CHAPTER XXXIV.—WOOD-WORKING.

PATTERN-MAKING.—Of the different kinds of wood serviceable to the pattern-maker, pine is, for many reasons, usually employed. It should be of the best quality, straight-grained, and free from knots; it is then easy to work in any direction, possessing at the same time sufficient strength for all but the most delicate kinds of work, and having besides the quality of cheapness to recommend it. Care taken in its selection at the lumber-yard will be amply repaid in the workshop. When it is straight-grained, the marks left by the saw will show an even roughness throughout the whole length of the plank; and the rougher the appearance, the softer the plank. That which is sawn comparatively smooth will be found hard and troublesome to work. If the plank has an uneven appearance—that is to say, if it is rough in some parts and smooth in others—the grain is crooked. Such timber is known to the trade as cat-faced. In planing it the grain tears up, and a nice smooth surface cannot be obtained. Before purchasing timber, it is well to note what convenience the yard possesses for storing. Lumber on the pile, though it be out in all weathers, does not deteriorate, but becomes seasoned; nevertheless its value is much increased if it has an extemporised roof to protect it from the sun and rain. But as it is not convenient to visit the pile for every customer, quantities are usually taken down to await sale, and for such a shelter must be provided, otherwise it will be impossible to insure that the lumber is dry, sound, and fit for pattern-making. It is obvious that the foregoing remarks on the storage of lumber apply to all woods.

The superiority of pine for pattern-making is not, however, maintained when we come to fine delicate patterns or patterns requiring great durability. When patterns for fine work, from which a great many castings are to be made, are required, a fine pattern wherefrom to cast an iron pattern is improvised, because, if pine were employed, it would not only become rapidly worn out, but would soon warp and become useless. It is true that a pine pattern will straighten more easily than one made of a hard wood; but its sphere of usefulness in fine patterns is, for the above reasons, somewhat limited. Iron patterns are very desirable on account of their durability, and because they leave the sand easily and cleanly, and because they not only do not warp but are also less liable than wooden ones to give way to the sand, while the latter is being rammed around them by the moulder, a defect that is often experienced with light patterns, especially if they are made of pine. Iron patterns, however, are expensive things to make, and therefore it is that mahogany is extensively employed for fine or durable pattern work. Other woods are sometimes employed, because they stand the rough usage of the moulding shop better and retain the sharp corners, which, if pine be used, in time become rounded impairing the appearance of the casting. Mahogany is not liable to warp, nor subject to decay; and it is exceedingly durable, and is for these reasons the most desirable of all woods employed in pattern-making, providing that first cost is not a primary consideration. There are various kinds of this beautiful wood: that known as South American mahogany is chiefly used for patterns.

Next to mahogany we may rank cherry, which is a very durable wood, but more liable to twist or warp than mahogany, and it is a little more harsh to the tool edge. If, however, it is stored in the workshop for a length of time before being used, reliable patterns may be made from it. In addition to these woods, walnut, beech, and teak are sometimes employed in pattern-making.

The one property in all timber to be specially guarded against is its tendency to warp, bend, expand, and contract, according to the amount of humidity in the atmosphere. Under ordinary conditions, we shall be right in supposing a moisture to be constantly given off from all the exposed surfaces of timber; therefore planks stored in the shop should be placed in a rack so contrived that they do not touch one another, so that the air may circulate between the planks, and dry all surfaces as nearly alike as possible. If a plank newly planed be lying on the bench on its flat side, the moisture will be given off freely from the upper surface, but will, on the under surface, be confined between the bench and the plank: the result being that a plank, planed straight, and left lying as described, will be found, even in an hour, to be curved, from the contraction of the upper surface due to its extra exposure; therefore it is obvious that lumber newly planed should be stored on end or placed on edge. Lumber expands and contracts with considerable force across the grain; hence if a piece even of a dry plank, be rigidly held and confined at the edges, it will shrink and break in two, often with a loud report. There is no appreciable alteration lengthwise in timber from the above causes; and if two pieces be glued together so that the grain of one crosses that of the other, they can never safely be relied upon to hold. Hence they had better be screwed so that there will be a little liberty for the operation or play of the above forces, while the screws retain their hold. The shrinkage, expansion, and warping of timber may perhaps be better understood by the following considerations: The pores of wood run lengthwise,

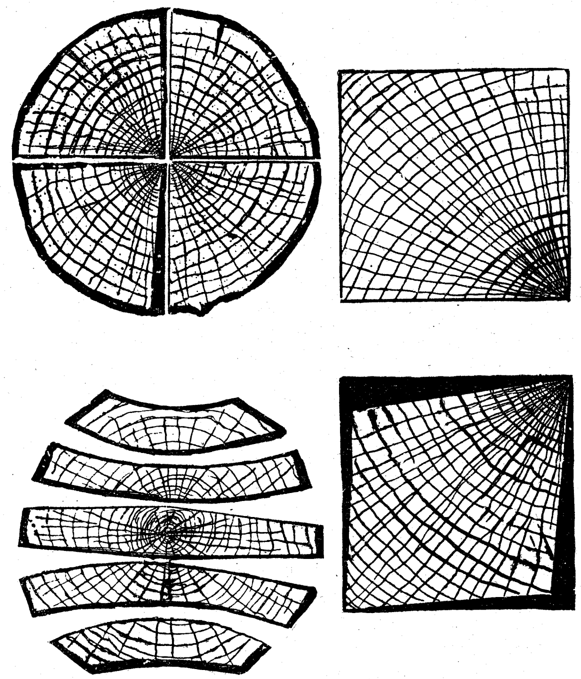

Fig. 2706.

or with its grain, and hence the moisture contained in these passes off more readily endwise or from any surface on which the pores terminate.

THE SHRINKAGE OF TIMBER.—The direction in which timber shrinks in seasoning or drying is shown in the following figures, which are extracted from a lecture delivered by Dr. Anderson before the Society of Arts in London, England. The shrinkage of timber lengthwise of the grain is very slight, its shrinkage in a direction across or at a right angle to the length of the grain being much greater and depending upon the part of the log from which it is cut.

The shrinkage is greater on the outside than near the heart of the tree; thus if a log be cut into four quarters it will shrink as in Fig. 2706, from the full block outside to the inside or white outline; or if we cut out a square as in figure, one corner extending to the heart, it will shrink to the form shown in the figure. If we sever the log by the four parallel saw cuts it will shrink as shown by the black outline, the shrinkage of the middle piece being more clearly shown in Fig. 2707.

It is evident, therefore, that to obtain a uniform degree of shrinkage throughout the length of a piece of timber, it should be sawn as near as possible parallel with the grain of the log. Thus in Figs. 2708 and 2709 we have a side and an end view of a log, the saw cuts at A being from logs that have been squared, the upper

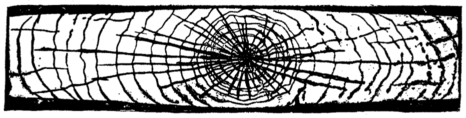

Fig. 2707.

slab B being waste material, and the planks being parallel to the squared sides of the log.

The lines from A to C on the lower half of Fig. 2709 represent planks that are what is termed flitched, the saw cuts following the taper of the tree, and it is plain that the shrinkage would be more uniform; thus the outside plank is near the bark from end to end, while at the top of the figure the outside plank is near the outside at the small end only of the log, and would therefore

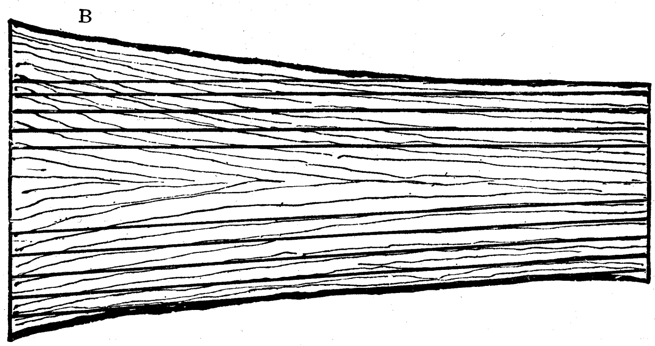

Fig. 2708.

shrink most at the right hand end. Furthermore as the planks at A cross the grain of the log at its large end, they are therefore weaker and more liable to split at that end.

BENDING TIMBER.—By bending a piece of timber to bring it as near as possible the required shape the strength of the work is increased, because the grain of the wood runs parallel with the shape of the work, and, furthermore, the cutting tools act on this account to better advantage. In bending a piece of timber it is obvious that

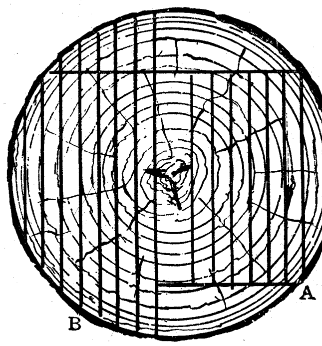

Fig. 2709.

either the convex side must stretch, or the concave one compress, or if no extraneous pressure is brought to bear upon the piece, both of these actions may occur, and as the side of the piece that was nearest to the heart of the tree is the hardest and strongest, it will stretch less if made the convex side, or compress less if made the concave side of the timber, but the bent piece will maintain its shape better if the heart is the convex or outside of the curve.

The modern method of bending wood is to fasten on the outside, or convex side of the piece, a strap that will prevent it from stretching. And it is found that wood thus bent is stronger, stiffer, and heavier than before it was bent, because the fibres become interwoven, and it is found that the wood is harder to split than before.

Suppose we require to bend a piece to a half circle, and after it has been boiled, steamed, or heated with a dry heat it is placed in

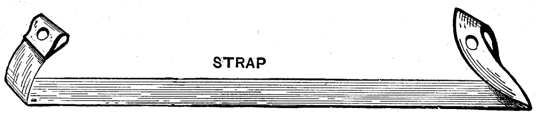

Fig. 2710.

an iron strap, such as shown in Fig. 2710, having an eye at each end in which a hook may be inserted to hold the piece in shape (after it is bent) until it is dry again. The piece with this strap on its

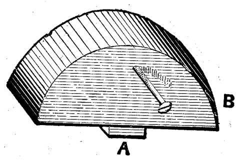

Fig. 2711.

outside or uppermost surface is laid on the *former* or forming piece shown in Fig. 2711, which has a projection at A, fitting into the recess A of the bending block in Fig. 2712. On the outside of the

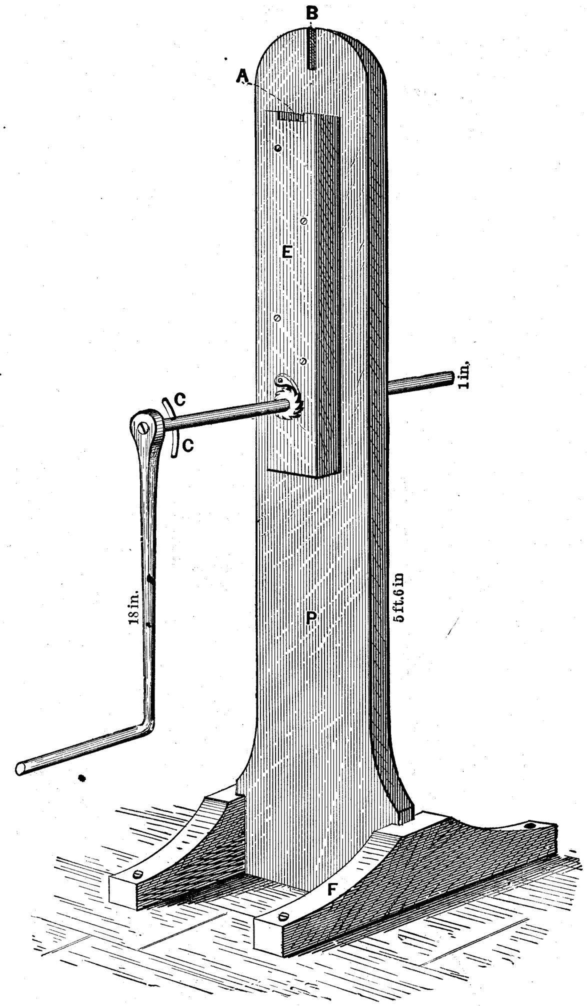

Fig. 2712.

piece is then placed the strap, shown in Fig. 2713, its blocks of wood fitting to the ends of the piece to be bent.

The winch of the bending block is provided with a rope, whose ends have two hooks which are engaged in the eyes of the straps, shown in Fig. 2714, and by operating the winch the piece is bent to shape, as shown in Fig. 2714. While in this position a hook is placed through the eyes of the band that is around the bent piece

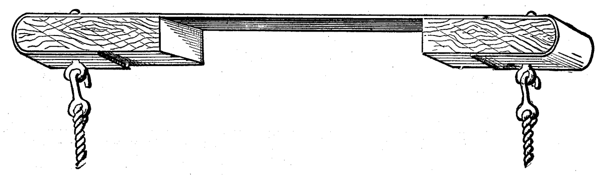

Fig. 2713.

of work, so that when removed from the forming block or stand it appears as in Fig. 2715.

When, however, the piece requires to be bent to more than one

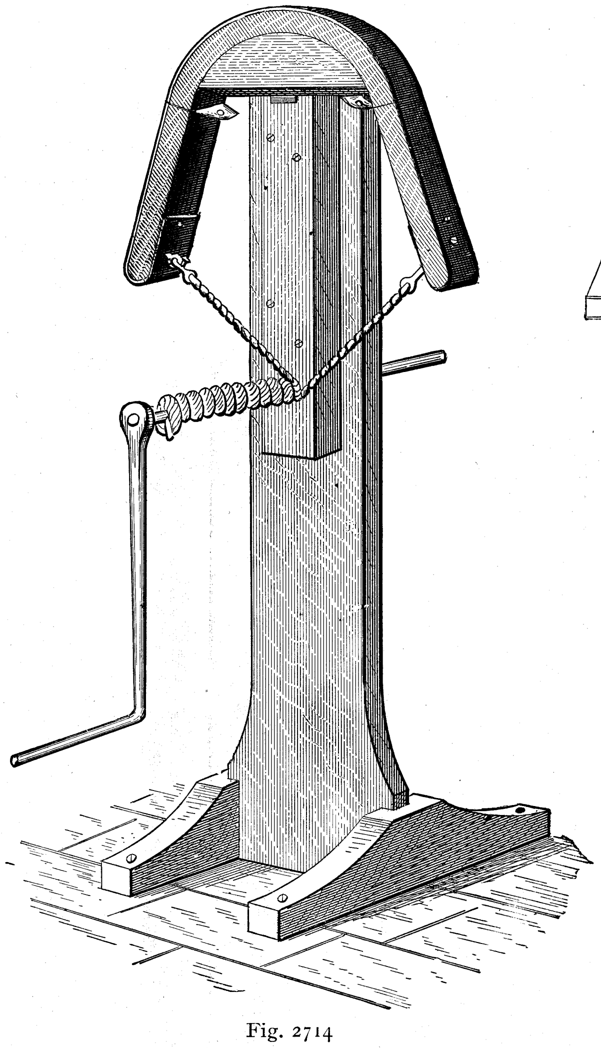

Fig. 2714

sweep or bend, the process requires to be changed somewhat. Thus, suppose the middle is to be bent circular and the two ends left straight, and the strap on the piece to be bent is provided with

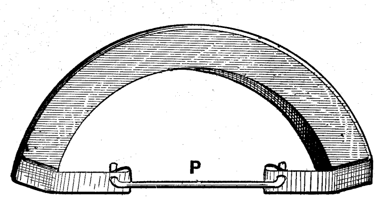

Fig. 2715.

a piece, such as in Fig. 2716, the ends B engaging in eyes in the strap, and the screw A abutting against the end of the piece to bind the strap firmly upon the ends, as in Fig. 2717, in which the piece is shown within the strap. After it has been bent to the former it is held there by straps and wedges, as shown in Fig. 2718.

The next operation is to lock the curve, as shown in Fig. 2719,

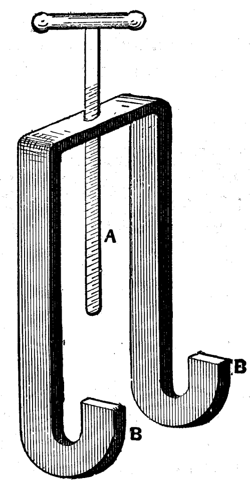

Fig. 2716.

between an inside and outside former by means of straps A A and wedges C, when the ends D of the piece may be bent up to the

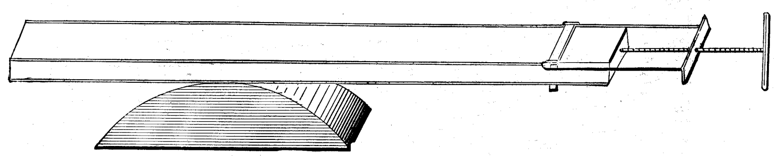

Fig. 2717.

dotted lines and locked to the ends of the top former by straps and wedges.

The length of time a piece should be boiled or steamed for the

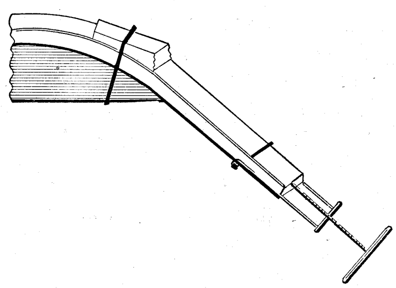

Fig. 2718.

bending process depends upon the size of the piece and the kind of wood, hard wood requiring longer boiling or steaming. A piece of ash, say 2 by 4 inches in cross section, would require about six

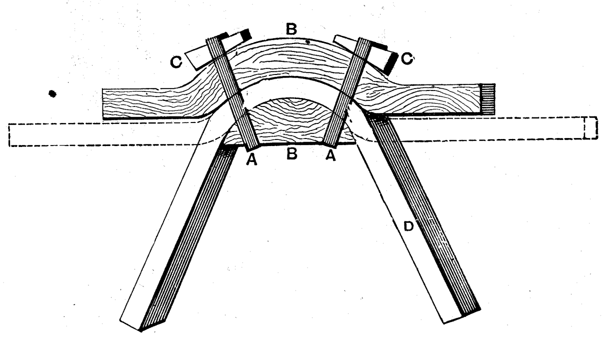

Fig. 2719.

hours' steaming with a low pressure of moist or wet steam, but it would not suffer damage if it were steamed for a day. Pieces not over half an inch thick may be bent after steaming them about half an hour.

If the wood is steamed too much it loses its elasticity and will pucker on the inside surface of the bend when in the former or bending block.

The period during which the piece should be held to its bent shape before being released varies from twelve hours for thin pieces to twenty-four hours for thick ones, and it is found that pieces which have been bent in a strap so as to prevent the outside from stretching, will, in drying, increase their bend or curvature, while those not confined at their ends straighten out.

The cracks that are found in timber are termed *shakes;* thus in

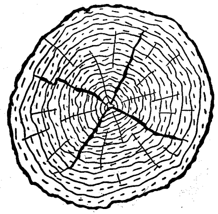

Fig. 2720.

Fig. 2720 the black lines represent what are called heart shakes, while those in Fig. 2721, being wider, are termed star shakes. When the shakes are circular, as in Fig. 2722, they are called cup shakes.

Many of the tools used by the pattern-maker have been described in connection with hand turning, hand boring tools, lathe tools, &c., and therefore need no further reference.

PLANES.—For roughing out the work the jack plane is employed, varying in size from 14 inches long with a cutter knife or blade 2

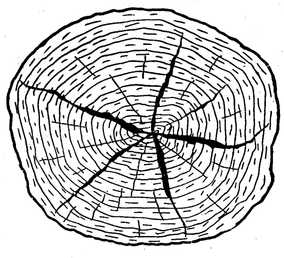

Fig. 2721.

inches wide, to 27 long with a blade $2\frac{1}{4}$ inches wide, and as its purpose is to make a flat surface, it is preferable that it be as long as the work will conveniently permit. The jack plane is followed by the fore plane, the truing, or trying plane, which varies in size from about 18 inches long with a blade $2\frac{1}{8}$ inches wide, to 20 inches long with a cutter or blade $2\frac{3}{8}$ inches wide. When the fore plane is made longer, as for planing long joints, it is termed a jointer plane, the length being as much as 30 inches and the blade $2\frac{5}{8}$ inches wide.

The smoothing plane varies from about 5 inches long with a

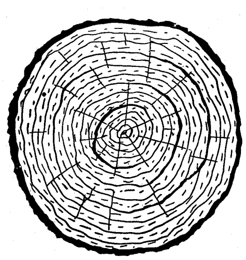

Fig. 2722.

blade $1\frac{1}{2}$ inches wide, to 10 inches long with a blade $2\frac{3}{8}$ inches wide. Smoothing planes are, as the name implies, used to simply smoothen the work surface after it has been trued.

The angle of the plane blade to the sole of the plane is for ordinarily soft wood 45°, but 50° or 55° may be used for very hard woods.

To break the shaving the blade is attached to what is termed a cover, which is shown in Fig. 2723, B representing the blade and A the cover. The cover is curved to insure that it shall bed against the blade at its very end, and, therefore, as near to the cutting edge as a maximum distance $\frac{1}{16}$ inch for rough and $\frac{1}{32}$ inch for finishing cuts. The blade of a jack plane is most efficient when it is ground well away towards the corners, as at A B in Fig. 2724, thus producing an edge curved in its length.

When the blade is in position in the stock for cutting off the maximum of stuff, its blade should project nearly $\frac{1}{16}$ through the sole of the stock, while the corners A B are about level with the face of the stock. The bevelled face should stand at about an angle of 25° to the flat face. In grinding it care should be taken to grind it as level as possible, rounding off the corners as shown above. The grindstone should be kept true and liberally supplied with water; the straight face should not be ground away, nor indeed touched upon the stone, except to remove the burr which will sometimes turn over. The pressure with which the blade is held against the grindstone should be slight at and toward the finishing part of

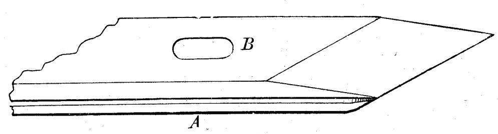

Fig. 2723.

the grinding process, so as not to leave a long ragged burr on the end of the blade, as is sure to be the case if much pressure is applied, and it will occur to a slight extent even with the greatest of care. The blade should not be held still upon the grindstone, no matter how true, flat, or smooth the latter may be; but it should be moved back and forth across the width of the stone, which will not only grind the blade bevel even and level, but will also tend to keep the grindstone in good order.

In oilstoning a plane blade, the straight face should be held quite level with the face of the oilstone, so that the cutting edge may not be bevelled off. Not much application to the oilstone is necessary to the straight face, because that face is not ground upon the grindstone, and it only requires to have the wire edge or burr removed, leaving an oilstone polish all along the cutting edge. The oilstoning should be performed alternately on the flat and bevelled faces, the blade being pressed very lightly on the oilstone toward the last

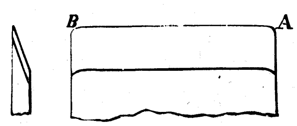

Fig. 2724.

part of the operation, so as to leave as fine a wire edge as possible. The wire is the edge or burr which bends or turns over at the extreme edge of the tool, in consequence of that extreme edge giving way to the pressure of the abrading tool, be it a grindstone or an oilstone. This wire edge is reduced to a minimum by the oilstone, and is then so fine that it is practically of but little account; to remove it, however, the plane blade or iron may be buffed backwards and forwards on the palm of the hand.

The blade being sharpened, we may screw the cover on, adjusting it so that its edge stands a shade below the corners of the iron, and then screwing it tight; the blade or iron and the cover must now be placed in the mouth of the plane stock, and adjusted in the following manner:—

The plane iron should be passed through the mouth of the stock until as much in depth of it is seen to protrude from the bottom face of the stock as is equal to the thickness of shaving it is intended to cut: to estimate which, place the back end of the plane upon the bench, holding the stock in the left hand with the thumb in the plane mouth, so as to retain the iron and wedge in position, the wedge being turned towards the workman. A glance down the face of the stock will be sufficient to inform the operator how much or how little the cutting edge of the iron protrudes from the face of the plane stock, and hence how thick his shaving will be. When the distance is adjusted as nearly as possible, the wedge may then be tightened by a few light hammer blows. If, after tightening the wedge, the blade is found to protrude too much, a light blow on the fore end on the top face of the plane will cause it to retire; while a similar blow upon the back end will cause it to advance. In either case the wedge should be tightened by a light blow after it is finally adjusted.

In using a jack plane we commence each stroke by exerting a pressure mostly on the fore part of the plane, commencing at the end and towards the edge of the board, and taking off a shaving as long as the arms can conveniently reach. If the board is longer than can be reached without moving, we pass across the board, planing it all across at one standing; then we step sufficiently forward, and carry the planing forward, repeating this until the jack planing is completed. To try the level of the board, the edge or corner of the plane may be employed; and if the plane is moved back and forth on the corner or edge, it will indent and so point out the high places.

The fore plane (or truing plane, as it is sometimes called) is made large, so as to cover more surface, and therefore to cut more truly. It is ground and set in the same manner as the jack plane, with the exception that the corners of the iron or blade, for about one-eighth inch only, should be ground to a very little below the level of the rest of the cutting edge, the latter being made perfectly

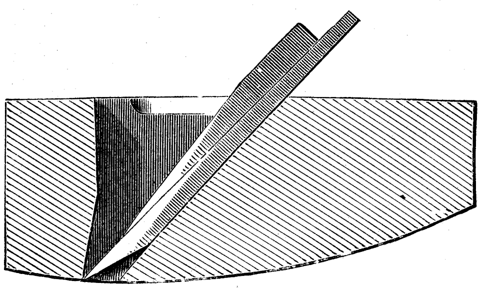

Fig. 2725.

straight (or as near so as practically attainable) and square with the edge of the iron. If the end edge of the cover is made square with the side edge, and the iron is ground with the cover on, the latter will form a guide whereby to grind the iron edge true and square; but in such case the cover should be set back so that there will be no danger of the grindstone touching it. The oilstoning should be performed in the manner described for the jack plane, bearing in mind that the object to be aimed at is to be able to take as broad and fine a shaving as possible without the corners of the plane iron digging into the work. The plane iron should be so set that its cutting edge can only just be seen projecting evenly through the stock. In using the fore or truing plane, it is usual, on the back stroke, to twist the body of the plane so that it will slide along the board on its edge, there being no contact between the cutting edge of the plane iron and the face of the board, which is done to preserve the cutting edge of the plane iron from abrasion by the wood: as it is obvious that such abrasion would be much more destructive to the edge than the cutting duty performed during the front stroke would be, because the strain during the latter tends mainly to compress the metal, but, during the former, the whole action tends to abrade the cutting edge. The face of the fore plane must be kept perfectly flat on the underside, which should be square with the sides of the plane. If the under side be hollow, the plane iron edge will have to protrude farther through the plane face to compensate for the hollowness of the latter; and in that case it will be impossible to take fine shavings off thin stuff, because the blade or iron will protrude too much, and as a consequence there will be an unnecessary amount of labor incurred in setting and resetting the plane iron. The reason that the under surface should be square, that is to say, at a right angle to the sides of the body of the plane, is because the plane is sometimes used on its side on a shooting board.

When the under surface of the plane is worn out of true, let the iron be wedged in the plane mouth, but let the cutting edge of the iron be well below the surface of the plane stock. Then, with another fore plane, freshly sharpened and set very fine, true up the surface, and be sure the surface does not wind, which may be ascertained by the application of a pair of winding strips, the manner of applying which will be explained hereafter. If the mouth of a fore plane wears too wide, as it is apt in time to do, short little shavings, tightly curled up, will fall half in and half out of the mouth, and prevent the iron from cutting, and will cause it

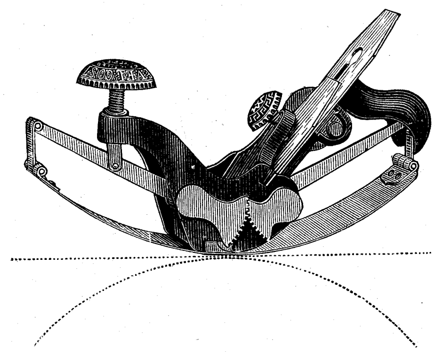

Fig. 2726.

to leave scores in the work, entailing a great loss of time in removing them at every few strokes. The smoothing plane is used for smoothing rather than truing work, and is made shorter than the truing plane so as to be handier in using. It is sometimes impracticable to make a surface as smooth as desirable with a truing plane, because of the direction of the grain of the wood.

Fig. 2725 represents an ordinary compass plane, which is a necessary and very useful tool for planing the surfaces of hollow sweeps. This tool is sometimes made adjustable by means of a piece dovetailed in the front end of the plane, which, by being lowered, alters the sweep and finally converts it from a convex to a concave.

In Fig. 2726 is shown a much superior form of circular or compass plane. Its sole consists of a flexible steel blade, whose ends

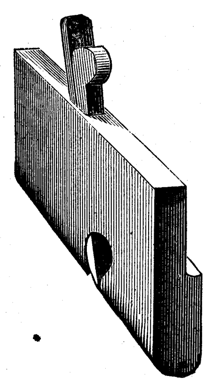

Fig. 2727.

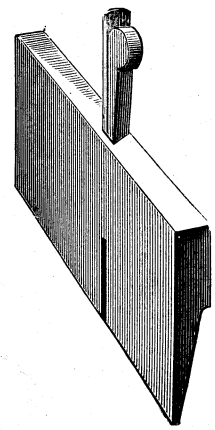

Fig. 2728.

are attached to levers that are connected together by toothed segments. By means of the large hand-screw the levers are operated, causing the sole to bend to the required curvature, and by reason of the toothed segments the levers move equally, and therefore give the sole a uniform curve throughout its length.

Planes are also made with the sole and the cutting edge of the blade made to conform to the shape of the work. Thus Fig. 2727 represents a rabbeting plane, and Fig. 2728 a side rabbet plane. The latter is, however, very seldom used, but is especially useful in planing hard wood cogs fitted to iron wheels, or the teeth of wheel patterns or other similar work. For ordinary use, it is sufficient to have two, a $\frac{3}{4}$ and a $1\frac{1}{4}$ inch, and two or three having a flat sole for flat bottom grooves.

What is known as a core box plane has its sole at an angle of 90°, or a right angle; the principle of its action is that in a semicircle the angle is that of 90°.

In Fig. 2729, for example, it is seen that if a right angle be laid

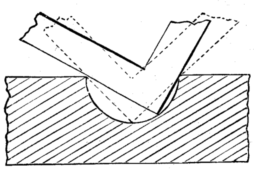

Fig. 2729.

in a semicircle so that its sides meet the corners of the same when revolved, its corner will describe a true circle; hence at each plane stroke the plane may be slightly revolved, to put on the cut, which must be very light, as the core box plane is only suitable for finishing purposes. For planing across the end grain of wood, what are termed block planes are used, the angle of the blade to

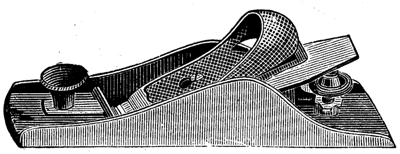

Fig. 2730.

the sole being from 65 to 85 degrees, as shown in Fig. 2730, which represents the Stanley iron frame block plane. In block planes the bevel that is ground to sharpen the blade is placed in front and therefore meets the shaving instead of the flat face as in other planes.

Fig. 2731 represents the Stanley bull-nose rabbet plane for

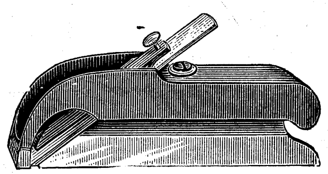

Fig. 2731.

getting close into corners, and Fig. 2732, a block plane, in which the blade may be set in the usual position or at one end of the stock as denoted by the dotted lines.

For fine work planes having an iron body are much preferable to

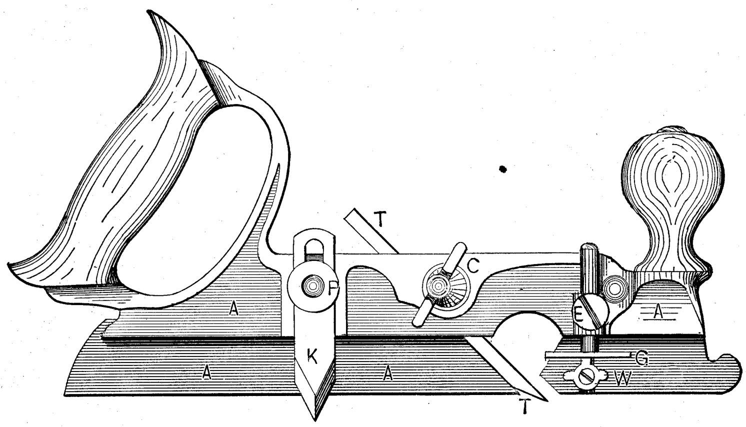

Fig. 2735.

the wooden ones, and in the improved form of planes there is provided a screw mechanism, whereby the blade may be set much more accurately and easily than by hammer blows, such as are necessary with ordinary wedge-fastened blades. Thus Fig. 2733 represents Bailey's patent adjustable planes, the handles only being of wood. The blade is secured by a simple lever movement, and is set by means of the thumb screw shown beneath and behind the blade.

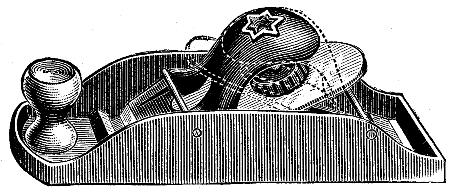

Fig. 2732.

The metal stock possesses several advantages, such as that the sole keeps true, the mouth does not wear too large, as is the case with wooden planes. Planes are also made having a wooden body and an iron top, the latter containing the mechanism for

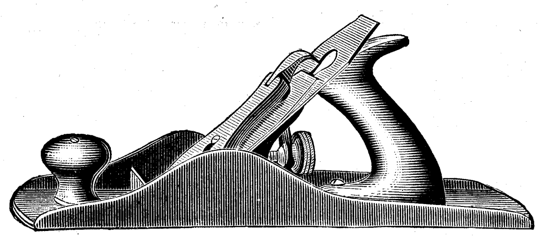

Fig. 2733.

locking the blade and setting it quickly. Fig. 2734 represents one of these planes.

Figs. 2735 to 2744 represent a combination plane. Fig. 2735 is a side, and Fig. 2736 a top view of the tool as a whole.

Pieces A and B form the body of the plane, between which the

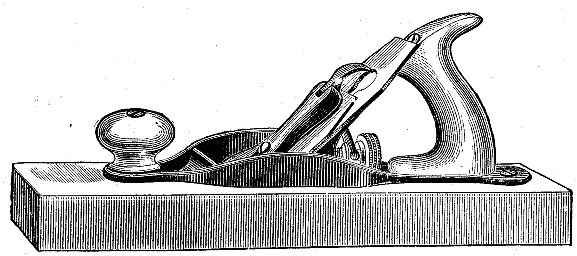

Fig. 2734.

bits or all the tools are carried except the slitting knife, which is carried by A alone.

In the figures T is a beading tool shown in position, having a bearing or seat in both A and B so as to support it on both sides, and being locked in position by the thumb-screw C. At G is a depth gauge which is moved over into the hole at D, when that position is most suitable for the kind of work in hand. Piece B is made adjustable in its distance from A so as to accommodate different widths of bits by sliding it on the arms M, securing it in

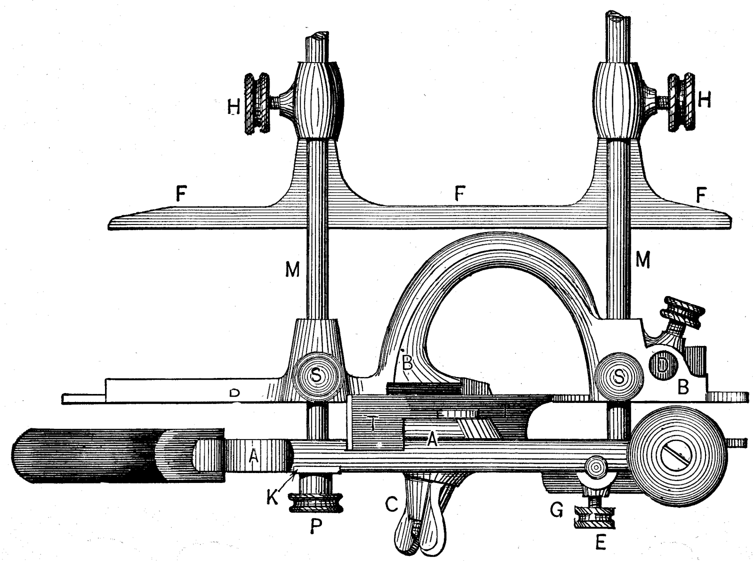

Fig. 2736.

its adjusted position by the set-screws S. Similarly the fence F slides on arms M, and is secured in its adjusted position by the set-screws H, thus enabling it to regulate the distance from the edge of the board at which the bits shall operate, and also guiding the bits true to the edge of the board or work. F is provided with an upper pair Q, and a lower pair R of holes (as seen in Fig. 2737) so that it may be set on the arms M at two different heights as may best suit the nature of the work. In Fig. 2736 it is shown with arms M passing through the lower pair of holes. The points of the set-screws H meet the bores of both pairs of holes and therefore

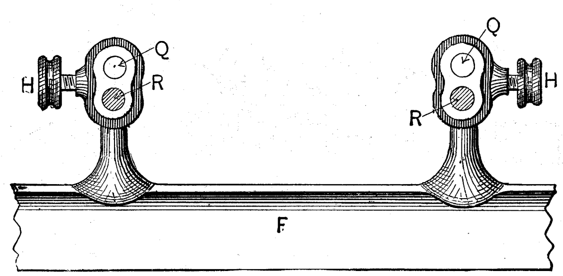

Fig. 2737.

lock F to the arms, whether the upper or lower holes are upon the arms. For rabbeting and fillister work the upper holes Q are used, while using ploughs the lower ones are brought into requisition.

At W, Fig. 2735, is a spur for cutting the end grain of the wood in advance of the bit, as is necessary in dado and other across grain work, the construction of the spur is seen more clearly in Fig. 2738. The pieces A and B are provided with a recess having

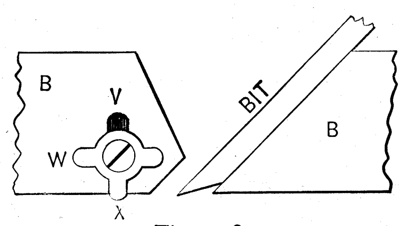

Fig. 2738.

four arms or branches, while the spur itself has but three, so that the spur may be set as in Fig. 2735 and be out of action, or its screw being loosened it may be given a half-turn, so that one of its arms will come below B as at X in Fig. 2738. The cutting edges of the spur come exactly flush with the outside faces of A and B, and the bits are so held in their seats that their edges also come flush with these outside faces, which therefore act as guide to the bit; thus Fig. 2739, shows a beading bit in position, and Fig. 2740 a section of work finished, A and B being in section. Fig. 2741 shows a plough in position on the work, A and B being shown in section. It is seen that their inner edges being bevelled, will in

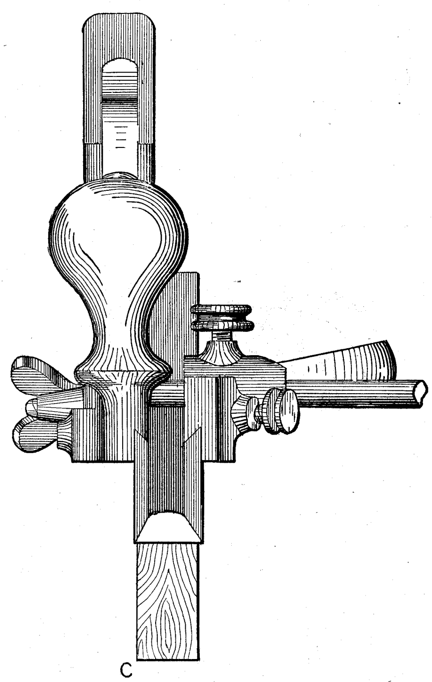

Fig. 2739.

using a beading tool, act as a gauge regulating the thickness of

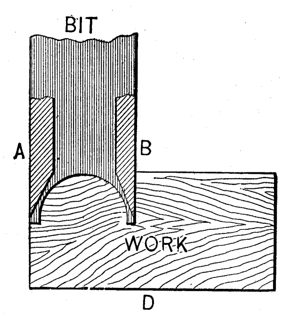

Fig. 2740.

shaving taken at each plane stroke, which will equal the depth to which the bit edge projects beyond the bevels of A and B. Simiiarly in grooving or ploughing the amount to which the bits project below the lowest edges of A and B regulates the thickness of the shaving, and as A and B follow the bit into the work, the blade

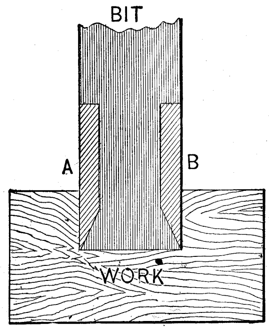

Fig. 2741.

being once set requires no further attention, the depth gauge regulating the total depth of tool action.

This principle of the side pieces entering the work with the bits and being adjustable to suit various widths of bits, gives to the tool

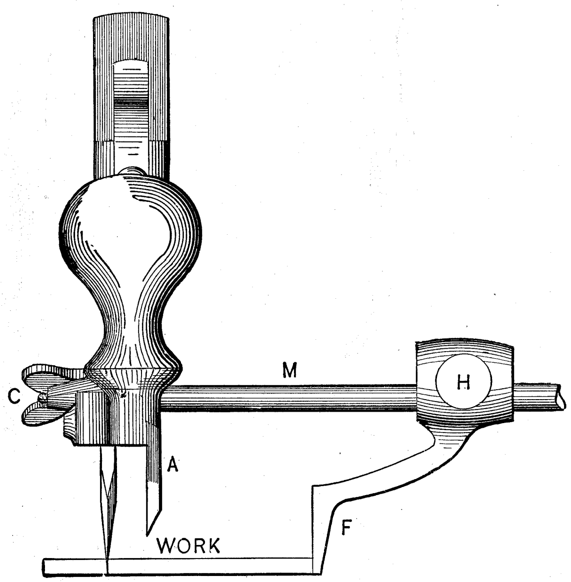

Fig. 2742.

a wide range of capacity. Fig. 2742 represents the tool arranged for slitting thin stuff into parallel slips, the piece B being removed. The depth gauge is not shown in figure, because it would hide the slitting knife from view, but it is obvious that it would rest on the surface of the work and thus steady the plane. Fig. 2743 is an

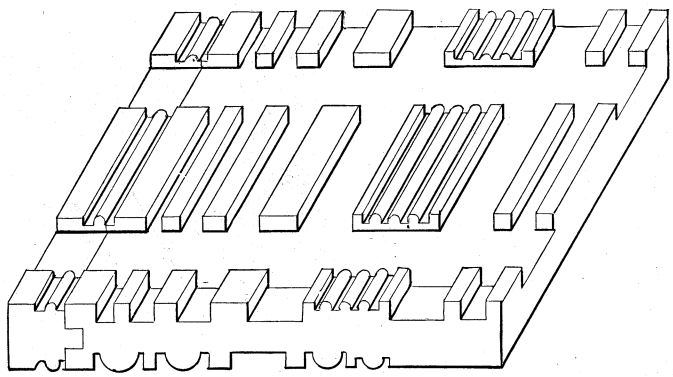

Fig. 2743.

example of a number of operations performed by this one tool. For tonguing, the bit shown in Fig. 2744 is employed, the depth gauge *g* being adjustable in the groove by means of the slot shown.

CHISELS.—The principal kinds of chisels are the paring chisel which is used entirely by hand, and the firmer chisel which is used with the mallet. The difference between the two lies in the shapes of their handles, and that the paring chisel is longest. A paring chisel worn to half its original length will serve for a firmer chisel, because when so worn it is long enough for the duty. A chisel should not, however, be used alternately as a paring and a firmer chisel, because the paring chisel requires to be kept in much better

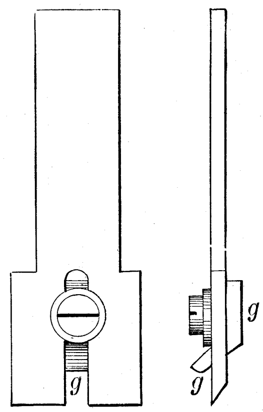

Fig. 2744.

condition than the firmer chisel does. Mortice chisels are made thicker than either the paring or the firmer because of their being longer and requiring rougher usage. It is necessary to have several sizes of chisels, varying in width from an eighth of an inch to one and a half inches.

Fig. 2745 represents the form of handle for a paring chisel, its total length being 6 inches, and from A to B being $1\frac{1}{2}$ inches. The diameter at C is $1\frac{1}{2}$ inches, the hollow below D of $\frac{3}{8}$ of an inch

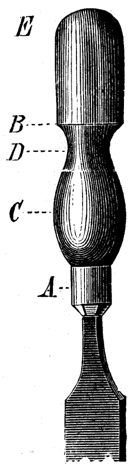

Fig. 2745.

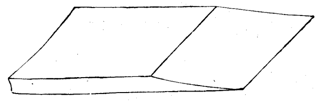

Fig. 2745*a*

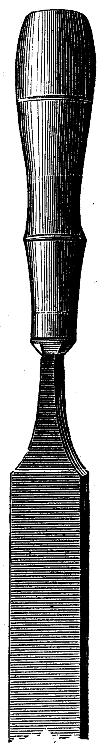

Fig. 2746.

radius, the diameter at D 1 inch, and the length from B to E $1\frac{1}{2}$ inches. This form affords a firm grip to the hand, the end E being applied to the operator's shoulder. The shape of handle for a firmer chisel is shown in 2746.

Chisels require great care both in grinding and oilstoning them, being held very lightly upon the grindstone when finishing the grinding so as to avoid as far as possible the formation of a long feather edge. The flat face of the chisel should never be ground, as that would make it rounding in its length, hence there would be nothing to guide it in cutting straight and the value of the tool would be almost destroyed.

In oilstoning the chisel, great care is necessary in order to avoid forming a second facet at a different angle to that at which it was ground, because such a facet is too narrow to form any guide whereby to move the chisel in a straight line, and the consequence is that the edge is oilstoned rounding and cannot do good service. The whole length of the ground facet or bevel should rest on the oilstone, but the pressure should be directed mainly to the cutting end so that at that edge the oilstone will entirely remove the grinding marks, which will, however, remain at the back. If there is at hand a grindstone of sufficiently small diameter, the chisel may be made hollow on the bevel, as shown in Fig. 2745*a*, so that when laid on the oilstone the bevel will touch at the back and at the end only, and this will enable the chisel to be pressed evenly down on the stone, thus producing a very even and flat edge, while leaving but a small area to be oilstoned.

The motion of the hands should not for the oilstoning be simply back and forth, parallel with the oilstone length, but partly diagonal, which will assist in keeping the chisel level. The back of the chisel should be laid flat upon the oilstone and moved diagonally, under

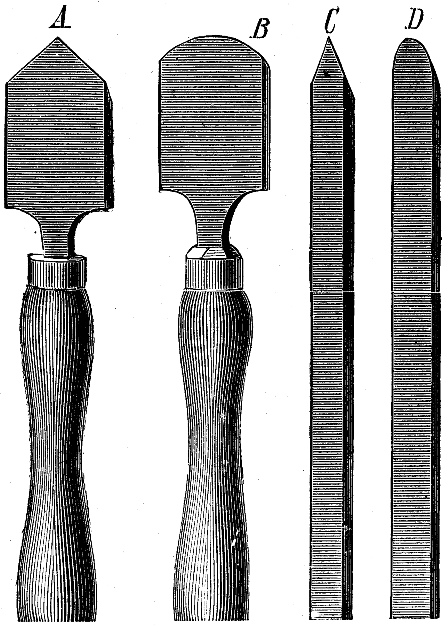

Fig. 2747.

a light pressure, which will remove the wire edge, which may be further removed by lapping the chisel on the operator's hand.

Chisels for turning work in the lathe are best if made short, and to enable the cutting edge to get up into a corner, the chisel is sometimes given two cutting edges, as at A, in Fig. 2747, the edges forming an angle, one to the other, of less than 90°. For finishing curves in the lathe the chisel shown at B in the figure is employed, or for deeper work, as in the bores of holes, handles are dispensed with, chisels being formed as at C and D in the figure.

Gouges, like chisels, are made "firmer and paring," the distinction being precisely the same as in the case of chisels.

When the bevel is on the outside or convex side of the gouge it is termed an outside, while when the bevel is on the inside or concave side it is termed an inside gouge.

Fig. 2748 represents an outside firmer gouge. The inside gouge may be ground a little keener than the chisel, and requires great care in grinding, because it must be held on the corner of the grindstone, which is rarely of the desired curve. In oilstoning the concave side of a gouge an oilstone slip is employed, the gouge being held in the left hand and the slip in the right, the latter being supplied with clean oil.

The convex side of an outside gouge should be made level on the face of the oilstone, and while the gouge is moved to and fro its handle must be revolved so as to bring all parts of the curve in contact with the oilstone. The small amount of surface on the gouge in contact with the grindstone makes it very liable to have a long feather edge, hence it must be very lightly pressed to the stone, and the same remark applies to the oilstoning in order to reduce the wire edge.

Fig. 2749 represents a gouge for lathe work, its handle being

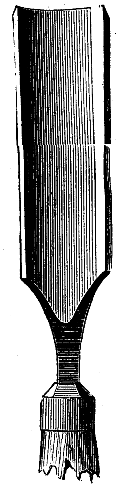

Fig. 2748.

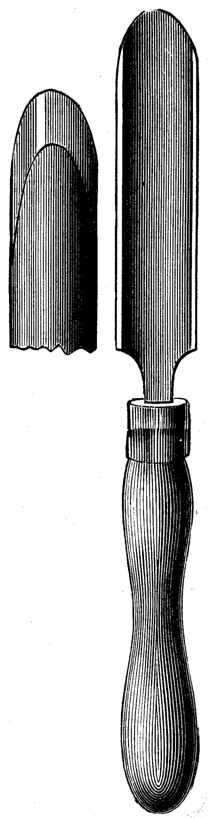

Fig. 2749.

made long enough to be held in both hands and used as described with reference to turning with hand tools.

Another tool, very useful to the pattern-maker, is the skew chisel, which is also described in connection with hand turning.

SAWS.—There are two principal kinds of saws, the rip saw for cutting lengthwise of the grain of the wood, and the cross-cut saw for cutting across the grain. In shaping these saws the end to be

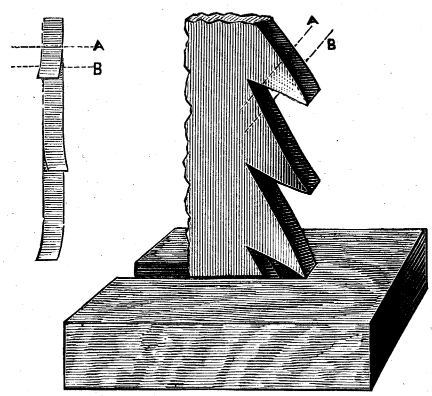

Fig. 2750.

obtained is to enable them to sever the fibre of the wood in advance of the effort to remove it from the main body.

In Fig. 2750, for example, the grain of the wood runs lengthwise and the throat, or front face of each tooth, is hooking or hooked, so that the cutting edge will cut through the fibres at their ends before it is attempted to remove them from the main body of the wood. Suppose, for example, that the saw shown in Fig. 2750 was put into

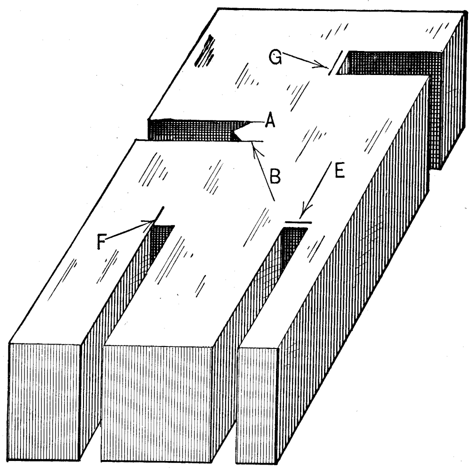

Fig. 2751.

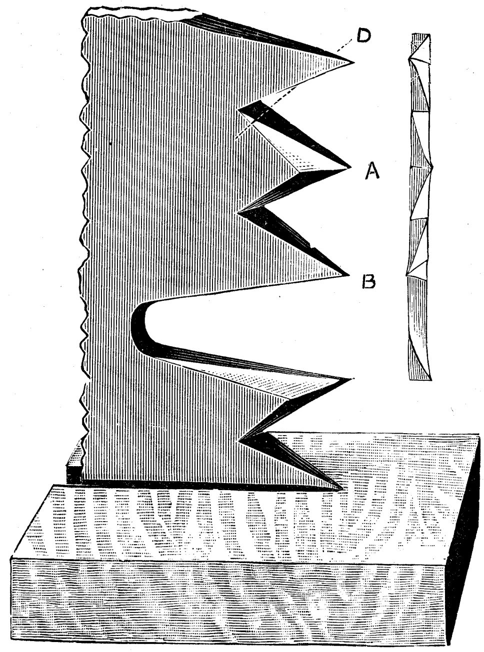

Fig. 2752.

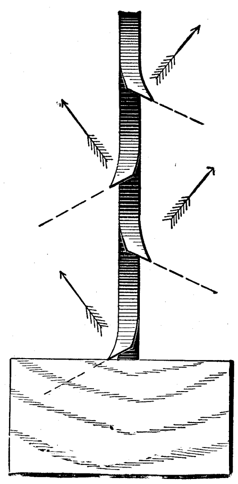
Fig. 2753.

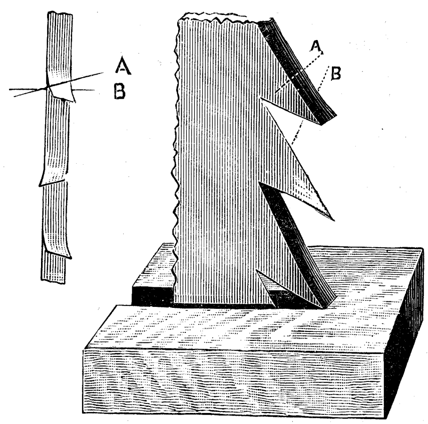

Fig. 2754.

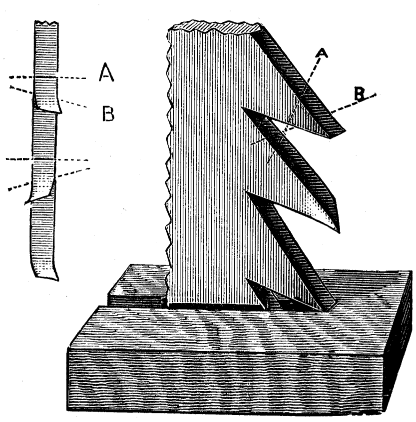

Fig. 2755.

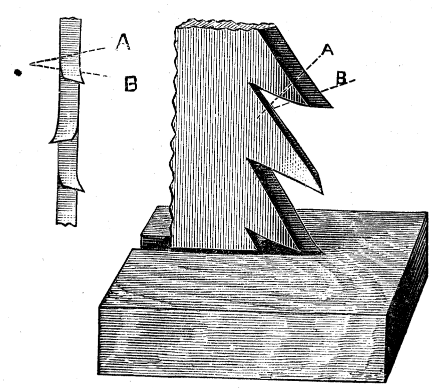

Fig. 2756.

a piece of timber and a tooth pressed hard enough on the wood to leave a mark, and this mark would appear as in Fig. 2751 at E, extending across a width equal to the full width of the saw tooth. It would do this because the front face or throat B and the back face A are both at a right angle to the saw length as is denoted by the dotted lines. As the grain is supposed in Fig. 2751 to run lengthways of the timber, clearly the fibre between the indentation E and the saw slot is severed and would be removed as the tooth passed farther down through the wood, the action of first severing the fibre at its end and then removing it being carried on by each tooth.

In Fig. 2752 is shown a cross-cut saw in action upon a piece of wood in which the grain or fibre runs across the timber, and in this case the teeth require to be shaped to cut on each side of the saw instead of directly in front of it, because in that way only can the ends of the wood fibre be severed before it is dislodged from its place.

To enable the cross-cut saw to accomplish this, one tooth cuts on one side of the saw slot and the next tooth on the other, as at A and B in Fig. 2751, from which it will be seen that as the grain runs lengthways of the timber, the fibres between the lines A and B will be severed at their ends by the extreme edges of the teeth before the thicker part of the tooth reaches them to remove them.

The necessity for this action may be plainly perceived if we apply the rip saw for cross-cutting and the cross-cut saw for ripping. Suppose, for example, we place the saw shown in Fig. 2750 to cut across

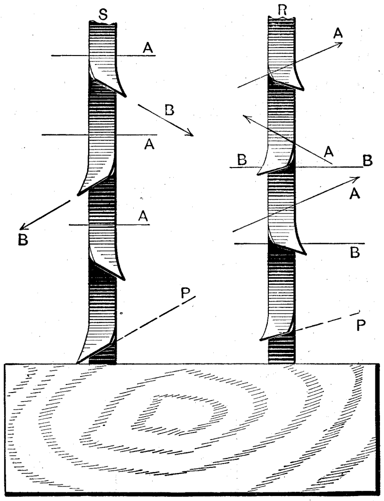

Fig. 2757.

the grain of the piece of timber, and as its tooth met the wood it would indent it as at G, Fig. 2751, and as this is in line with the grain, the tooth would wedge in the piece and the piece cut could not be dislodged without first tearing the fibres apart at each end. Or suppose we take the cross-cut saw and apply it for ripping (as cutting lengthways of the grain is called) and if we indented the surface with a single tooth it would leave a mark as at F, Fig. 2751, which is lengthways of the fibre, so that the tooth would here again wedge between the fibres and not cut them. The next tooth would make a mark parallel to F, but on the other side of the saw slot or kerf as it is called, still leaving the fibre unsevered at its ends where it should be severed first.

In order that the saw may not rub against the sides of the slot or kerf, and thus be hard to move or drive, it is necessary that the kerf be wider than the thickness of the saw blade, and to accomplish this the teeth are bent sideways, each alternate tooth being bent in an opposite direction, as shown in the front view of the teeth in Fig. 2753. This bending is called the set of the saw, and should be sufficient to make the kerf about two-thirds wider than the thickness of the saw blade.

While preserving the feature of severing the fibre before attempting to dislodge it from its place, we may at the same time give the teeth of rip saws more or less sharpness by fleaming their faces.

In Fig. 2754, for example, the throat face is filed square across or at a right angle to the length of the saw, but the back face A is at an angle, making the points of the teeth sharper, and therefore enabling them to cut more freely. The result of this fleam would be that the tooth, instead of cutting equal and level all the way across as in Fig. 2751 at E, would cut at the corner first and only across its full width as it entered deeper into the wood; we have, in fact, placed the leading part of the cutting edge more at the extreme point and less in front of the tooth.

In Fig. 2755 the throat or front face of the saw is given fleam, as shown by the line B, which is not at a right angle to the saw length, and as a result the cutting edge is carried still more advanced at the point and more towards the side of the tooth,

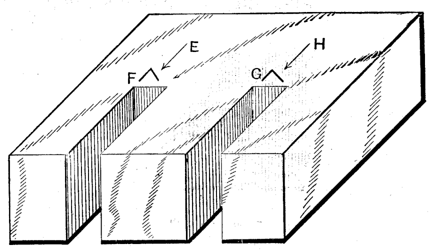

Fig. 2758.

and we have, therefore, to a certain extent, qualified it as a cross-cut saw.

We might give the face B so much angle as to carry the leading part of the cutting edge to the side of the saw, thus giving it the characteristics of a cross cut.

In Fig. 2756, both the throat face B and the back face A are given fleam, making the points extremely sharp, and showing the leading part of the cutting edge towards the side, the corner leading still more.

In Fig. 2757 we have two saws R and S, the latter having fleam on the front and the former on the back face of the tooth, the amount or degree of fleam being equal.

In Fig. 2758 we have indentations of their teeth. The teeth of S would leave a mark as at E F, and R would leave a mark as at G H. The side cut F being more than the side cut G, and the front cut E being at a less angle to F than the front cut H to G, it follows that the saw S would be the best, provided the grain of the wood ran diagonally as shown, not only because it has more side and

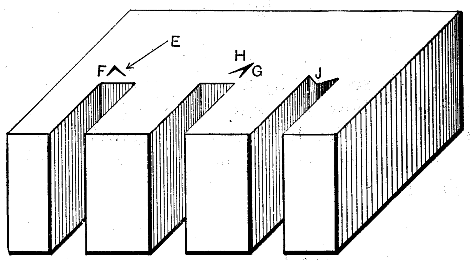

Fig. 2759.

less front cut, but also because its cutting edge is keener on the side, as is seen on comparing the lines P and A in Fig. 2757.

If we give fleam to both faces we alter the indentation, as denoted in Fig. 2759, in which E F represents the line of tooth cut when one face has fleam, and G H the line of tooth cut when both faces are fleamed, the shape of the actual saw cut being shown at J.

Obviously the fleam makes the points weak, but this in coarse saws may be partially remedied by shaping the teeth as in Fig. 2760. Fleam on the front face or throat of the tooth has the effect of preserving its set, the pressure of the cut being as shown by the arrows in Fig. 2753.

It is evident that the finer the point of the tooth the sooner it will become dulled, and that the harder the timber the more quickly the tooth will become dull. So soon as this occurs the teeth refuse to cut freely, and the extra pressure on them acts to spring them upward and to take off the set. It is obvious that for soft wood the teeth may be given fleam on both faces, and that the front face should have some fleam, even for the hardest of wood, whether the back face has fleam or not. Also, that in proportion as the grain of the wood runs more across the saw kerf than in line with it the teeth should be filed to cut on the side, and the hook of the front face may be lessened, while *vice-versâ*, in

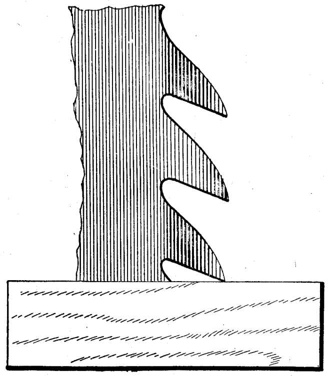

Fig. 2760.

proportion as the grain of the wood runs parallel with the kerf, the tooth may have hook and fleam on the back face with a slight fleam on the front one.

GAUGES.—Of gauges for marking on the work lines parallel to its edges there are several kinds, a common form being repre-

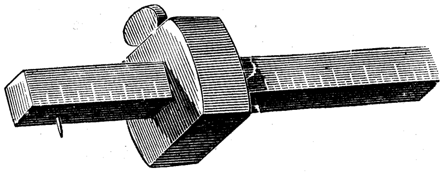

Fig. 2761.

sented in Fig. 2761, in which the block that slides against the edge of the work is secured by a set-screw.

A better method, however, is to use a key set at a right angle to the stem, so that the head may be tightened or loosened by striking it, as if it were a hammer, against anything that may happen to lie on the bench, hence the gauge may be set and

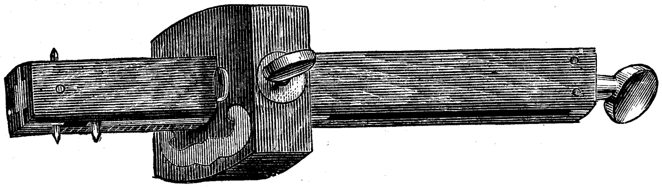

Fig. 2762.

adjusted with one hand while the other is holding the work, as is often necessary when marking small work. The marking point should be a piece of steel wire fitted tightly in the stem, the protruding part being ground or filed to a wedge, with the two facets slightly rounding, and whose broad faces stand at a right angle to the stem of the gauge, the point or edge only projecting

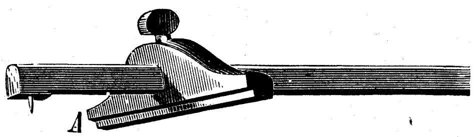

Fig. 2763.

sufficiently to produce a line clear enough to work by; otherwise it will not be suitable for accurate work.

The mortice gauge, Fig. 2762, is similar to the above as regards the stem and sliding piece, but it is provided with two marking points, their distance apart being adjustable. The head screw works in brass nuts.

For lines that are to be marked more than about ten inches from the edge of the work a broader base is necessary to the head or block, which may be shaped as shown in Fig. 2763.

The lines drawn upon pattern work require to be very fine, and for this purpose the cutting scriber, Fig. 2764, is employed. The end A is bevelled off on both sides like a skew chisel. The end B

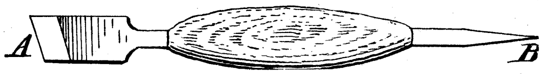

Fig. 2764.

is ground to a fine point and both ends are oilstoned. The point end is for drawing lines with the grain, and the knife end for lines across the grain of the wood. The wooden handle is to afford a firm grip.

In Fig. 2765 we have the cutting gauge, in which a steel cutter takes the place of the marking point, being wedged in position.

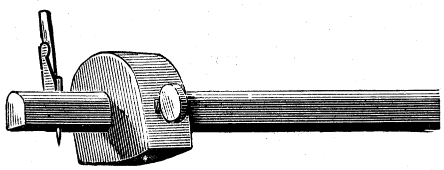

Fig. 2765

It is employed to cut thin strips of wood, that is to say, of thicknesses up to about a quarter of an inch. The cutter point should be tempered to a dark straw color,

The principal forms of joints employed by the pattern-maker are as follows:—

Fig. 2766 represents the mortice and tenon, the thickness of the tenon being one-third that at C, which leaves a thickness at E and

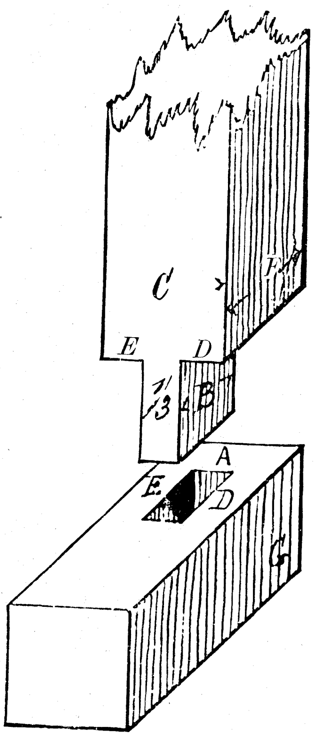

Fig. 2766.

D equal to that of the tenon. When the mortice is away from the end of the work the breadth B of the tenon is made less than the breadth F of the work so as to leave stuff at A to strengthen the mortised piece. To make this joint the two pieces, having been planed or otherwise made to size as required, are marked for the position and length of the mortice in one case, and for the length of the tenon in the other; both pieces are now gauged with a mortice gauge, both being marked alike; and then from the face side we mark a tenon or mortice of the dimensions required.

If the stuff is broad two or more tenons and mortices may be given, as shown in Fig. 2767.

To lock the tenon in the mortice two methods may be employed. In the first and preferable one the mortice is tapered, as in

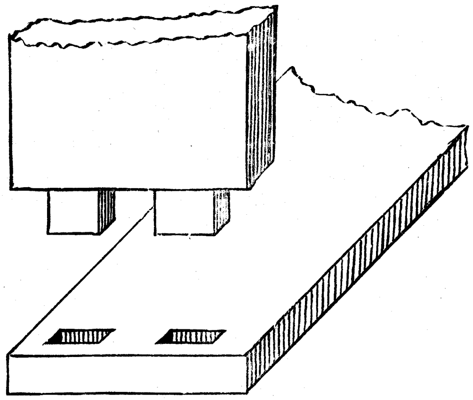

Fig. 2767.

Fig. 2768, and the two wedges are inserted and driven home. In the second the tenon is provided with saw cuts to receive the wedges.

A very superior method of jointing is the dovetail, shown in Fig. 2769, which is serviceable for connecting the ends and sides of a box, or any article in that form. The strength of the corner

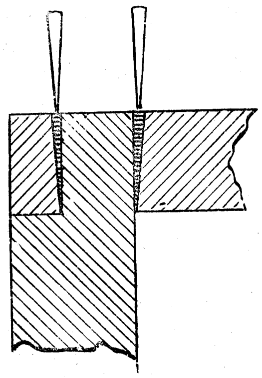

Fig. 2768.

formed in this way is only limited by that of the material itself; therefore it should be preferred when available in making standard patterns, or for work too thin to admit nails or screws; the corner formed by this joint is not limited to 90° or a square, so called, but may form any angle. Nor is it imperative that the sides or ends of the box or other article be parallel. They may incline towards

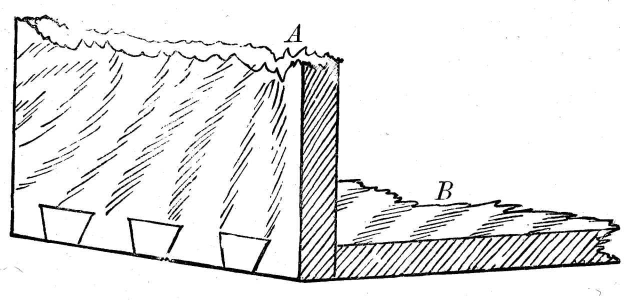

Fig. 2769.

one another like a pyramid; a mill hopper is a familiar example of this. If it be required to dovetail a box together, get out four pieces for the sides and ends, to be of the full length and width respectively of the box outside. They are to be planed all over, not omitting the ends. The gauge, that is already set to the thickness of the stuff, must now be run along the ends, marking a line on both sides of each piece. Then mark and cut out the pins as on the piece A; the dovetail openings in B are traced from the pins in A. The pieces having been tried and found to go together are finally brought into contact and held in their places with glue.

Fig. 2770 is a mitre joint, the only one serviceable to mouldings, pipes, and other curved pieces. It is not a strong form of joint, and is only used where the preceding kinds are inapplicable. It is made with glue, the pieces having been previously sized; and as an additional precaution, if the work will admit, nails, brads, or screws are inserted at right angles to one another.

Fig. 2771 represents the half check joint, and it is obvious that

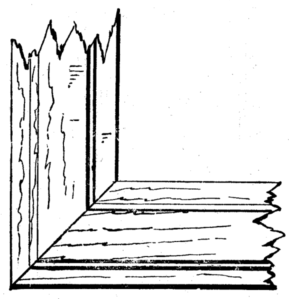

Fig. 2770.

the thickness at A must equal that at H, and be half that at B, which will give each half equal strength.

A gland for an engine piston rod forms a simple example of the different ways in which a pattern may be formed. Fig 2772 represents the drawing for the gland.*

"Let us suppose the pattern-maker to be uninformed of the purpose the casting is to serve, or how it is to be treated: in such a case he is guided partly by his knowledge of the use of such patterns, and a consideration of being on the safe side. The form shown in Fig. 2773 would suggest itself as being a very ready method of making the pattern; by coring out the hole, it can be made parallel, which the drawing seems to require. The advantage of leaving the hole parallel is that less metal will require to

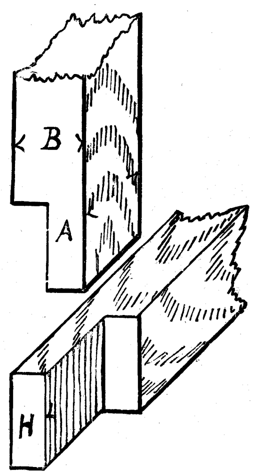

Fig. 2771.

be left for boring in case it should be necessary; because, if the hole is made taper, the largest end of the bore will require to have the proper amount of allowance to leave metal sufficient to allow the hole to be bored out true, and the smaller end would, therefore, have more than the necessary amount; while just the least taper given to the exterior would enable the moulder to withdraw the pattern from the mould. Made in this way, it would be moulded as shown in Fig. 2774, with the flange uppermost, because almost the whole of the pattern would be imbedded in the lower part of the flask, the top core print being all that would be contained in the cope; and even this may be omitted if

* From the "Pattern Maker's Assistant."

the hole requires to be bored, since the lower core print will hold the core sufficiently secure in small work, unless the core is required to be very true. The parting of the mould (at C D, Fig. 2774) being level with the top face of the flange, much taper should be given to the top print (as shown in Fig. 2773), so that the cope may be lifted off easily. Were this, however, the only reason, we might make the top print like the bottom one, providing we left it on loose, or made it part from the pattern and adjust to its place on the pattern by a taper pin; but another advantage is gained by well tapering the top print, in that it necessitates the

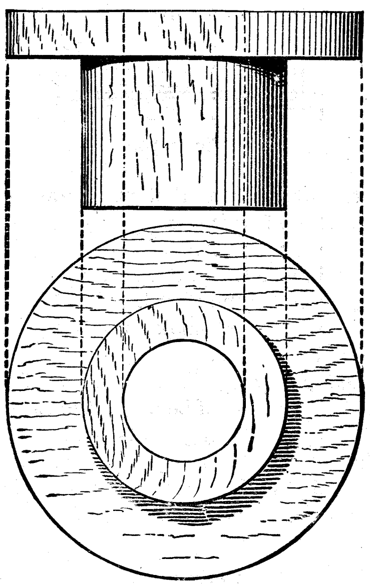

Fig. 2772.

tapering of the core print at that end; so that, when the two parts of the mould are being put together, that is to say, when the cope is being put in place, if the core has not been placed quite upright, its tapered end may still arrive and adjust itself in the conical impression, and thus correct any slight error of position of the core. The size of the core print should be, at the part next the pattern, the size of the core required; for if the extremities are made of the size of the core, and the taper or draft is in excess, there will be left a useless space around the core print, as shown at A B in Fig. 2774, into which space the metal will flow, producing on the casting, around the hole and projecting from the end face, a useless web, which is called a fin, which will of course require to be dressed off the casting.

"We will now suppose that our piece, when cast, is to be turned under the flange and along the outside of the hub or body, and that the hole also is to be bored. In this case the pattern made as above would still be good, but could be much more easily made and moulded if it has to leave its own core, its shape being as shown in Fig. 2775; because the trouble of making a core is obviated, and the core is sure to be in the centre of the casting, which it seldom is when a core is used. We must, however, allow more taper or draft to a hole in a pattern than is necessary on the outside; about one-sixteenth inch on the diameter for every inch of height on work of moderate size is sufficient. The allowance for boring should be one-sixteenth inch at the large end of the hole, provided the diameter of the hole is not more than five or six inches, slightly exceeding this amount as the diameter increases; whereas, if the pattern had been made with core prints, an allowance of one-eighth inch for small, and three-sixteenths inch for larger work would be required. These are the advantages due to making the pattern leave its own core. We have still to bear in mind, however, that, if the casting require a parallel hole, a core must be used; and furthermore, if the hole is a long one, we have the following considerations: The separate dry sand core is stronger, and therefore better adapted to cases where the length of the hole greatly exceeds the diameter. Then again, if the hole require to be bored parallel, it can be more readily done if the hole is cast parallel, because there will be less metal to cut out. The casting also will be lighter, entailing less cost, provided it has to be paid for by the pound, as is usually the case. The moulder is given more work by making the core; but the saving in metal and in turning, more than compensates for this, provided the length of the hole is greater than the diameter of the bore.

"Let it now be required that the casting is to be finished all over. It would, in that case, be preferred that if the casting should contain any blow or air holes, they should not be on the outside face of the flange, and this will necessitate that the piece be moulded the reverse way to that shown in Fig. 2773: that is to say, it must be moulded as shown in Fig. 2776, with the flange downwards; for it may be here noted that the soundest part of a casting is always that at the bottom of the mould; and furthermore, the metal there is more dense, heavier, and stronger than it is at the top, for the reason that the air or gas, which does not escape from the mould, leaves holes in the top of the casting or as near to the top as they can, by reason of the shape of the casting, rise. The bottom metal also has the weight of the metal above it, compressing it, and making an appreciable difference in its density. It must, therefore, be remembered that faces requiring to be particularly sound should be cast downwards, or at least as near the bottom of the mould as they conveniently can. Following this principle, our gland will require to be moulded as shown in Fig. 2777, P P representing the line of the parting of the mould; so that, when the cope is lifted off, the loose hub A will rise with it, leaving the flange imbedded in the lower half of the mould. It is evident that in this case the pattern must be made, as shown in Fig. 2776, the body and core prints being in one piece and the flange in another, fitting easily on to a parallel part on one end, and adjoining the core print, as shown at A. For glands of moderate size, this method is usually adopted, and it answers very well for short pieces; but in cases where the length of the body approaches, say, three diameters, the horizontal position is the best, and the pattern should be made as shown in Figs. 2778, 2779, or 2780. Even in short pieces, when the internal diameter approaches that of the external, this plan is the best, because it is difficult for the moulder to tell when his core is accurately set in position.

"For a pattern to be moulded horizontally, Fig. 2780 shows the best style in which it can be made. Its diameters are turned

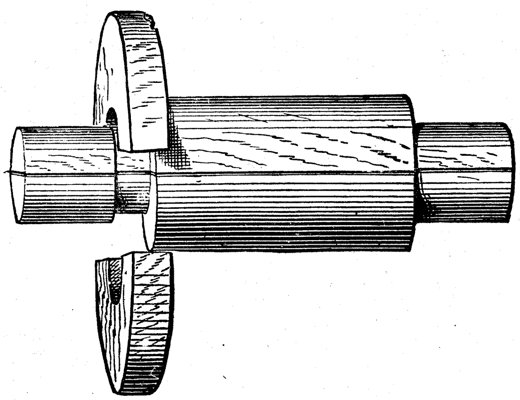

Fig. 2780.

parallel; the required draft is given by making the rim of the flange a little thinner than at the hub, and by making the end faces of the hub and the core prints slightly rounding. If the hub is very small, as, say, a half-inch or less, and the flange does not much exceed it, the pattern may be made solid, as shown in Fig. 2778; but if the hub be small and the flange large, it should be made as shown in Fig. 2776.

"To construct the pattern shown in Fig. 2773, we proceed as follows: From a piece of plank we saw off a piece of wood a little larger and thicker than the required flange, and turn it up between the lathe centres, using a pattern makers' contraction rule, which has its measurements larger than the actual standard ones in the proportion of one-eighth inch per foot: so that a foot on the contraction rule is $12\frac{1}{8}$ standard inches, and an

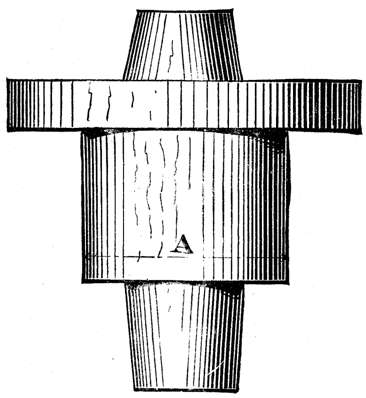

Fig. 2773.

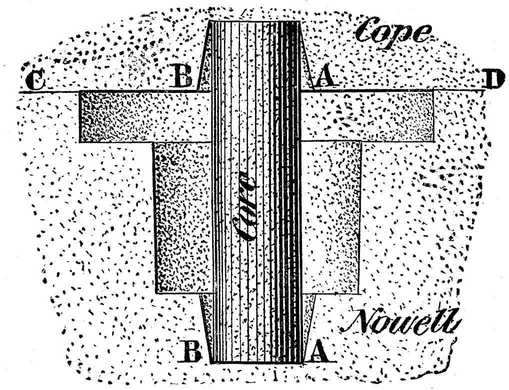

Fig. 2774.

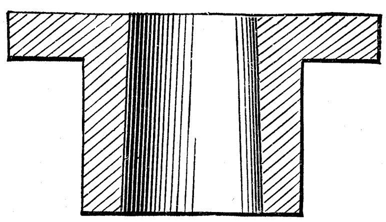

Fig. 2775.

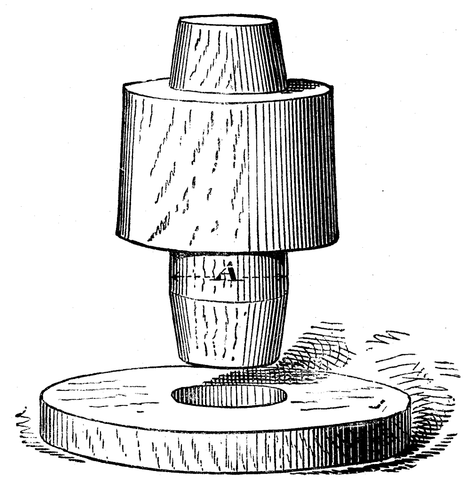

Fig. 2776.

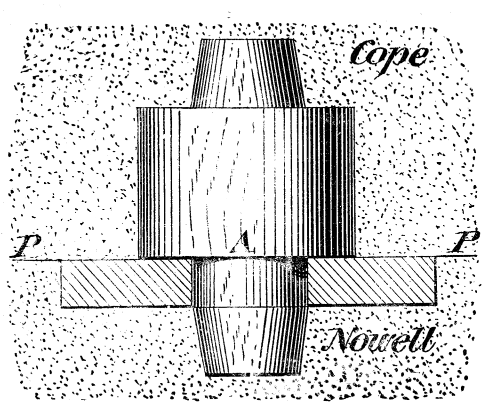

Fig. 2777.

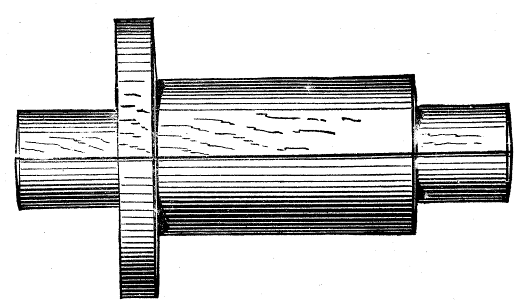

Fig. 2778.

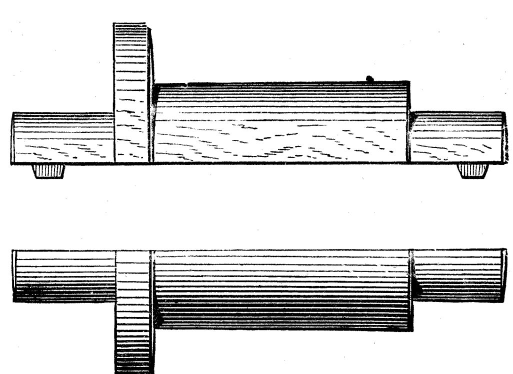

Fig. 2779.

inch is $1\frac{1}{96}$ standard inches. The reason for this is, that when the metal is poured into the mould, it is expanded by heat; and as it cools it contracts, and a casting is, therefore, when cold, always smaller than the size of the mould in which it was made. Brass castings are generally said to be smaller than the patterns in the proportion of one-eighth inch per foot, and cast-iron castings one-tenth inch per foot; and so, to avoid frequent calculations and possible errors, the contraction rule has the necessary allowance in every division of the foot and of the inch. It is not, however, to be supposed that the possession of such a rule renders it possible for the pattern-maker to discard all further considerations upon the contraction of the casting; because there are others continually stepping in. Such, for example, is the fact that the

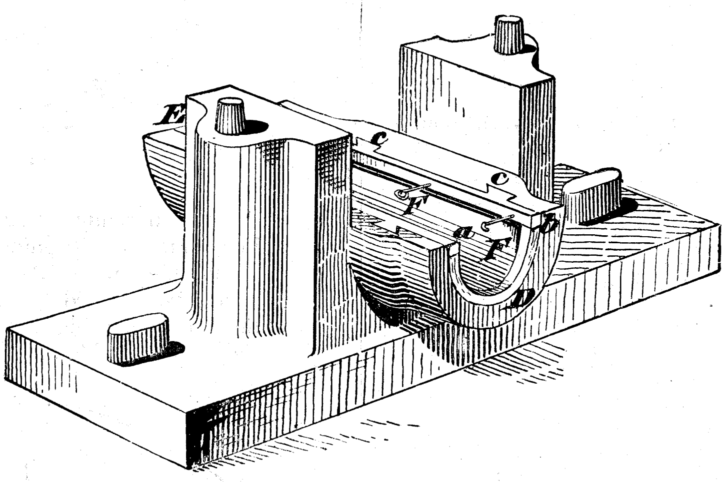

Fig. 2781.

contraction will not be equal all over, but will be the greatest in those parts where the casting contains the greatest body of metal.

"In the smaller sizes of patterns, such as those of 6 inches and less in diameter, there is another and a more important matter requiring attention, which is, that after a moulder has imbedded the pattern in the sand, and has rammed the sand closely around it, it is held firmly by the sand and must be loosened before it can be extracted from the mould. To loosen it, the moulder drives into the exposed surface of the pattern a pointed piece of steel wire, which he then strikes on all sides, causing the pattern to compress the sand away from the sides of the pattern in all directions; and as a result, the mould is larger than the pattern. In many kinds of work, this fact may be and is disregarded, but where accuracy is concerned, it is of great importance, especially in the matter of our example (brasses for journals), for they can be chipped and filed to fit their places much more rapidly than they can be planed, and it is necessary to have the castings as nearly of the correct conformation as possible. In cases where it is necessary to have the castings of the correct size without any work done to them, the shake of the pattern in the sand is of the utmost importance. If it is required to cast a piece of iron 3 inches long and 1 inch square, supposing the pattern were made to correct measure by the contraction rule, the moulder, by rapping the pattern (as the loosening it in the mould is termed) would, by increasing the size of the mould above that of the pattern, cause the casting to be larger than the pattern; that is to say, it would be longer and broader, and therefore, in those two directions, considerably above the proper size, since even the pattern was too large to the amount allowed for contraction. The depth, however, would be of correct size, because the loosening process or rapping does not drive the pattern any deeper in the mould. It follows that, to obtain a casting of as nearly the correct size as possible, the pattern must be made less in width and in length than the proper size, to the amount of the rapping; and to insure that the moulder shall always put the pattern in the sand with the same side uppermost, the word "top" should be painted on the face intended to lie uppermost in the mould. The amount to be allowed for the rapping depends upon the size of the pattern, and somewhat upon the moulder, since some moulders rap the patterns more than others; hence, where a great number of castings of accurate size are required, it is best to have two or three castings made, and alter the pattern as the average casting indicates. For castings of about 1 inch in size, the patterns may be made $\frac{1}{32}$ inch too narrow and the same amount too short; but for sizes above 6 inches, allowance for rapping may be disregarded.

"In patterns for small cast gears, the rapping is of the utmost consequence. Suppose, for instance, we have six rollers of 2 inches diameter requiring to be connected together by pinions, and to have contact one with the other all along the rollers; if we disregard the allowance for rapping, the pinions will be too thick, and we shall require to file them down, entailing a great deal of labor and time, besides the rapid destruction of files.

"Let it be required to cast a pillow block to contain a babbitt-metal bearing. In this case there requires to be a cavity to receive and hold the babbitt metal. This is provided by casting ridges of metal around the edges of the bearing, as shown in Fig. 2781, at D E and on each side at F, the pieces D E may be made solid with the pattern, but those for the sides must be removable, having dovetails as at *c c* to hold them in position

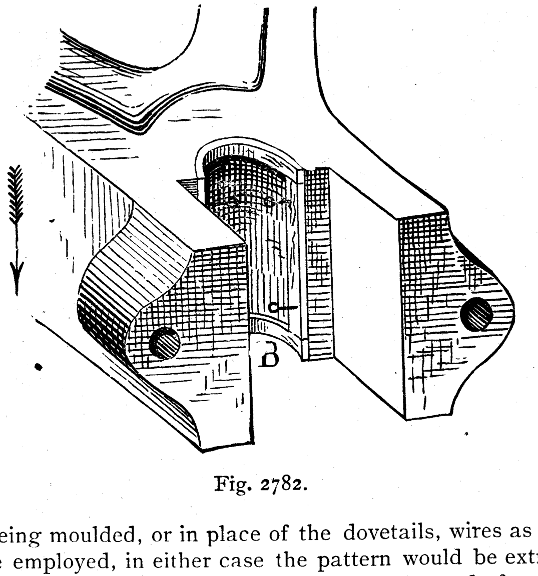

Fig. 2782.

while being moulded, or in place of the dovetails, wires as at F F may be employed, in either case the pattern would be extracted from the mould, leaving the side strips to be removed afterwards. If, instead of a pillow block, a bracket or frame, such as in Fig. 2782, were required, it must be moulded in the direction of the arrow, and in that event it would be desirable to core out the journal bearing. This would be accomplished by providing a core print to block up the whole opening B. A suitable core box for the bearing would be as in Fig. 2783. The core print must project below the casting so as to form in the mould a core print for the core, and it is obvious that the core itself must be made of increased depth to the amount allowed for core print; hence the end piece B, Fig. 2783, is increased in thickness to the amount allowed for core print."

Patterns for cylindrical bodies, especially those that are hollow

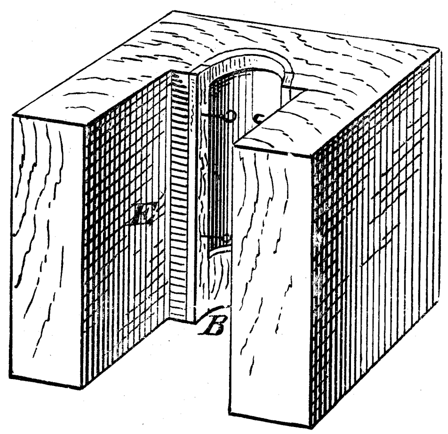

Fig. 2783.

and thin, are constructed in pieces by a process termed "building up." The pieces are usually segments of circles, and the manner of marking them is as follows:—

Let it be required to make a pattern for a flanged pulley, such as shown in section in Fig. 2784. It would be constructed in two halves composed of a number of courses as from 1 to 8, and each course would be composed of segments of the form shown in Fig. 2785. The length of the arc of these segments must be such that it will require a certain number of these to complete the circle of that part of the cylinder which the segment is to form; and the manner of accomplishing this is shown in Fig. 2786, in which the

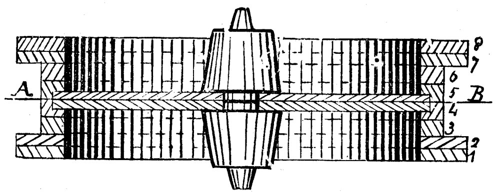

Fig. 2784.

circle C is of the diameter of the outside, while circle D is that of the outside of the pulley proper, circle E is of the diameter of the inside of the pulley rim. These circles are divided into as many equal divisions as there are to be segments in the circumference; hence the number of divisions determines the length of arc of the segments. Thus A would be a segment for the body of the pulley, and F a segment for the rim. A template is then made of each one of these segments, as at A and F. This template must be made slightly larger in every direction than the respective divisions, to allow for the stuff that will be turned off in truing the pattern in the lathe and in jointing the segments to one another during the building. The templates are employed to mark out

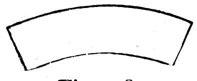

Fig. 2785.

on the board which should first be planed to the required thickness. This will be a trifle thicker than the course so as to allow for truing the surface of each finished course in the lathe. The courses are best built up on the chuck of the lathe on which they are to be turned, and a saving in time will be effected if there are two chucks, so that a course on one half of the pattern may be built up while the glue of another course on the other half is drying. On the lathe chuck, and directly beneath, where the joints of the segments will come, pieces of paper as at *a*, *c*, *e*, *g*, Fig. 2787, and if the segments are long ones, intermediate pieces of paper, as *b*, *d*, *f*, *h*, will be necessary. The radial edges of the segments are trimmed on what is termed a shooting board, which is a device such as shown in Fig. 2788, in which A is a piece of board on which is fastened the piece B. S is a piece projecting above B, and is provided to rest the segment S′ against, the flat surface of the latter lying on the board B. It is thus held

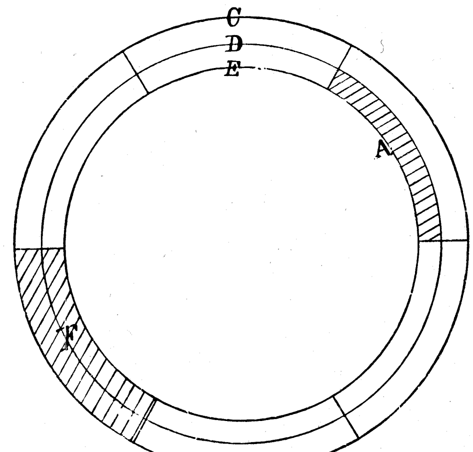

Fig. 2786.

in a fixed position, ready to have its edges E planed, the whole being laid upon the bench against the bench stop G. If, however, it is more convenient to rest the shooting board across the bench, a piece C may be fastened beneath A, so as to come against the edge of the bench as in Fig. 2789, in which T is the bench. The plane is laid with its side on A as in Fig. 2790, so that the sur-

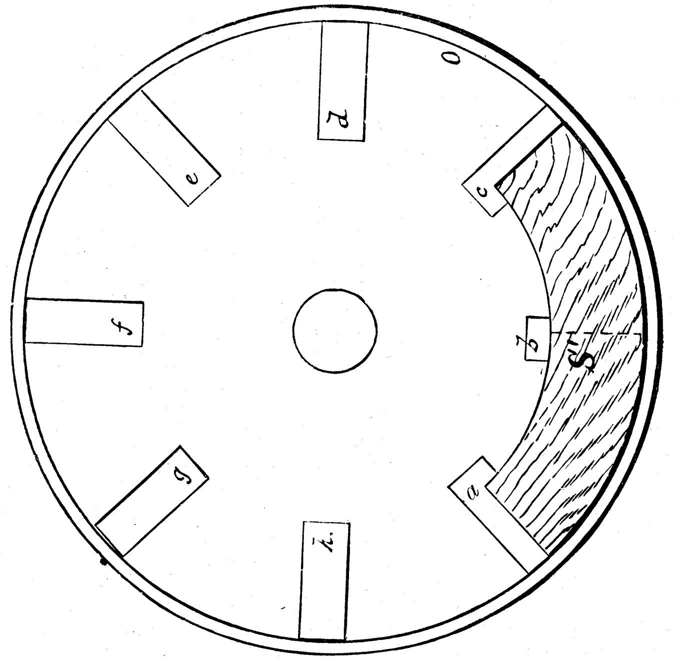

Fig. 2787.

face of A acts as a guide, keeping the edge of the plane vertical, and thus planing the edges of the segment square. The plane is operated by hand in the usual manner (save that it lies on its side), taking its cut most off the outside or inside of the edge of the segment S′, according as the position of the latter is varied. In some of the shooting boards manufactured by tool makers, the height of B from A is adjustable, so that all parts of the plane blade edge may be used, which saves grinding, since only that part of the edge that is used dulls. Also there is provided means whereby the required lateral position of the segment may be adjusted; such a device is shown at P, Fig. 2788, which is a plate having a slot through it, through which passes the thumb screw V, which screws into S. Hence the plate may be adjusted so that when one end of the segment rests against the end of S, and the other against the end of P, its edge E will be in the proper position to be planed to correct angle by the plane, whose line of action is in this case rendered positive by means of a slide on the plane, acting in a groove in the base A.

The first segment is glued to the pieces of paper on the chuck, as shown in Fig. 2787, S′ representing the segment. A second segment is then added, being set fair to the pencil circle O, and jointed and glued both to the chuck and to the ends of the first segments. Successive segments are added until the whole circle or course is completed, and when dry the radial face of this course is turned in the lathe so as to be true, flat, and of the required thickness, and the diameter is trued. The second course may then be added, but the joints at the ends of the segments should not come over those of the first course, but in the middle as shown by the dotted line. The ends of the segments should be made to

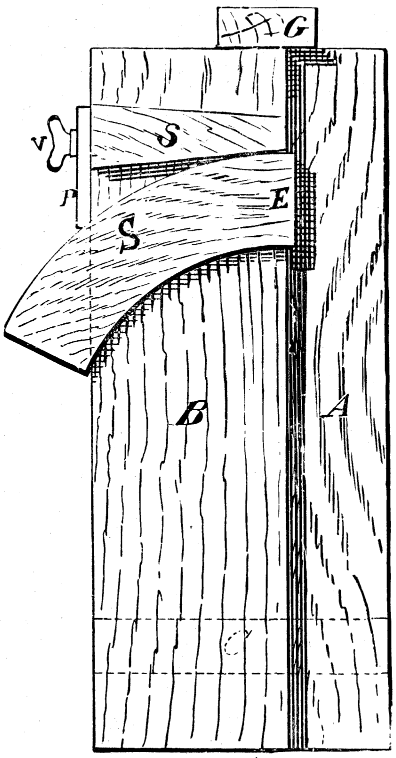

Fig. 2788.

bed properly against each other, and glue should be applied to the joint between the two courses and at the ends. By adding the successive courses the whole may be built up on the chuck ready to receive the arms As each segment is added it should be clamped or weighted to press it firmly to its seat and press out the excess of glue.

If the pattern consists of two, or say three, courses, the glue will be sufficient to hold it to the chuck while turning, but if there are more courses a screw should be inserted through the chuck and into each segment of the first course. The cylinder must then be turned inside and out ready to receive the spokes. These are made of pieces equal in length to the internal diameter of the rim, or a trifle longer, so that the ends may be let into the rim. A line is then marked along the edge of the rim, dividing its thickness into two divisions, and in the centre of the length a recess should be cut out from the face to the line, the width of the recess equalling the width of the arm, so that one arm will let into the other, forming a cross, of which the flat surfaces lie in the same plane. This cross is let into the rim of the wheel and fixed tempo rarily with brads. The lathe may then be started and the centre of the arms (and therefore that of the cylinder or pulley) be found by a pencil point moved until it marks a point and not a circle when the lathe revolves. The arms may then be marked to shape and a recess turned at their centre to receive the hub. The arms being marked to their respective places and their outside faces being marked with a pencil so that they may be replaced in the same position in the wheel, they may be removed and shaped to the required dimensions and form, and then replaced and glued to the rim.

If the wheel is to have six arms they may be constructed as follows:—

Instead of taking two pieces of the diameter of the rim, as in the case of four arms, three pieces are necessary, and in this case the thickness of the edge of each piece is divided by two marked lines which will divide the thickness of the edge into three equal

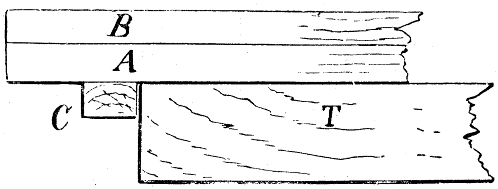

Fig. 2789.

divisions, as shown by the dotted lines 1 and 2 in Fig. 2791, which will divide the thickness of the edge into three equal divisions of thickness. From the centre of the lengths of each of the three pieces we mark on the flat face a circle whose diameter will equal the width on the flat face of the pieces themselves.

With an angle square having its adjustable blade set to an angle of 60°, and set so that the back is fair with the edge of the piece, and one edge coincident with the perimeter of the circle, lines tangent to the circle and crossing each other are drawn on the pieces A C. On the piece B four of such tangent lines (two on each side) must be drawn. The piece A is recessed between one pair of tangent lines to the depth of the second lines on its edge, or, in other words, to a depth of two-thirds its thickness, and between the other pair to a depth of one-third, as shown, the two-thirds at D, the one-third at E. The piece D must be recessed between its tangents on each side to a depth of one-third its thickness, as denoted at F F, while on C the whole space between the tangent lines must be recessed to a depth equal to two-thirds its thickness, as shown at G. The pieces may then be put together so that the two diametrically opposite arms will be in one piece. If an odd number of arms is employed this form of construction cannot be followed; hence each spoke will be a separate piece, extending from the rim to the centre and jointed at the latter, as in Fig. 2792, which is for five arms.

For this construction draw a circle *c*, Fig. 2792, and divide it into as many equal points of division as there are to be arms in

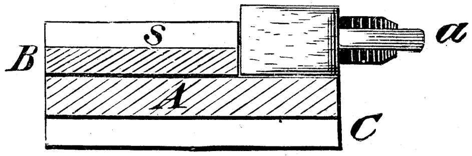

Fig. 2790.

the wheel. From these points of division draw lines to the centre, and these lines will show the required bevel at the end of each spoke, as shown in the figure. The ends should be verified for bevel by striking from the common centre a second circle, as D; and measuring if the arms are equidistant, measured at the circle and from the edge of the arm to that of the next, finished along the full length. When fitted, corrected, glued and dry, the spokes may be let into the wheel and a recess turned into the centre to receive the hub.

The rim and all parts that can be got at may then be turned in the lathe, the pattern then being reversed in the lathe to turn the inside of the rim, or the other side of the spokes, when the job will be complete. When, however, the rim is to be a very thin one, it may be necessary to fasten the segments together at the ends by other means as well as glue, hence a saw-cut may be made in each end, and a tongue inserted.

It is obvious that each half of the pattern is constructed by similar segments, the line of parting being through the centre of the arms, as at A B, in Fig. 2791. To keep the two halves coincident when in the mould, pins are inserted in the rim and arms of one half, fitting closely into holes provided in the other half.

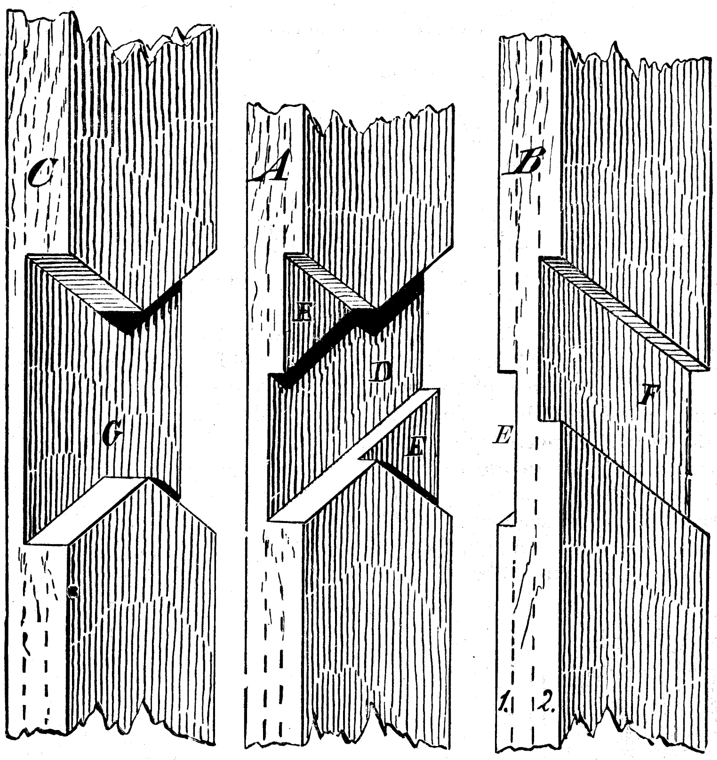

Fig. 2791.

To construct a pattern for a pipe, the pattern would be made in two halves, and constructed of what are termed staves, that is, pieces of wood running lengthways of the pipe. The number of

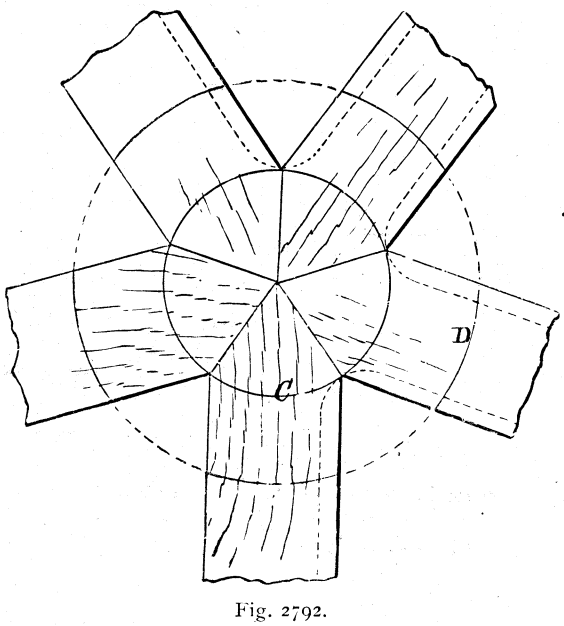

Fig. 2792.

these staves is optional, save that it must be even, so that each half pattern will contain an equal number.

Let it be required to make a pattern for a pipe 18 inches in diameter, and to be 1 inch thick. Draw the line A B, Fig. 2793, and from a point on it, as C, draw a semicircle A B, equal in diameter to the diameter of the outside of the pipe. Also the circle D E F, equal to the diameter of the inside of the pipe, and these will represent an end view of the pipe. Divide these semicircles into as many equal divisions as it is decided to have staves in the half pattern—as 1, 2, 3, 4, 5, 6; and from one of these divisions make a template as denoted by the oblique lines at 2, leaving it slightly larger than the division, to allow stuff to work on in fitting the staves, &c.

Now, when the staves are cut out it is necessary to have some kind of a frame or support to hold them while jointing them;

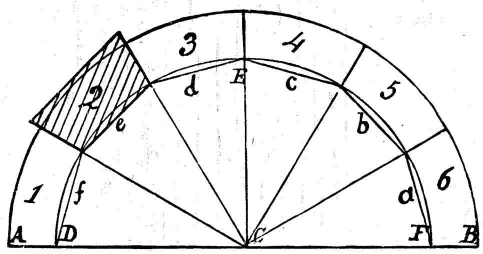

Fig. 2793.

hence, draw also from the points of division, as D, E, F, the lines *a*, *b*, *c*, *d*, *e*, *f*, and these will form the sides of a half-disk polygon, whose diameter is from D to F. A sufficient number of

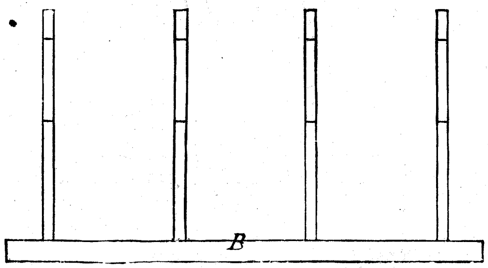

Fig. 2794.

these polygonal half-disks are cut out to stand about two feet apart along the whole length of the pipe, as in Fig. 2794, and on these, temporarily fastened to the board B, the staves are jointed and fastened together by glue while each stave is held to its place on each half-disk by a screw. The top stave may be put on first, as it will act as a stay to the half-disks. If the pipe is so long that it is composed of more than two pieces, the end pieces should be put on first, and the intervening space filled up last, which enables the ends to abut firmly. The second half may be added to the first one, putting a piece of paper between the edges of the two to prevent their sticking together.

If the pipe has a bend, it is built up separately, instead of being formed of staves, the process being as follows:—

In Fig. 2795 let B represent the centre of the bend curve, the line C representing one end, G the other end, H the inner and J the outer arc of the bend. Let it be determined to build up the

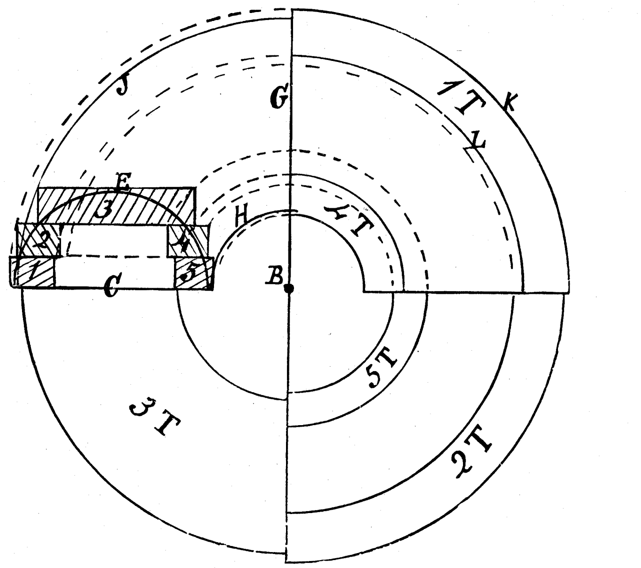

Fig. 2795.

bend in five pieces, as shown at 1, 2, 3, 4, 5, which represents an end view of the half pattern. Templates are then made for each of the pieces 1, 2, &c., being formed as denoted by the oblique lines, whose dimensions slightly exceed the half circle E of the pattern, to allow wood for dressing up. To find the curve for these pieces, set the compasses to a radius from B to the outer corner of piece 1, and draw the arc K. Set the compasses to the radius from B to the inner corner of piece 1, and draw the arc L, and the space between these two arcs, which space is marked 1 T, is a template for the curve of piece 1. By a similar process applied to pieces 2, 3, 4 and 5 similar templates for their respective curves are obtained; and selecting timber of a proper thick-

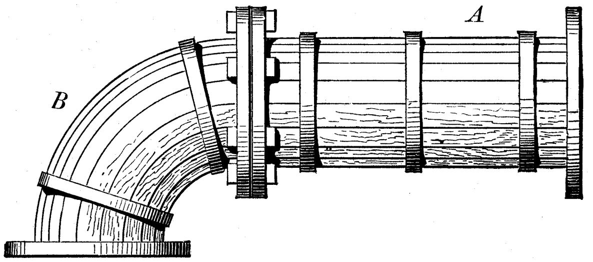

Fig. 2796.

ness, we mark out the respective curves from these templates, which may be of thin board or of stiff paper. In putting these pieces together the lower ones are set to lines forming a plan of the bend, being set a little outside the lines to allow wood for truing the pieces to shape after they are put together. The lower pieces are temporarily fixed to the board on which the plan is marked, and the upper ones fastened to the lower by glue, the joint surfaces of each line being planed true previous to being glued. It is a great assistance, however, to cut out two half circles, representing the ends of the pipe, and to place them on the board to build upon. When a bend of this kind occurs in a covering for a pipe that is exposed to view, it is necessary, for the sake of appearance, to have the pieces composing the bend to correspond with those on the straight part of the pipe, as shown in Fig. 2796. The part A would be got out in staves, as described for the pattern of a pipe. The bend B would be also got out as described for that figure for a bend, save that the number of staves for the bend would equal the number on the pipe. But in this case each stave should be fitted to its fellow by pins, or its

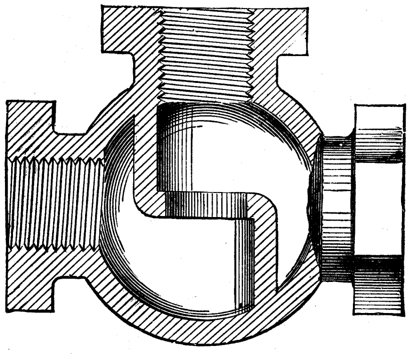

Fig. 2797.

edge fitting into dowels on the edge of its fellow; thus one edge of a stave would have the dowels and the other the pins; the whole, when finished, being bound together by metal bands, as shown in the figure.

The patterns for a globe valve, such as shown in section in Fig. 2797, would be made as follows (which is taken from "The Pattern Makers' Assistant"):—

"The flanges vary in shape; but as a rule small valves are

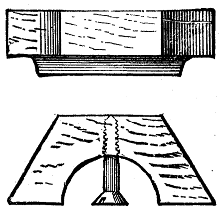

Fig. 2798.

provided with hexagons and large ones with round flanges suitable for bolting to similar flanges to make joints. For small valves, say up to 2 inches, the pattern is usually made with the hexagons cut out of the solid, but for sizes above that, they should be made in separate pieces, as shown in Fig. 2798, and screwed to the pattern, so that in case of necessity they may be removed, and flanges substituted in their stead. In Fig. 2799, we have a per-

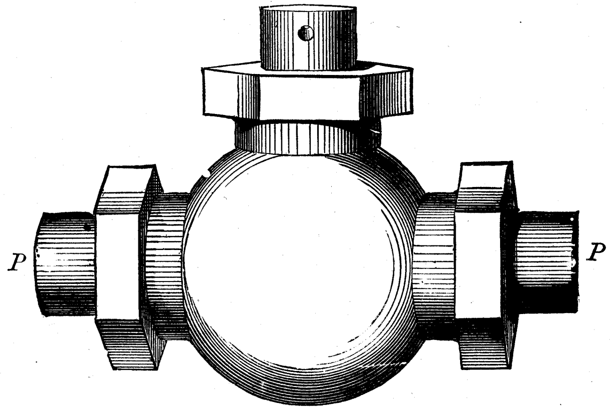

Fig. 2799.

spective view of the finished pattern; and Fig. 2800 represents the pattern as prepared, ready to receive a flange or hexagon as may be required. A globe valve pattern should be made in halves, as shown in Fig. 2801, the parting line of the two halves being denoted by A B. To make this pattern, we first prepare two pieces of wood so large that, when pegged together, the ball or body of the pattern can be turned out of them, and long enough not only to reach from P to P, in Fig. 2799, but also to allow an excess by means of which the two pieces may be glued or otherwise fixed together. These two pieces we plane to an equal thickness, and then peg them to retain them in a fixed position, taking care, however, that the pegs do not occur where the screws to hold the flanges will require to be. We also place two pegs within a short distance of what will be the ends of the

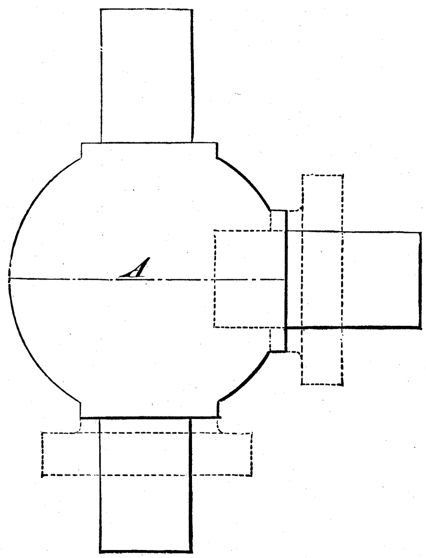

Fig. 2800.

pattern when the excess in length referred to is turned off. We next prepare, in the same way, two more pieces, to form the two halves of the branch, shown at B, in Fig. 2801, for which, however, one peg only will be necessary. These pieces must be somewhat wider than the size of the required hexagon across the corners, that is, supposing the hexagon is to be solid with the branch; otherwise we must make them a little wider than the diameter of the hub of the flange, or of the round part of the hexagonal pieces. Their lengths must be such as to afford a good portion to be let into the ball or body of the pattern (as shown by the dotted lines in Fig. 2800), which is necessary to give sufficient strength. The two pieces must be firmly fixed together, and then turned in the lathe.

"During the early stages of the turning, or, in other words, during the roughing out, we must occasionally stop the lathe and examine the flat places on the body; for unless these places disappear evenly, the work is not true, and one half will be thicker than the other, so that the joint of the pattern will not be in the middle. It was to insure this that the pieces were directed to be planed of equal thickness, since, if such is the case, and the flat

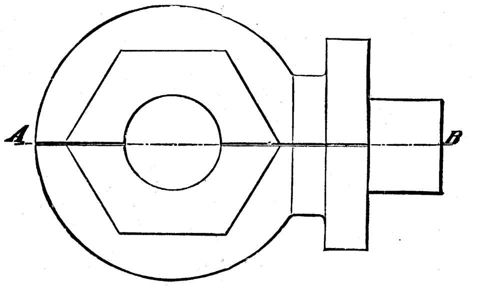

Fig. 2801.

sides disappear equally and simultaneously during the turning, the joint or parting of the pattern is sure to be central. If the lathe centres are not exactly true in the joint of the two pieces, they may be made so by tapping the work on the side having the narrowest flat place, the process being continued and the work being trued with the turning tool at each trial until the flat places become equal. By this means, we insure, without much trouble, two exact halves in the pattern, which is very important in a globe valve pattern on account of the branch and other parts, not to mention the moulding. Having turned the body of the pattern to the requisite outline, and made, while in the lathe, a fine line around the centre of the ball where the centre of the branch is to come, as shown in Fig. 2800 by the line A, we make a prick point (with a scriber) at each crossing of the line A and the joint or parting of the pattern. We then mount the body upon a lathe chuck, in the manner shown in Fig. 2802. A point centre should be placed in the lathe and should come exactly even with the line A. In Fig. 2802, V V are two **V**-blocks made to receive the core prints. These **V** s are screwed to the lathe chuck, and the pattern is held to them by two thin straps of iron, placed over the core prints and fastened to the **V** s by screws. If the chuck and

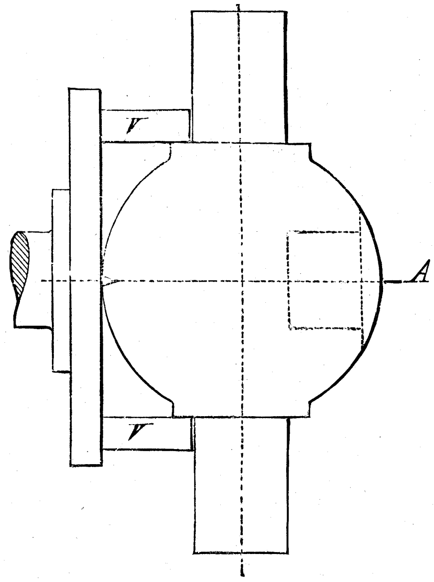

Fig. 2802.

centre point run true, the **V**-blocks are of equal height, and the core prints are equal in diameter, the prick point opposite to the one placed to the centre point will run quite true; and we may face off the ball or body to the required diameter of branch, and bore the recess to receive the same. We make the holes in the flanges of the same size as the core prints; but we should not check in the print, because, if a flange with a different length of hub were substituted, it would be a disadvantage. To obtain the half flanges, we take a chuck and face it off true in the lathe; then, with a fine scriber point, we mark the centre while the

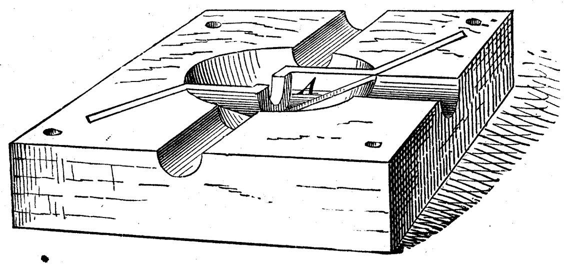

Fig. 2803.

chuck is revolving. We then stop the lathe, and, placing a straight-edge to intersect the chuck centre, we draw a straight line across the chuck face. We then take two pieces suitable for the half flanges, and plane up one flat side and one edge of each piece. If the flanges are not large ones, they may be planed all at once in a long strip. We place the pieces in pairs, and mark on each pair a circle a little larger than the required finished size of flange. We then fix each pair to the chuck, with the planed faces against the chuck, and the planed edges placed in contact, their joint coming exactly even with the straight line marked on the chuck face, and we may then turn them as though they were made in one piece and to the requisite size.

"In Fig. 2803 we have a representation of one half of a suitable core box, the other half being exactly the same, with the exception that the position of the internal partition is reversed. To get out this core box, we plane up two pieces of exactly the same size and length as the pattern, and of such width and thickness as will give sufficient strength around the sphere, allowing space for the third opening. After pegging these two pieces together, we gauge, on the joint face of each, lines representing the centres of the openings and the centre of the sphere. We then chuck them (separately) in the lathe, and turn out the half sphere. We next place the two halves together, and chuck the block so formed in the three positions necessary to bore out the openings; or if preferred, we may pare them out. The partition (A, in Fig. 2803)

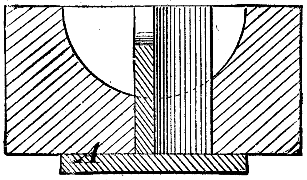

Fig. 2804.

follows the roundness of the centre hole, and is on that account more difficult to extract from the core than if it were straight and vertical. When, however, the partitions are of this curved form, the pieces of which they are formed are composed of metal, brass being generally preferred. Patterns have in this case to be made wherefrom to cast these pieces, and they may be made as follows: First, two half pieces are turned; each is then cut away so as to leave the shape as shown at A in the same figure, and is then fitted into the spherical recess in the core box, letting each down

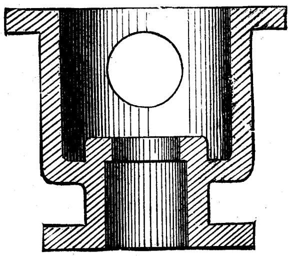

Fig. 2805.

until both are nearly but not quite level. The two wing pieces are then fastened on, and this pattern is complete. When the pieces are cast, they must be filed to fit the core box, and finished off level with its joint face, a small hole being drilled in the centre, and a pin being driven through the piece and into the box to steady the corners. We then saw the pieces in halves with a very fine saw.

"If the partition, instead of following the roundness of the valve seat, is made straight, the construction of the core box is much more simple. In this case, a zigzag mortice is made clear

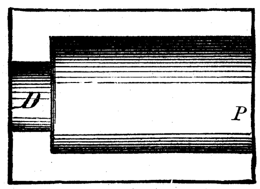

Fig. 2806.

through each half of the box, its size and shape being that of the required partition. Fig. 2804 represents a half-core box of this kind. A piece of wood A is fixed, as shown, to the partition, to enable the core maker to draw it out before removing the core from the box. The mortice for the partition should be turned out before the half-spherical recess, the mortice being temporarily plugged with wood to render easy the operation of turning.

"In very large valves (say 10 or 12 inches) a half-core box is generally made to serve by fitting the two half partitions, shown at A, in Fig. 2803, to a half-core box, and keeping them in position by means of pegs, a half-core being made first with one and then one with the other in the core box. It is often necessary to form a raised seat in the body of an angle valve, such as shown in Fig. 2805, which represents a section of such a body. It is shown with flanged openings, though in small valves hexagons to receive a wrench would be substituted.

"Fig. 2806 is a plan of half the core box necessary for forming the raised seat. From this construction, it will be seen that the large core, though solid with the branch core, is not solid with

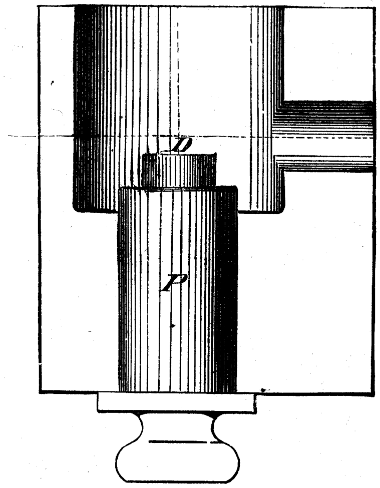

Fig. 2807.

that forming the hole in the seat and the part below it; therefore the core prints on the body pattern must be left extra long to give sufficient support in the mould for the overhanging cores. The loose round plug P, is made of the size of the outside of the seat and fitted to the box. The part outside the box is a roughly shaped handle to draw it out by. The diminished part D is a print, and into the impression left by it is inserted the core made in box shown in Fig. 2807. The print D is of the same diameter as the hole in the seat; and the print on the pattern is of the size

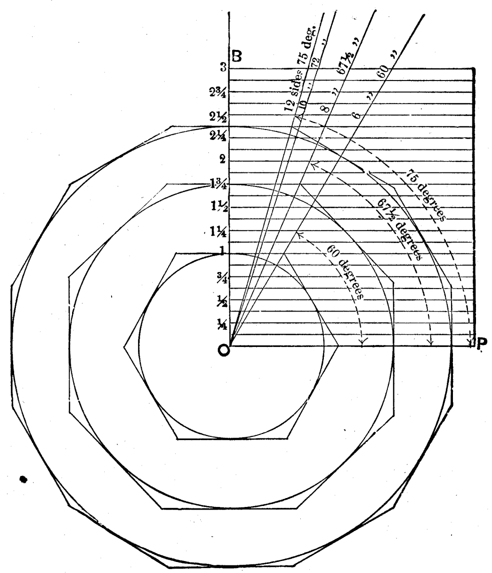

Fig. 2808.

of the increased diameter below the seat. Large angle valves are made with half a core box by making a branch opening in the box right and left, a semicircular plug being provided. Two half-cores are made with the plug, first in one and then in the other branch opening. The plug P should be in this case only half round."

For finding the lengths of the sides of regular polygons, scales, such as shown in Figs. 2808 and 2809, may be used, the construction being as follows:—

Draw a horizontal line O P, Fig. 2809, and at a right angle to it the line O B. Divide these two into inches and eighths of an inch, and draw lines meeting the corresponding divisions on O P, O B. From the point O draw the following lines: A line at $55\frac{1}{2}$ degrees from line O P, which is to serve for polygons having 9 sides; a line at $52\frac{1}{2}$ degrees to serve for polygons having 8 sides; a line at 49 degrees for polygons having 7 sides; a line at 45 degrees for 6 sides; a line at 40 degrees for polygons having 5 sides. It may be added, however, that additional lines may be drawn at the requisite angle for any other number of sides.

The application of the scale is as follows:—

The point O represents the centre of the polygon; hence from O to the requisite line of division on O B represents the radius of the work. From the line O B to the diagonal line (measured along the necessary horizontal line of division) is shown the length of a side of the polygon. From the point O, measured along the line having the requisite degrees of angle, to the horizontal line denoting the radius of the work, gives the diameter across corners of the polygon. The diameter across the flats of a square being given, its diameter across corners will be represented by the length of a line drawn from the necessary line of division on O B to the corresponding line of division on O P. A cylindrical body is to have six sides, its diameter being 2 inches, what will be the length of each side? Now, the radius of the 2-inch circle of the body is 1 inch; hence, find the figure 1 on line O B and measure along the corresponding horizontal line the distance

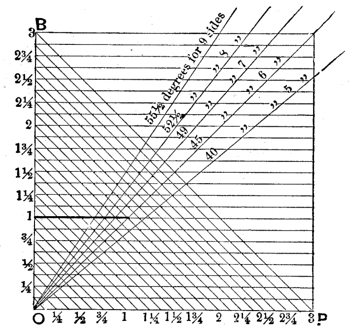

Fig. 2809.

from the 1 to the line of 45 degrees, as denoted by the thickened line.

A body has six sides, each side measuring an inch in length, what is its diameter across corners? Find a horizontal line that measures an inch from its intersection of the line O B to the line of 45 degrees, and along this latter to the point O is one-half the diameter across corners.

Example 3.—It is desired to find the diameter across corners of a square whose side is to measure 3 inches. Measure the distance from the 3 on line O P to the 3 on line O B, which will give the required diameter across corners.

This scale lacks, however, one element, in that the diameter across the flats of a regular polygon being given, it will not give the diameter across the corners. This, however, we may obtain by a somewhat similar construction. Thus, in Fig. 2808, draw the line O B, and divide it into inches and parts of an inch. From these points of division draw horizontal lines; from the point O draw the following lines and at the following angles from the horizontal line O P:—

A line at 75° for polygons having 12 sides.
" 72° " 10 "
" $67\frac{1}{2}$° " 8 "
" 60° " 6 "

From the point O to the numerals denoting the radius of the polygon is the radius across the flats, while from point O to the horizontal line drawn from those numerals is the radius across corners of the polygon.

A hexagon measures 2 inches across the flats, what is its diameter measured across the corners? Now, from point O to the horizontal line marked 1 inch, measured along the line of 60 degrees, is $1\frac{5}{32}$ inches; hence the hexagon measures twice that, or $2\frac{5}{16}$ inches across corners. The proof of the construction is shown in the figure, the hexagon and other polygons being marked for clearness of illustration.

Let it be required to make a pattern for a section of pipe such as shown in section and in plan in Fig. 2810, which is from "The Pattern Maker's Assistant." This pattern would be made to mould, as shown in the section, lying horizontally, and must therefore be made in two halves, the line of joint for the two halves being along A B in Fig. 2811.

"The body A and the branch B would be made separate from the flanges, and would be reduced in diameter at the ends to receive them. To form A, take two pieces of timber, say three

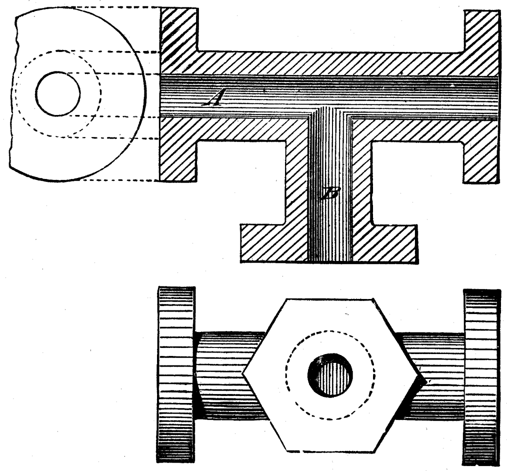

Fig. 2810.

inches longer than the length of A, including the core prints, and measuring a little more than half the diameter of the pipe one way, and a little larger than the full diameter of the pipe the other way, and glue them together at the ends for a distance of $1\frac{1}{2}$ inches, which will serve to hold them while turning them in the lathe.

"The pieces may then be turned in the lathe to the required diameter. During this turning, however, it is essential to insure that the joint of the two pieces be exactly in the centre, otherwise one half of the pattern will be (when the halves are separated) thicker than the other.

"The ends are then turned down to receive the flanges, the

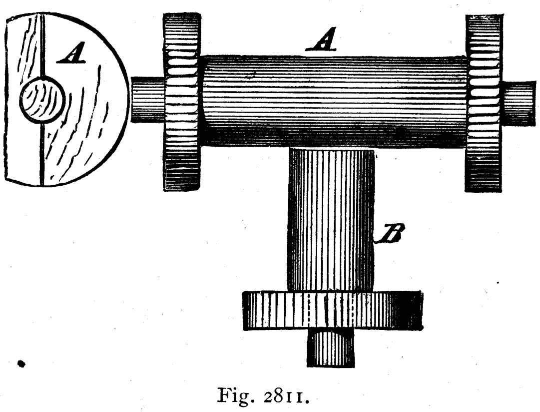

Fig. 2811.

reduced diameter being necessary so as to leave a shoulder for the flanges to abut against to keep them true, or at a right angle to the axial line of the body. The branch is turned up in the same way, and the flanges are then turned and put on.

"The end of the branch may be cut to fit the circumference of the body as follows:—

"Set a bevel square to an angle of 45°. Take the halves of the branch apart, and rest the stock or back of the bevel against the end face, and let the blade lie on the joint face, and mark two lines A B in Fig. 2812, which lines must just meet in the centre of the branch at the end. Cut away the angular pieces C and D down to the lines A B. This performed on each half will leave them when given a quarter turn as shown in Fig. 2812, and the curve shown by the junction of the horizontal with the vertical shading lines is the curve for the end; hence the surface covered with the horizontal lines requires to be cut away.

"When this is done on both halves the branch will fit to the body, as shown in Fig. 2813, in which A is the body and B C the two half

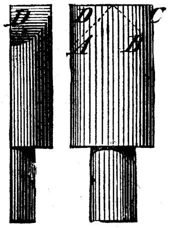

Fig. 2812.

branches. For a temporary pattern the branch may be fastened to the body with a few screws; but for a permanent pattern it should be glued also, which is done as follows:—

"Lay one half of the body A, Fig. 2813, on a board, with the flange overhanging to be out of the way, and clamp it there; lay the branch also on the board, and draw it firmly up to the body by clamps,

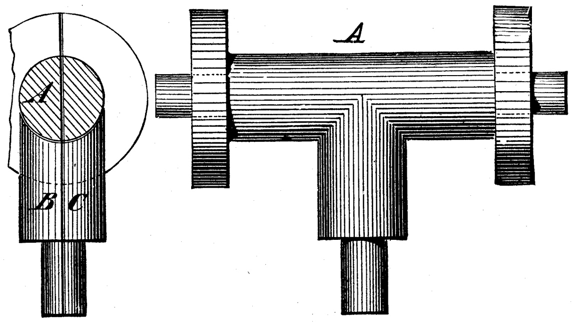

Fig. 2813.

while also clamping it flat down to the board, as shown in Fig. 2814. This will insure that the joint faces are true with one another, that is, lie in the same plane. Paper should, however, be placed between the joint faces and the board to prevent them from becoming glued to the board, and the edges, therefore, from breaking away. The second half can be put together as the first one,

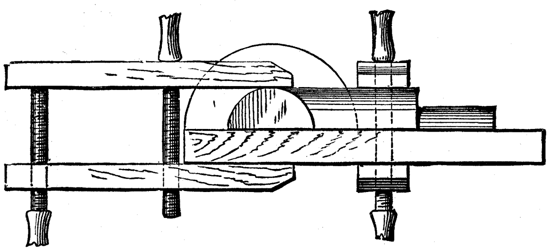

Fig. 2814.

paper being put between the two to prevent them from being glued together; and to further strengthen the joint, let into each half a piece of hard wood P, Fig. 2815, and put in the screw shown at A.

"Suppose now that the diameter of the branch had been smaller than that of the body of the pattern, then the length of curve

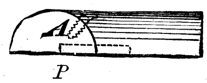

Fig. 2815.

necessary on the branch end to let it abut fairly against the cylindrical pattern body may be found as follows:—

"Draw on a piece of board the line A B, Fig. 2816, and from any point C mark a semicircle equal in radius to that of the radius of the body of the pattern, draw the line E parallel to A B, and distant from it to an amount equal to the radius of the branch, then from the junction of E with the semicircle as at D, mark the line F at a right angle to A B. Let it now be noted that the semicircle A G represents half the pattern body, and E D F B the branch; hence from F to G is the length of the branch end that will require to be curved to fit the

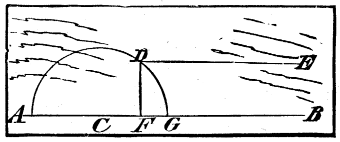

Fig. 2816.

circumference of the body, while it is also the length to be added to the distance the branch requires to stand out from the body. To draw the curve on the end D F G of the branch the gauge or marking instrument, shown in Fig. 2817, is employed. The branch P is placed in V-blocks (Fig. 2818), resting upon a plane surface. The

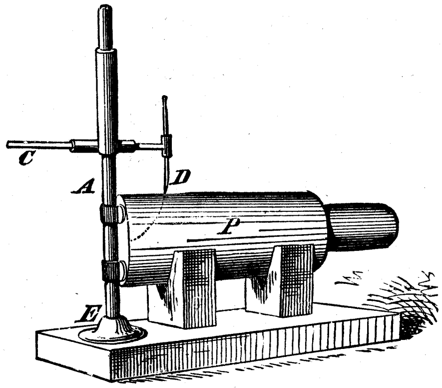

Fig. 2817.

gauge consists of a stand E carrying a vertical bar A; upon A is the closely fitting cross-tube carrying the arm C, which in turn carries the marking pointer D, which is set distant from the centre of the bar A to the amount of the radius of the piece of work or the cylinder is to fit against.

"If the branch required to stand at an angle to the body, as in Fig.

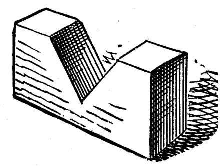

Fig. 2818.

2819, the marking may be performed by the same gauge and in the same manner, but the axial line of the branch must be set, when marking one side, at an acute angle to the axial line of A, and at an obtuse angle to A when turned over to mark the other side, which may be done in each case by raising one of the V-blocks

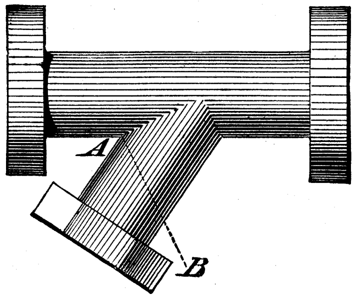

Fig. 2819.

until the branch lies in either case at the same angle to A as it will require to stand to the body on which it is to fit.

"When the body is much larger in diameter than the branch, a hole may be bored in the former to receive the end of the latter, by giving to the branch end a stem, as in Fig. 2820, and then cutting in the body a recess for the branch end and its additional stem. This recess may be cut out in the lathe, chucking the body as in Fig. 2821.

"Should it occur that one end of the **T** is of larger diameter than

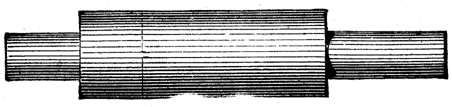

Fig. 2820.

the other, one chucking **V** must be deeper than the other, and we may find their respective depths by the following process :—

"Draw line A B, Fig. 2822, which line represents the chuck face. Let point C represent the centre of the lathe. Mark line C E and set a pair of compasses to the radius of the body of the pattern at the centre of the branch location. Then take a radius from C and

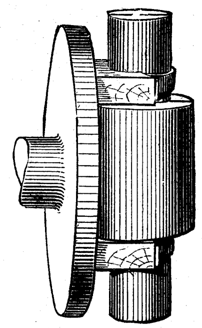

Fig. 2821.

about $\frac{1}{16}$-inch up from line A B, and with this radius we mark on the line C E the point E. From this centre we mark the two arcs having radii corresponding to the unequal diameters of the pattern at the location where the chucking **V**'s are to be placed. We then draw tangent lines to each of these arcs, and thus obtain the correct depth of **V** necessary to hold the axial line of the pattern parallel to the lathe chuck.

"The core box would, unless the pattern were a small one, be built up in courses, as shown in Fig. 2823. The box would be drawn in plan, and end and side views drawn as shown, so as to draw in the half circle representing the bore of the half-core box and mark off the courses as from 1 to 6. These courses need not be of equal or

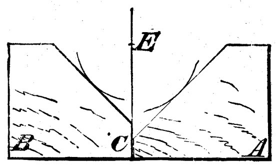

Fig. 2822.

of any particular thickness, but may suit that of any suitable timber at hand. Courses 1 and 2 should extend over the whole outline of the box, while the pieces 3 and 4 are made in width to suit the curvature of the core as shown, and to extend the full length of the box. The pieces 7, 8, 9, and 10 are of the length of the branch, and are

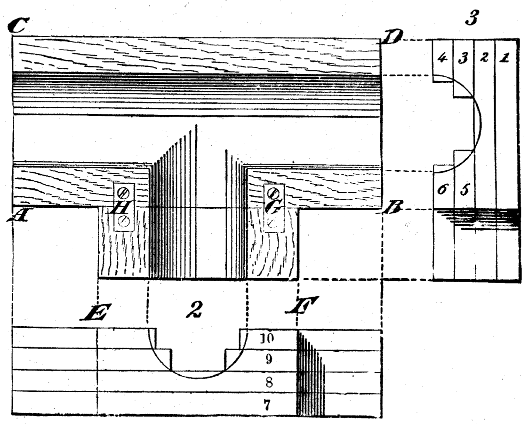

Fig. 2823.

made in width to suit the curvature of the branch core. If the branch core were a short one it could be cut out of the solid ; but in any event, the grain of the wood should be as shown, and the holding pieces at G and H should be employed."