four pints of well-ripened seed of elder flowers, pour them into a japanned earthenware pot and add thereto half an ounce of powdered alum. Pour on the top a pint or a pint and a half of strong vinegar, or an equal quantity of clear urine, and dip the ivory in it. Boil the mixture and stir it frequently.

The first method imparts to ivory a much more beautiful blue than the second. Instead of indigo, Indian-wood may be used.

#### HOW TO MAKE YELLOW IVORY WHITE.

Dissolve in a sufficient quantity of water as much alum as may be necessary to make it white

and boil it till it has the consistency of soup. Plunge the pieces of ivory in it and allow them to soak therein for about an hour, rubbing them with small brushes.

When they have become white, wrap them in some linen or sawdust in order to prevent from splitting, and allow them to dry slowly.

Ivory may also be rubbed with dark soap, coating it with an even layer of it and bringing it near to the fire, raising the whole of its surface to the same temperature. When the soap begins to bubble dry the piece, and the yellow colour will be found to have disappeared. If the piece has not been coated with soap in all parts, or if it has been heated unequally, it will turn out to be variegated.

#### ANOTHER METHOD OF MAKING IVORY WHITE.

The method just described is not adapted to pieces made upon the lathe, or which may be so worked. Slake some lime in water, allow it to settle, and then decant it. Plunge the pieces of ivory into it, and cause it to effervesce. The ivory will whiten very quickly. Remount the piece on the lathe and polish it again as if it had just been turned. Finish by rubbing it with some moist whiting, and afterwards with dry whiting. But as we have already said elsewhere, whiting must not be used in the form in which it is generally used, namely in rolls, for in that state it contains a quantity of grit which would spoil the work of polishing. It must be diluted with a sufficient quantity of water, agitated and then allowed to remain quiet in order that the coarsest pieces may fall to the bottom. At the end of five or six minutes pour the water into another vessel, cover it carefully, allow it to settle for twenty-four hours and then decant it. When the paste has perfectly dried it will produce a tolerably fine powder free from all foreign matter.

#### HOW TO WHITEN AND TAKE THE FAT OUT OF BONES.

Bones, even those which are found in the legs of cattle, can very rarely be mounted on the lathe, for they do not possess sufficient thickness to be turned round either internally or externally. Besides as they contain only tubes and have no solidity, they must, in case the amateur should make boxes of them, have their hollow parts filled up. This is the reason why turners seldom use them. Yet they are sometimes made into different objects, as pegs, counters, and veneering.

Their grain is quite different to that of ivory; they have not the same sort of whiteness, and there are very few persons, however little acquainted with their characteristics, who could mistake bone for ivory. For this reason, we believe it to be our duty to state the method of cleaning them of fat and making them white. Some amateurs have assured us that both these objects may be obtained by exposing them on a roof or a similar place, to the open air, to the rain or the sun for some considerable time, as five or six months. But this method, however good, is somewhat tedious, and besides it is not always possible or convenient for the amateur to wait so long. In that case he should adopt the following method.

Place some lime in a new pot containing water. Boil the bones in this decoction and the fat will be got rid of in a short time.

We have tried this experiment ourselves with success; but it seems to us that this method changes somewhat the nature of the bones if boiled for any length of time, and that patches of grease reappear if the boiling be not continued long enough.

In the course of this operation the fat and a blackish scum are seen after a few minutes floating on the surface of the water. If the boiling takes place in the same water, the bones

will retain their grease. We are of opinion then that it is much better to make two mixtures and to dip the bones in each successively, so that the second may remove, without altering the nature of the bones, the small pieces of fat which may still remain in them.

This second decoction is obtained by throwing into boiling water, some rock-alum and a handful of sawdust. This mixture clears the bones of fat perfectly without in any way altering their composition.

#### HOW TO DYE BONES RED.

Boil two pounds of lime and one pound of calcined-alum in water. When the mixture has been reduced by one third add two pounds of quick-lime, boil it until an egg floats in it without sinking. Allow it to settle, and then pass it through a filter.

Take two pounds of this water, which is about six pints, and into it put half a pound of Brazil-wood and four ounces of scarlet-dye. Boil the whole for a quarter of an hour on a slow fire.

Decant the clean part of the mixture, and add a third less of water than the first time to the rest. Boil and strain it again, and then mix both liquids together. Continue the process of boiling and straining until the water becomes colorless. Then put the bones into the water so purified and boil them gently until they become quite red.

#### HOW TO DYE BONES BLACK.

Take six ounces of litharge and the same weight of quick-lime and dissolve them in water. Then add the bones which are to be coloured. Place the vessel containing the mixture on the fire, and as soon as it begins to boil take it off the fire and stir it until it becomes cold. On taking the bones out they will be found to be black.

#### HOW TO DYE BONES GREEN.

Put the bones into an earthen vessel and pour into it some pulverized verdigris and vinegar. Place the lid upon the vessel and close the joining by means of some gummed paper. Then bury it in some manure for fifteen days. At the end of that time take the bones out when they will be found to have a green colour. If no manure is close at hand, put the vessel in an oven, a stove, or warm cinders. There are a great many ways of dyeing bones green ; but as we intend to treat of dyeing hereafter we shall for the present content ourselves with the method just described.

## CHAPTER III.

**Dyes and Varnishes for Woods and Metals.****PART I.**

## THE DYEING OF WOODS.

## HOW TO PREVENT GREEN WOOD FROM SPLITTING.

**R**OUGHLY give your wood the shape you intend it to have and make a light wash with the ashes of some green wood. Put your wood in this and boil it for about an hour. Take the vessel off the fire and let the whole cool ; then dry the contents.

## TO HARDEN WOOD.

Give it the necessary shape and boil it in nut-oil. In a little while its texture will become much altered ; it is in this manzer that clockmakers harden their wooden wheels.

## TO DYE WOOD ANY PARTICULAR COLOUR.

Put a sufficient quantity of good vinegar in a varnished earthenware vessel. Infuse in it for seven or eight days some copper-filings, a little vitriol, some rock-alum, and some verdigris. Boil your wood in this decoction in order to dye it green. If you wish to dye it red, you must use some Brazil-wood instead of verdigris. To dye it blue, use some indigo dissolved in vitriol and so on for other colours. In every case, however, rock-alum must be employed.

## ANOTHER WAY.

Take some fresh horse droppings, press out all the moisture they contain, put them in a bottle. Add some rock-alum and the same quantity of gum-arabic to each half-pint of the liquor. Now take some of the liquor and give it any colour desired. At the end of three days the mixture can be used to dye wood, layer after layer being added till it has taken a fine dye.

## TO DYE WOOD IN EBONY COLOUR.

Boil some Indian-wood till the water in which it is boiled assumes a strong violet tinge. Then throw in a piece of rock-alum about the size of a nut. While the mixture is still hot rub it into the wood with a brush. Now dissolve some iron-filings in vinegar, and add a little salt. Rub some of this new dye into the wood that is already of a violet hue and it will at once change to a deep black. To insure the black being as perfect as possible it will be well to give the wood a second coating of the violet dye and then a final one of the other. When the wood is dry, rub it well with a slightly waxed cloth, it will then become as lustrous as if it had been varnished; for this reason the wooden objects should be quite completed before the dye is applied. The harder the wood the finer will be the effect of the dye. The above is a capital way to dye ivory and bone black.

## ANOTHER WAY TO PRODUCE AN EBONY DYE.

Powder four ounces of gall-nut, put them in a new earthenware pot. Add an ounce of Indian-wood in little shavings, a quarter of an ounce of vitriol and half an ounce of verdigris. Boil these ingredients in a sufficient quantity of water, and strain the decoction while it is still hot through a piece of linen. Then rub the liquor into the wood, which will at once become a deep black. Leave it to dry, and in the meantime prepare the following infusion for a second coating. Dissolve half an ounce of iron-filings in a quarter of a pint of good vinegar; slightly heat the solution and rub it in to the already blackened wood. Repeat this three or four times, using friction as soon as the dye is dry. Finally rub it well with a slightly waxed cloth.

## A THIRD WAY TO PRODUCE AN EBONY DYE.

Take some Indian-wood, cut into very small pieces, and add a little alum; boil the whole well and the result will be a strong violet dye. Rub in several coats of this dye until the wood becomes a very deep violet. Now boil some verdigris in vinegar and rub coat upon coat of the infusion into the wood till it turns quite black.

## A FOURTH METHOD.

Put a little vitriol and five gall-nuts in a small quantity of water, and heat it till it is nearly at boiling point. Dissolve half a pound of iron-filings in some strong vinegar; rub the wood with it and then with the first mixture, and finally with a coat of pure vinegar. When the whole is dry, polish it with a piece of serge.

## TO DYE WOOD BLACK.

Soak your wood for some four and twenty hours in some vinegar, and in the meantime boil in some more vinegar, some vitriol, some yellow orpiment, some pomegranate rind, and some gall-nuts, having previously reduced them all to fine powder. Boil the wood in this until it is sufficiently black; then add some sulphur, some quick-lime, and some saltpetre in equal parts.

## ANOTHER METHOD FOR HARD WOODS.

After having given the wood the necessary shape and finish, apply some diluted aquafortis with a brush. To judge of the proper strength of this diluted aquafortis, wet the end of your finger with



it and apply it to your tongue ; if it bites too sharply add some water ; if, on the contrary, it is too weak, add some aquafortis. As the wood dries the surface will roughen ; these rough parts must be got rid of by placing the wood on the lathe and rubbing it with some pumice-stone. A second coating must now be given it, and it must be rubbed again with the pumice-stone. Then use the following composition.

Put a pint of strong vinegar, two ounces of fine iron-filings, and half a pound of powdered gall-nuts into a glazed earthenware pot, and let the whole simmer for three or four hours on some hot cinders. Then increase the heat of the fire, and put four ounces of vitriol in half a pint of water in which has been already dissolved half an ounce of borax and some oil of vitriol, containing a little indigo. Make an infusion of all these drugs and put several coatings of it upon the wood ; when the latter is dry all that will be necessary will be to polish it with some oil and some tripoli-powder. If the wood is soft the tripoli will insinuate itself into its pores, but if it is hard it will have no effect.

#### TO DYE WOOD RED.

Steep the wood you are about to dye in some vinegar for twenty-four hours, throw into the vinegar enough Brazil-wood to turn it a bright red, and add some rock-alum. Boil the whole till the colour is satisfactory. All these dyes are pretty good, as well as those which we shall hereafter describe ; but the one thing required in the matter of dyes is that they should be fast and not disappear when exposed to the air. Unfortunately none of these colours last more than a year or two.

#### A PURPLE DYE.

Steep some German litmus in some water and add some Brazil wood boiled in some lime-water.

#### A BLUE DYE.

Dissolve four ounces of litmus in a pint and half of water in which some quick-lime has been previously placed. Boil it for an hour and rub several coatings of it into the wood.

#### A GREEN DYE.

Bray some verdigris up very fine in some strong vinegar, add two ounces of green vitriol and boil the whole for a quarter of an hour in two pints of water. Throw the wood into it and it will assume a bright green colour.

#### ANOTHER METHOD.

Boil two ounces of rock-alum and one ounce of feather-alum in a sufficient quantity of water ; add some verdigris in quantity proportionate to the degree of vividity you wish to give your dye. Steep the wood in it, and, when dry, polish it.

#### A MAHOGANY DYE.

First make a good red dye from some Brazil-wood by boiling it in some water with a little alum, adding a little potash to deepen the hue. Now take a brush and put some of this colour on the wood to be dyed, imitating as well as possible the graining of mahogany, leaving the ground the natural colour of the wood. The amateur may also take a little more potash and give a deeper colour to a small quantity of the same dye, and then give some darker touches here

and there in imitation of nature ; he may even go far as to add a few black marks, but with the greatest care, or he will spoil the whole thing. When all this has been done, and the wood is quite dry, add a coating of a tint made with clay and red colour until the ground of the wood has a natural mahogany tone ; this must be laid on all over with rather a large brush while the liquor is still hot. The amateur, however, must take care to stand the wood on end, and allow the dye to drain off and not collect on the corners, otherwise the tints will be too deep in certain places.

When the whole is dry the veining will stand out from the ground. Greater relief may even be given to them by touching them up with the same dye, still hot, on the point of a camel's-hair brush ; this last operation requires the greatest care. Finally, polish with some wax, rubbing it in vigorously and leaving as little as possible of it on the wood.

#### A YELLOW DYE.

Pound four ounces of the Avignon-berry, and boil them in a pint of water. Add thereto some rock-alum about the size of a small nut, and soak the wood in it after having strained it through a piece of linen.

Instead of Avignon-seed, clay may be used, which gives a much browner yellow.

#### ANOTHER KIND OF YELLOW DYE.

Take an earthenware vessel rather larger than is absolutely necessary, and pour into it a sufficient quantity of water, and adding gradually some iron-filings, when dark vapours like thick smoke are at once given off. Take care not to inhale them as they produce suffocation and are very injurious to the chest. It would be advisable to conduct this operation in a place quite open on all sides. Put in only a little of the filings at a time, as a strong ebullition at once sets in, and the liquor which rises quickly might escape over the top of the sides. When all the filings have been dissolved, the ebullition ceases. As the liquor and the vessel are very hot they must be allowed to cool before using them again. Spread some of this liquor over the wood, which may be made to acquire a very deep brown colour, or even grained here and there by means of a pencil. Any kind of figure that may be desired may be traced upon the wood by means of a pencil and some yellow wax ; then put some of the liquid mixture on the ground and cause it to assume a yellow or brown colour according to the number of coatings that are spread upon it. When the whole is dried carefully remove the wax, when all the figures will be found to present the colour natural to the wood upon a yellow or brown ground. It is in this way that flutes of a brownish yellow and very dark brown bassoons are dyed.

#### YELLOW DYE FOR CHAIRS.

A few years ago chairs made upon the lathe could only be dyed yellow or, perhaps, fashion ruled it thus. Now they are dyed red, blue, or green. They are dyed yellow in the following manner.

Pound in a mortar four ounces of barberry, pour them into a new glazed earthenware pot, containing three pints of water, and boil the whole. Strain the decoction through a piece of white linen. If it is not yellow enough, add some gamboge-gum at intervals more or less great.

Turners also use the Avignon-berry for dyeing chairs. It produces a beautiful yellow, which takes well provided a little rock-alum be added to it.

DYE FOR BOXWOOD.

We have already said elsewhere that the colours of boxwood are not sufficiently well concentrated and that in consequence it is necessary to introduce some dye into the back-ground which may alter the capricious natural arrangement they present and thus harmonize them. To induce amateurs to purchase snuff-boxes made of this wood the colours should be well pronounced and firmly fixed. We are therefore inclined to think that we shall afford some pleasure to our readers if we describe both the nature of the dye used to produce this effect and the method of applying it.

Soak the pieces of boxwood in a vessel containing some water, for eight or ten days and change the water every day washing them well each time. But before allowing this to act upon them it is necessary to give them in the shape & form of almost the same size as that which they are to finally have, so that after having recovered from the action of the spirituous liquor to be described they may be repaired in the lathe and easily finished off.

When they have been in this way soaked for the time specified, enclose them in a box and wrap them up in some linen or sawdust to prevent them from drying too fast or splitting. Expose them by degrees to the air removing them in the lathe and refine them to the form and proportions required.

Take half a pound of Roman earth in eight pints of water, boil and allow the mixture to set down. Soak the boxes in this preparation well for a few days.

Take now eight pints of water & a pound of shavings or chips of Pernambuco-wood which must have been kept soaking in the water from the day before, and pour all the mixture, strained to a fine hair, and add to it half an ounce of rock-alum. Take the vessel off the fire, and when the dye has become cool, put the boxes in it.

The wood having been left to soak for four days, dry it in a box as before and gradually expose it to the air, finally finishing it in the lathe.

The method of finishing for fixing the wood red. If the wood is to have a green or a blue colour prepare it in the same manner and then plunge it in a solution of indigo and verdigris if a blue dye is required, and in one of copper's if a green one is desired.

ARTS OF FINING AND POLISHING BOXWOOD BOXES

Boxwood boxes may be stained with red green blue or black colours. To make the colours stand out in a particular style, the red and green of a combination of the three colours may be made very dark or not dark at all of the above-mentioned colours as it would appear the result. The following method should be used. Before adding any colour suitable some powdered pumice-stone in a sieve to a bowl, then stick or other material and polish the box. The pumice-stone should be passed in some linen and then shaken over the top of the box thus preventing any rough particles or any insufficiently powdered part from falling in the surface. The surface will be a fine white, a brush beginning with water when it is to be stained, and finishing with clear water as a wash brush. When the dye is small, give a quantity of dye in the dye for the colour which is required to cover every part of the inside and this may be done in the following manner.

When the dye is small, give a quantity of dye in the dye for the colour which is required to cover every part of the inside and this may be done in the following manner. The dye should be mixed with some water and the mixture should be applied to the inside of the box with a brush. The dye should be mixed with some water and the mixture should be applied to the inside of the box with a brush.















