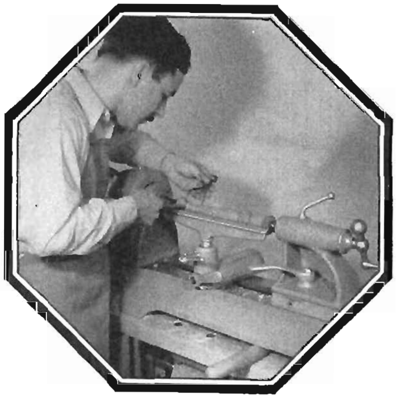
GETTING THE MOST OUT OF YOUR LATHE

4570 A DELTACRAFT PUBLICATION 50¢

GETTING THE MOST OUT OF YOUR WOOD LATHE

A Deltacraft Publication
POWER TOOL SERIES



Edited by
SAM BROWN

A Complete Handbook Covering all Branches of Lathe Operation in the Home Workshop with Over Two Hundred Photographic Illustrations and Line Drawings

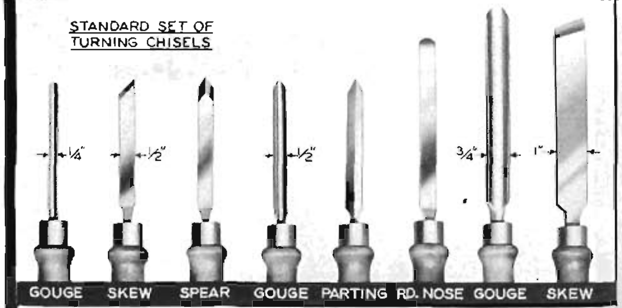
DELTA MANUFACTURING DIVISION
ROCKWELL MANUFACTURING COMPANY **MILWAUKEE 1, WIS.**

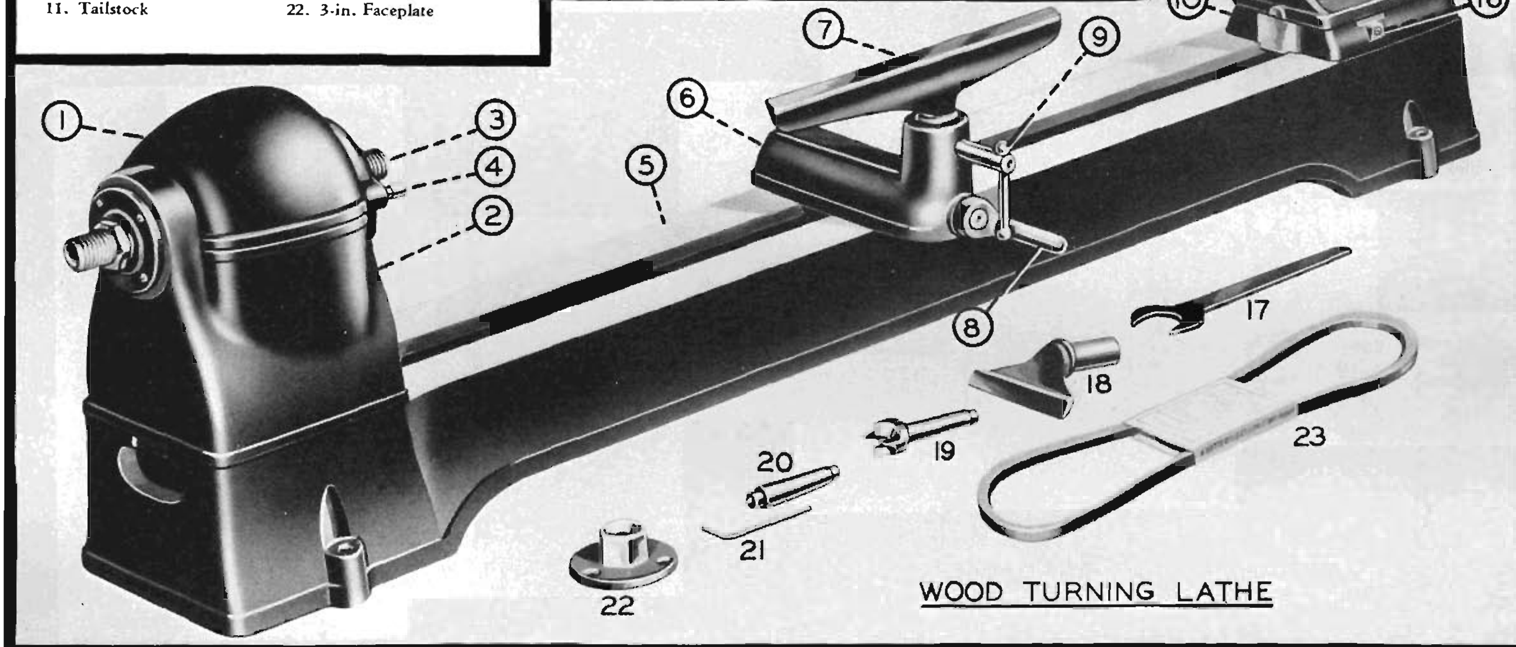
Printed in the United States of America

Fourteenth Edition
10M—7-48

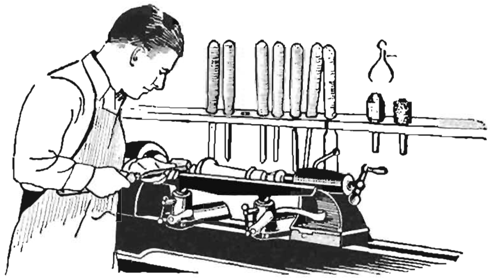
PRINCIPAL PARTS OF THE LATHE

1. Pulley Guard
2. Headstock
3. Headstock Spindle
4. Index Pin
5. Lathe Bed
6. Tool Rest Base
7. 12-in. Tool Rest
8. Tool Rest Base Clamp
9. Tool Rest Clamp
10. Tailstock Base
11. Tailstock
12. Tailstock Spindle
13. Tailstock Spindle Clamp
14. Tailstock Feed Handle
15. Tailstock Clamp
16. Set-Over Screw
17. Headstock Wrench
18. 4-in. Tool Rest
19. Spur Center
20. Cup Center
21. Allen Wrench
22. 3-in. Faceplate





WOOD TURNING LATHE



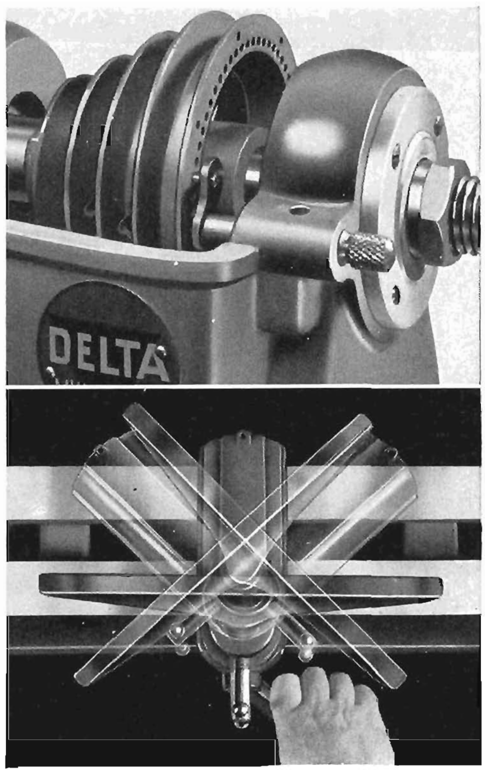
The LATHE *and* EQUIPMENT

WOOD TURNING is a fascinating art, and the lathe, more than any other tool in the shop, is in itself a complete unit capable of producing finished work. The operation of the machine is not difficult; indeed, any beginner can make a creditable turning on the very first try by using scraping methods. True wood turning, however, is a cutting operation, and the acquisition of the necessary skill to fashion turnings quickly and well in this manner demands some knowledge of methods and considerable practice in their application.

The Wood Lathe.—Wood lathes are designated according to the maximum diameter of work which can be swung over the bed—a lathe capable of swinging a 10-inch diameter disk of wood is called a 10-inch lathe. The terms *wood lathe* or *speed lathe* are usually used to avoid confusion with screw-cutting, metal turning lathes. A typical 12-inch wood lathe is shown in the photograph on the opposite page. The essential parts comprise the lathe bed, the headstock, the tailstock, and the tool rest. The tool rest consists of two main parts—the base and the tool rest or support itself. Different types of rests are interchangeable in the same base.

There are two general types of lathe headstocks—the spindle is either hollow or solid. The lathe shown in the illustration has a hollow spindle, internally tapered at both ends to take No. 2 Morse shanks. Smaller lathes have either a hollow spindle with No. 1 Morse taper, or a solid spindle. The spindle of the tailstock is usually made to match the headstock spindle so that various attachments can be used in either position. The two main attachments are the spur center, No. 19, which fits the headstock spindle, and is consequently known as the live center, and the cup center, No. 20, which fits the tailstock spindle, and is known as the dead center. In operation, the work is mounted between these two centers for turning, the spurs of the live center serving as the driving member.

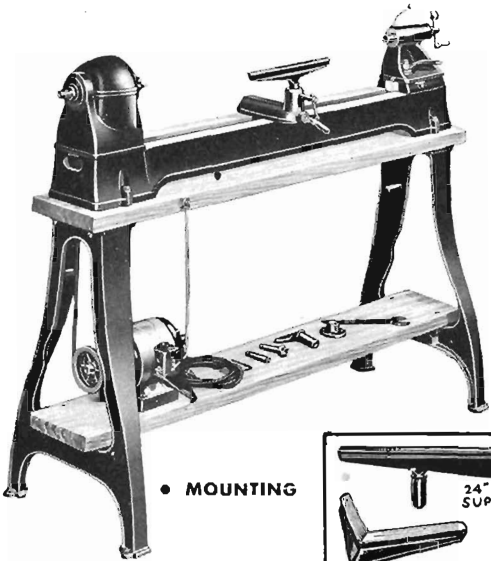
The tailstock of the lathe has three adjustments. First of all, it can be moved bodily along the lathe bed and can be clamped at any position by means of the wrench, No. 15, which fits over the tailstock clamp screw. Secondly, it can be moved within slight limits across the bed of the lathe by means of the set-over screws (No. 16). Thirdly, the spindle can be projected or retracted inside the body of the tailstock by manipulating the feed handle (14). Any desired position can be fixed by clamping the spindle with the tailstock spindle clamp (No. 13).



Top, headstock with pulley guard removed shows cone pulley drive and indexing mechanism. Phantom view of tool rest shows universal adjustment.

Indexing Mechanism.—The indexing mechanism consists of two rows of holes, accurately spaced around the rim of the drive pulley, as can be seen in the upper photo. There are 60 holes in the inside row, spaced 6 degrees apart, and 8 holes in the outer row, spaced 45 degrees. The sliding pin on the side of the headstock has a short lever on the end which can be turned to engage any hole in either inner or outer row. The indexing mechanism is used for dividing faceplate work, and for spacing cuts in fluting and reeding.

Tools.—The standard set of tools used in wood turning comprises five different shapes. Most important of these is the *gouge*, a roundnose, hollow chisel which is used for roughing cuts, cove cutting and other operations. Next

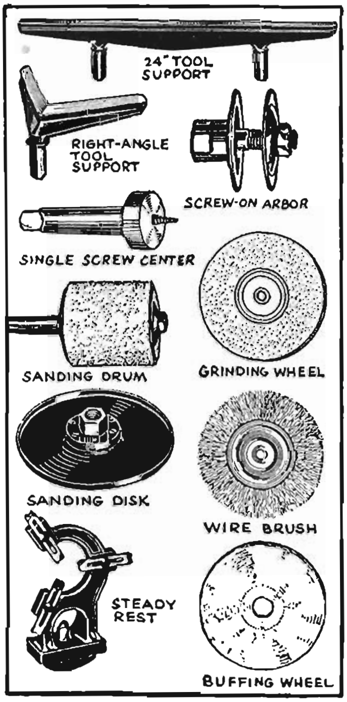


• MOUNTING

in importance is the *skew chisel*, a double-ground, flat chisel, with the end ground to an angle instead of being square across. This tool is used for smoothing cylinders, and for cutting shoulders, beads, vee-grooves, etc. The *spear* or *diamond-point chisel* and the *round-nose chisel* are scraping tools which are used where their shape fits the contour of the work. The *parting tool* is a double-ground chisel, and is used for cutting-off and for making straight incisions or sizing cuts to any required diameter.

Installation. — The lathe can be mounted on any work bench or on a special bench with cast iron legs, as shown in the upper photo. The height of the lathe spindle centerline should be 40 to 44 inches above the floor, or, in other words, at waist level. The motor can be mounted below or to the rear of the lathe, depending on the method of installation. The motor should be 1/3 h.p., 1750 r.p.m. capacitor or repulsion-induction for average wood turning. A switch rod or electrical off-on switch should be installed to bring the power control within convenient reach.

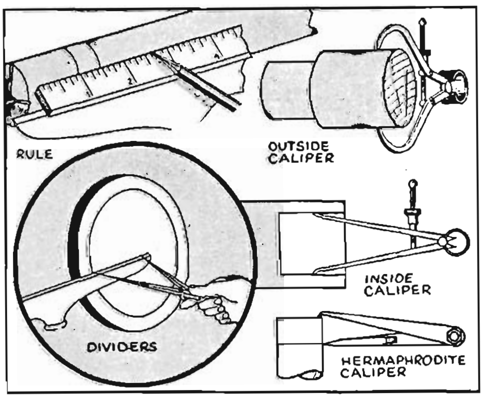
Accessories.—The drawing in the center of the page pictures various accessories which are frequently used in wood turning. The *24 in. tool support* is invaluable when doing turnings which cannot be covered from end to end with the shorter tool rest. The *right-angle support* is used for faceplate work, and permits operations on both the rim and face of the turning. The *screw center* furnishes a quick and satisfactory method of mounting small faceplate turnings. The *screw-on arbor* is valuable as a means of mounting a grinding wheel, wire brush or buffing wheel; this is available in both right and left-hand thread to fit either end of spindle. Sanding accessories are worthwhile aids, the two most common types being the *sanding drum* and the *sanding disk*. The *steady rest* is used as a support for long, slender turnings, or as an end support for shorter work. Accessories for any specific model lathe may vary slightly in construction to suit the mechanics of the lathe.



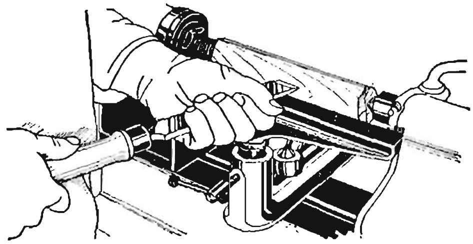
• ACCESSORIES

Measuring Tools.—Lathe work demands certain measuring tools, namely, the *rule* and *calipers*. The rule is used for taking dimensions along the turning, while the various calipers are used in measuring diameters. Calipers are best of the spring type since they are often applied directly to the revolving stock, and must be depended upon to hold a set dimension when in this position. The dividers are used mainly in faceplate work where they are useful in setting off diameters.

Safety.—The lathe is a safe tool. The cardinal safety rule has to do with clothing — never let your necktie dangle, and never work with unbuttoned, frayed or dangling sleeves. Always mount the work securely, using the standard methods described throughout this book. Get in the habit of spinning the work by hand before throwing the switch—you will get to do this automatically if you fit a handwheel on the outboard end of spindle. Keep your chisels sharp for easy cutting, and run all work at a comfortable high spindle speed.



• MEASURING TOOLS



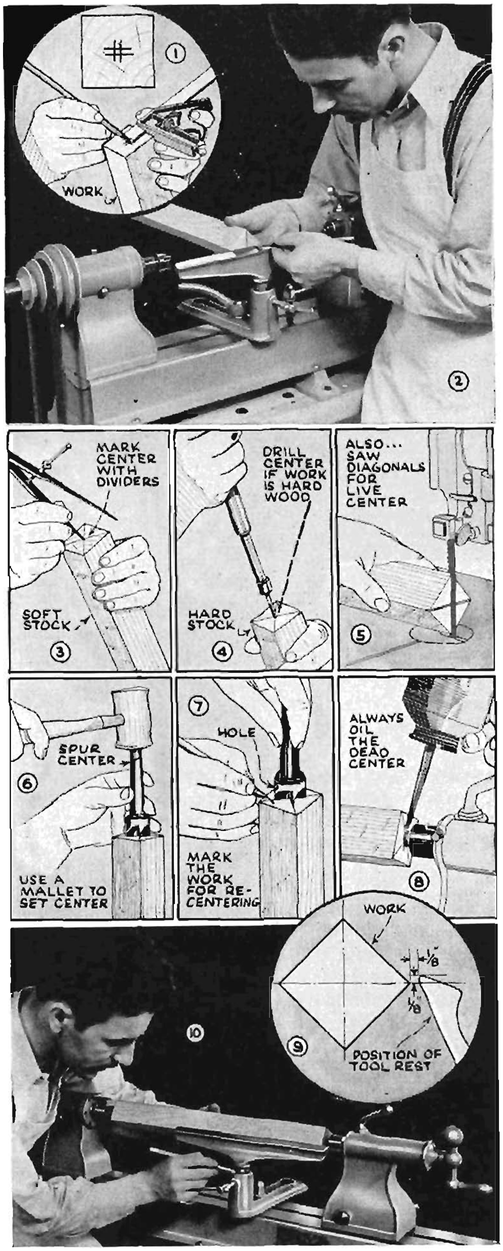
How to Turn SPINDLES

ANY TURNING which is worked between lathe centers is called a spindle turning. This is the principal type of wood turning, as typified by chair and table legs, lamp stems, etc. The turning of spindles can be done with either a scraping or cutting technique, the cutting technique by virtue of faster wood removal and a cleaner surface being almost a must for good work.

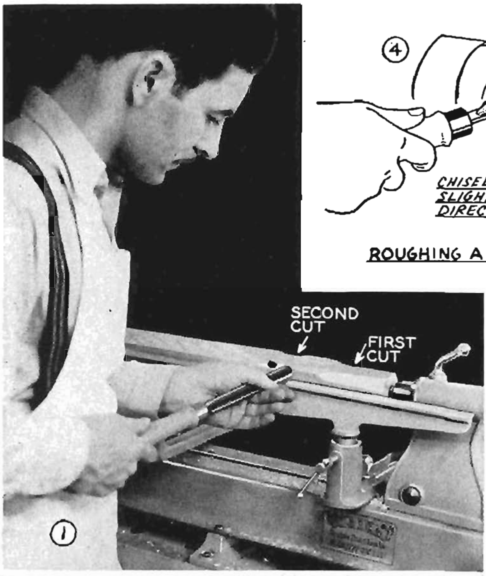
Centering the Work.—Wood stock for any spindle turning should be approximately square, and the ends should be square with the sides. Two common methods of determining the center are shown in Figs. 1 and 2. In the first of these, a distance a little more or a little less than one-half the width of the stock is set off from each of the four sides. The small square thus set off in the center can then be used in marking the true center. The diagonal method, Fig. 2, consists of drawing lines from corner to corner, the intersection marking the center of the work.

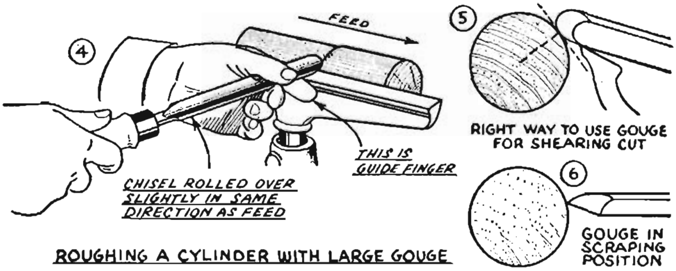
After marking each end, the true center should be definitely marked with a punch awl or dividers, as shown in Fig. 3. If the stock is hardwood, the centers should be drilled to a depth of about ⅛ in. The spur or live center is then placed against one end of the work and seated by striking with a mallet, as shown in Fig. 6. In hardwood, it is advisable to make a starting seat for the spur center, this being done by sawing on the diagonal lines, Fig. 5, and drilling a small hole at the intersection. After driving the center, it is best to hold center and work together and fit immediately to headstock spindle. The end of work at tailstock center should be oiled, placing the lubricant on the wood either before or after it is put in the lathe, Fig. 8. Many turners use beeswax, tallow, or a wax-and-oil mixture as a lubricant. The ideal method is to use a spinning center, which eliminates lubricating entirely. If the work is to be removed from the lathe before completion, *an index mark should be made as a guide for* re-centering, Fig. 7. A permanent indexer can be made by grinding off one corner of one of the spurs.

Mounting.—Mounting the work is done by moving the tailstock up to a position about 1 or 1½ in. from the end of the stock, and locking it in this position. Advance the tailstock center by turning the feed handle until the center makes contact with the work. Continue to advance the center while slowly rotating the work by hand. After it becomes difficult to turn the work, slack off on the feed about one-quarter turn and lock the tailstock spindle.



Photographs and diagrams above show various operations in centering lathe work.





ROUGHING A CYLINDER WITH LARGE GOUGE

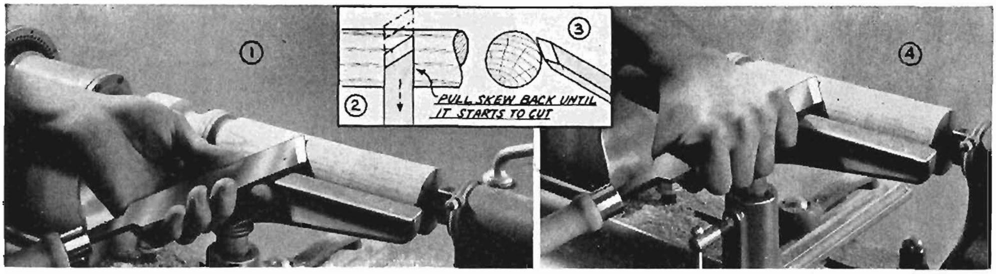
Photos show right and wrong methods in roughing a cylinder with the large gouge. Proper tool position for shearing cut is illustrated in the drawing.

Tool Rest Position.—The tool rest is now mounted in place, about ⅛ in. away from the work and ⅛ in. above the work centerline, as shown in Fig. 9. This position may be varied to suit the work and the operator. A guide mark to show the most suitable working position can be placed on the tool rest shank, as shown in Fig. 10 on the previous page, as an aid to quick and accurate re-setting. Once some experience has been obtained, the setting of the tool rest will become almost second-nature.

Roughing a Cylinder.—The large gouge is used in the first turning operation of roughing-off the sharp corners of the work. Run the lathe at low speed, and hold the gouge in the manner shown in Fig. 1. The cut starts about 2 inches from the tailstock end, and continues from this point towards and off the tailstock end. A second bite is then taken about 2 or 3-in. to the left of the first cut, advancing again towards the tailstock to merge with the cut previously made. This procedure continues until a point about 2 in. from the live center is reached where the gouge is rolled in the opposite direction to carry the final cut off the live center end of the work. The roughing cut should not be carried out with one continuous movement, as shown in Fig. 3, as this tends to tear long slivers from the corners of the work; neither should the cut be started directly at the end of the stock, Fig. 2, for the same reason. The cut can be safely carried from the center of the stock towards and off either end once the first roughing cut has been made.

The position of the gouge in relation to the work involves two or three important angles. First of all, the tool may be advanced along the work either from right to left or from left to right. From left to right or from headstock towards tailstock is preferable, since this throws the chips clear of the operator. The gouge is rolled over slightly in the same direction it is advancing, as shown in Fig. 4. The tool is held well up on the work, with the bevel or grind tangent to the revolving surface, as shown in Fig. 5. In this position it will make a clean, shearing cut. When pushed straight into the work, like Fig. 6, the gouge has a scraping action, which is normally poor practice in spindle turning. The roughing cut is continued until the work approaches ⅛ in. of the required diameter, stepping up to second or third speed (1400 to 2400 r.p.m.) once a barely cylindrical form has been obtained.

Position of Hands.—In all tool handling, the handle hand takes a natural position, being nearer or further from the end of chisel depending on the amount of leverage required. The position of the tool rest hand is more a matter of individual liking rather than any set or "proper" position. However, a palm-up grip, as illustrated with the gouge, is generally considered the best practice. In this position, the first finger acts as a guide, as shown in Fig. 4, sliding along the tool rest as the cut is made. The alternate position is a palm-down grip, which is shown in two of the photos on the opposite page. In this position, the heel of the hand or the little finger serves as a guide. The palm-down position is solid and positive—excellent for roughing or heavy cutting. Most beginners start with the palm-down grip, switching later to the palm-up position for better manipulation of the chisel.

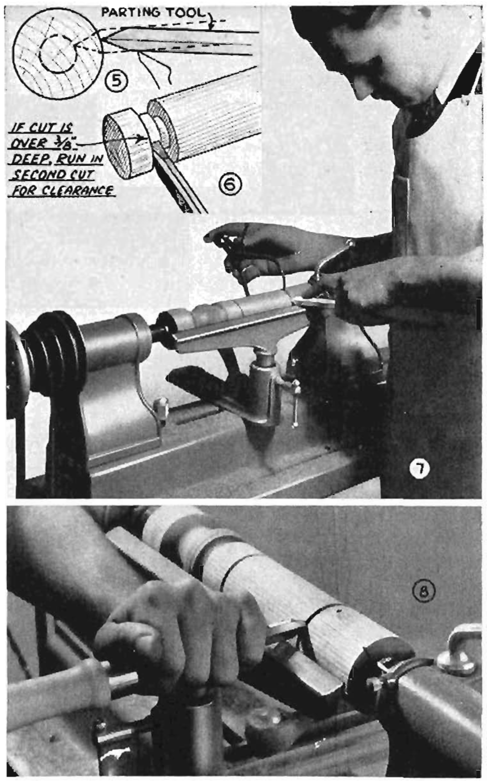


Smoothing a cylinder with the large skew is one of the most important cuts in wood turning do not use scraping methods for this operation.

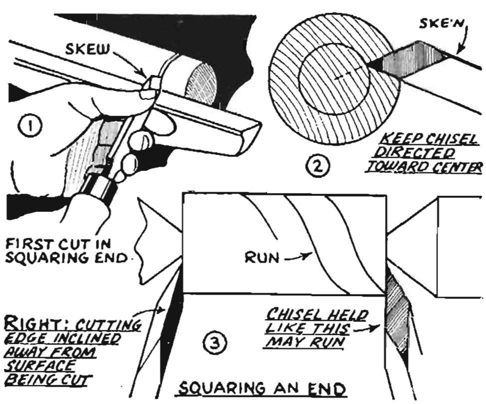
Smoothing a Cylinder.—This operation is done with the large skew chisel. It demands a little practice, but should be mastered thoroughly because it is one of the most important cuts in turning. Figs. 1 and 4 show how the chisel is held, using either grip as desired. The cutting point is near the center of chisel and high on the work, as shown in Fig. 3. The chisel must be supported by the tool rest at all times—in striving for a certain position in relation to the work, the beginner often overlooks this all-important point. Beginners often use the method shown in Fig. 2 to locate the proper tool position. To do this, you place the skew well over the work and riding flat against it. Pulling back slowly on the tool will eventually put it into position where it will bite into the wood. Raising the handle increases the depth of cut; lowering the handle makes the cut less. As with the gouge, the skew can be advanced in either direction. The part of the skew which does the actual cutting is the center portion and toward the heel. It is worthwhile to stop a test cut in progress and note just how the skew cuts. You will note that the back portion of the grind or bevel supports the tool, and the handle hand controls the depth of cut by rocking the chisel on this pivot point. For this reason it is important that the skew bevel be kept perfectly flat, not a double bevel nor rounded.

Using the Parting Tool.—The parting tool is perhaps the easiest turning chisel to handle. It is a scraping tool, and is simply pushed into the work, as shown in the photos at right. A somewhat better cutting action is obtained if the handle is held low, raising gradually as the work diameter decreases, as shown in Fig. 5. The tool is frequently used with one hand, as pictured in Fig. 7, the other hand holding calipers in the groove being cut. When parting tool cuts are deep, a clearance cut should be made alongside the first cut, as shown in Fig. 6, to prevent burning the tool point.

Squaring an End.—This operation can be done with parting tool. However, the parting tool is a rough cutter, so that ultimately the skew must be used in cleaning the cut. The whole operation can be done with the skew, and this technique is illustrated by the drawing at right. The first movement is a nicking



Photos above picture the use of parting tool. Drawing below shows squaring an end and illustrates the clearance angle which is essential in skew manipulation.



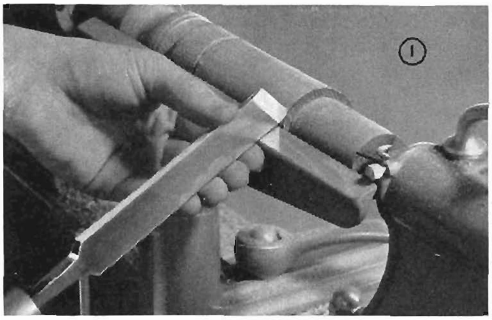
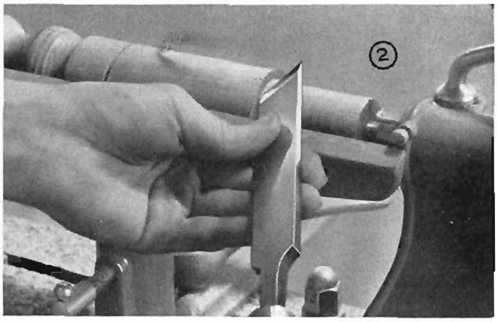


Photo above shows how the skew chisel is held when making the side cut in squaring a shoulder.



The heel of the skew chisel is used in making the horizontal cut where it joins with the side cut.

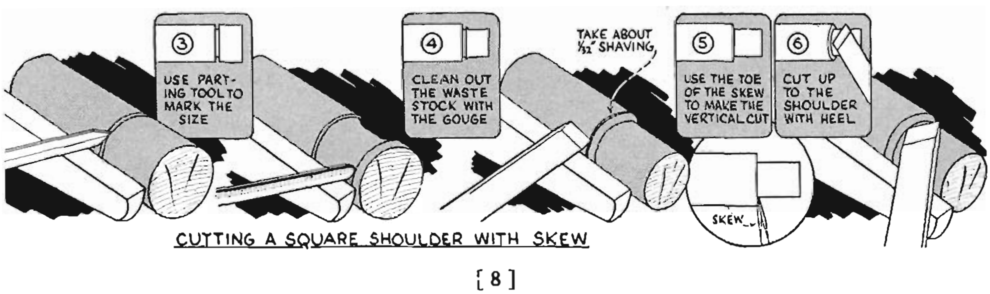
cut with the toe of the skew, as shown in Fig. 1. This cut cannot be made very deep without danger of burning the chisel, so a clearance cut is made by inclining the skew away from the first cut and again pushing the tool into the work. This procedure of side cut and clearance cut is continued as often as needed. The important point to note is that while the skew can be pushed into the wood in any direction, the cutting edge itself must be inclined a little away from this plane. Study Fig. 3 on previous page. Note that if the full cutting edge of skew bears against the cut surface, the tool will have a tendency to run. Now, observe the proper way to make the cut, as shown at left end of figure 3. The chisel is pushed straight into the work, but the cutting edge is inclined away from the cut surface—only the extreme toe cuts. This is the most important principle in skew handling, and you will run into it repeatedly in making shoulders, beads and vee cuts.

Cutting a Shoulder.—The parting tool is first used to reduce the wood to within 1/16 in. of the required shoulder and diameter, as shown in Fig. 3 below. The waste stock is then cleaned out with the gouge, Fig. 4. Actual cutting of the shoulder is done with the skew, as shown in Fig. 5 and photo Fig. 1 above, and is a duplication of squaring an end. The horizontal cut is also made with the skew, but in a little different manner from that used in doing plain cylinder work. If the shoulder is long, the ordinary skew position can be used for the outer portion of the cut, but at the angle between the horizontal and vertical cuts, the heel of the chisel moves into a position tangent between the skew and the cylinder, as shown in Figs. 2 and 6. In this position, the handle of the chisel is raised slightly to allow it to cut as the tool moves along the rest. A very light cut should be taken in order to produce smooth work. The heel of the skew can be used for making the entire cut, if desired, but the cut, whether in this position or any other position, should not be picked up directly at the end of the stock. It is quite evident that any horizontal cut started directly from the end of the work will have a tendency to bite into the wood, often ruining the entire piece. Always run *off* the end and not *into* it. Where a very short shoulder makes this impossible, it is best to use the skew flat in a scraping position. If the cutting technique is used, engage only with the heel of skew in a very light cut.

Cutting Small Beads.—Beads can be scraped or cut. The easy method of scraping is done with the spear chisel, and works to best advantage on beads separated by parting tool cuts, as shown in Fig. 1 on the opposite page. Scraping is slower and less productive of clean work than cutting, but it has the advantage of perfect safety—you won't spoil the work with long gash runs.

Cutting beads quickly and accurately with the small skew is one of the most difficult lathe operations. Various working methods can be used, the usual system being as shown in Figs. 2 to 4. The first cut is a vertical incision at the point where the two curved surfaces will eventually come together. This cut

Diagram below pictures successive operations in roughing-out and finishing a shoulder.

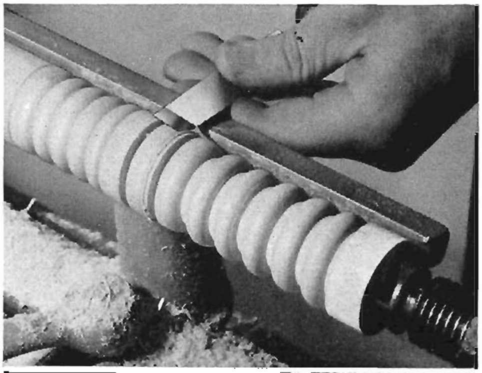


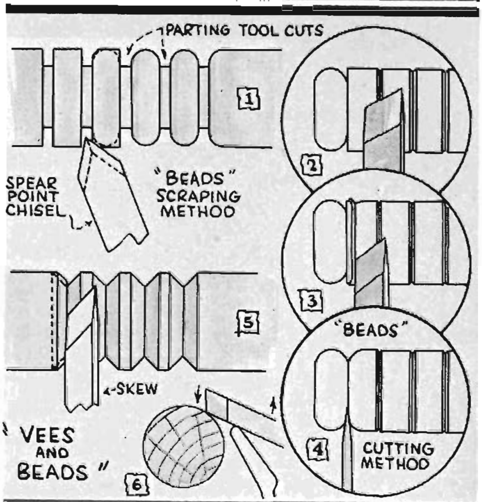
can be made with either heel or toe of skew, the lower photo showing the toe being used. Now, place the skew at right angles to the work and well up on the cylinder, as shown in Fig. 2. The chisel is flat on its side at the start, and is evenly rotated through the successive stages of the cut, as shown in Figs. 2, 3 and 4. At the same time, the chisel is pulled slightly backwards to maintain the cutting point. The entire cut is made with the heel of chisel. The opposite side of the bead is cut in the same manner, one cut serving to produce the full shape in each instance. Beads cut in this manner are beautifully smooth and polished, and the technique is well worth mastering.

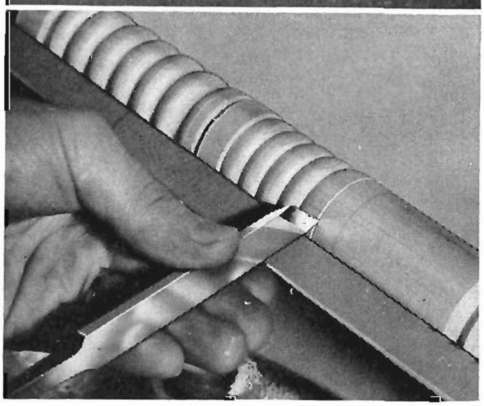
Vee Grooves.—Cutting the vee groove demands much the same technique as the bead, except the skew is hinged straight into the work without rotation, as shown in Fig. 5. Only one-half of the vee is made at a time, and one, two or more cuts may be needed on each side to obtain the desired shape. As in all cutting with the skew, the bevel next to the cut must be used as a fulcrum, without at the same time allowing the full edge of the chisel to catch and cause a run. Vee grooves can also be made with the toe of the skew, in the manner already described for squaring an end.

Long Cuts.—Long cuts are usually either convex or straight-tapered surfaces. With a convex surface, the method used in making the finishing cut is shown in Figs. 1 and 2 below. The gouge is turned on the tool rest so that it will be inclined considerably in the direction in which it is about to move. The grind is tangent to the work, and the center point of the cutting edge is the contact point with the wood. As the cut progresses towards and around the end of the curve, the handle is gradually raised and swung to the right, as shown in Fig. 2, in order to maintain the tangency between the grind and the surface being cut, Fig. 3.

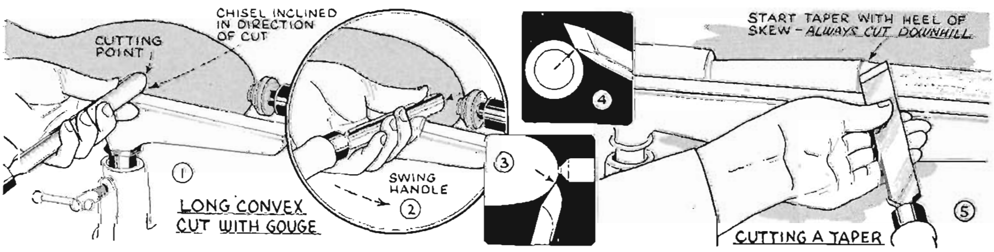
Figs. 4 and 5 show the cutting of a long taper. The skew is used, and the operation differs from smoothing a cylinder only as regards the start of the cut. The starting cut should be made with the heel, as shown in Fig. 5, to prevent the tool from digging into the work. As the tool runs down the work, the chisel can be pulled back to allow the center point of the cutting edge to cut. However, the full taper can be made with the

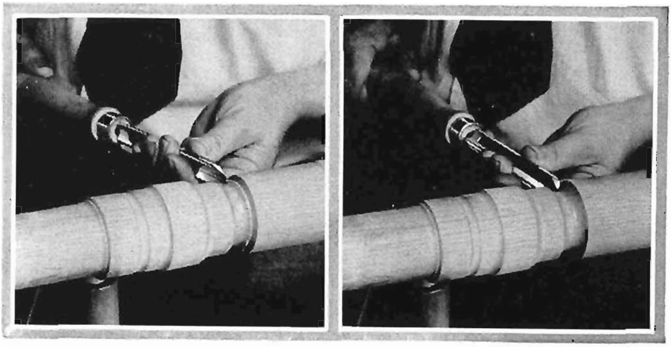






Photos above show cutting of vees and beads. The diagram below shows manner of making long cuts.





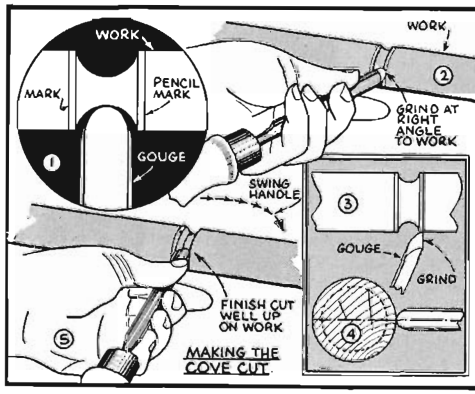
Above, left, shows the start of the cove cut. The photo at right shows how chisel is rolled. Various steps in cove cutting are shown in the diagram.

heel. There will be a tendency to cut too deeply at the center of the taper which should be guarded against. The direction of cutting is always downhill.

Cove Cuts.—Second to forming a perfect bead, the cove or concave cut is the most difficult to master. This cut is made with the gouge, the size of the tool depending upon the size of the cut. The size of the intended cove is first laid out, and the gouge is pushed directly into the work to remove the surplus stock, as pictured in Fig. 1. The cove cut can now be made. The gouge is placed on edge on the tool rest in such a position that the grind of the chisel forms an approximate right angle with the work, as shown in Figs. 2 and 3. The chisel contacts the work at the center of the cutting edge, the tool being held so that the centerline of the gouge is pointing directly towards the center of the revolving stock, as shown in Fig. 4. This starting position is important; otherwise the gouge will have a tendency to run along the surface of the work.

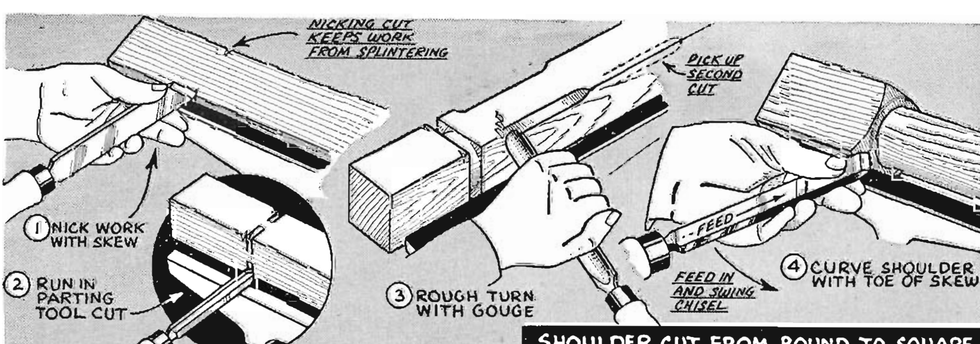
From the starting position, the gouge is pushed into the revolving stock, and the tool is rolled on the rest. A triple action takes place here: First, the chisel is rolled to follow the shape of the cut; second, the handle is dropped slightly so that the portion already cut will force the lip of the chisel sidewise; third, the chisel is pushed forward so that at the end of the cut, Fig. 5, it will be well up on the work and tangent with the cut surface. Only one-half of the cut is made at one time, then the chisel is reversed to cut the other half. The occasional turner is advised to make cove cuts with a scraping technique, using either the small gouge or round nose chisel.

Square Sections. — When the turning has a square section, the stock should be jointed before turning. Good centering is essential



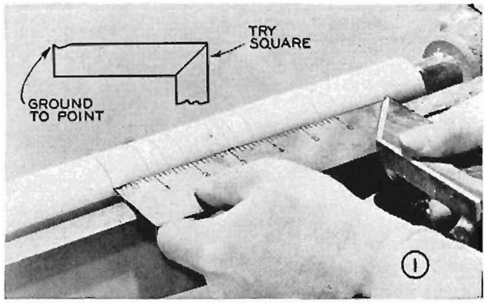
since any error will show at the shoulder where the round meets the square. Turning of the shoulder from square to round can be done in various ways, one method being pictured in the drawing below. If the parting tool is sharp, the nicking cut with skew, Fig. 1, can be omitted. The final trimming operation, Fig. 4, can be done with either the skew or spear chisels. This is a scraping operation. While the shoulder can be cut with the same technique used for cutting a bead, the simpler scraping method pictured does clean work and is easier to do.

Making a Turning.—Any spindle turning is simply a combination of the individual cuts previously described. The work is roughed with the gouge to a maximum-size cylinder,

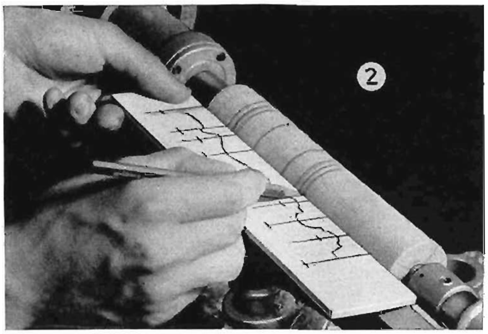


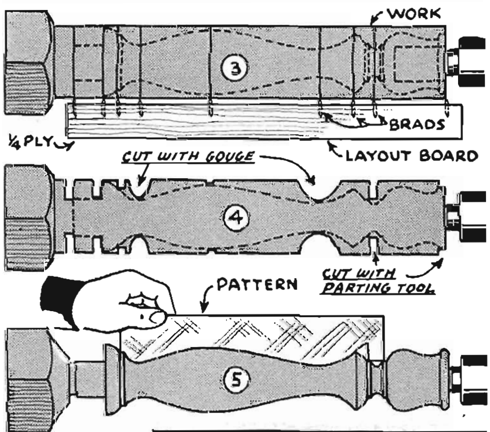
and is then given one running cut with the skew to make it smooth enough to take pencil marks. The required dimensions along the turning are set off with ruler and pencil. If the pencil marks are made about half-an-inch long, they will be visible when the work is under power. Marking can also be done while the work is rotating, using either rule and pencil or some kind of marker, Fig. 1. A half-section pattern of the work, Fig. 2, is useful when more than one turning is to be made. Another device used for production is the marking board, Fig. 3, which is fitted with sharp brad points to mark all needed layout lines in one operation. Fig. 4 shows the turning roughed with parting tool and gouge to the main diameters. Sizing cuts of this kind should be a little fat and a little wide of the actual mark to allow for a finishing cut. Fig. 5 shows the use of a pattern. This is most useful on long curves. It can be made of sheet metal or cardboard, in which case it is used only as a template to check the work after turning; some workers make use of a plywood pattern and manipulate the chisel directly over the pattern to produce the required shape.

Use of Master Spindle.—In all spindle turning requiring two or more duplicate spindles, the turning first completed automatically becomes the master spindle and is used as a reference in forming the others. It is helpful to mount this turning directly behind the lathe so that it can be seen while the other turnings are being made. If the master spindle is nailed or tied to a hinged board, it can be brought forward and used as a layout guide for succeeding turnings, as shown in Fig. 6. Calipers are the single greatest aid in determining diameters; time is saved if several pair set to different sizes are used. Many turners prefer the wooden diameter gage consisting of a half circle cut along the edge or end of a piece of plywood, Fig. 7. Gages of this kind are easily sawed to shape, and can be lightly burned-in to exact size and shape by applying to a revolving hardwood spindle of the proper diameter.

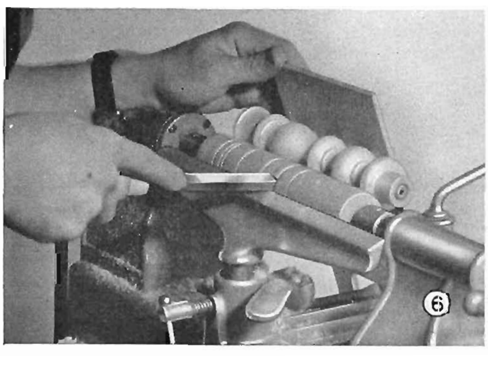


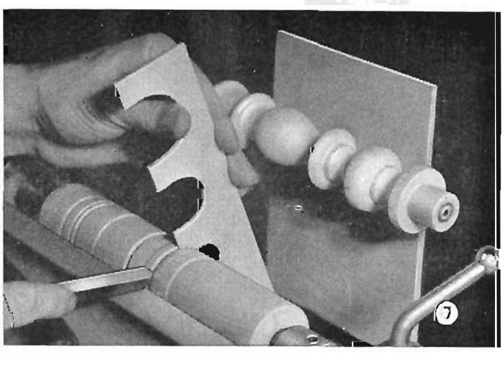
Above, direct marking of spindle with try square. Photos and drawing below show various other methods used in laying out and sizing duplicate turnings.



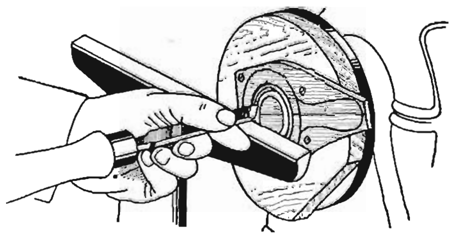


STEPS IN MAKING A TURNING





FACEPLATE *and* *Chuck* TURNING

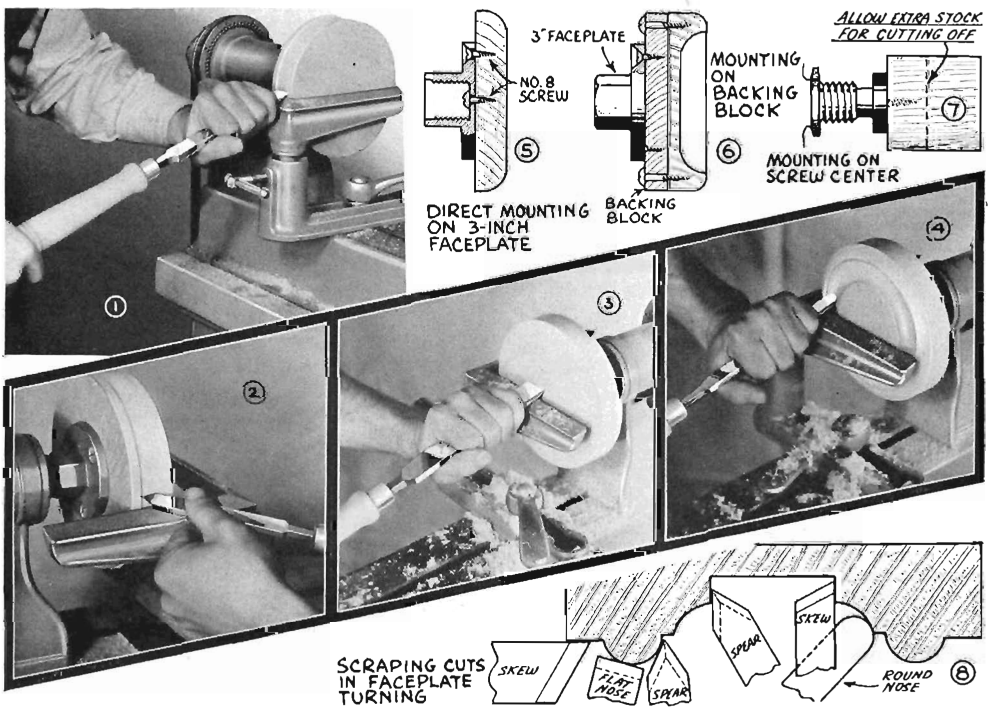


TURNINGS which cannot be worked between centers must be mounted on a faceplate or other work-holding device. The greater part of this type of turning is done with the faceplate mounting, although there are a number of jobs which require special chucks. All cutting in faceplate work is done by scraping; any attempt to use a cutting technique on the edge grain of large work will result in a hogging, gouging cut which may tear the chisel out of your hands. All work should be roughly band sawed a little oversize to eliminate heavy roughing cuts in turning.

Mounting the Work. — Fig. 5 shows direct mounting to the 3-in. faceplate. Because it is easy to set up, this mounting should be used whenever the work permits. Larger pieces can be held in the same way by using the 6-in. faceplate. When normal screw-fastenings interfere, the work can often be mounted on a backing block, as shown in Fig. 6. When screws are not permissible at all, the work is glued to the backing block, fitting a sheet of paper at the joint to allow later separation without damaging the wood. Some work can be screwed or nailed from the face side into backing block, as pictured in heading drawing. Work less than 3-in. diameter can be mounted on the single screw center, Fig. 7.

Turning.—All turning is done by scraping, with the tool rest positioned to put the cutting edge of chisel on the work centerline. The handle end of chisel is usually dropped slightly to give a better cutting angle. Any chisel can be used which fits the surface being cut, and most cuts can be made in several different ways. Cutting the mounted disk of wood to diameter is commonly the first operation, and this can be done with a square nose chisel, Fig. 1, or with the spearpoint, Fig. 2. The gouge and skew can also be used, both in a level, scraping position. There is no square-nose chisel in the average turning set, so you will have to make your own. The preferable chisel for finishing the edge is the spearpoint, Fig. 2, picking up a bite at the edge of the work and holding the bite right across the surface.

Facing the work can be done with the square, spear, skew or gouge chisels. Fig. 3

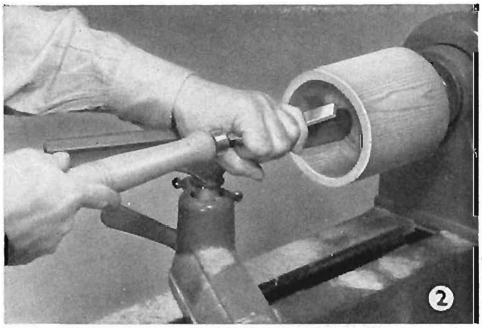


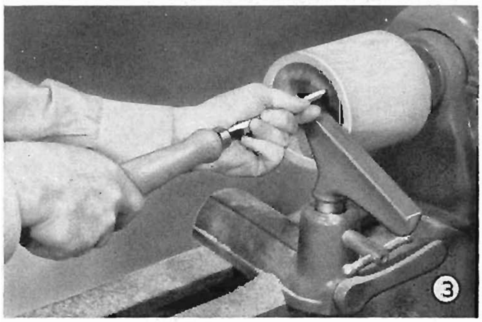
shows the square chisel being used, while Fig. 8 shows how the skew is pushed into the work for a facing cut. A surfacing cut with spear chisel is generally taken by starting at the center of work and cutting toward the rim. Roughing cuts in facing should be worked with the gouge since its action is much faster than other chisels.

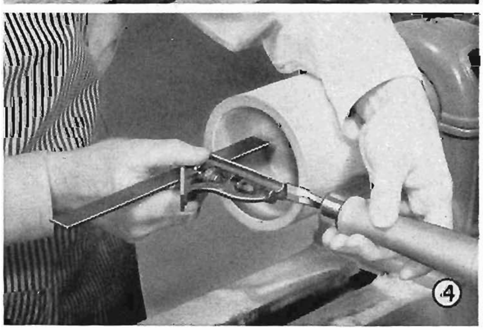
Large faceplate work is mounted on outboard end of spindle. Below, methods used in deep boring with the use of hand chisels—note tool rest positions.

Large Turnings. — Large turnings are mounted on the 6 inch faceplate or handwheel and, are worked on the outboard end of spindle, as shown in Fig. 1. A floor stand is needed to hold the tool rest. Lacking this equipment, good work can be done with a metal bar or Delta 11-inch lathe tool rest base clamped to the table of drill press.

Deep Boring.—Deep boring is required for bowls, boxes and similar faceplate work. The work is not difficult, but it is slow. Whenever practical, it is faster to rough out the recess by drilling a series of holes to the required depth on the drill press. In any case, a central starting hole should be drilled. The chisels used for deep boring are the skew, round nose and spearpoint. Fig. 2 shows the skew being used. It is useful for sliding down the edge of the hole, and can also be used with a series of jab contacts to rough the wood at bottom of recess. Cuts on the bottom only are best worked with the round nose chisel, starting at the center and working with short strokes directed toward the center, Fig. 3. Note in the photos how the tool rest is positioned to give maximum support to the chisel. The accuracy of the boring can be checked with a combination square held against a parallel edge spanning the work opening, as shown in Fig. 4. Final finished cuts down the side are made with the skew.

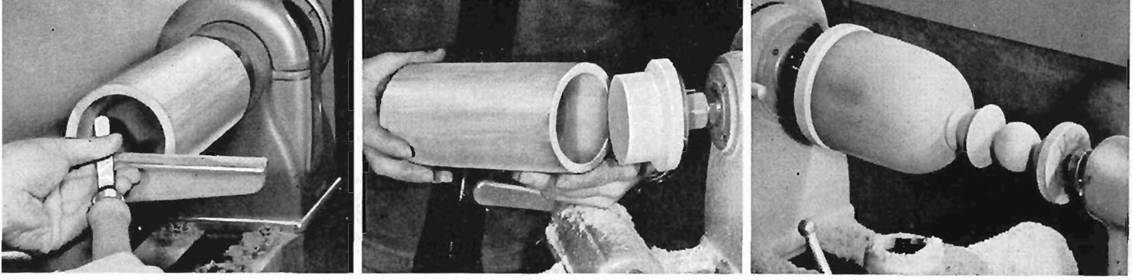






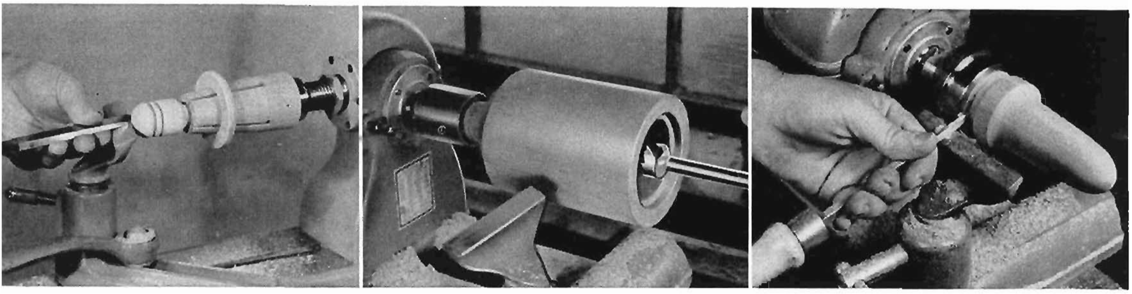
Chucking Methods.—Practically the whole technique of faceplate and chuck work has to do with the various methods of chucking or holding the work—the actual turning is simple. Four standard methods are pictured on the following page. The general technique calls for a wood chuck or holding device of some kind so that the work itself can be reversed for turning on both sides. The first series of pictures shows the spindle chuck, so called because it is a spindle in itself and fits inside the work. It is used for all work having a straight central opening. The turning of the central opening, which is done first, is called the first chucking, while the chucking on spindle chuck is labeled second chucking or rechucking. Plug chucking methods shown in second series of photos are usually second chuckings after turning the plug or tenon.

Turning a ring, as shown in third series of pictures, shows the use of a recessed chuck. This type of chuck is used for bowls, rings and other types of work which can only be gripped from the outside. Time is saved in making the recessed chuck if the rim portion



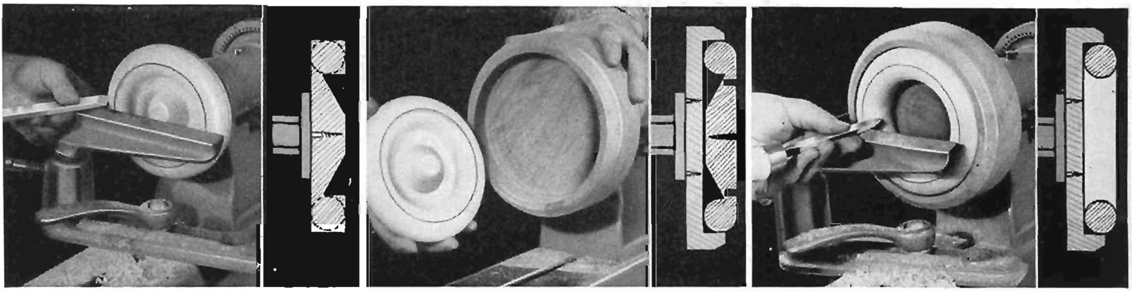
Spindle Chucking

The spindle chuck is used for most cylindrical forms. The work is first mounted on faceplate or screw center to permit internal turning of one end, as shown in left photo. A spindle chuck is then made, over which the work is press-fitted, as in center photo. Opposite end of work can then be turned or bored straight through as desired.



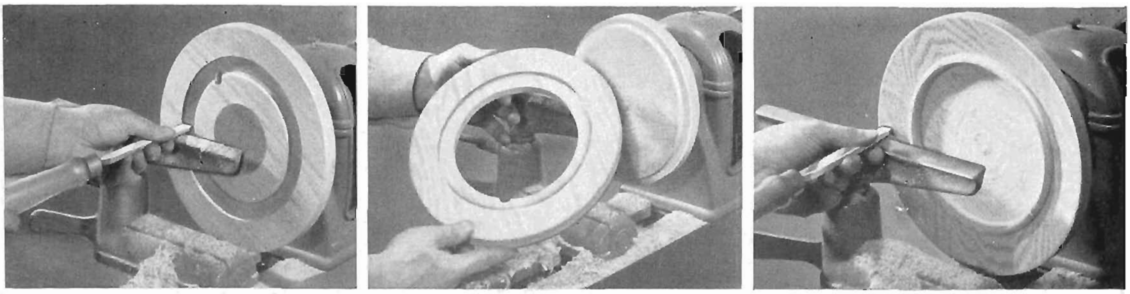
Plug Chucking

In this type of chucking, a plug or tenon is first turned on one end of the work. This plug is then gripped by or driven into some form of chuck. First photo shows a home-made ring chuck. Chuck in center photo is a threaded metal sleeve fitted to spindle nose; the work is a drive fit. Plug on work in right photo is gripped by collet chuck.



Turning a Ring

This shows the use of a recessed wood chuck, which is just the opposite of a spindle chuck. Outside and face of work are first turned to net size, as in left photo. Recessed chuck is then made for a firm pressure fit, center photo. With work mounted in recessed chuck, the center of ring is cut out, after which the second face and internal cuts are made.



Rabbeted Frame

The rabbeted picture frame is a job of spindle chucking. The work is first mounted on 3 inch faceplate and the rabbet is turned, as shown in left photo. Surplus wood at center of frame is sawed out with jig saw. A spindle chuck is then made up to take the rabbeted frame. Mounted on spindle chuck, the face of frame is turned to shape.

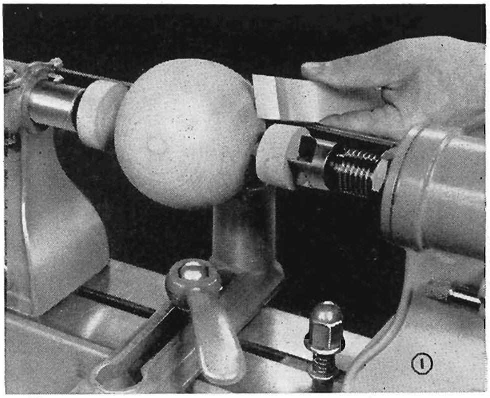
is band sawed and nailed to the body; another similar method is to nail four pieces of wood around the face of chuck. In both cases, of course, the applied wood is trued by turning. All wood chucks for rechucking must be accurate and a firm pressure fit. This is particularly true when the holding surface is small, such as the rabbeted frame shown in lower series of photos.

Turning a Ball.—Wooden balls of any size can be worked as spindle turnings, mounting the work between centers, as shown in Fig. 1. Care must be used in maintaining the length the same as the diameter. Frequent check with a template is advisable. The turning operation itself is best done with a scraping technique, although if you are good enough you can roll a finishing cut with the skew, as in Fig. 1. After the ball is roughed as accurately as possible, one end can be turned down to a stub tenon for rechucking in plug or cup chuck, as shown in Figs. 5 and 6.

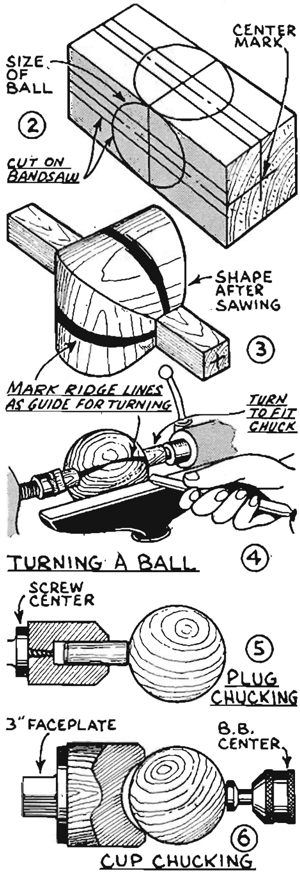
If the ball is over 2 in. diameter, a roughing operation with the band saw can be used to advantage. Do this by marking the ball shape on two adjacent sides of the square turning stock, extending the centerlines to ends of work, as shown in Fig. 2. Work a little oversize to allow for cleaning up. Band saw to shape, nailing the pieces from the first cut back in position to allow the second cut to be made. The finished piece will be like Fig. 3. Blacken ridge lines on this, as shown, and then center carefully in lathe. Now, if the piece is turned exactly to the ridge line, Fig. 4, it will be a perfect ball-shape as true as your band sawing. Another helpful guide is the fact that the ball shape will be clearly visible if the work is not turned at too high a speed.

Final finishing is done in plug and cup chucks, using one or both as desired. If you use the plug chuck, the work is rounded by working over the whole surface, using a plywood template and sandpaper, as shown in Fig. 8. If you use the cup chuck, Fig. 6, turning and sanding is done on the major diameter only, the work being rotated as needed to present new surfaces. The cup chuck is especially suitable for smoothing since it allows working the whole surface. However, it is possible to make a clean cut-off from the plug chuck and call the work finished at this stage.

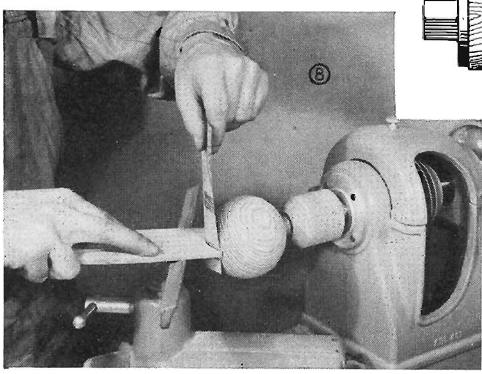
Where a number of similar balls are required, they should be worked in a string, as shown in Fig. 9, allowing a parting tool cut between for cleaning up. After careful sanding with a template, the balls are cut apart on the band saw and can then be finished in one chucking in a cup chuck. Balls less than 1 in. diameter

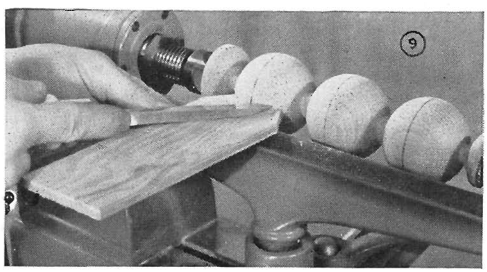


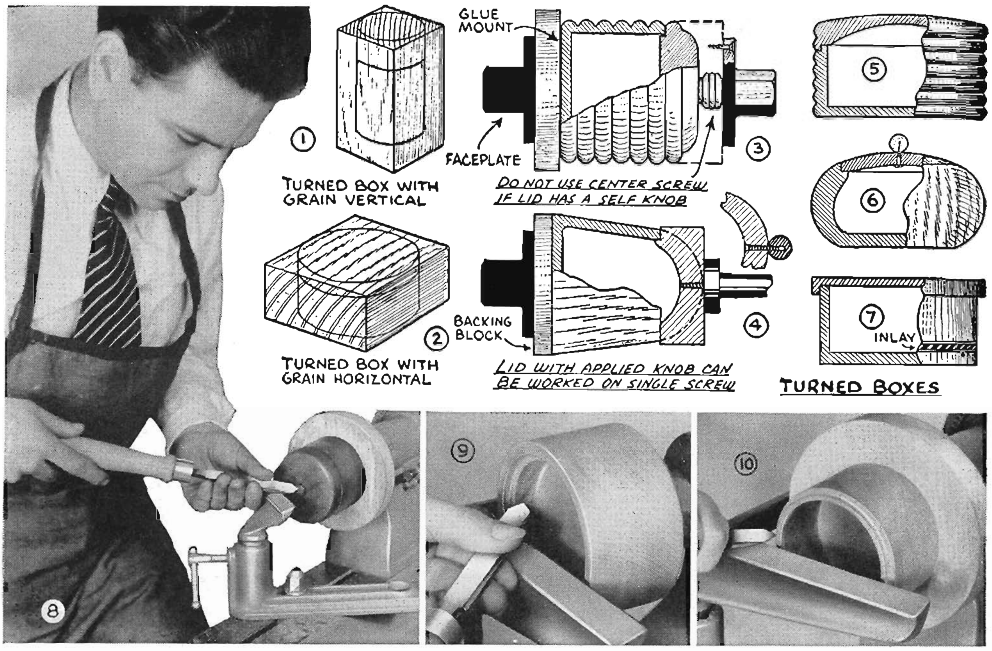
Balls are turned between centers. Compound band sawing, as pictured at left, is useful for large work.



Wood template used with sandpaper gives perfect ball shape. Photo at right shows balls turned in series.





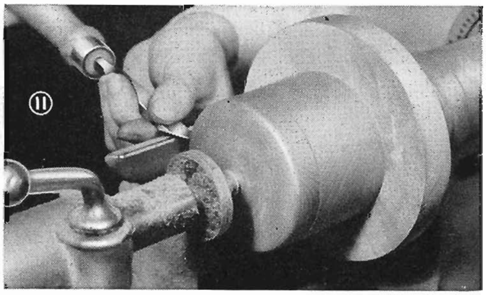


are often worked with a special chisel ground to the required shape.

Turned Boxes.—Boxes can be made with the grain vertical, Fig. 1, or horizontal, Fig. 2. The vertical grain is preferable since this construction is somewhat more stable. The general working procedure consists of turning the inside of both lid and body as separate faceplate turnings, and then combining the two parts to permit turning the outside shape. Typical lid and body styles are shown in Figs. 5, 6 and 7. Fig. 5 lid is the type commonly used and is illustrated further in the photos.

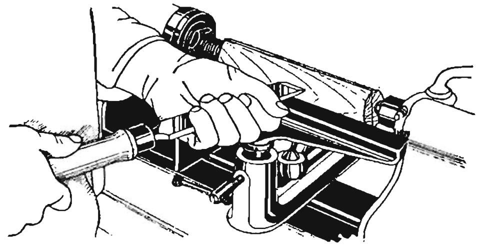
The inside of the lid is turned first. Because it is shallow, direct mounting on faceplate is usually practical. Notice, Fig. 3, if the lid has a knob integral with lid, center screw should not be used since this would penetrate the knob — use outer faceplate screws only. When the lid has an applied knob, mounting on the single screw center works perfectly, Fig. 4. Fig. 9 shows the lid portion of a typical box being turned. Fig. 10 shows the separate mounting of the box body. Since this has a shallow bottom, it is usually necessary to glue the work to a backing block. The joint can be made with paper between for easy separation after turning, or, a direct wood-to-wood glue joint can be made, separation in this case being done by turning or band sawing.

After turning the inside of both parts, the lid is removed from its faceplate and fitted



directly to the box, Fig. 11. A tight joint between lid and body is essential for final clean-up turning, Fig. 8, where the lid is held by the box alone. After the outside turning is complete, the joint on box body can be relieved slightly for an easy fit.

Wood Must be Seasoned.—Most faceplate turnings run to light wood sections of fairly large diameter. It is important, therefore, that the wood be perfectly seasoned so that it will retain its turned shape without warping. Proper conditioning is automatically obtained by storing normally seasoned wood for two or three months in the same location as the finished turning will occupy. Some turners go this one better by first rough turning the job, and then giving it about six weeks seasoning "on location." In this way, the wood is allowed unrestrained warp; any twisting it is going to do will be done before the work is turned to final shape.

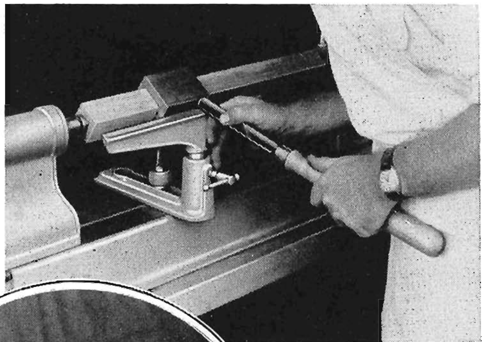


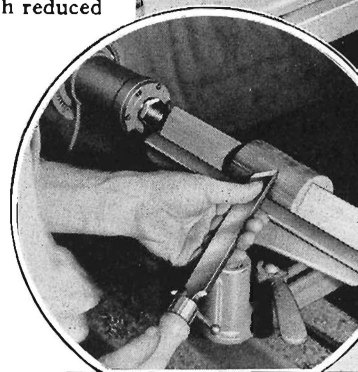
Special Types of SPINDLES

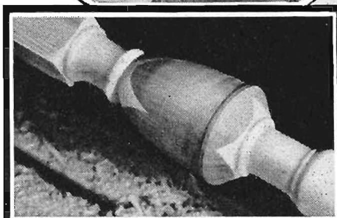
SEVERAL types of spindle turnings have special features which set them apart from the usual run of work. Included in this division are post blocked turnings, off-center work, spirals, combination turnings, split turnings, etc.

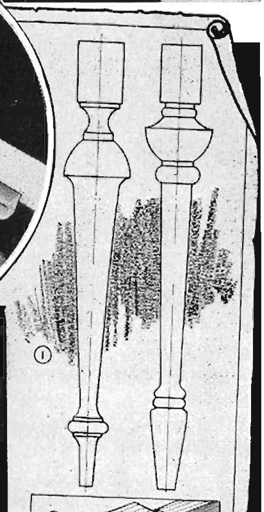
Post Blocking.—A spindle turning with a square section which is smaller than the diameter of the largest round section is described as having a reduced square. The two table legs shown in Fig. 1 are typical. In preparing the stock for turnings with reduced squares, two distinct methods can be used. The first of these consists in using stock large enough to accommodate the largest diameter of the turning. The reduced squares at either end or along any part of the turning are cut to the required size on the band saw, as shown in Fig. 2, or on the jointer, as in Fig. 3. The second method of working is known as "post blocking," and with careful workmanship and good glue results in a finished product almost as good as the solid stock turning while being less expensive. The first operation in post blocking calls for jointing the main body of the turning to a perfectly square section. Then, blocks of the same wood of sufficient size are glued to two sides of the square stock at the proper position. Notice, Fig. 4, that a slight projection is allowed so that the wood may be sanded or jointed to a perfectly flush joint. Fig. 6 shows the two remaining blocks glued into place.

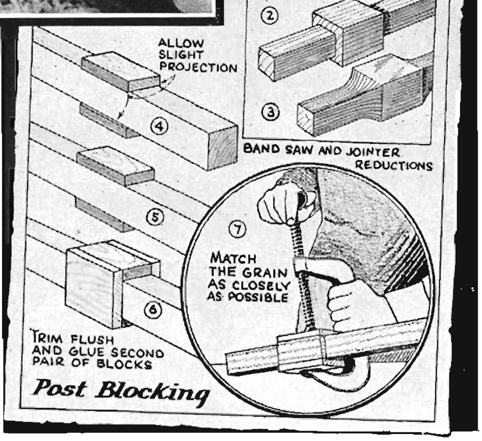
The blocked post is turned the same as any other spindle. The work should be reasonably well-centerd to avoid a lop-sided appearance. However, with perfectly matched wood the joints will be invisible. The photo example shown on this page makes use of contrasting woods in order to show the operation, but in actual practice the wood should be carefully matched for grain and color.



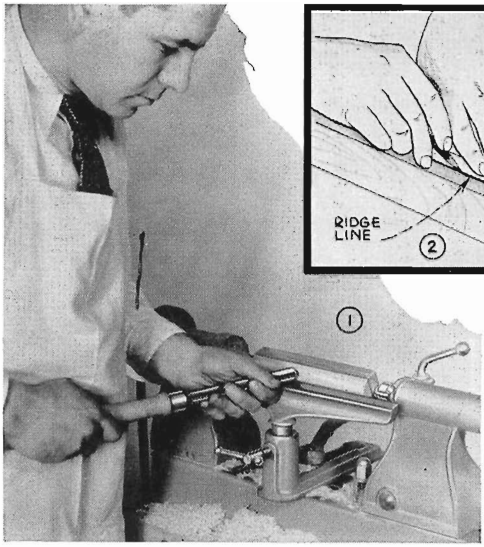


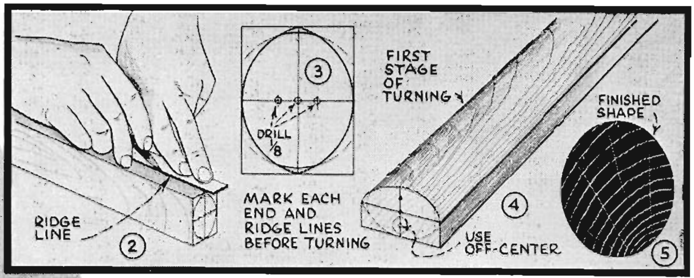




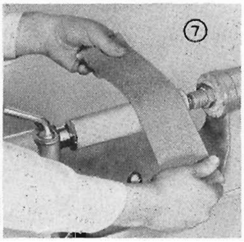


Oval Turnings.—This kind of turning can be made on the lathe by off-centering the piece to be turned. The stock from which the turning is to be made can be square or a suitable rectangular shape. The true center is located in the usual manner, after which the required off-center points can be located by experiment. A compass is used in marking





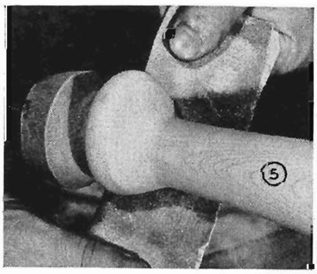
Above, laying out work for oval turning. Photos at left show operations in turning the work.

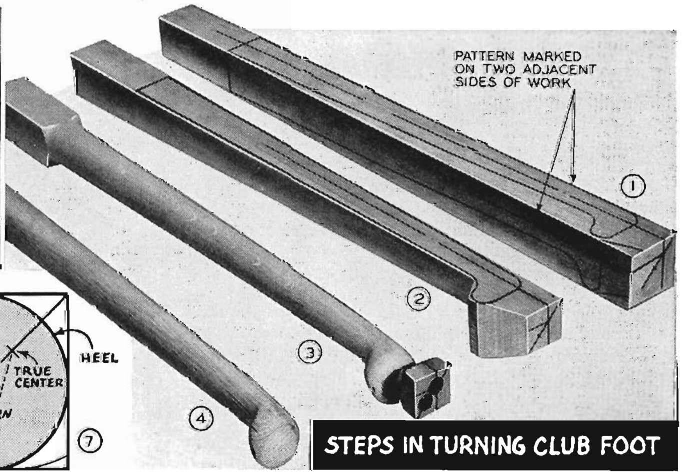


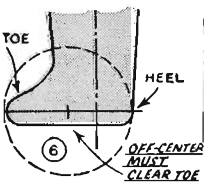
the end of the stock, as shown in the diagram above, the compass curves showing exactly how the finished work will shape up. The ends of the major axis of the ovals should be connected with a heavy pencil line, as shown in Fig. 2. This line is called the ridge line, and serves as a guide when making the turning.

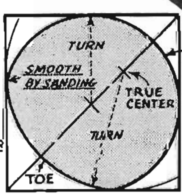
In making the turning, centering holes are drilled at the two off-centers and the true center at each end. The work is then placed in the lathe, using two corresponding off-centers as centers. Turn the lathe by hand to see that the revolving stock will not strike the tool rest. Use slow speed for the roughing cut and second speed to finish. The lathe should be stopped frequently to inspect the progress of the work. Cutting should continue until one side of the stock is rounded off exactly to the ridge line, as shown in Figs. 1 and 4. The work is now removed from the lathe and remounted, using the opposite pair of off-centers. Duplicating the same procedure as before, the work is turned down to the ridge line, as shown in Fig. 6. The stock is finally mounted on the true centers and the sharp points cut away. A further approximation of a true ellipse is obtained by sanding while the lathe is running with the stock on true centers. The same procedure is followed in turning tapered ovals, such as screwdriver and hammer handles. The work is first mounted on true centers and turned to shape. Ridge lines are then marked, after which the work is off-centered and turned to the ridge line as before.

The Club Foot.—This style of turning is started by making a paper pattern, which is used to mark the shape on two adjacent sides of the work, as shown in Fig. 1 at bottom



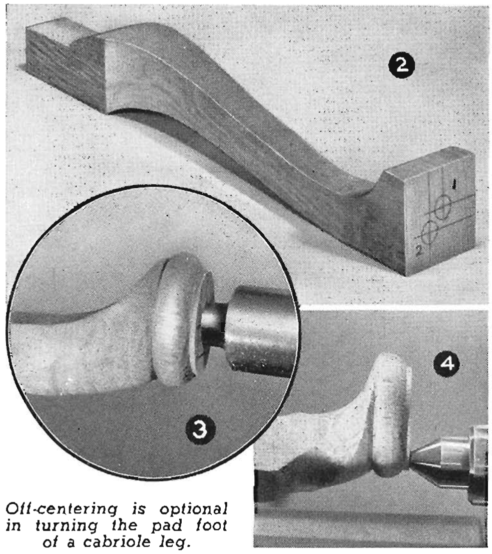




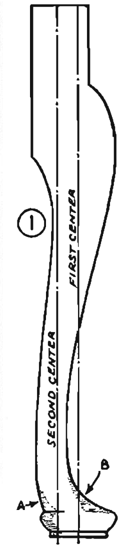


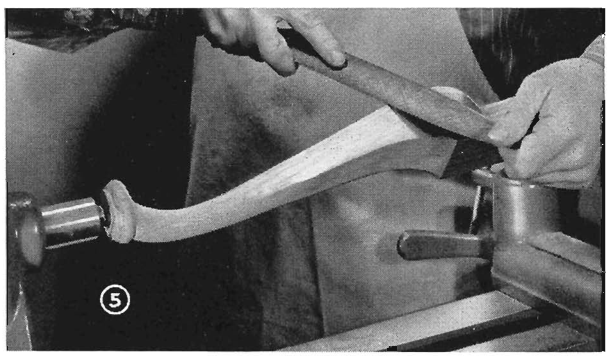
of opposite page. The true center is marked on each end of the work. Off-centering is done at tailstock end only, as can be seen in the photos. As in oval turning, experimenting with a compass will show the centers needed for any desired shape. Note, Fig. 6, that toe of work must be in the clear when the work is in the off-center position.

Getting back to the work itself, Fig. 2 shows the waste wood removed by compound band sawing. This saves a lot of rough wood turning. The leg is then mounted on true centers and turned to shape, which includes the full length and covers the front or toe portion of the club foot. The work is now off-centered at tailstock end only, and the heel portion of the club foot is turned, stopping the lathe frequently for inspection. Second low speed should be used for this operation. When turning is complete, there will be a sharp ridge line where the two circular arcs meet. This is softened with a few file strokes, after which the work can be run at low speed and sanded smooth, as shown in Fig. 5.



Off-centering is optional in turning the pad foot of a cabriole leg.



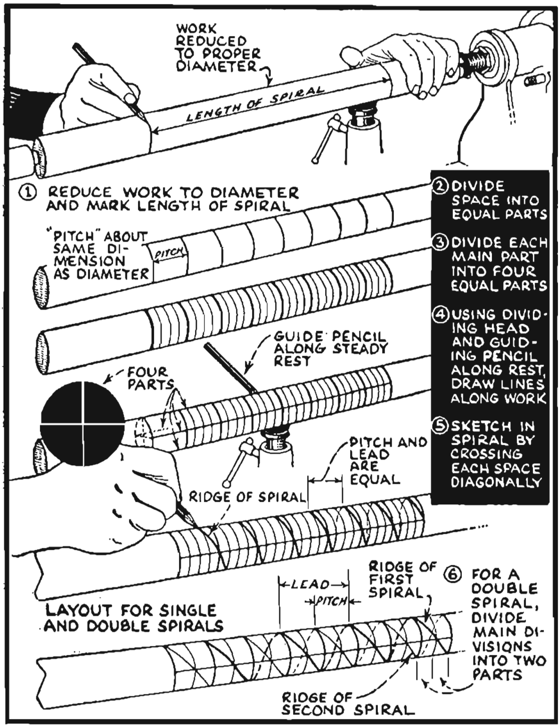


The Cabriole Leg.—Turning the foot of the cabriole or Queen Anne leg has the advantage of uniformity not easily obtained by hand carving. The work is similar to the club foot previously described, except that off-centering is optional. The foot itself is circular, and is usually referred to as a pad foot, especially if the extremity is a circular pad, as shown in the photos and drawing. In making the leg, the profile shape is laid out on two adjacent sides of the work. The center of the foot is marked across both ends of the wood, and is the No. 1 center. A second centerline is marked at the extreme heel of the fillet at the bottom of the foot, as can be seen in Fig. 1. Fig. 2 shows the work after it has been compound band sawed.

The work is mounted in the lathe on the No. 1 centerline. The fillet and toe portion are then turned, running the cut a short distance along the internal corner, as at A, Fig. 1. The turner should watch the cut closely, as it is very easy to remove too much wood. Fig. 3 shows the work at this stage, with pad foot fully formed. If desired, turning can be discontinued at this point. However, if mounted on the second center, it is possible to clean up the external toe, as shown at B, Fig. 1, and in Fig. 4. The work must be stopped frequently for inspection to avoid over-cutting. Final modeling of the leg is a matter of handwork with a cabinet rasp and other files. The lathe serves as a convenient holding device, as shown in Fig. 5, but is not in operation.

Spiral Turnings. — These are not actually turned on the lathe, the lathe serving only to hold the work while the spiral portion of the turning is worked by hand. The most common type is the single twist or single spiral. Like any screw thread, the pitch of the spiral is the distance from center to center of consecutive ridges. The lead is the distance advanced in one revolution. In the single spiral, the pitch and lead are equal. A double spiral has two ridges advancing along the cylinder. The pitch is the same as the single spiral, but the lead or distance traveled is twice as great. In a triple spiral, three ridges wind around the cylinder and the lead is three times as great as the pitch.

To lay out a single spiral, turn the wood stock to a cylinder of the required size, and on it mark the extremities of the intended spiral, as shown in Fig. 1 on following page. Select a suitable pitch. This is most pleasing if about the same dimension or a little less than the diameter of the work. The exact dimension is somewhat decided by the length of the spiral, since the length must be

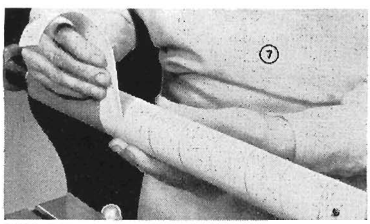


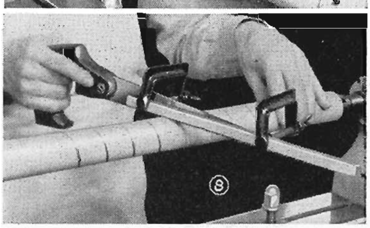
divided into a number of equal spaces, each space representing the pitch of the spiral, as shown in Fig. 2. Each of these main divisions is again divided into four smaller parts, as shown in Fig. 3. Next, the dividing head is set to quarter the stock, and four horizontal lines are drawn on the work, using the edge of the tool rest as a guide, as shown in Fig. 4. The ridge of the spiral can then be sketched in by drawing a line diagonally across each of the spaces, as shown in Fig. 5. The distance between threads or ridges (pitch) is the same as the distance the thread or ridge advances in one revolution (lead).

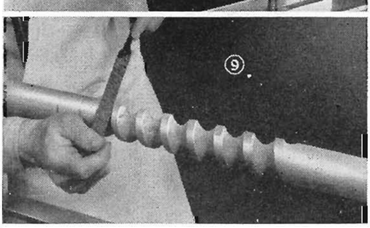
In laying out a double spiral, each main division is divided into two parts instead of four parts. A diagonal line is then drawn as before to give one ridge of the double spiral. The second spiral is started directly opposite the first. The distance between ridges remains the same, but the distance each ridge travels in one revolution is twice the pitch.

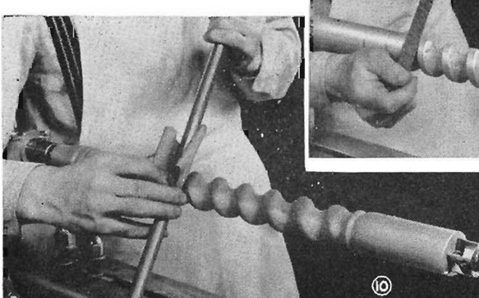
Besides the ridge line, other lines can be drawn, preferably in colored pencil, to mark the bottom of the groove, the limits of the true groove portion, etc. The same result can be obtained in a simpler manner by wrapping a strip of paper spirally around the turning, as shown in Fig. 7, marking between the edges of the strip to arrive at the ridge line. A double spiral laid out in this manner would require two strips of paper.

The actual work of turning is started by sawing a spiral cut accurately between the ridge lines, as shown in Fig. 8. A stop block should be clamped to the saw to set the depth of cut. After the saw cut has been made, a wood rasp is used to rough out the hollow of the spiral, the saw cut serving as a guide and depth indicator. The lathe, of course, is not under power. After a uniform groove is formed, Fig. 9, the edges are rounded over to the ridge line. The lathe can then be run at low speed, chasing up the spiral with sandpaper, as shown in Fig. 10. The tedious work of fashioning the spiral by hand can be largely eliminated by using the moulding head on the circular saw to make the main cove cut. This operation is described in the book on the circular saw and jointer. After cutting the cove with the moulding head, it is relatively simple to round the corners by rasping and sandpapering.

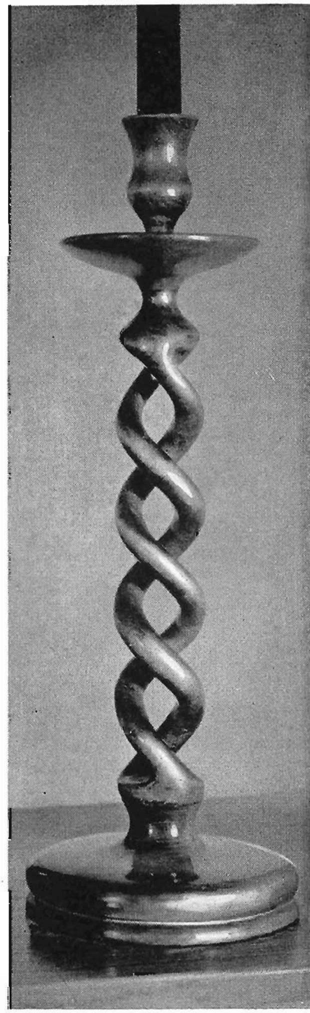








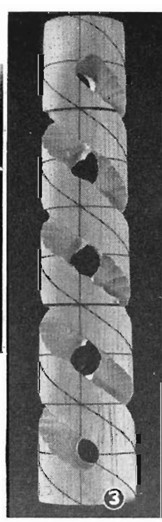
Taper Spirals.—The layout method previously described applies to straight cylindrical work. Sometimes the spiral is a straight taper and in this case the layout varies a little. The general idea is to make the pitch equal to the diameter of the work throughout the turning. Start by measuring the diameter at the large end of work. Lay off this distance along the turning to mark the first main division. Then measure the work diameter at this point and lay off this shorter distance for the second main division. Continue in the same manner to the small end of work—the result will be that main divisions representing the pitch will decrease in proportion to the diameter of the work. Other operations in marking and working the taper spiral are the same as for straight work.

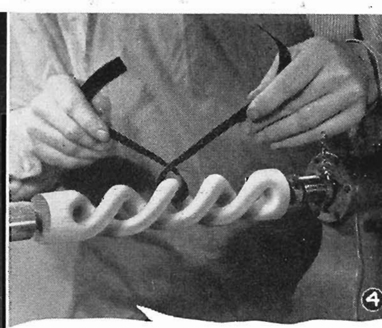


Hollow Spirals.—Hollow spirals are made with double, triple and quadruple twists. It is not practical to use a single twist because the piece would not be symmetrical. The photo at right shows a double twist, which is the simplest as well as the most attractive form. The work is laid out in the usual manner, setting off the lead and dividing into four equal parts, or, setting off the pitch and dividing into two parts. The ridge line and a line between ridge line are marked on the turned piece of work, as shown in Fig. 1. The in-between-line, which normally represents the bottom of the groove, is used as a drilling line, as shown in Fig. 2. A vee-block must be used for this operation in order to insure accuracy. Fig. 3 shows the work completely drilled. The holes go straight through the turning, but are best drilled half and half from either side to avoid splintering and possible complications. A mortising chisel can be used for the hollowing operation, this being especially advantageous on shapes where the twists are left more or less flat.

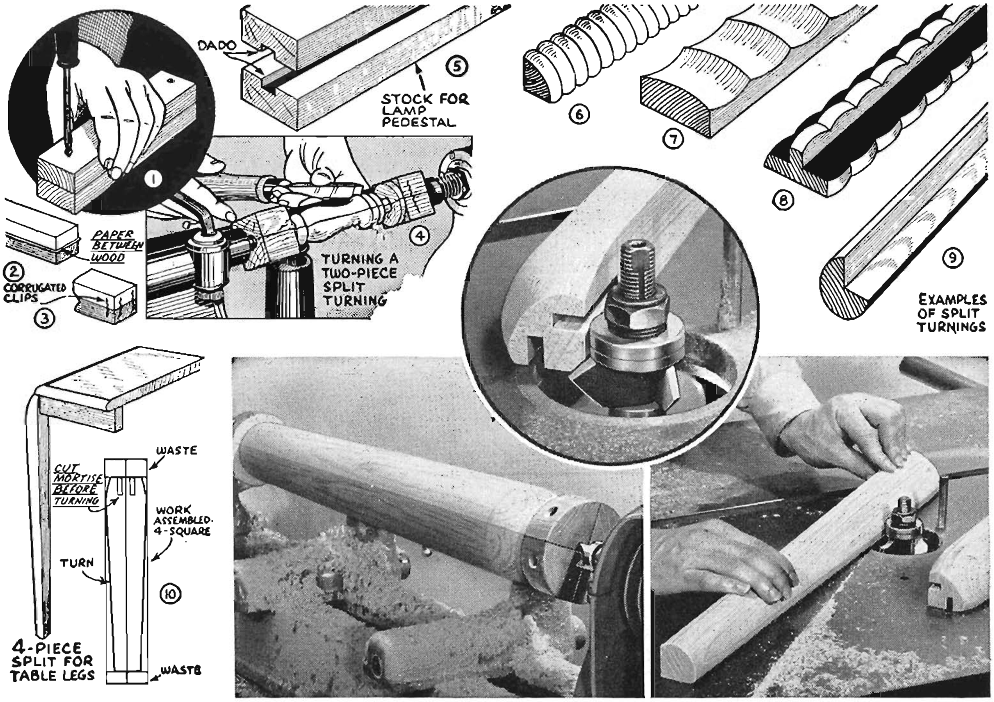
Finishing work on the piece is done with an assortment of files and sandpaper, as shown in Fig. 4. The lathe is not in operation, but is used merely as a holding device. Needless to say, a goodly amount of patience and skill are required for neat work. Wood used should be tough, hard and free from splintering: mahogany, walnut, maple, beech, lemonwood, etc. The candlestick is in maple; job set-ups were run off in white pine for easier working. The top and bottom of candlestick are separate faceplate turnings, assembled to the spiral with dowel pins.

Split Turnings.—Split turnings are made by turning up a full round spindle and then splitting into half or quarter sections. The half or two-piece split is the most common, and is usually worked by screwing or gluing two pieces of wood together, as shown in Figs. 1, 2 and 3 on following page. If glue is used, a glazed or slick paper should be used at the joint; this will hold for the turning but allow splitting





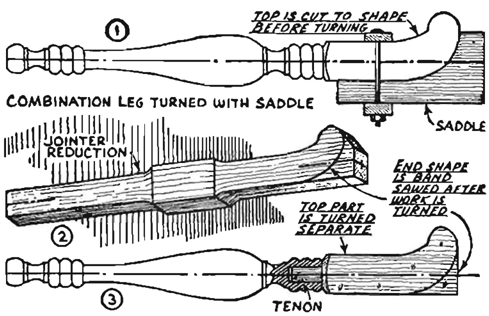
Hollow spirals are made with two or more twists in order to be symmetrical. Example shown is double twist and is laid out in same manner as solid work. A series of drilled or mortised holes roughs the work to shape, after which the twists are finished by filing and sandpapering.

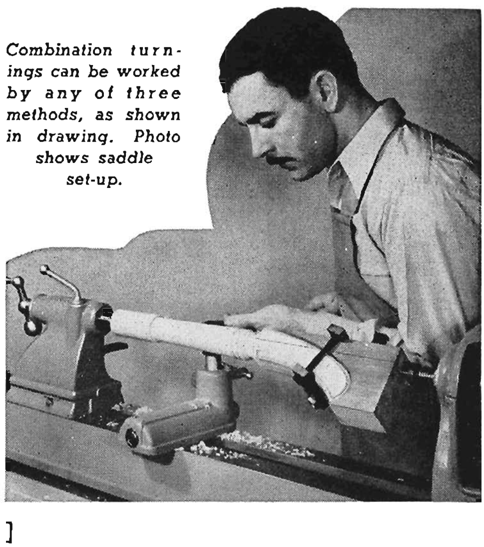


apart after the work is complete. Sometimes the two-piece assembly is used for permanent work, such as the stem of a lamp, Fig. 5, where the split construction is necessary to permit running in the wiring groove.

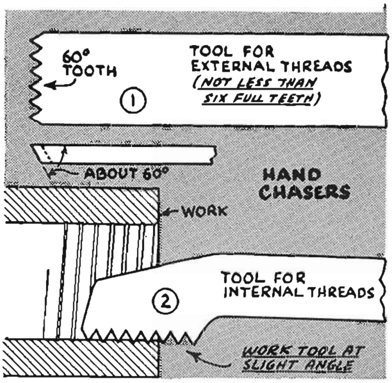
Attractive mouldings, as shown in Figs. 6 to 9, can be made by using the split turning method. The quarter-round mould, Fig. 6, is usually assembled four-square and then turned; other examples are worked in the solid and then sawed apart to the desired shape. The four-piece split can be used to advantage in making quarter-round table legs. Fig. 10 shows a typical job; left photo above shows the work turned to shape. Other photos above show the edges of leg being rounded on shaper, and bevel cut on back for table brace.

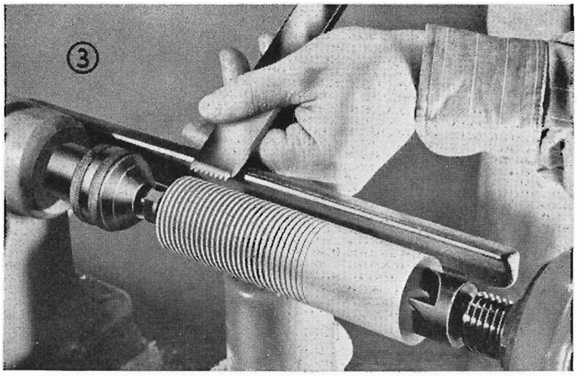
Combination Turnings. — Legs for stools, chairs and other pieces of furniture often have one end turned while the opposite end is a curved square section. A typical example is shown in drawings and photo at right. Three methods can be used for combination work of this kind, the selection of method depending on the shape of the work and amount of waste involved in cutting. In one method, the square top section is worked first, and the leg is then mounted for turning by using a saddle, as shown in Fig. 1 and photo. A second method is pictured in Fig. 2, with the top partly formed previous to turning. The third method is to treat the work as two separate turnings, making an assembly by means of a tenon turned on one of the members, as shown in Fig. 3.



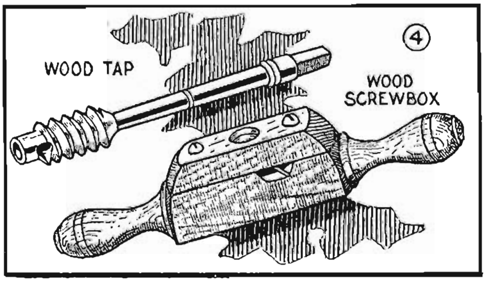


Combination turnings can be worked by any of three methods, as shown in drawing. Photo shows saddle set-up.





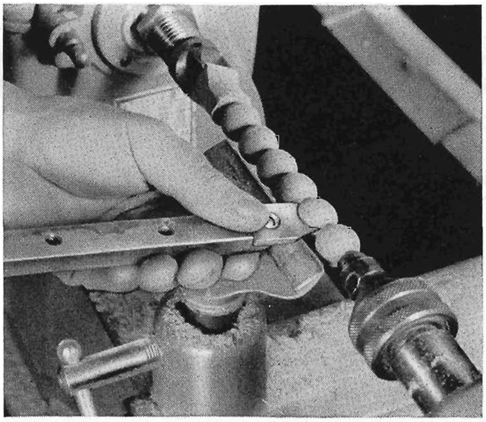
Hand chasing of threads in wood is not difficult although screw boxes, below, are better for occasional work.



Thread Chasing.—Sometimes it is necessary to cut a thread on a wood spindle. Work of this kind is best done on a regular screw-cutting lathe with a suitable tool, or, with the use of hand screw boxes and taps, Fig. 4. The job can also be done by hand chasing on the lathe, a method formerly used for practically all commercial brass work. The general idea is shown in Fig. 3, the tool being moved along at a uniform rate while the work is turning at slow speed. Offhand, this might appear to be a difficult if not impossible job, but it is actually quite simple. The tool movement is simplified by the fact that when it is moving at the proper rate, the work seems to stand still. The job starts with a light spiral cut, which is gradually deepened to produce the full thread shape. Once the cut is tracking properly, it is simple to engage the chasing tool in the grooves and extend the thread.

Thread chasing tools are shown in Figs. 1 and 2. The material should be good tool steel, 3/16 to ¼ inch thick. A front clearance angle of about 30 degrees is satisfactory for hardwood or soft metals. Both tools should have at least 10 degrees side clearance on the leading edge of each tooth. Smoothest cutting is obtained if the tool is used with a fair amount of negative rake, that is, the tool handle is held high, as shown in Fig. 3. Thread chasing is impractical in soft woods and should be attempted only on plastics, soft metals and hard woods, the latter preferably close-grain, such as rock maple. One pitch of threading tool can be used on any diameter of work; eight threads per inch is satisfactory for most jobs.

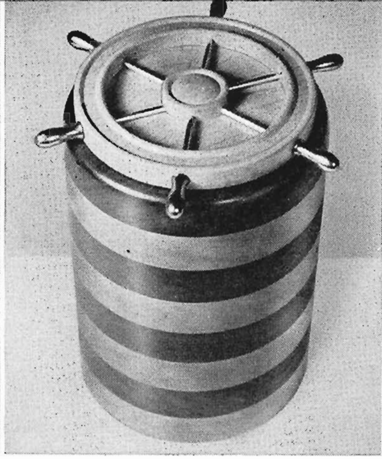
Spool Turnings.—A spool turning gets its name from the fact it is shaped like a series of spools placed end to end. The term is often applied to any turning showing a repeat motif. Work of this kind requires a fair degree of accuracy in maintaining the design motif exactly the same size and shape throughout. This is particularly true of continuous beads. Special chisels ground to the required shape are helpful in work of this kind, as shown in photo at right. The special chisel should not be used for roughing cuts unless the total wood removal is light—rough turn with other chisels and use the special shape only for the final cut.



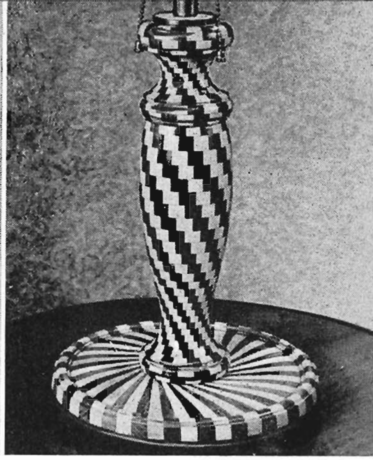
Spool and continuous bead shapes are accurately turned with the use of a special chisel ground to shape.

Fluting and Reeding. — Turnings having flutes or reeds cut lengthwise of the spindle are a product of the lathe insofar as the general shape is concerned, but the fluting itself is best done on the shaper with use of fluting jig. Methods of working the job directly in the lathe are described on page 38. The recommended shaper method is described in shaper instruction book.

Laminated . . . SIDE STACK

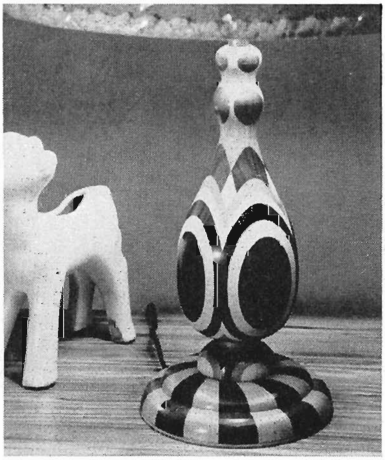


Laminated . . . SANDWICH

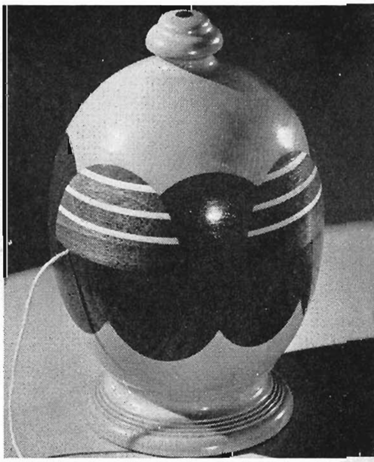


Segments . . . SOLID FORM

Segments . . . HOLLOW RING



Post Blocked . . . FOUR-SQUARE



Post Blocked . . . EIGHT-SQUARE

BUILT-UP TURNINGS

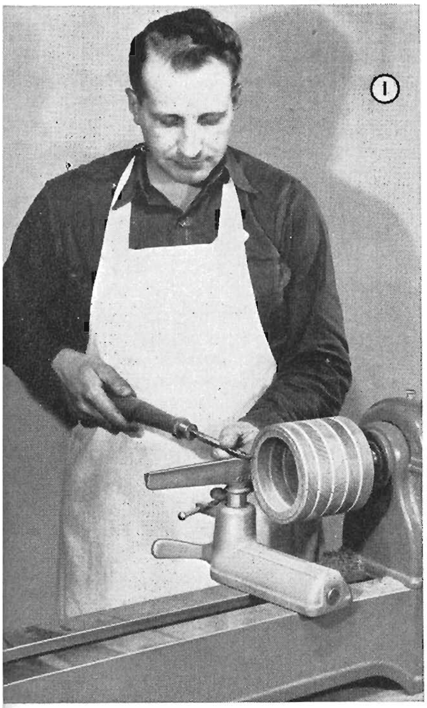
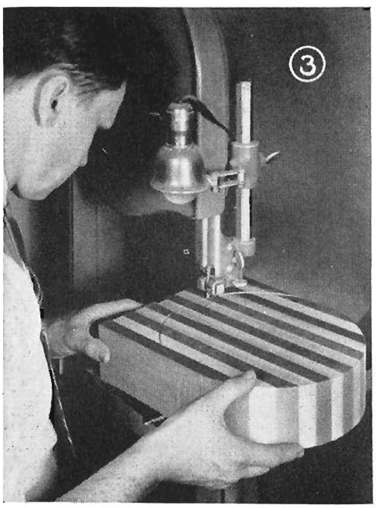


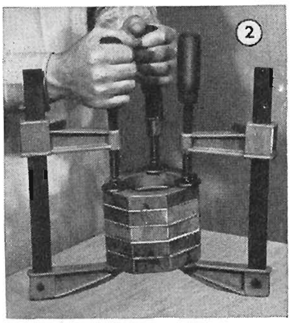
Photo above shows laminated work being turned to shape. Below, rough sawing a side stack to shape.



BUILT-UP turnings consist of lathe projects fashioned from several or more pieces of wood glued together in a definite pattern. There are three general classes of work: (1) Laminated, (2) Post Blocked, (3) Segments. Examples of each are shown in the photos on opposite page. Work of this kind demands perfectly seasoned wood and perfect glue joints—a good piece of built-up turning will last a lifetime while poor work will open at the joints after a few seasons of climatic changes.

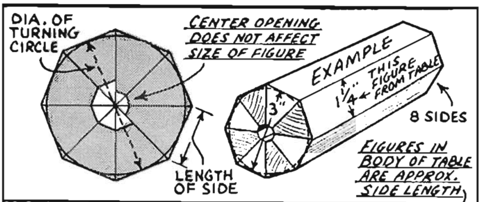
Selection of Wood.—Wood should be selected for color and hardness. The table below lists several typical woods graded in order from lightest to darkest. Two-color pattern effects are based on a white wood, such as holly or maple, combined with a dark wood like mahogany or walnut. The woods used should be about the same hardness; at any rate, extremes of hard and soft should be avoided because such combinations will often turn out-of-round or develop flats when sanded. Stability or freedom from warping is worth consideration, although practically any wood seasoned to 7 or 8 percent moisture content will be stable if kept indoors.

Laminations.—This is the simplest type of built-up work and consists of several layers of wood glued surface-to-surface. If the finished project shows the various layers one over the other, the combination is called *sandwich* or *bread-and-butter* construction; if the layers are side by side, the construction is a *side stack*. The assembly of the work is simple and requires only that the joining surfaces be perfectly flat. It is usually desirable in sandwich construction to break the grain,



WOODS FOR BUILT-UP TURNINGS

	WOOD	COLOR	HARDNESS	STABILITY
LIGHT	HOLLY	Very White	Medium	Good
	MAPLE	White	Hard	Good
	PRIMA VERA	Cream	Soft	Good
	BIRCH	White to Pink	Medium	Good
MEDIUM	RED GUM	Red-Brown	Soft	Fair
	BUTTERNUT	Amber Brown	Soft	Excellent
	CHERRY	Red	Medium	Good
	MAHOGANY	Red-Brown	Medium	Excellent
DARK	WALNUT	Brown	Medium	Excellent
	PADAUK	Red	Hard	Good
	PURPLEHEART	Purple	Hard	Good
	ROSEWOOD (E.I.)	Dark Purple	Hard	Good



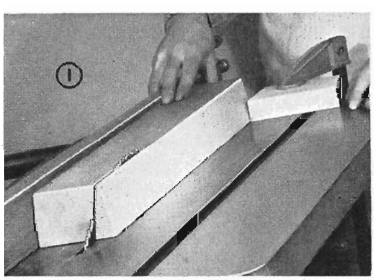
DIA. OF TURNING CIRCLE	NUMBER OF SIDES								
	8	10	12	14	16	18	20	24	30
2	27/32	21/32	17/32	15/32	13/32	3/8	5/16	9/32	7/32
2½	1 1/16	13/16	11/16	19/32	1/2	15/32	13/32	11/32	9/32
3	1 1/4	1	13/16	11/16	19/32	17/32	1/2	13/32	5/16
3½	1 15/32	1 5/32	15/16	13/16	23/32	5/8	9/16	15/32	3/8
4	1 21/32	1 5/16	1 3/32	15/16	13/16	23/32	21/32	17/32	7/16
4½	1 7/8	1 15/32	1 7/32	1 1/32	29/32	13/16	23/32	19/32	1/2
5	2 3/32	1 5/8	1 11/32	1 5/32	1	29/32	13/16	21/32	17/32
6	2 1/2	1 15/16	1 5/8	1 3/8	1 7/32	1 1/16	31/32	25/32	21/32
7	2 29/32	2 9/32	1 7/8	1 19/32	1 13/32	1 1/4	1 1/8	15/16	3/4
8	3 5/16	2 5/8	2 5/32	1 27/32	1 19/32	1 7/16	1 5/16	1 1/16	27/32
9	3 3/4	2 15/16	2 7/16	2 1/16	1 13/16	1 19/32	1 7/16	1 3/16	31/32
10	4 5/32	3 1/4	2 11/16	2 9/32	2	1 25/32	1 19/32	1 5/16	1 1/16
12	5	3 29/32	3 7/32	2 3/4	2 13/32	2 1/8	1 29/32	1 19/32	1 9/32
14	5 13/16	4 9/16	3 3/4	3 7/32	2 25/32	2 15/32	2 7/32	1 27/32	1 1/2
16	6 5/8	5 7/32	4 9/32	3 21/32	3 3/16	2 27/32	2 17/32	2 1/8	1 11/16

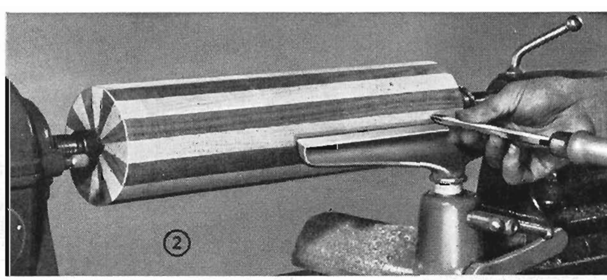
Table above shows side length for any size regular polygon. Photos below show operations in making a solid segment form from bevel-ripped strips.

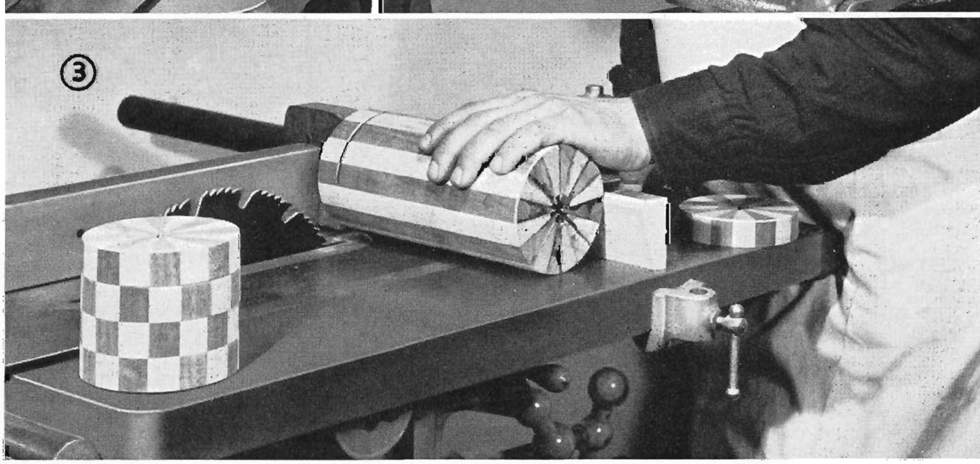
placing the grain of each layer at right angles to the piece below it. Turning effort is saved if the various rings are roughly band sawed to shape before gluing. Fig. 2 on previous page shows a job being glued up; Fig. 1 shows the same assembly being turned to shape; Fig. 3 shows a side stack being band sawed to shape previous to turning. It is not practical to break the grain in a side stack, but a similar anti-warp protection is obtained by alternating the heart side.

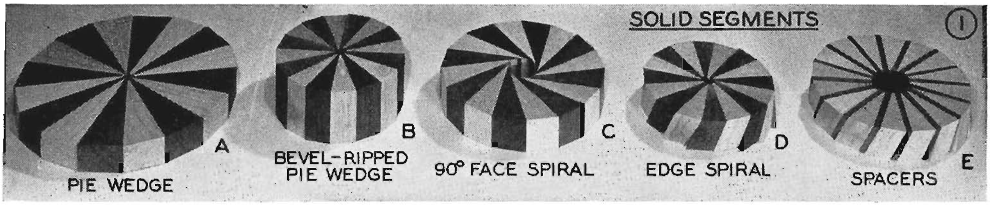
Solid Segment Form.—This assembly is a solid and is used for lamp bases, box lids and bowl bottoms. The form can also be re-glued for various checkerboard effects, a typical example being the stepped checkerboard pattern shown in one of the lamp designs. Although this appears complicated, it is simply a matter of ripping wedges, Fig. 1, gluing together and turning, Fig. 2, and finally slicing into the solid segment form, Fig. 3, which is then built-up in checkerboard form. The secondary build-up can be turned to any desired shape without affecting the pattern.

The table on this page gives useful data in determining the size of wedges required for any particular figure. After finding the dimensions of the pieces required, the wedges are ripped or cross cut as desired, using the direct circular saw settings given in table on opposite page. Several forms of construction are shown in Fig. 1. The familiar pie-wedge, A, is made from a single length of wood, turning the board over on alternate cuts, as shown in Fig. 2. Segments cut in this



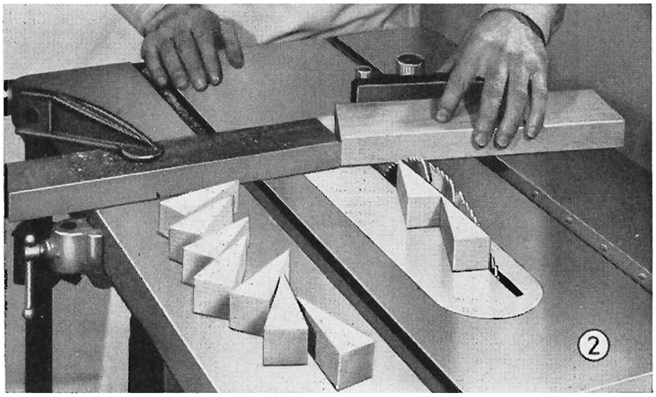






MITER AND TILT ANGLES

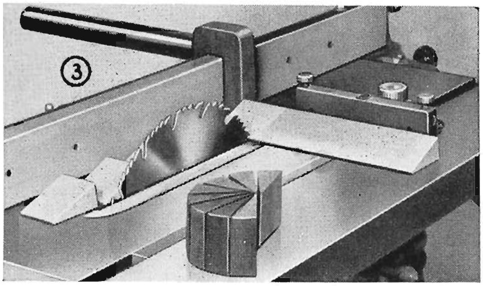
NUMBER OF SIDES	MITER SETTING	TILT SETTING
6	60	30
8	67.5	22.5
10	72	18
12	75	15
14	77.15	12.85
16	78.75	11.25
18	80	10
20	81	9
24	82.5	7.5
30	84	6

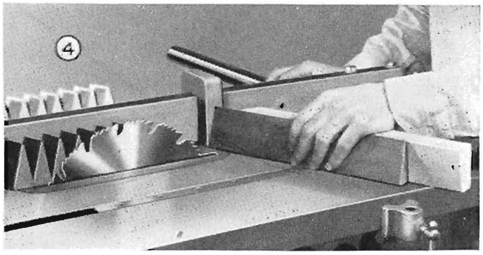


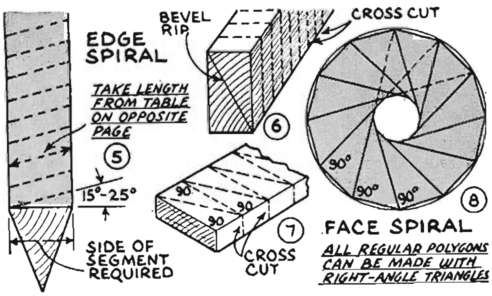
Common figures used in the solid segment form include the pie wedge, face spiral and edge spiral. The photos picture cutting operations in making the figures.

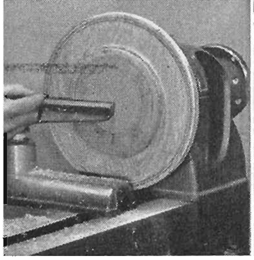
manner will show the grain running round-and-round. Bevel ripped segments, B, will show end grain on the face side of assembly; Fig. 3 shows these wedges being cross cut from a single bevel ripped piece. The face spiral, C, is built-up from right-angle triangles, as shown in Fig. 8, which can be cut by either of the methods shown in Figs. 6 and 7. The edge spiral, D, is made by angling the cross cuts on a beveled strip, as shown in Fig. 4. The angle cut can be anything between 15 and 25 degrees (75 to 65 degrees direct miter gage setting). The narrow edge of the beveled strip is flat against the saw table, being supported in this position by a suitable wedge-shape piece fastened to the miter gage. A little experimenting with a drawing like Fig. 5 will give the side of the beveled strip required for any size figure: it can be seen that the beveled strip should be a little narrower than required for a straight pie assembly. Cutting angles, however, are the same as before, and are taken from the table on this page.

Sawing and Assembly.—A sharp planer blade must be used for all sawing in order to obtain smooth work ready for gluing. The assembly can be made with any kind of glue. A dry assembly should always be made to check the joints. Most work of this kind can be clamped after gluing with improvised column clamps or merely twine or rubber wrapped around the piece. Good use can be made of anchor pins or small brads in many of the assemblies. Any of the forms shown can be made up with thin spacers, as shown at E, Fig. 1, without affecting the cutting angles. It should be noted, however, that spacers increase the size of the work and diameter of center opening.

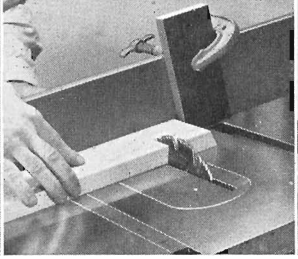




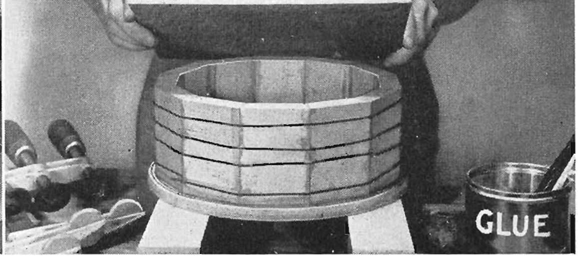




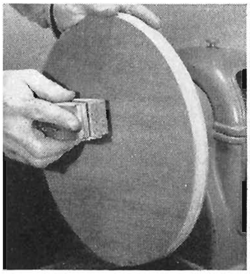
1 Fasten mounting plate on 3 in. faceplate and turn 10 in. diameter. Face off about 2 in. at outer edge and mark pencil circles as centering guides.



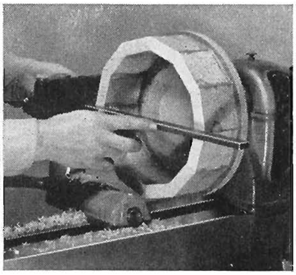
2 Rip $\frac{7}{8}$ in. stock, $3\frac{1}{4}$ in. wide by 30 in. long. Tilt table 15 degrees and crosscut 12 segments, $2\frac{1}{2}$ in. long, by alternately turning work face up and face down.



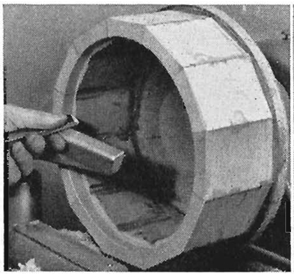
3 Glue the segments together and to the mounting plate. Use casein glue to permit time for adjusting the various pieces. Segments can be clamped by twisting soft bailing wire about the assembly. Clamps are used to clamp the assembled segments to the mounting plate. Circles on mounting plate serve as guides in centering the work.



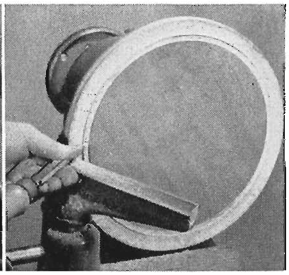
4 Mount bowl bottom on the 6 in. faceplate. Use screwed bottom for large work to eliminate cutting-off when work is finished (see drawing).



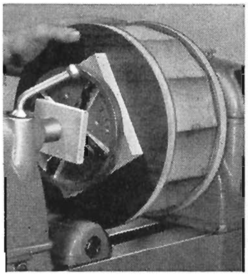
5 Remount side assembly. Face outer edge to take bottom, checking with a straight edge to make certain that the cut is square across the work.



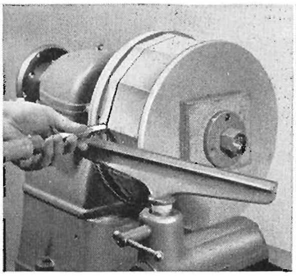
6 Turn recess for bottom, making cut to finished inside diameter and about $\frac{3}{4}$ in. deep. Use diamond point or skew chisel to make the recess for bottom.



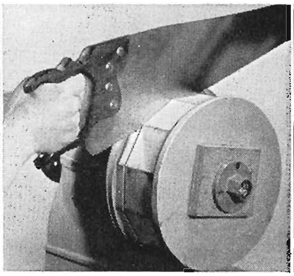
7 Remount bottom. Turn $\frac{1}{4}$ in. wide rim to make a snug fit in the recess cut in side assembly. Check frequently to insure good fitting at the joint.



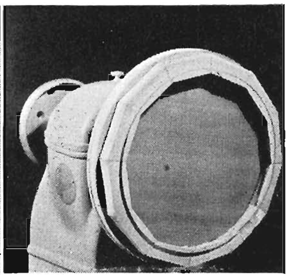
8 Glue the bottom to the sides. Clamp with tailstock and three clamps fitted around rim. Avoid getting any glue on finished surface of bottom.



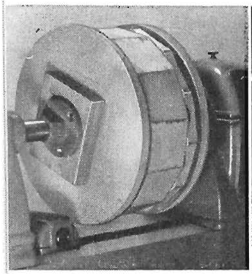
9 With parting tool, make a cut about $\frac{3}{4}$ inch from outer edge of bottom. Continue cutting until about three-quarters through work but do not cut free.



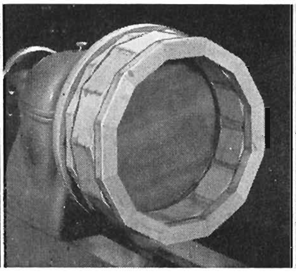
10 Finish cutting with a hand saw. The work is not under power. (Smaller projects can often be cut free with lathe chisels with work revolving at slow speed.)



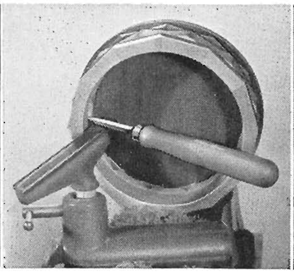
11 After cutting off, the work will look like this. Face off the edges of both parts to a true surface. Check with straight edge for accurate gluing surface.



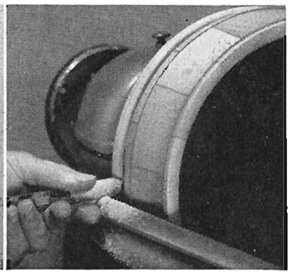
12 Glue the two parts together breaking the joints. When dry, cut off another section about $1\frac{1}{2}$ in. wide and reglue in the same manner.



13 This shows the finish glue-up of three side sections mounted on the bottom. The mounting plate has been cut off and discarded.

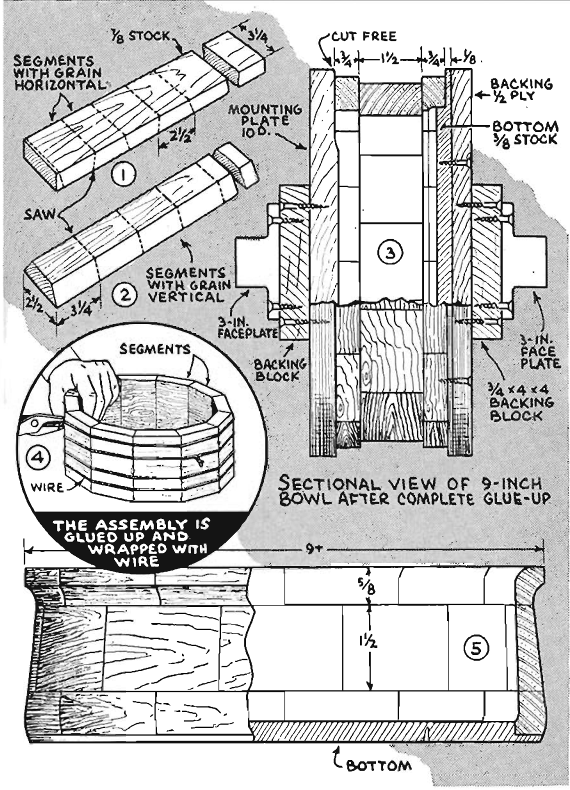


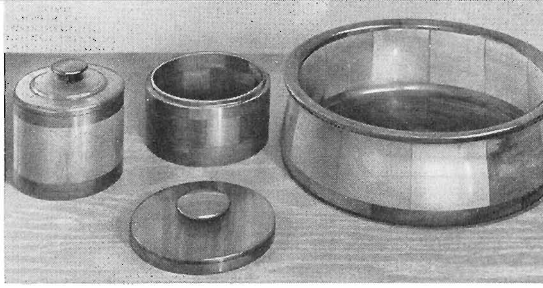
14 Turn the inside of the bowl to shape. Use the diamond point chisel, supporting the chisel by advancing the tool rest to a position inside the bowl.



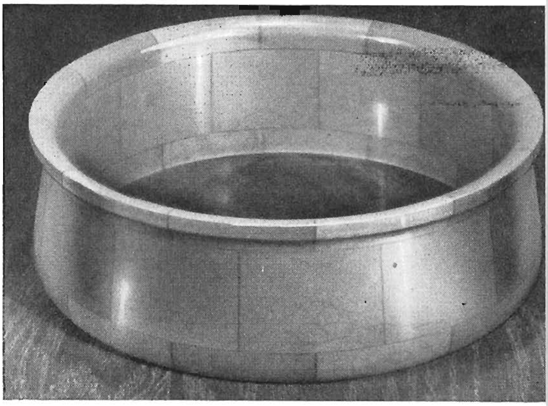
15 Turn the outside to shape. Finish sand with 5-0 paper. Apply wax or French polish finish before removing the work from the lathe.

ALL DIMENSIONS ARE FOR A 12-SIDED BOWL TO FINISH 9-INCH DIAMETER





• Box at left has cherry center and outer rings of walnut. Other box is walnut and red cedar. The bowl is myrtle and walnut with radial walnut bottom. Bowl below is apple with mahogany bottom.

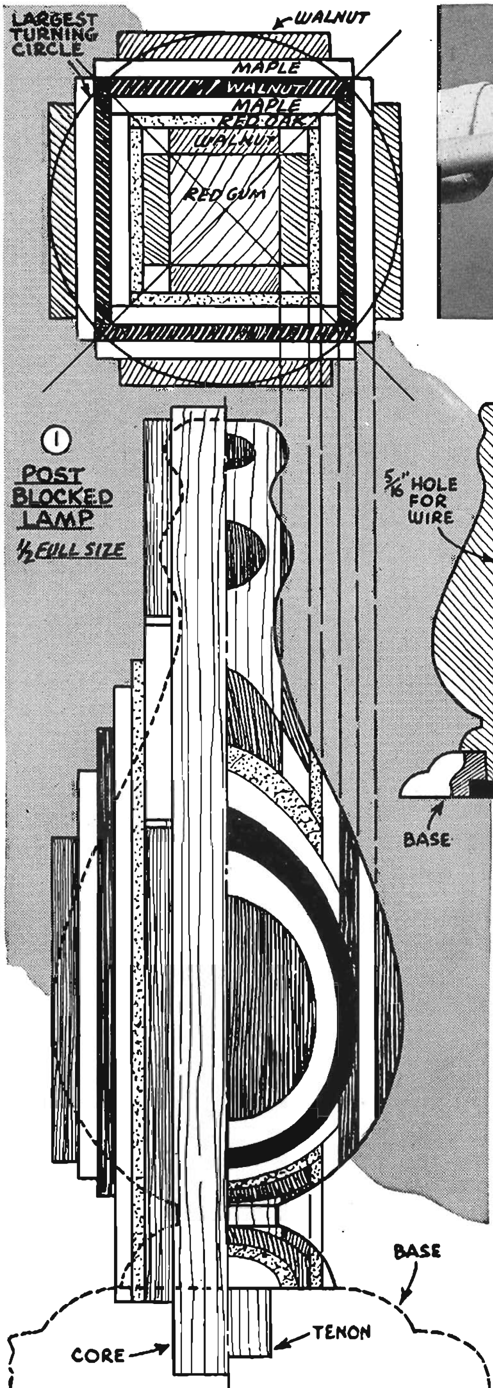


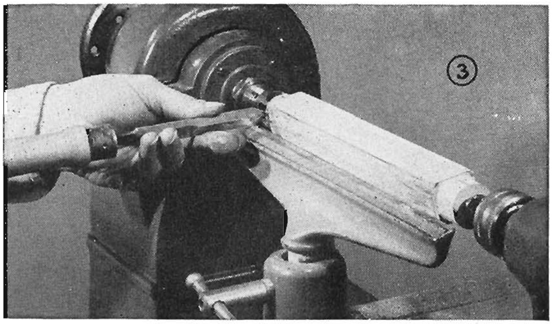
Segment Rings.—Certain projects such as bowls and boxes are worked to better advantage if the segment build-up is a hollow ring instead of the solid construction previously described. The length of side and cutting angles are the same as before since the ring segment is simply the outside portion of a full pie-shaped wedge. Segments can be cut with the grain horizontal or vertical, as shown in Figs. 1 and 2, selection depending on the nature of the project and color scheme.

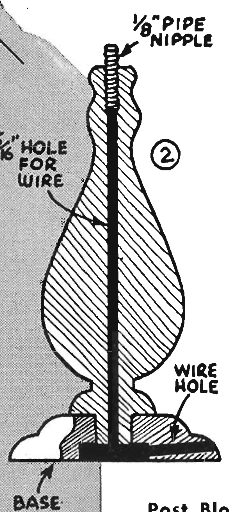
Monotone Bowl.—A bowl built-up from one kind of wood makes a good starting project. This is shown in the photo above, and job operations are pictured on the opposite page. Specifications are 9 in. diameter, twelve sides. From the table on page 26, it can be seen that the side length should be about 2-7/16 in. long. Call this an even 2½ in., and cut twelve segments from a 30 in. length of ⅞ in. stock, as shown in Fig. 1 above, also in Operation 2 on opposite page. Glue the segments together with any kind of slow-setting glue, wrapping the assembly with soft bailing wire, as shown in Fig. 4. Introduce wedges under the wires to tighten, and be sure that the assembly is true and clean at all joints. Needless to say, the very heart of all built-up work is perfection of joints and gluing. Best results are obtained by sawing the segments with a sharp hollow-ground blade. Always make a dry assembly to check the fit. Some workers prefer gluing the segments in pairs previous to the full assembly, although slow-setting glue normally provides plenty of time for making the whole assembly.

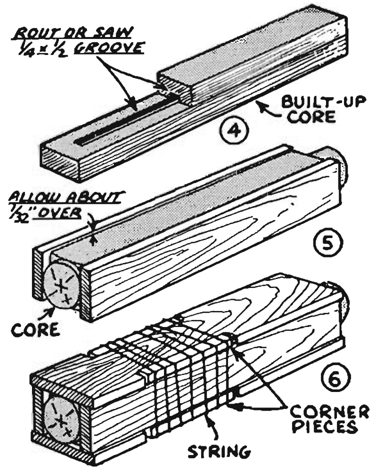
Operations in turning the job are covered by the photos and text on opposite page. Screwed backing blocks are used in order to simplify the work. On jobs where this is not practical, the joint between bowl bottom and backing piece can be made with glue, inserting a sheet of slick magazine paper at the joint to allow later separation. On small boxes the paper can be omitted, using a plain glue joint and cutting the whole thing free with parting tool. However, cutting off a 9-in. bowl is quite some job, hence the advisability of using either a paper glue joint or screws.

Pattern Effects.—The segment ring permits many different pattern effects, including all of the basic assemblies shown at top of page 27. A single ring is often worked with plain laminated rings at top and bottom. Checkerboard patterns are worked with two separate rings of different wood, the assembly and working being the same as the sample bowl described except the light and dark woods are alternated. If the grain is vertical, a pleasing striped pattern can be worked on the initial ring and requires no further treatment other than turning. Bottoms of bowls and bottoms and lids of boxes can be worked in any of the solid segment forms. Also, these parts can be simple laminations or can be veneered or inlaid as desired—indeed, there is no end to the many pattern effects possible by combining various working techniques. It should be noted, however, that too many woods and colors spoils the effect; the most pleasing designs are worked in two or three colors only.







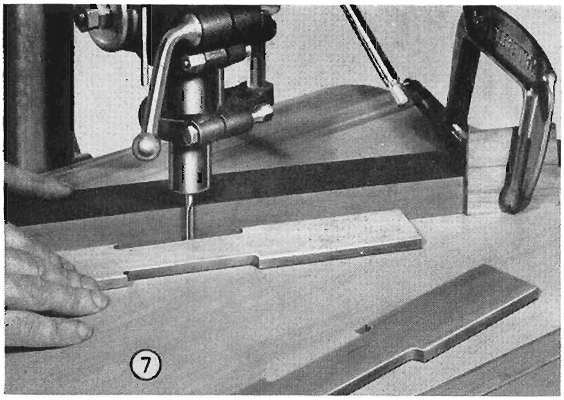


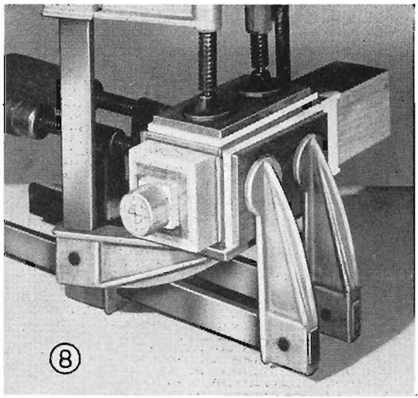
Lamp drawing above is typical of post blocked work. It is drawn ½ full-size and can be readily scaled if you care to make it. Fig. 2 shows how the wiring is run in. The base is a segment form. Photo at top shows how the core is centered, and drawings at right picture successive stages in the build-up.

Post Blocking.—This is an artistic form of conventional post blocking and differs from regular work only in that more pieces are used and the wood is selected for contrast instead of match. A typical project is shown in Fig. 1, and it should be apparent how the different side blocks shape up into a form of imitation inlay when the work is turned. The preparation of the core is the first step. This can be a solid block, or, if through drilling is required and drills are not available, can be glued up from two pieces previously grooved to within a short distance of the ends, as shown in Fig. 4. The solid end surface provides for lathe centering, and it is an easy matter to drill into the groove after the work is complete.

The core should be carefully centered in the lathe, after which a test cut should be run in with parting tool at either end, as shown in Fig. 3. If the work shows out of center, the heavy sides should be dressed down—the finished piece will show a faulty, out-of-balance design if the core is not perfectly centered. Witness marks should be used on the driven end of work so that it can be returned to the same position on spur center for each of the various turning operations.

Fig. 5 shows the first pair of blocks applied. They should overhang the core slightly to permit exact flush dressing. Any kind of glue

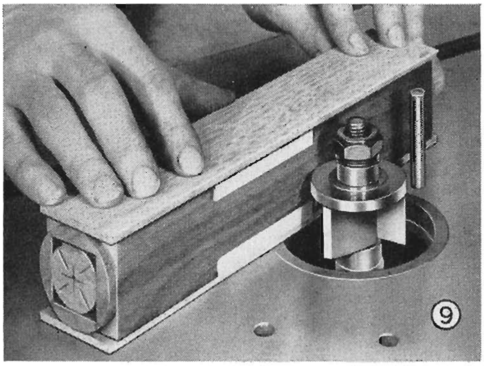


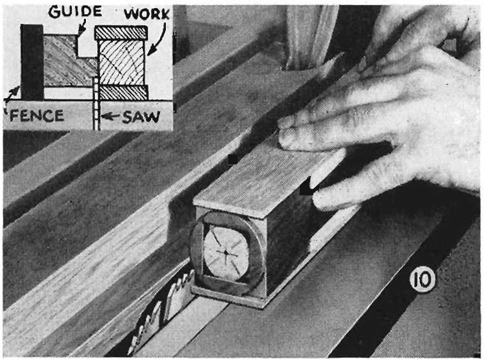


Above, inletting the first course of blocks for corner figure. Photo at right shows complete build-up.

can be used. A sufficient number of clamps should be used to assure good contact. After the glue has dried, the overhangs are dressed flush with the core, and the second pair of blocks are applied, as shown in Fig. 6. In this particular design, these blocks are inletted to take the small squares of maple which make the corner diamond figure. This operation is done by routing, as shown in Fig. 7. The maple squares can be tied in with string at the same time the second pair of blocks are applied, Fig. 6. An alternate method of working would be to glue the corner blocks into the cutouts before applying the pieces to the core. In any case, it is important that the inner edge of the small squares come exactly flush with the edge of core. The build-up proceeds in successive layers. On all central layers, only one set of blocks can be applied at a time; no attempt should be made to rush the work. The overlapping joints at corners are preferably broken all one way. The outer layers, which do not overlap, can be glued face to face at any time, and the double blocks can be fitted to all four faces in one gluing, as shown in Fig. 8. Throughout the build-up, small nails can be used to anchor the wood against slippage when clamp pressure is applied. Needless to say, the nails must be well inside the turning surface.

Dressing Overhangs. — The principal mechanical operation is dressing the overhanging edges of each layer. This can be done on the shaper, using a collar the same exact diameter as cutter, as shown in Fig. 9. A second method makes use of a flush guide on the circular saw, as shown in Fig. 10. The inset diagram shows how the work rides against the guide to set a perfectly flush cut of the overhanging edge. A planer blade must be used for smooth cutting. The set-up should be carefully made in order to obtain exact flush joints. As a further assurance of perfect fitting, the work should be rubbed on a sheet of 80-grit sandpaper over a level surface. It is also good practice to test the concentricity of work by making test turning

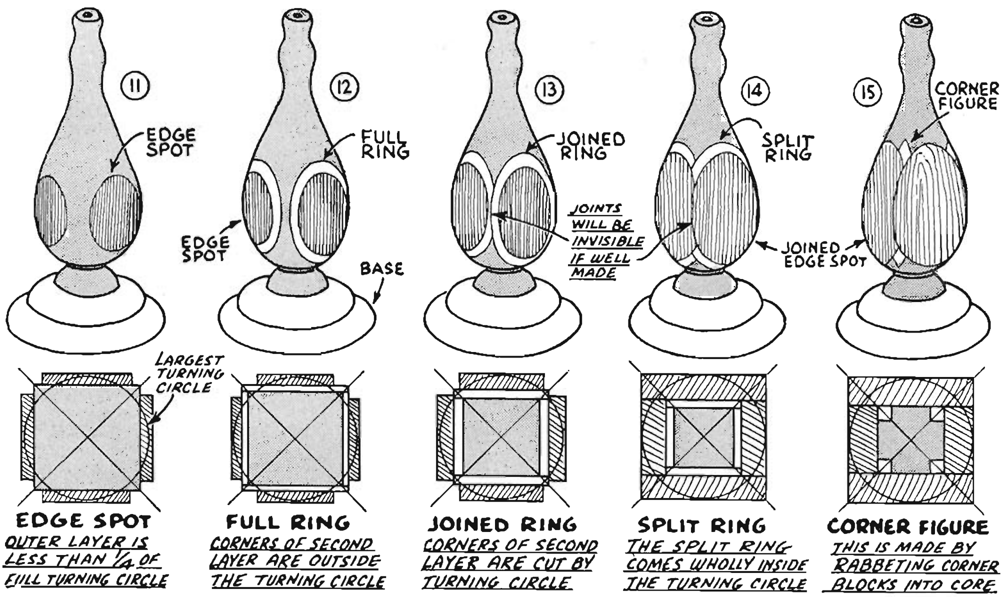




The important operation of dressing overhangs can be worked on either the shaper or circular saw.

cuts at the ends as previously described. Perfect joints and perfect balance are the two big "musts" if you want nice post blocked work.

Woods to Use.—Like all forms of built-up turned work, the woods used should be of approximately the same hardness to avoid developing flats. A great variety in color is unnecessary, in fact, too much color may spoil an otherwise good design. Maple and walnut comprise a good pair for light and dark, while cherry, gum or oak does for a third color. Joining surfaces of the same wood should be carefully matched for grain and color the same as for regular post block-

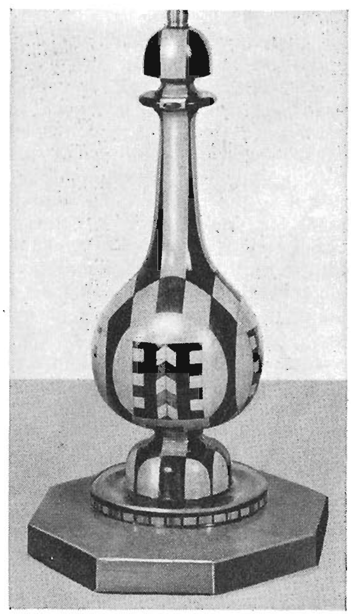


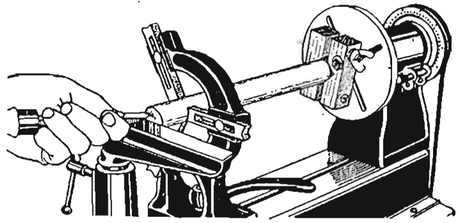
ing. If this is properly done, the joints which are not actually a part of the design will be practically invisible.

Basic Figures.—The five basic figures in post blocking are shown in Figs. 11 to 15. The nature of any figure depends on whether it comes inside or outside the largest turning circle on lines diagonally across the work, as shown in the cross sections. Variations of the basic figures are made by laminating the various layers previous to their assembly in the build-up. The upper photo at right, for example, shows an intricate lamination of the edge spots, and a plain side stack laminate for the joined rings. Variations are almost unlimited. However, super-intricate designs are generally less attractive than a bold design of basic figures. The work can be combined with regular inlay and inlay banding as desired. Bases of lamps and stands are usually some form of segment work.

Designing.—Designing your own built-up post blocked work is not difficult. An essential is that the work must have a predominating bulge at either top or bottom in order to reveal the pattern of the successive layers. Designing starts with an outline of the proposed turning. Above this should be drawn the largest square, the largest turning circle, and the diagonal lines from corner to corner, as shown in Fig. 1. The contour and plan are then sliced off layer by layer to form the basic figures. The height of any figures is easily obtained by running lines across from its side intersection; widths can be determined by making a cross section at the desired point. Generally, only the basic figures at the bulge need be worked out—the rest of the design comes as it will. Corner figures are usually best stopped off inside the turning, that is, they should show at the top of the bulge only. Likewise, some of the edge spots are best eliminated. The general idea is to avoid mere slivers of wood—the design should be positive or it should be eliminated.

Eight-side Blocking.—Six or eight side blocking is worked in about the same manner as four-side, but is obviously more work. The eight-side block is excellent for shallow forms, such as bowls and boxes. The larger diameters of work run to very thin blocking pieces which must be centered with great accuracy in order to keep the figure in balance.



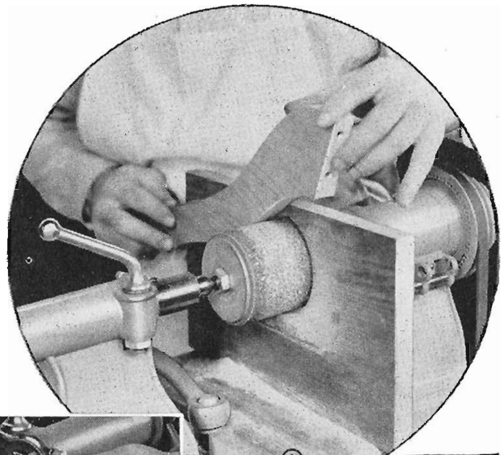


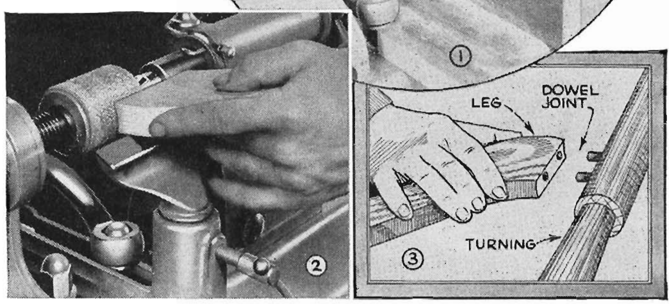
JIGS *and* ATTACHMENTS

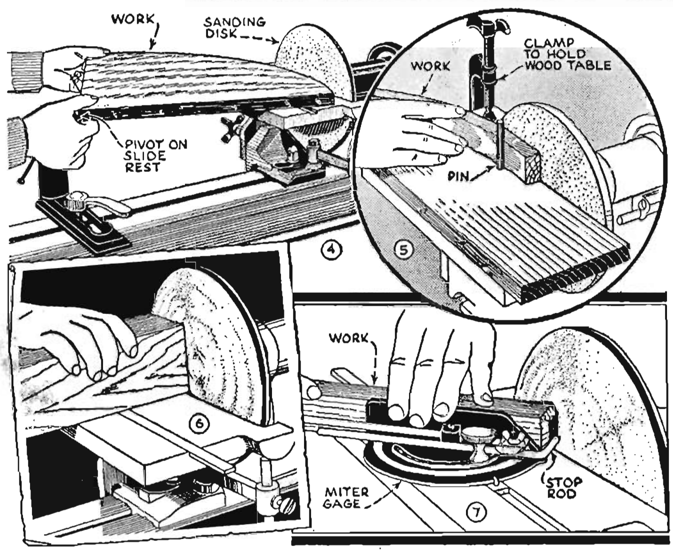
VARIOUS jigs and attachments add to the convenience and scope of operations done on the lathe. Certain attachments, such as sanding drums and steady rest, are indeed almost indispensable. A vast number of special purpose jigs have been worked out for the lathe, and a few of these are described in this chapter.

Sanding Drums.—Sanding drums can be obtained in various sizes, usually mounted on Morse shanks. In order to keep the drum securely mounted, it is always best to bring up the tailstock with plain or ball bearing center inserted, as shown in Fig. 1. Another good mounting for all free-end Morse shank fittings is a tie rod extending through the hollow headstock spindle with a wing nut at opposite end. Fig. 1 pictures a simple vertical support which is useful for holding a true edge. Fig. 2 shows a sanding drum being used to cut the curved surface of a table leg, Fig. 3.

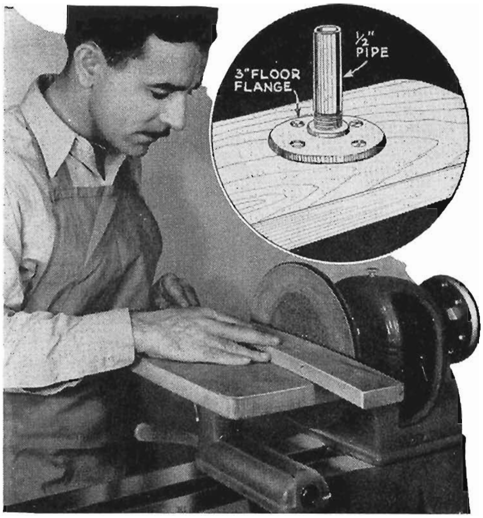
The Sanding Table. — The sanding table or sanding disk alone is used for a wide variety of finishing work in wood, metal and plastics. If your lathe does not have a sanding table, it is quite easy to make a table of wood. A good sanding disk can be made from a disk of soft wood permanently mounted on an extra 3 inch faceplate. A few of many operations done with the disk are shown in Figs. 4 to 7. Fig. 4 shows how circular curves can be sanded to a uniform radius by pivoting the work against the tool rest. The use of a pivot pin, as in band sawing circles, can also be used to advantage. Curved surfaces can be sanded to uniform width by first band sawing and smoothing one side, and then using a spacer pin, as shown in Fig. 5, to set the finish cut on the opposite side. Fig. 7 shows one of the many uses of the miter gage—beveling the edges of a piece of square stock. The gage sets the proper angle,



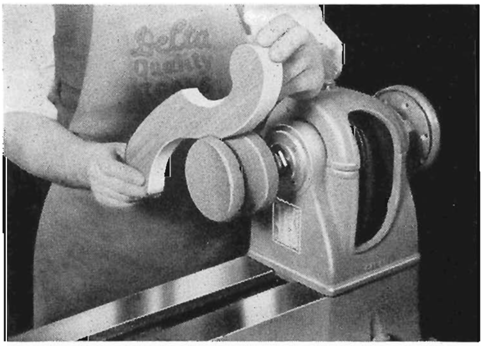




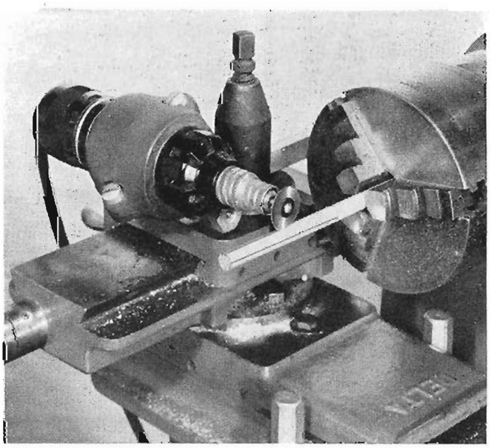
The photographs above show a few of the many uses of sanding drums on the lathe. The drawings picture typical operations using the adjustable sanding table in connection with the sanding disk.



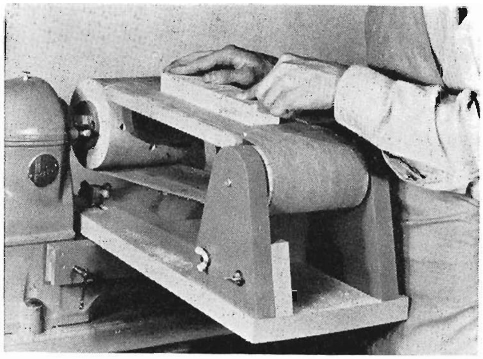
Above, wood sanding table mounted by means of pipe and floor flange. Right photo pictures an easily made belt sander driven by lathe headstock spindle.



Special sanding forms can be made by cementing abrasive grains to a turned base. Photo shows cove form used to round edges of band sawed work.



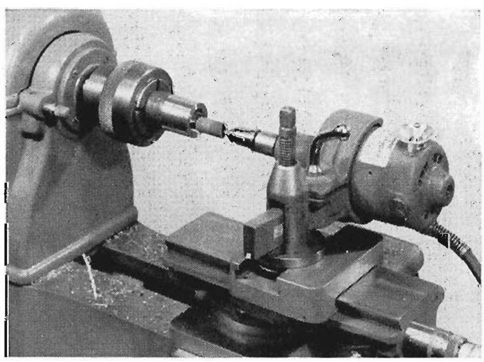
Small rotary tool used with tool post bracket in slide rest does numerous jobs. Above, slotting a wood dowel with small saw; right, internal grinding on a bushing.

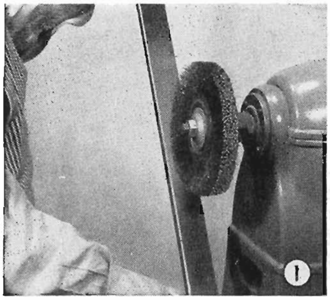


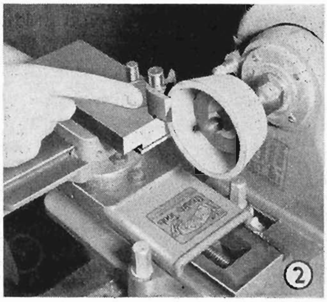
while the stop rod controls the depth of cut. In general use, the table should be within ⅛ inch of the sanding dish and slightly above the center of the disk. The table can be lowered, however, to accommodate large work, as shown in Fig. 6. Sanding in all operations should be done on the front half of the disk. If the work extends past the center, firm pressure should be applied to prevent it from being kicked upwards. The tilting table is a useful asset in beveling work to any required angle. A good homemade sanding table can be made by fitting an 8 by 14 inch wood table with a floor flange and pipe upright, as shown in top left photo. The unit is held in the tool rest base.

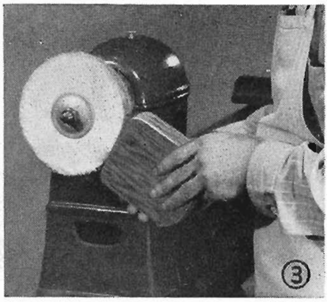
Belt Sander.—Photo at top right shows how a belt sander can be made up to drive from the lathe headstock. The base of the unit is held to the lathe bed by means of two of the star wheels used to clamp steady rest. An alignment bar fastened to underside of base and fitted with two screws which seat in shallow holes drilled in lathe bed serves to tension and track the sanding belt. One of the brackets supporting the smaller drum is fastened with bolts and wing nuts, permitting easy removal when changing belts. Overall dimensions of the unit are made to take the 6 x 48 inch belts used on the regular Delta belt sander. A similar attachment can be made to take 3 inch wide sanding belts.

Sanding Forms.—Special shapes of sanding forms for use in the lathe can be made by cementing abrasive grains to a wood form of the required shape. Cement and abrasives

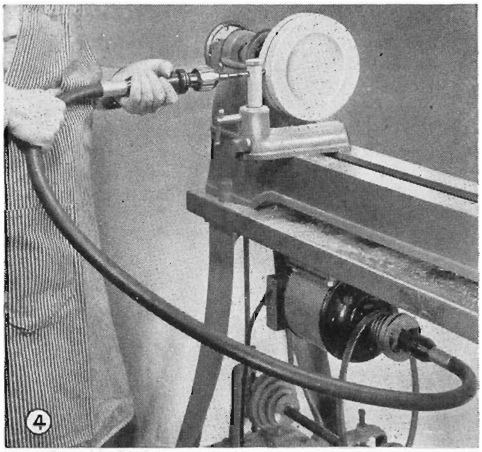


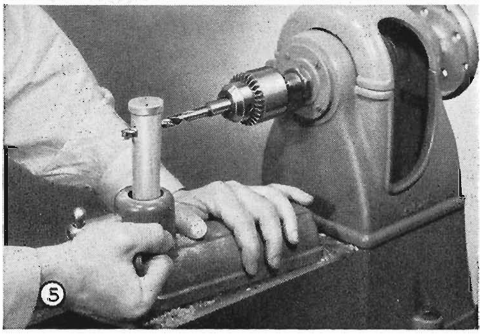






Above, screw-on arbor is useful for wire-brushing, grinding, buffing and other jobs. Below, flexible shaft hook-up and method used for boring holes.





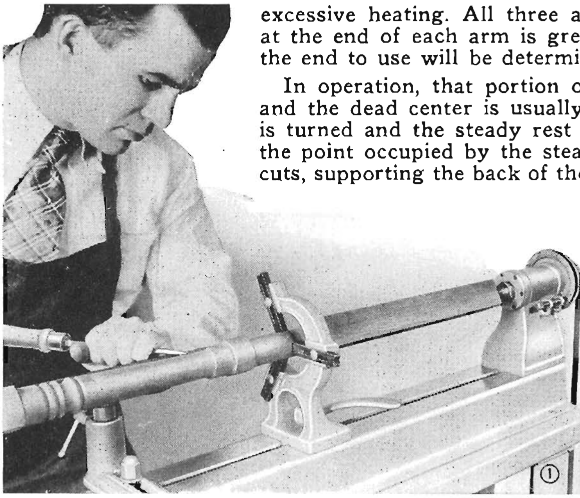
for this purpose are supplied in the Deltacraft Sanding Kit. Equally good work can be done with animal hide glue and any type of abrasive grain, the process of setting-up being completely described in the abrasive manual.

Using Rotary Tools.—Tool post brackets can be obtained for most rotary tools such as the Handee and Dumore Duplex. Used in connection with the slide rest, the rotary tool can be used for numerous jobs of light grinding and milling. Bottom photo at left on opposite page shows a typical operation where an arrow for a crossbow is being slotted to provide a mounting for vanes. The spacing of the slots is set by the index head while the slide rest provides the required feed. Photo at right bottom on opposite page shows rotary tool set up with grinding wheel for grinding a bushing.

Screw-on Arbor.—The screw-on arbor (see page 4, is available with either right or left-hand thread to fit inboard and outboard ends of spindle respectively. The arbor spindle is ½ inch diameter, and it can be used to mount any accessory tool with ½ inch hole. Fig. 1 shows a left-hand threaded arbor fitted on outboard end of spindle being used with wire brush for a rust clean-up job on angle iron. Fig. 2 pictures a set-up for sharpening shaper cutters, using the right-hand arbor on inboard end of spindle. Fig. 3 shows a buffing job with a 6 inch buff. The arbor is also useful for mounting wooden disks for turning where the work permits a ½ inch central hole.

Flexible Shaft.—The lathe motor or spindle provides a good take-off for a flexible shaft. The Delta flexible shaft has a ½ inch end fitting, and can be connected by means of a ½ inch rod in either 3-jaw or Jacobs chuck. If the Jacobs chuck is used, it should be fitted with a through-the-spindle tie rod to prevent it from coming out of the lathe spindle. The lathe take-off from spindle provides a good range of speeds suitable for most work done with the flexible shaft. Generally, the speed should be in the upper brackets since all flexible shafts work better at higher speeds. A take-off from outboard end of lathe spindle is impractical unless the rotation direction of motor is reversed.

Where the flexible shaft is used on a job mounted in the lathe, the take-off can be made from motor, as shown in Fig. 4. The ½ inch stub shaft necessary to make the fitting is inserted in end of motor pulley and held by a set-screw. This flexible shaft set-up works best with a 6-ft. shaft—5 ft. shaft shown in the boring job, Fig. 4, is a little on the short side for comfortable handling. The 6 ft. shaft would also be satisfactory for coupling to the motor of a four-speed lathe, with motor mounted on lower shelf of lathe bench. Fig. 5 shows how the pilot hole for boring jobs is drilled. To do this, secure a round piece of wood or metal in the slide rest base. Then, slacking off the clamp handle slightly, push the base forward so that the drill bores a central hole. Drilled in this manner, it is obvious that the pilot hole will be accurately

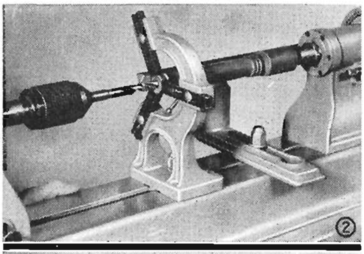


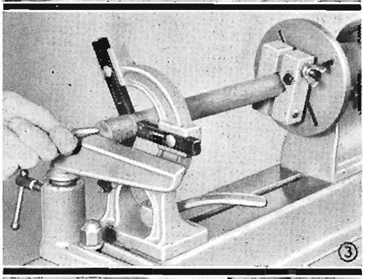
Steady rest is a valuable aid in turning long work or boring the end of a spindle.

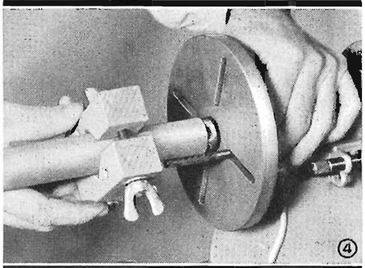
on center in one plane and needs only lining up across the work. A somewhat similar setup can be used for boring holes in face of work, or boring holes at an angle. If you have a slide rest, a good type of pilot can be provided by using a wood or metal block mounted on slide rest compound. Similar jobs in lathe cross-boring can be done with an electric drill, or by moving the drill press over the work. Obviously, most of the uses of the flexible shaft are not concerned with lathe work, the lathe being used only as a power source.

The Steady Rest.—The steady rest or center rest has two important uses in lathe operation: (1) It is used as a support when making long turnings of small diameter, and (2) it forms a bearing for the free end of the turning when doing end boring or similar operations. In the first of these operations, the work is turned down to a cylinder somewhere near the center of the stock. The lathe is then stopped, and the steady rest is moved over this section. The three supporting arms are adjusted to hold the turning firmly, but the pressure should not be so great as to cause excessive heating. All three arms are reversible. That is, the curve at the end of each arm is greater at one end than at the other, and the end to use will be determined by the size of the turning.

In operation, that portion of the turning between the steady rest and the dead center is usually turned first; then the live center end is turned and the steady rest is removed. Finishing cuts at or near the point occupied by the steady rest can be run in by making light cuts, supporting the back of the turning with the left hand while using the chisel with the right. In most cases the rest can be shifted a little to permit access to all parts of the turning. You will find that the supporting arms burn the work to some slight extent. Friction can be avoided by using beeswax as a lubricant, or by wrapping the contact point with adhesive tape.







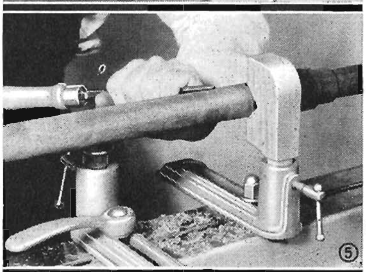


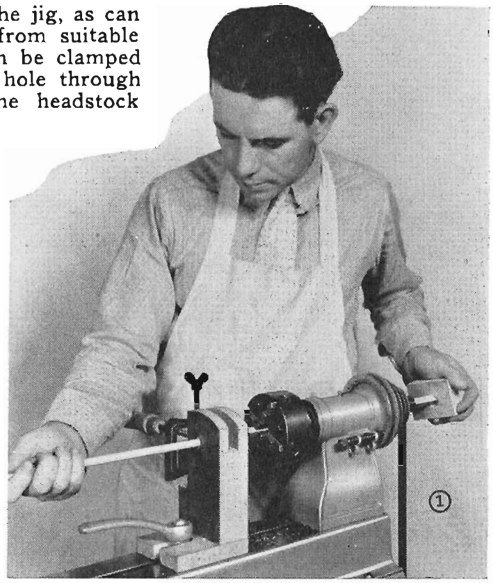
Fig. 2 shows the steady rest being used to support the free end of the turning for end boring. The same general procedure applies, the rest being properly adjusted before the tailstock is set free from the turning. If possible, the steady rest should contact a shoulder or similar cut so that it will not only center the work, but also keep it pressed against the live center. This is not strictly essential for end boring since the drill itself will exert enough end pressure, but it is a necessity when doing end turning. Fig. 3 shows one method of holding the work to the live center when there is no shoulder on the turning against which the steady rest can press. The jig is shown in detail in Fig. 4. As can be seen, it consists of two vee-blocks which bolt around the work, the blocks, in turn, being bolted through the slots in the 6-in. faceplate. Fig. 5 shows a simple back rest. This is a variation of the steady rest, and is most useful as a support for long turnings.

Dowel Jigs. — Pictured on the opposite page are two simple dowel jigs, both of which will produce good work. They are best suited for small sizes (up to about ⅝ in.) since the cut from square to round is made in one operation and larger sizes will involve removing excessive wood.

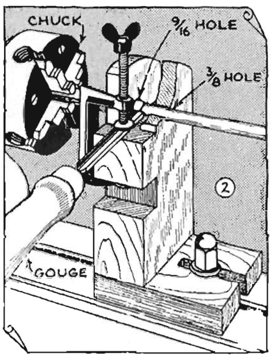
Figs. 1 and 2 picture a jig which is suitable for making dowels up to 7/16 in. diameter. The cutting tool is a ½ in. gouge, this being clamped to the jig, as can be seen in Fig. 2. The jig itself is made up from suitable wood stock, and is so constructed that it can be clamped to the lathe bed in the manner shown. The hole through the jig must be accurately aligned with the headstock spindle. This can be easily done by inserting a 60-degree center in the headstock and then advancing the jig to mark the hole position. The hole is not the same diameter all the way through the jig. The hole on the headstock side must be of a size which will admit the square stock which is to be used. The hole on the side farthest from the headstock is the same diameter as the finished dowel.

In use, the square stock is inserted through the hollow headstock spindle. It is caught by the chuck, which is set so that the work can slip through it readily and yet retain enough grip to drive it. A push block is necessary to feed the revolving work into the jig.

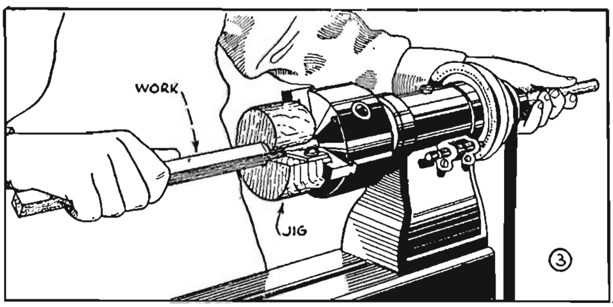
The second jig, shown in Figs. 3 and 4, is constructed on a somewhat similar principle. Since the finished dowel goes through the headstock, it is suitable for work up to about ⅝ in. diameter. In this case, the jig turns, while the work is held stationary. This same jig can also be used for larger dowels by simply advancing it along the work while the work is being driven between centers. In this case, the work turns while the jig is held stationary.

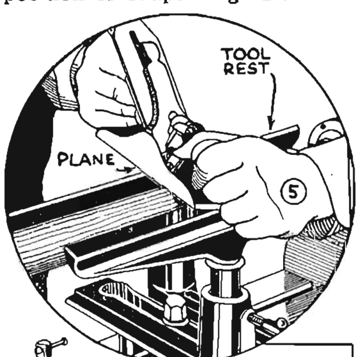


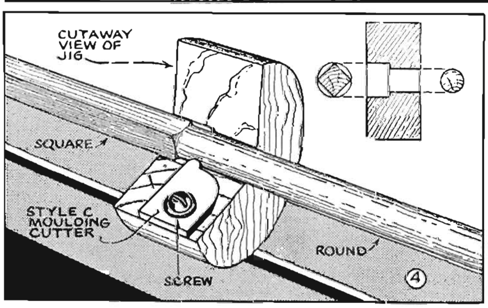
Dowels up to about ⅝ inch diameter are cut with these simple dowel jigs.

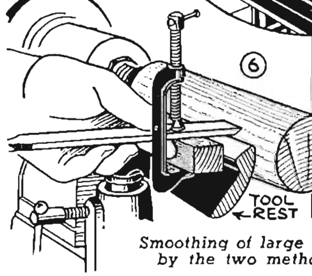


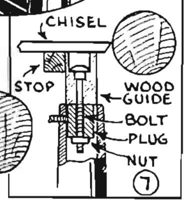
Large Dowels.—Large dowels or rounds are usually turned by ordinary woodturning methods with the work mounted between centers. The cylinder can be smoothed with a plane after roughing to shape. Good results can be obtained by using two tool rests to support the plane, the rests being set at a height to suit the required diameter of work, as shown in Fig. 5. Another smoothing and truing device consists of a large square nose chisel with a guide block clamped to it, as shown in Fig. 6. Both devices demand a smooth and straight tool rest. A somewhat better guide is made of wood fitted with plugs to fit into the tool rest bases, Fig. 7. The same idea can be used for tapers and slow curves by altering the position or shape of guide.



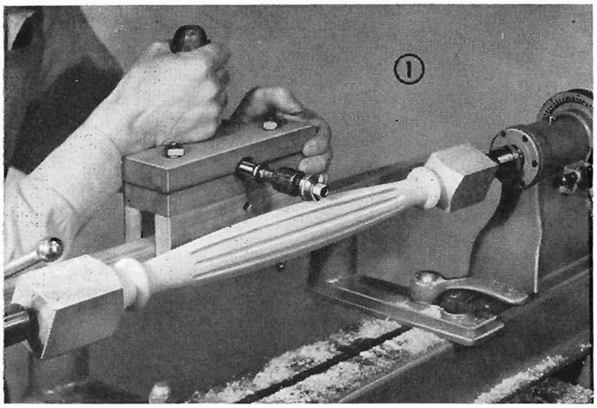


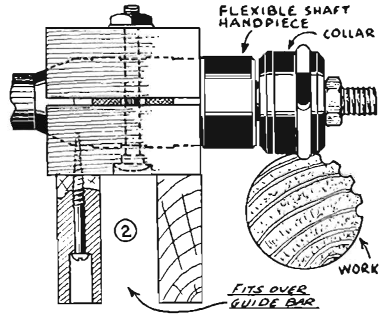




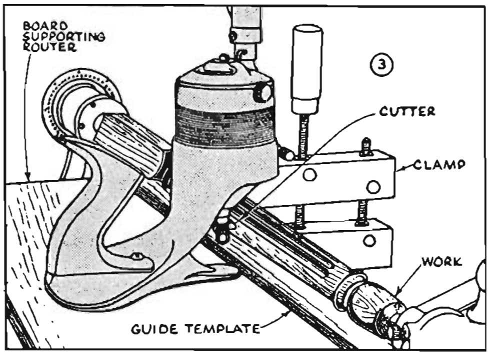


Smoothing of large dowels is simplified by the two methods shown above.



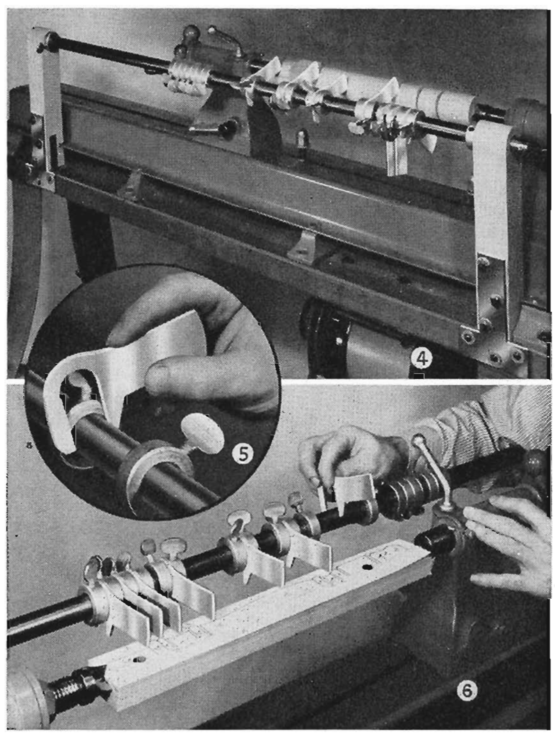


Top photo and diagram show how fluting is done with flexible shaft. Portable router method is shown at left.

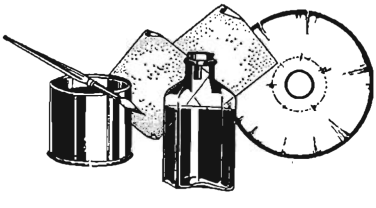


Fluting Jigs. — Spindles requiring flutes or beads make use of the lathe as a holding device only, the actual cutting being done with shaper cutters. One method, involving the use of a flexible shaft, is shown in Figs. 1 and 2. The shaft is secured mounted between blocks of wood, and is positioned by two parallel legs which fit over a wooden guide bar. If the cutter has a 5/16 inch hole it is mounted on a suitable spindle which is gripped by the flexible shaft chuck, as shown in photo. The drawing, Fig. 2, shows a ½ inch hole cutter mounted directly on the flexible shaft spindle, which is a better set-up because there is less overhang. In either case, the depth of cut is controlled by a collar, while the spacing is worked by means of the lathe indexing head. A second method of fluting is shown in Fig. 3. This makes use of a portable router which is guided by a curved or straight template to conform to the work. The elimination of the depth collar results in cleaner cutting without burning.

Semaphore Jig.—The semaphore jig is a setting-out device, used to automatically mark all important lengths and diameters of the turning. It is useful only for production work. The general arrangement is shown in Fig. 4 and consists of a bar mounted behind the lathe carrying from 20 to 40 metal collars. The collars are used to position the metal semaphore arms. A complete set of arms covering all common diameters used in wood turning should be made up. The arms should be a press fit over the shaft, Fig. 5, so they will not fall off. In use, the arms are set to a half-pattern of the work. The manner in which each arm sets off the location and diameter of the required sizing cuts run in with parting tool should be apparent from the pictures. After the sizing cuts are run in, it is a simple matter to work the turning to the required shape.

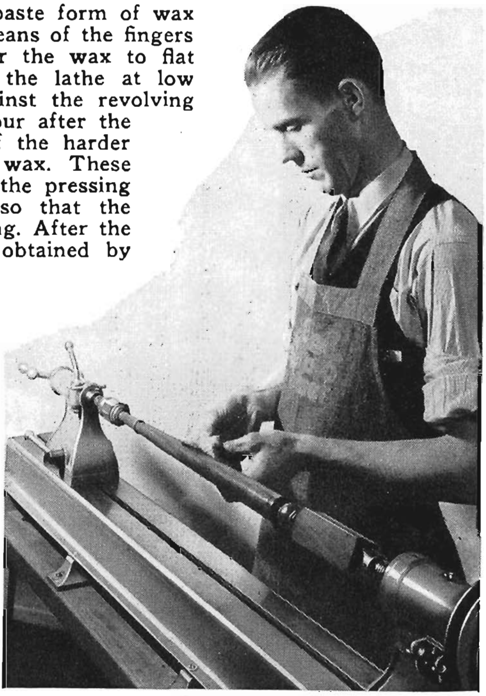


The semaphore jig is a production tool, used to set off all important diameters and lengths of the turning.



Finishing your LATHE WORK

Wax Finish.—By this is usually meant the paste form of wax which can be applied direct to the work by means of the fingers or a cloth. About ten minutes is allowed for the wax to flat out; then the piece is polished by running the lathe at low speed and holding a piece of soft cloth against the revolving spindle. A second coat can be applied one hour after the first. The wax finish also includes the use of the harder waxes—Carnauba wax, beeswax or paraffin wax. These are in lump form, the application calling for the pressing of the lump against the revolving spindle so that the wax will become soft and adhere to the turning. After the piece is evenly coated, the actual polish is obtained by rubbing with a soft cloth.



Proper application of pad in applying french polish. The lathe should be operated at low speed.

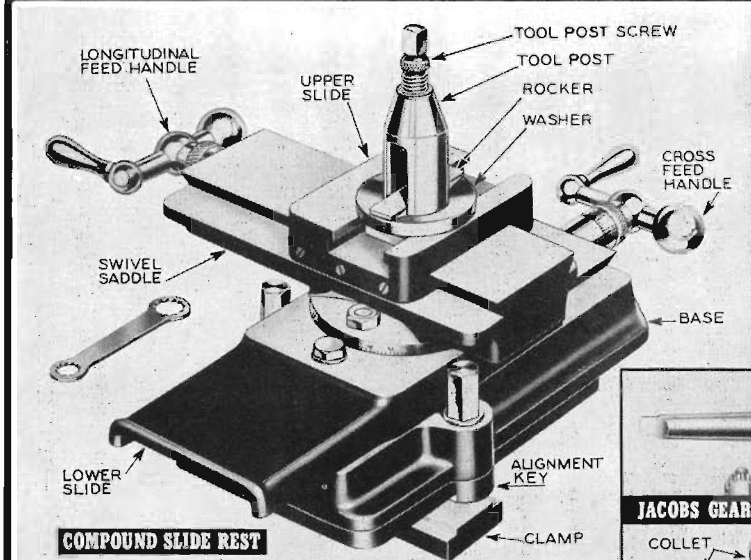
Frictional Polish.—A handful of fine shavings taken from the work are cupped in the hand and pressed against the revolving spindle. This will bring out some measure of shine to the work, but is usually done only as an initial step for some other form of finishing.

Oil Finish. — This entails the use of hot, boiled linseed oil as the only polishing medium. The oil is brushed on, and then thoroughly rubbed with a soft cloth as the lathe revolves. Considerable rubbing is necessary to entirely dry the oiled surface.

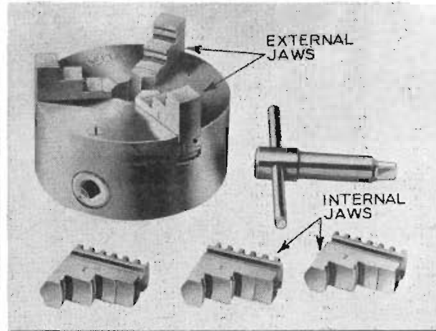
Varnish.—The varnish finish is applied to turnings much the same as for any other form of cabinet work. The finishing is not done on the lathe with the possible exception of paste filler, if required, which may be rubbed off at a low spindle speed.

French Polishing.—For a first project, best results can be obtained by using maple, with boiled linseed oil or paraffin oil as a first coat. The polish is made of pure white shellac, boiled linseed oil and denatured alcohol. These are not mixed in one bottle, but are kept in three separate bottles. A soft rag (no lint) or absorbent cotton completes the equipment. Both are sometimes used—a pad of cotton wrapped in, say, cheese cloth. The pad should be about ½ inch thick by 2 inches in diameter. Place the pad over the mouth of the shellac bottle, and tip the bottle to fairly well saturate the rag; then, place the pad to the mouth of the alcohol bottle and put on about half as much alcohol as shellac. Add two or three drops of oil. Run the lathe at low speed and apply the pad to the spindle. Hold the pad lightly at first, increasing the pressure until the cloth is almost dry, then, add a little more shellac and an equal amount of alcohol, and apply again until the pad is almost dry. The operation is repeated until the whole surface of the work is evenly coated. After the first coat has hardened (24 to 48 hours) apply a second coat. The second coat is usually more difficult than the first coat. Whereas the first coat can be put on with a fairly wet pad, the second and all later coats should find the pad just damp with the necessary mix. Gradually increase the proportion of shellac, using just enough alcohol and oil to prevent rings from forming on the work as the shellac piles up. A pure water or alcohol rub is necessary as a final step to completely remove any oil film.

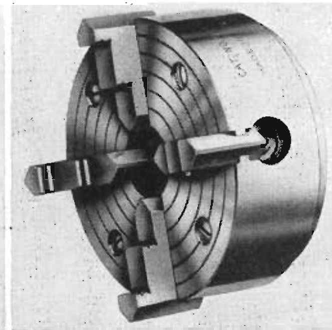
Shellac Finish.—This is a polished shellac surface, somewhat similar to French polish. The lathe is turned by hand and a coat of pure white shellac applied. The shellac is allowed to dry for about ten minutes, and is then lightly sanded with worn sandpaper. Using the same kind of pad as for French polishing, moisten the cloth with a very little thin shellac and apply to the revolving work. A drop or two of linseed or machine oil can be used as a lubricant. After the necessary polish has been obtained, wash with clear water.



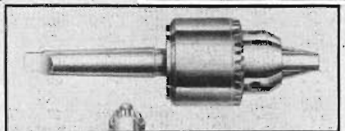
COMPOUND SLIDE REST



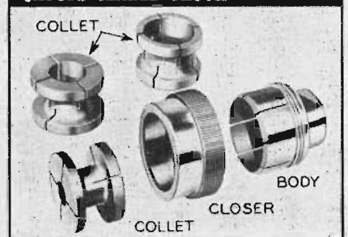
3-JAW SCROLL CHUCK



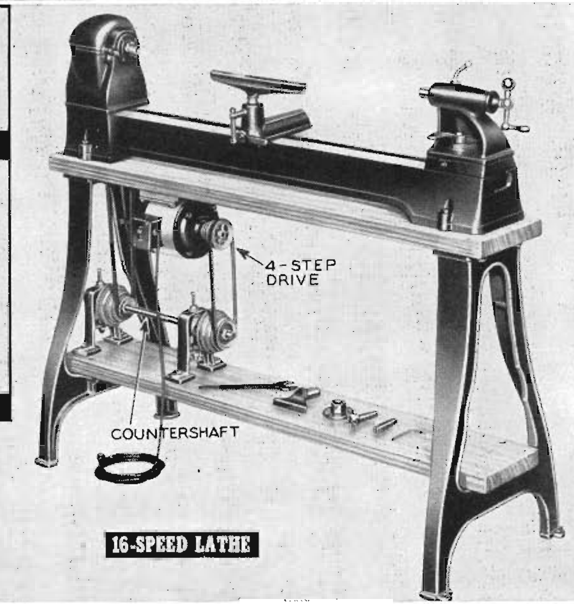
4-JAW INDEPENDENT CHUCK



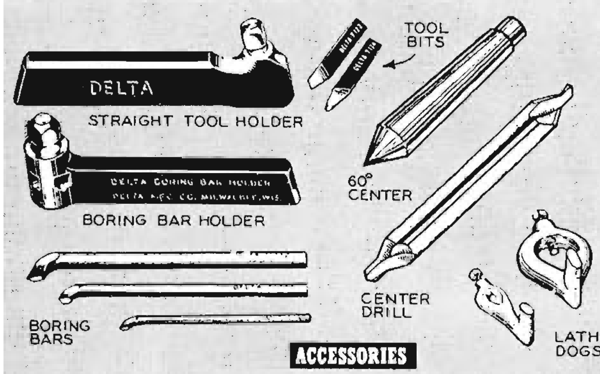
JACOBS GEARED CHUCK



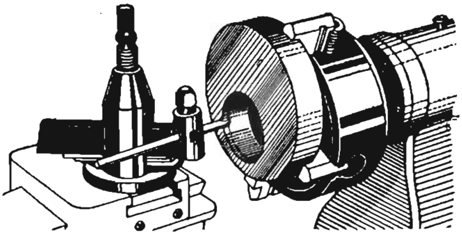
COLLET CHUCK



16-SPEED LATHE



ACCESSORIES



Equipment for METAL WORK

WHEN equipped with a low-speed countershaft and various accessory tools, the larger wood lathes can be used for many standard metal turning operations. Since this partial conversion does not include a lead screw, it is impossible to cut threads, but all other operations including straight and taper turning, boring, knurling, drilling and tapping can be done. The set-up in general is also ideally suited for many operations in wood and plastic turning where the precision of a mechanical feed is often required.

The Compound Slide Rest.—This is the name given to the whole of the unit which slides along the bed of the lathe. It is supported by a base casting, and is guided by a machined projection which rides in the central opening of lathe bed. The slide rest can be clamped at any position along the lathe bed by means of two screws fitting into bed clamps. Above the base is the cross slide or lower slide which is used to feed the cutting tool across the work. The lower slide supports the compound rest swivel which in turn carries the longitudinal or upper slide. At the very top is the tool post, with its clamping screw, washer and rocker.

Accessories.—Items shown at lower left on opposite page picture the standard small items used in metal turning. The straight tool holder has an inclined square hole through it, and is used for mounting any style of ¼ inch square tool bit used for external turning. The boring bar holder is used for mounting small boring bars up to ¼ inch diameter, and it will also take ¼ inch square tools. 60° centers, faceplate and lathe dog are used when work is mounted between centers, as shown by various examples on other pages. The center drill cuts a 60° cone-shaped hole and is used to bore the holes for the 60° centers.

Lathe Chucks.—When the work is not mounted between plain centers, it is generally held and driven by one of two kinds of lathe chucks. The one shown at left on the opposite page is known as a universal chuck, the three jaws moving in or out simultaneously through the use of one key. This automatically centers any round stock without further adjustment other than tightening the jaws. The inside and outside jaws are interchangeable to accommodate a wide range of work. The second type of chuck is an independent four-jaw chuck, so-called from its four jaws which are moved in or out independently from each other. The jaws can be adjusted to center round stock, while irregular stock can also be centered by means of the independent adjustment.

Collet Chuck.—The collet chuck is useful for specific work diameters. The body of chuck shown is slotted to make a 2 inch collet. When the internally beveled closer is screwed in place, it squeezes the sections of the slotted body to hold the work securely. Interchangeable collets are mounted inside the body, each being bored from both ends to accommodate two sizes: ½ and ⅝, ¾ and 1, and 1¼ and 1½ inch. For best results the diameter of workpiece should be net or not more than .010 inch undersize.

Drill Chuck.—The drill chuck can be used as a work-holding device, but it is intended primarily for holding drills, reamers and other tools. The type recommended is the geared chuck with key, as shown in photo, this offering a more positive grip than any type of hand-operated chuck. The drill chuck has a No. 2 Morse shank and can be used in either tailstock or headstock as required.

Sixteen-Speed Lathe. — The typical wood lathe is a high-speed machine, and does not offer the slow speed required for metal turning. Low speeds as well as the high speeds needed for wood turning are obtained by using a countershaft, as shown. Thus equipped, the lathe has a total of sixteen different speeds, ranging from 340 to 3400 r.p.m., as tabulated in table below. The power required to drive a wood lathe fitted with countershaft is more than a plain wood lathe, and ranges from ⅓ to ¾ h.p., depending upon the nature of the work. For average homeshop use, ⅓ or ½ h.p. can be used, the heavier motor being preferable. The type of motor should be either capacitor or repulsion-induction—a split phase motor will eventually burn out in starting a load as heavy as this.

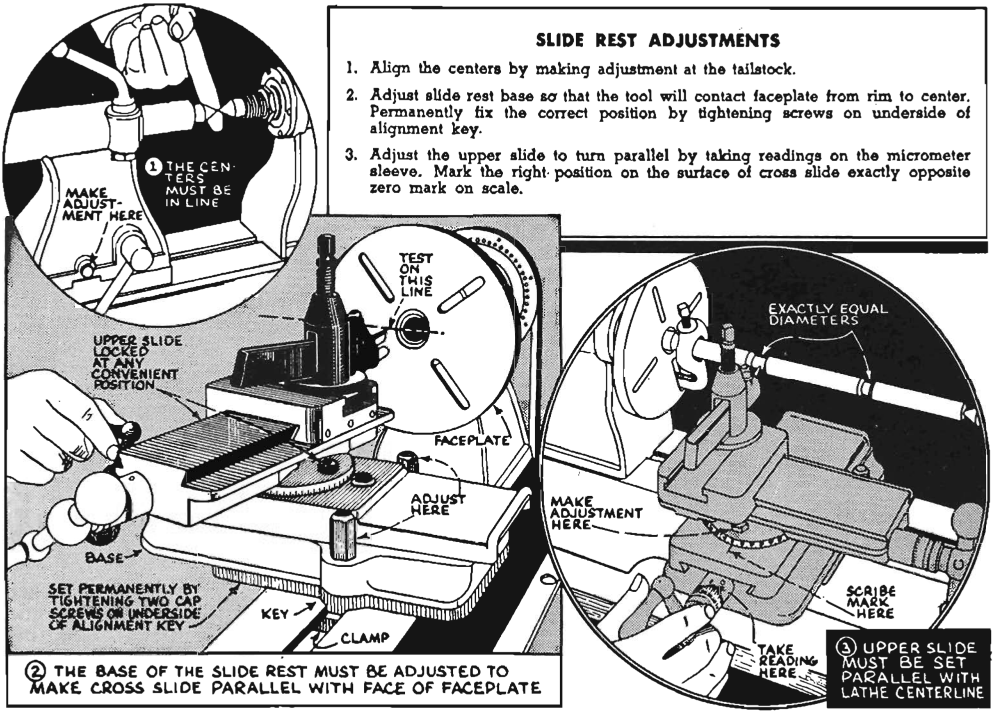
Set-Over Tailstock.—A set-over tailstock is a necessary part of the metal-turning lathe, not only to put the centers in perfect alignment, but to permit he machining of long tapers. This type of tailstock differs from the fixed type in that it can be moved cross-

SPEEDS OF 16-SPEED LATHE

MOTOR TO COUNTERSHAFT	COUNTERSHAFT TO LATHE			
	LOW	2nd LOW	3rd LOW	HIGH
LOW SPEED	340	525	825	1225
2nd LOW	475	750	1125	1700
3rd LOW	675	1050	1575	2500
HIGH SPEED	900	1400	2200	3400

SLIDE REST ADJUSTMENTS

1. Align the centers by making adjustment at the tailstock.
2. Adjust slide rest base so that the tool will contact faceplate from rim to center. Permanently fix the correct position by tightening screws on underside of alignment key.
3. Adjust the upper slide to turn parallel by taking readings on the micrometer sleeve. Mark the right position on the surface of cross slide exactly opposite zero mark on scale.



② THE BASE OF THE SLIDE REST MUST BE ADJUSTED TO MAKE CROSS SLIDE PARALLEL WITH FACE OF FACEPLATE

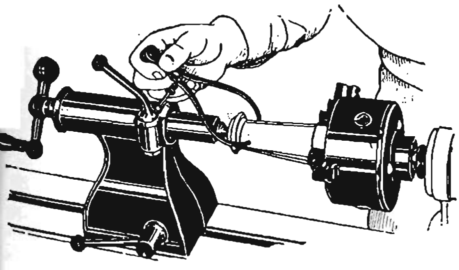
③ UPPER SLIDE MUST BE SET PARALLEL WITH LATHE CENTERLINE

wise with the lathe as well as lengthwise. The adjustment is made by means of two screws, one on either side of the tailstock. These work through a fixed block, and by loosening one screw and tightening the other, the upper portion of the tailstock may be adjusted in either direction from the centerline.

Adjusting Tailstock.—Fit the 60° centers in tailstock and headstock spindles and advance the tailstock until the two centers are touching, as shown in Fig. 1. If not in perfect alignment, loosen the tailstock clamp and make the required correction at the set-over screws. When the centers are aligned, scribe a mark across the joint between the tailstock and tailstock base to indicate zero. Most lathes have a small pad at one end or the other of tailstock, and the index mark is located on this pad; if already marked, the setting should be checked and remarked if original marks are not in line.

Adjusting Slide Rest.—The slide rest must first be adjusted so that the base is parallel with the lathe bed. To do this, make the set-up shown in Fig. 2. Since this adjustment concerns the base only, the upper slide can be set at any convenient position. Align the base by eye approximately square across the lathe bed and tighten the two bed clamp screws. Now, advance the tool bit to touch the faceplate, and then use the crossfeed to run the tool bit across the surface of faceplate. The tool bit should maintain its contact, just touching the faceplate all the way from center to rim. If not in perfect alignment, loosen the bed clamp screws and adjust as needed until correct. After perfect contact is obtained, tighten the two socket head cap screws on underside of alignment key. The cross feed is now accurately across the lathe, and it will stay that way regardless of how often the slide rest is removed from the lathe.

The upper slide must now be set so that it will make a parallel cut. To do this, set the slide as nearly as possible by eye or square; then, mount a length of work between centers and turn two collars. Make the first of these cuts at the extreme end of the longitudinal feed toward the faceplate. Make the second cut about 4 in. from the first cut. Caliper the collars and make both the same *exact* diameter. Now stop the lathe, and run the tool bit in until it lightly jams against one of the collars. Mark the reading on the micrometer sleeve, say 65. Back off and run the tool up to the other collar. Advance the tool to the collar until it jams lightly as before. Take the reading on the sleeve. It will probably not be the same as the first collar, say 95. This represents a difference of 30 between the previous reading. Jam the tool bit against the collar with the higher reading, and then back off half the difference, or to 75. Loosen the adjusting screws and swing the rest until the bit again jams against the work. Tighten the screws. Both collars should now read at 75, and the rest is set to turn parallel. Recheck, and when the final adjustment is made, scribe a mark with a fine, sharp point on the top surface of the cross slide exactly opposite the zero mark on the compound swivel. Split hairs about doing this—it is an important adjustment.



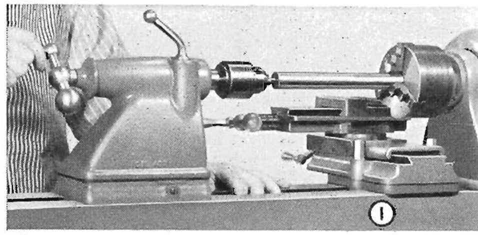
Operations in METAL TURNING

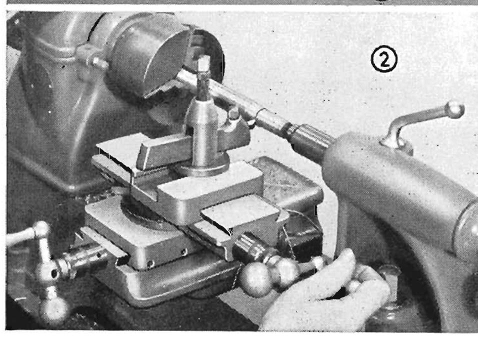
THE BASIC idea in metal turning with a slide rest is to use as high a spindle speed as possible. High spindle speed permits smooth work despite the slightly erratic movement of hand feeding, and the feed itself can be fairly rapid. Use the tables on page 61 to find surface feet per minute and revolutions per minute for material and diameter of work. The maximum depth of cut in steel is about 1/16 inch, reducing the diameter 1/8 inch in one pass. The feed can be fairly rapid—ten to thirty complete turns of the feed handle per minute.

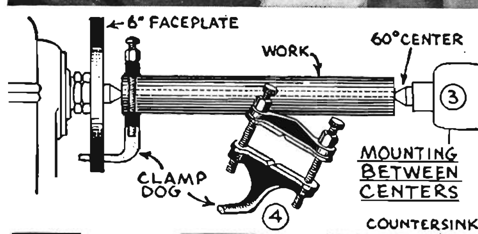
Center Drilling.—Most lathe work is center drilled by holding the work in the 3-jaw chuck while the center drill is advanced by the tailstock, as can be seen in Fig. 1. A wide variety of spindle work is done by chucking the work and supporting the center-drilled free end with a 60-degree center, Fig. 2. Since even a good 3-jaw chuck may be as much as .010 inch off-center, work done in this manner must be completed in one chucking and cannot be rechucked with any degree of accuracy.

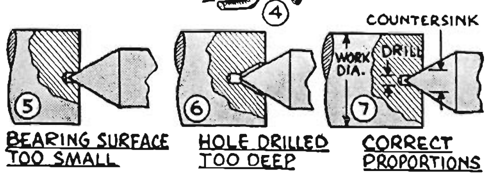
Mounting Between Centers.—The usual manner of driving spindle work is the between centers mounting shown in Fig. 3. The recommended clamp dog is the adjustable style, Fig. 4, which fits both round and square stock in a wide range of sizes. The dog is clamped to the work, and the tail of the dog fits into faceplate slot. The tail of dog must be a loose fit in faceplate slot and must not bind; some sawing and enlarging of one of the faceplate slots may be needed.

When accuracy is required in mounting, the work is first center marked with a combination square centerhead, as shown in Fig. 8. The work is then center punched and the center punch marks are used to support the work between centers. Revolving by hand, as in Fig. 9, reveals whether or not the punch marks are accurate. If not accurate, the holes are repunched, directing the punch toward the high spots determined by chalk-



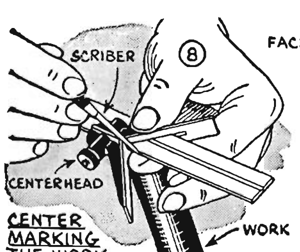


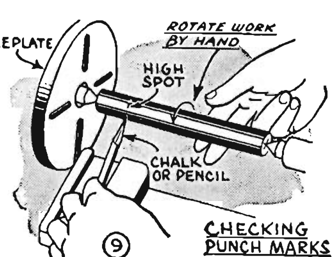


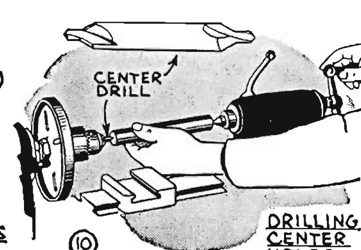


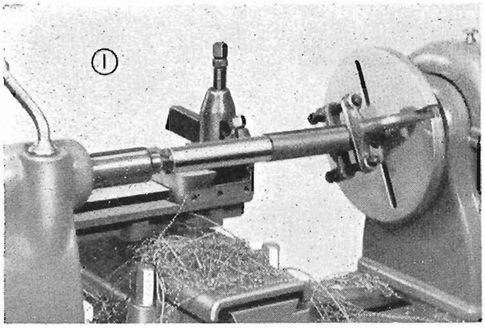
Center drilling and mounting of work between centers are basic operations in metal turning. A 3/32" center drill can be used for most work.

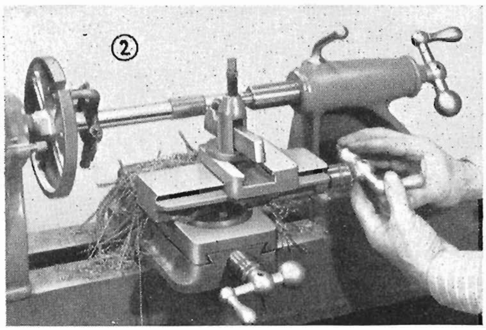
WORK DIA.	D	C
3/16-3/8	1/16	1/8
3/8-1	3/32	3/16
1-2	1/8	1/4



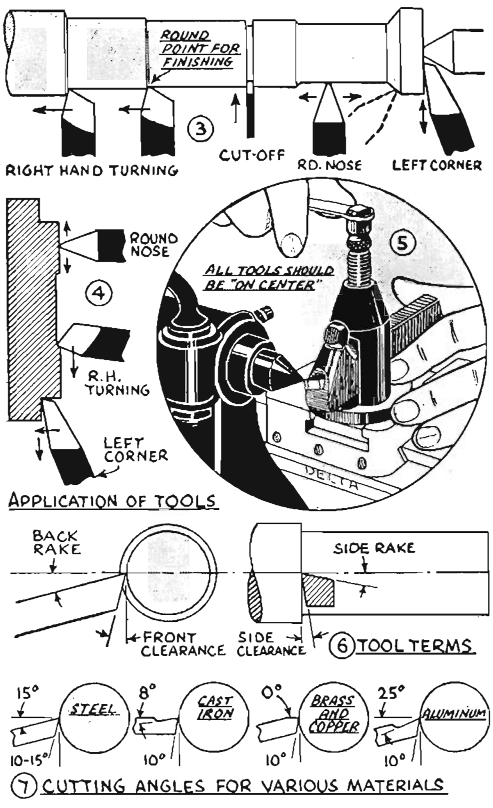








Above, turning a shaft by reversing the work. Drawing below explains tool terms and gives cutting angles suitable for various metals.



ing. After accurate punch marks are obtained, the center holes are drilled by the method shown in Fig. 10. Some obvious errors in center drilling are shown in Figs. 5 and 6; Fig. 7 shows correct proportions and size of center drill to use.

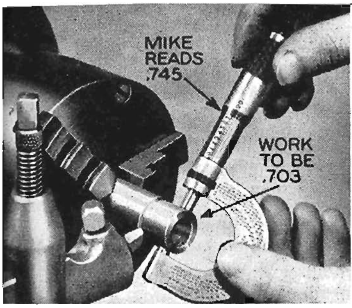
Turning a Shaft.—Drill and mount the work between centers, as previously described. Use firm pressure in running up the tail center, and then back off slightly to prevent binding. Always oil the tail center. Mount a turning tool on the slide rest and feed from tailstock end to about the center of the work, as shown in Fig. 1. On the final cut, do not disturb the infeed, but simply stop the lathe and run the tool back to the tailstock end. Now, reverse the work, placing the dog on part already turned, as can be seen in Fig. 2. Since the second end is turned at the same tool setting, the work will be the same diameter throughout providing the slide rest is accurately adjusted to turn parallel.

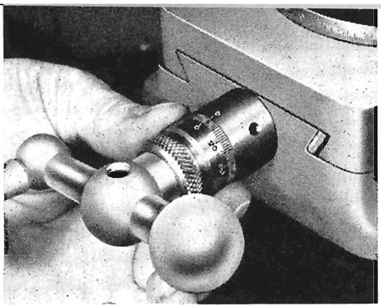
Application of Tools.—Fig. 3 shows the general application of basic tools in spindle turning. A slight round on the right hand roughing or turning tool is recommended since this shape will serve for both roughing and finishing. The round nose tool is a favorite for brass work. If the work is to be faced at the tailstock end, the point of the left corner tool should be ground a little sharper to fit the angle between work and center. The left corner bit when used for facing is preferably worked from center to rim of work. Fig. 4 shows tool applications in larger faceplate work. Facing in this case is done with the right hand turning tool as shown.

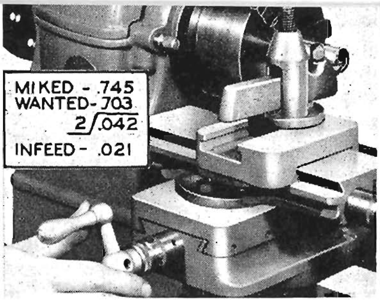
Mounting of Tools.—Lathe tools have a ¼ inch square body and fit into a square hole in tool holder. This hole is inclined 15 degrees so that the point of tool slants upward or has positive rake. All tools should be mounted with point at level of work centerline, this setting usually being obtained by adjusting the tool to touch the tip of tailstock center, as shown in Fig. 5. Various types of height gauges are also used for setting; many workers prefer special flat tool post rings which are used without the tool post rocker. For utmost rigidity, the tool should not project too far from the tool holder, and the tool holder should be kept close in to the tool post.

Tool Terms.—The various terms used in describing lathe tools are given in Fig. 6. Front clearance and side clearance are absolutely essential in any tool shape—without clearance the tool would simple rub against the work and would not cut. The rake angles, back and side, are intended to give the tool the proper "bite" into the work. Back rake is automatically obtained by the position of the tool in holder, while side rake is ground on the tool itself.

Tools for Various Materials.—Tool angles for various materials are shown in Fig. 7. The general idea is that steel takes a heavy positive rake, cast iron a little less, brass zero, and aluminum very heavy positive back rake. In all materials, the front and side clearance

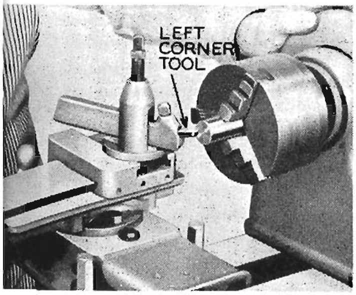


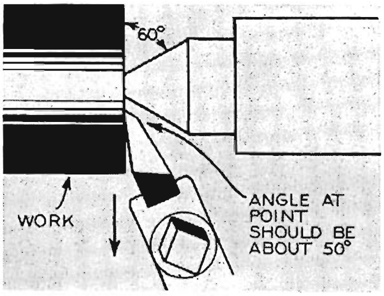


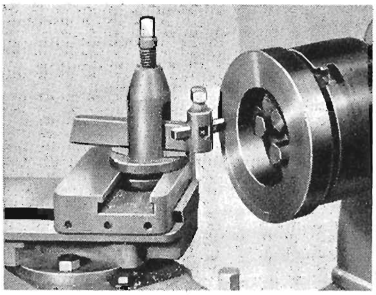


Turning to Diameter

After rough turning, the work is miked. The difference between miked size and desired size is divided by two to give the amount of infeed required, which can be made in one or more bites. Tension-fit micrometer sleeve can be rotated (always clockwise) to zero, as shown in center photo, to provide a zero for measuring infeed.

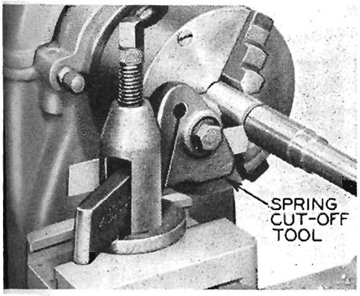


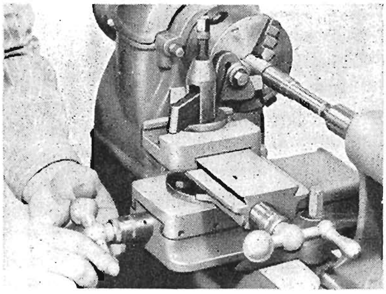


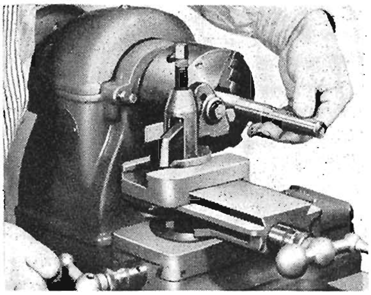


Facing Operations

Left photo shows squaring an end, using a left corner bit and feeding from inside to outside. When squaring the end of work supported by the tail center it is necessary to use a tool sharpened to about 50° as shown in center drawing. Facing on large work is best done with a carbide turning tool, as shown in right photo.

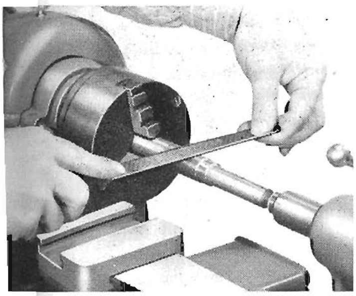


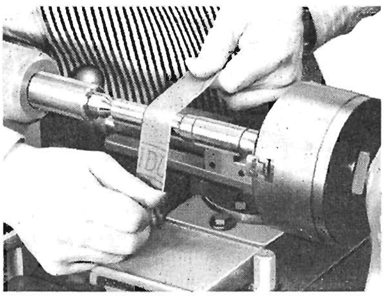


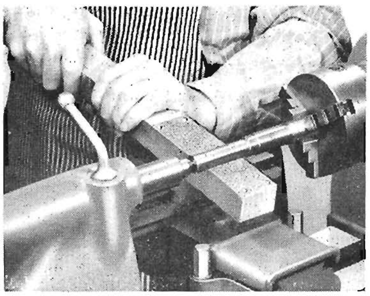


Cutting Off

Cutting-off should be done at low speed and as near the chuck as possible. The work can be supported by tail center until reduced to about 1/4 inch diameter, after which the tailstock must be pushed out of the way. Cutting oil is helpful but not essential. Use a firm and positive feed—pick up a fair chip and feed fast enough to hold it.

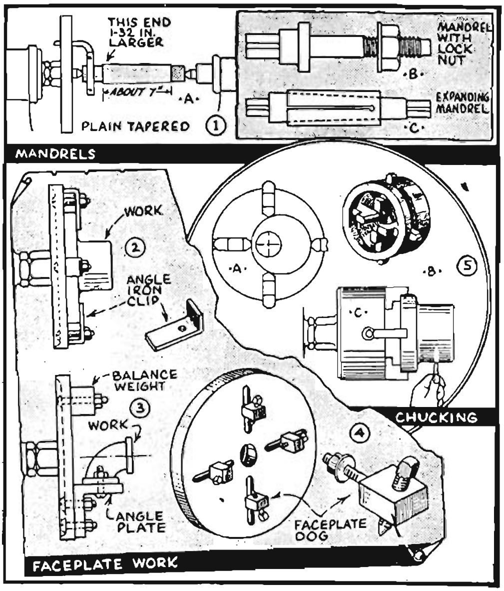




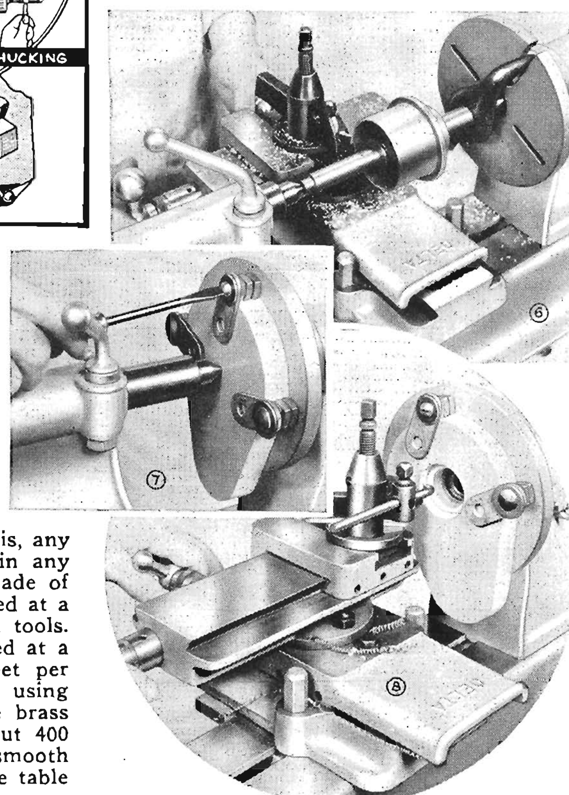


Filing and Polishing

Use long even strokes when filing, pointing file slightly away from chuck. Do not drag the file backwards. Use a file card and keep the file clean. 100-grit aluminum oxide cloth-backed abrasive is excellent for finishing, especially when used with oil. Considerable pressure should be used, and is best applied if abrasive is tacked to a board.



Drawing above and photos at right show a few of many methods used in mounting odd-shaped work in the lathe.

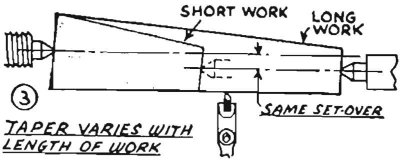


angles should run about 10 degrees. Side rake is simply a way of increasing the back rake—if the tool needs heavy back rake, give it some side rake. Beginners are advised to use ready-ground tool bits and in this way gradually pick up a knowledge of tool shapes and why they cut. As a starter, simply see that the tool has front and side clearance; given this, any type of tool will do passable work in any kind of material. Good use can be made of carbide tool bits, which can be obtained at a cost about double that of high speed tools. Carbide permits the work to be turned at a higher spindle speed—200 surface feet per minute is a good rule-of-thumb when using carbide tools for cutting steels, while brass and aluminum can be worked at about 400 s.f.m. These higher speeds give extra smooth work with a fairly fast hand feed. The table on page 61 shows s.f.m. converted to r.p.m. for various diameters of work.

Common Operations.—Four of the commonest operations in metal turning are covered by the photos and text on previous page. The Delta slide rest is one of the few slide rests having adjustable micro sleeves, and use should be made of this feature in all cutting to depth and exact diameter, as outlined in the strip on turning to diameter. The strip on cutting-off shows a spring type tool holder. This style is far superior to a rigid holder because it eliminates climbing and compensates for irregular hand feed. Tool holder shown is Williams No. NS-30-R—it is a right offset holder suitable for working close to the chuck as well as all-around cutting.

Mounting Methods.—Various mountings used in lathe work are shown on this page. The mandrel is handy for pulleys and similar work, Figs. 1 and 6. Fig. 2 shows work clamped to the faceplate, and Figs. 7 and 8 show a job of this kind being mounted and turned. Irregular work is often mounted on an angle plate, Fig. 3. Fig. 4 shows one type of faceplate dog used to mount irregular shapes. Chucking in the 4-jaw chuck is pictured in Fig. 5. Jaws of this chuck are worked independently, allowing off-center chucking, as shown in Fig. 5A. The 4-jaw chuck is also used for the finest precision work in chucking rounds because it can be adjusted to perfect accuracy, Fig. 5C, which is not possible with the 3-jaw chuck.

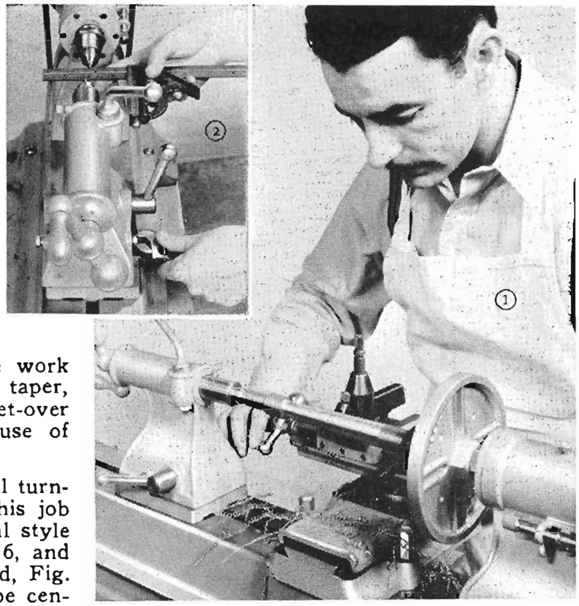
Set-Over Tapers.—It is sometimes necessary to turn a tapered instead of a straight spindle. One method of doing this is by off-setting the tailstock, as shown in Fig. 2 on opposite page. Off-setting is usually done toward the operator, which makes the small end of taper the tailstock end. The amount of set-over must be calculated, and rules and examples for doing this are given on page 63. It should be noted that in tapering by the set-over method, the length of work must always be considered—the shorter the work the greater the taper for any specified amount of set-over, as can be seen in Fig. 3. Actual turning is done as usual, except a double check should be made to see that the cutting point of tool is exactly on center. The taper should be



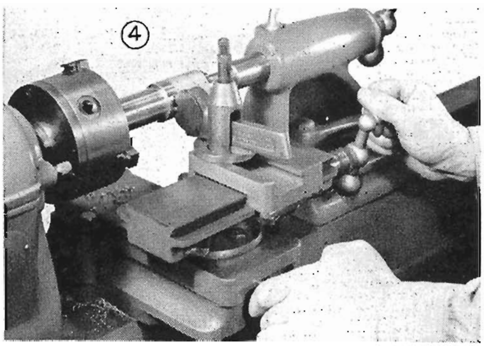
checked as soon as an inch or so of surface has been cut. This is usually done by chalking the surface and fitting the work inside a test sleeve. Adjustments are then made to correct the taper as required. The best practice is to set the tailstock over a little less than calculated. This will leave the outer, tailstock end of the work fat—the idea is not to run over the taper, which would require a reversal of the set-over and consequent possible errors because of backlash in the screws.

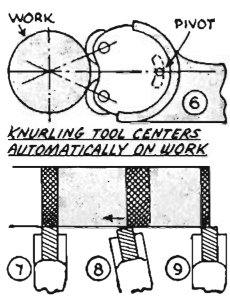
Knurling.—Knurling is used on metal turnings for ornamentation or traction. This job is done with a knurling tool, the usual style being the type shown in Figs. 4 and 6, and the usual pattern the medium diamond, Fig. 10. In use, the knurling tool should be centered with the work, although a certain degree of deviation from a true position is automatically corrected by a pivoting action, as shown in Fig. 6.

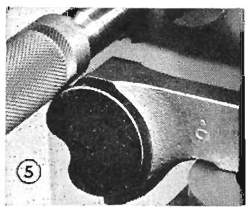
The secret of good knurlng is the application of a good amount of pressure applied before the lathe is set in motion. If you are knurling steel, the crossfeed should be jammed in with a heavy turn of the feed handle; softer metals require less pressure. In any case, the knurling wheels must bite into the metal. For most work, the wheels should be square with the work, Fig. 7. A slight angular setting, Fig. 8, is sometimes useful for picking up the starting bite on hard metals. Similarly, it is always best to start a half track wide at end of work, Fig. 9, or make a shoulder to allow engaging a half track. After the bite has been made, lubricate the work and tool with machine oil, then start the power at lowest speed. Stop the lathe immediately and examine the knurling track. If the cut is clean, the job is as good as done; if the knurl shows a ragged or split pattern like left end of Fig. 10, pick up a starting bite at some other spot. After the knurling tool is tracking properly, feed the tool slowly along the work, as shown in Fig. 4. Stop the lathe when the desired area has been knurled, and pick up a second bite with the infeed handle. Feed the tool back to the starting position. Two bites



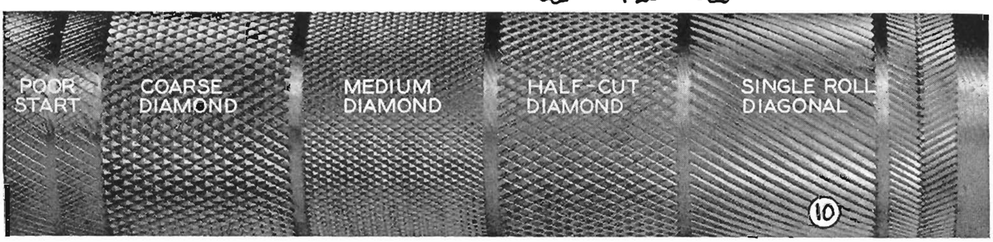
Above, taper turning by the set-over method. Length of work must always be considered.

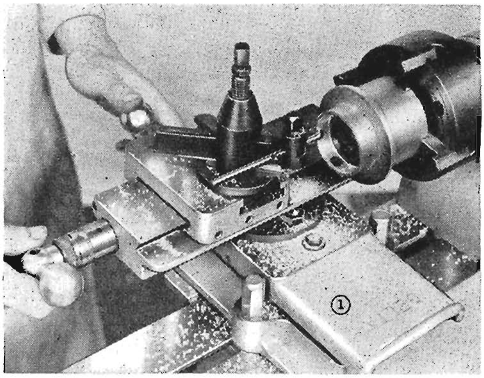


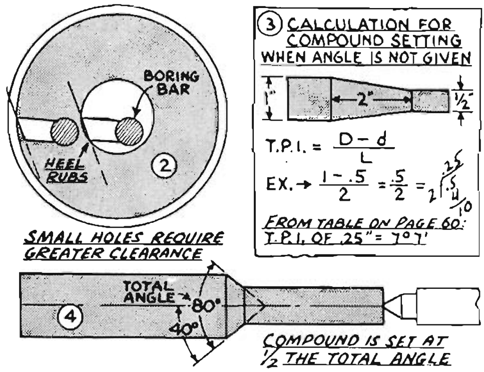




Knurling requires heavy pressure. Photo below shows various patterns.







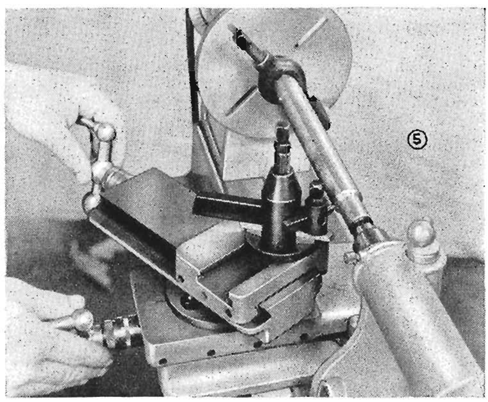
Internal cutting or boring is done with a boring bar mounted in boring bar holder.

or passes will usually produce a full knurl. Any poor starts will iron out. The diagonal knurl, Fig. 10 on previous page, can be made with a regular diamond knurler by turning tool over and using just one wheel, as in Fig. 5. The heavy pressure required for knurling may cause the feed screw of slide rest to slip—tighten the collar screw under base as much as possible for this work.

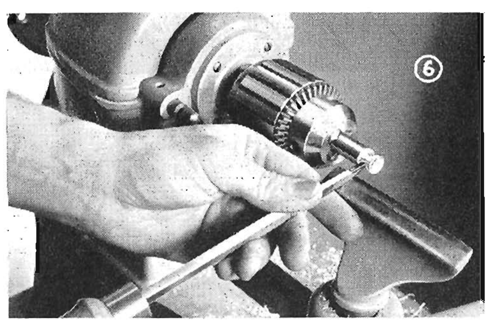
Boring.—Boring is done with a boring tool mounted in the boring tool holder, as can be seen in Fig. 1. Always use the largest boring bar possible, and extend it no more from the tool holder than is necessary. Watch your clearance angle — note, Fig. 2, that a small hole requires more clearance on tool than a large hole.

Compound Tapers.—Good tapering can be done by setting the compound at the required angle. This method is always used for fast tapers and inside tapers, neither of which can be worked by the set-over method. On some jobs, the taper angle is given, and the compound setting is simply one-half the total angle, as shown in Fig. 4. The compound can be rotated either way from center to make the cut, Fig. 5. If dimensions only are given, apply the formula in Fig. 3 to find the taper-per-inch. Then, consult the table on page 60 for the required compound setting. Unlike the set-over method, the total length of work does not enter into calculations for compound setting. If you are cutting a standard taper, such as a No. 2 Morse, the compound is quickly and accurately set by mounting a No. 2 Morse taper in the lathe and setting the compound to match. This direct system can also be used for set-over tapering provided the work is made the same exact length as the test piece.

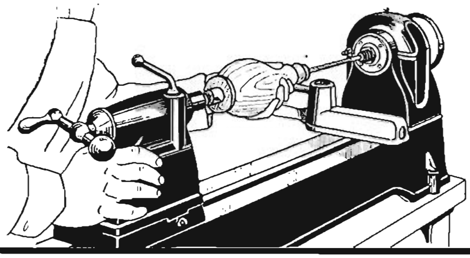
Freehand Turning. — The use of the compound slide rest is largely confined to straight surfaces. About the best you can do on a curve is to rough it in by working both feed handles at once, cleaning up with a file and sandpaper. A much better system is the use of carbide-tipped hand tools. These can be used with the regular woodturning tool rest,



Above, tapering with compound. Photo below shows carbide chisel used for freehand turning.



as shown in Fig. 6. The extreme hardness of tungsten carbide permits a much higher spindle speed which contributes greatly to the smoothness of work and ease of operation. Use the speeds tabulated in the appendix. The general handling of carbide tools is much the same as high speed steel, using negative rake for brass and plastics and a slight positive rake for steels and aluminum. The tool should be kept moving. Because carbide is hard it is also somewhat brittle, hence shock loads and rough plunge cuts must be avoided to prevent chipping the tool.



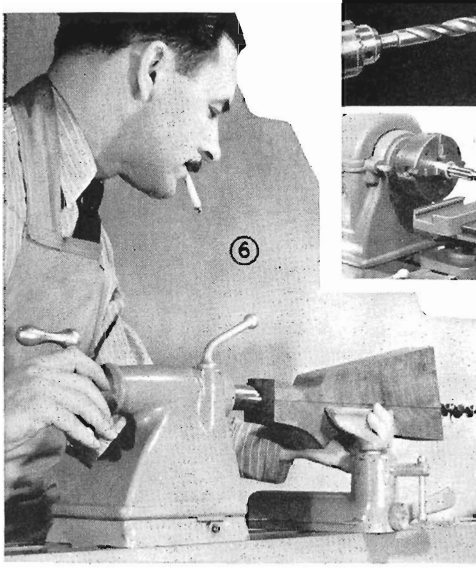
The Use of DRILLS *and* TAPS

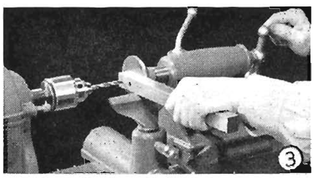
DRILLING in the lathe is an essential operation in wood and metal turning. Threading with the use of taps is an allied operation since the hole for the tap must first be drilled. Because the wood or speed lathe has no lead screw mechanism, taps and dies provide the only method of doing threading work.

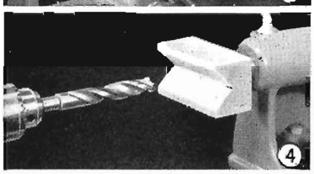
Drilling.—Two general methods are used in drilling. The first and main method calls for holding the drill stationary in a chuck mounted in tailstock, while the work, mounted on lathe spindle, revolves, as shown in Fig. 1. The feed is usually made with the tailstock feed handle, as shown. Specific depths of drilling can be set by making a pencil mark on the drill or on the tailstock spindle, or, by wrapping a piece of adhesive tape around the drill. In the second method of working, Fig. 2, the drill revolves while the work is stationary. The feed can be made by pushing on the tailstock, Fig. 2, or by using the screw feed, Fig. 6. The latter operation shows how boring is done from both ends of the work, using the 60° center in tailstock.

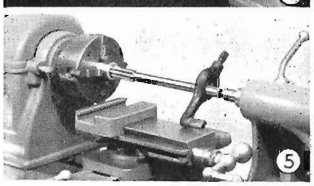
Drilling Accessories. — A type of miniature drill table

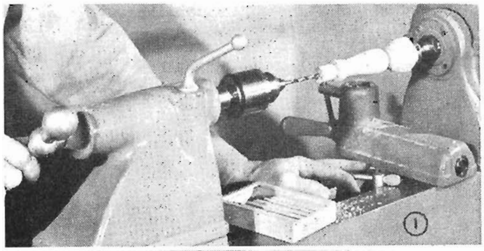
Long holes can be worked by drilling from both ends, as shown below.







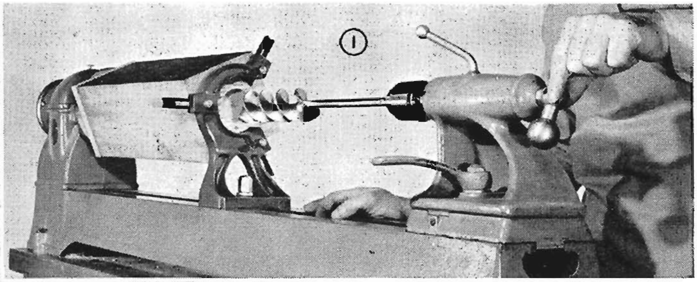


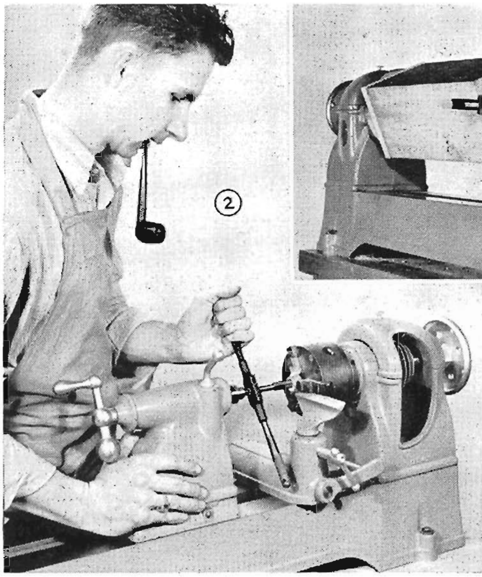


Drilling can be done from headstock or tailstock, as shown.

is mounted in the tailstock when the lathe is used as a substitute for the drill press. The pad center, Fig. 2, is used for all flat work, and is combined with a wood facing if the drilling operation is in wood, the same way as a base block is used on the drill press. The pad center itself is made from a Delta No. 2 Morse adapter on which is mounted a Delta faceplate with ½ inch hole. The crotch or vee center, Fig. 4, can be made from a piece of hardwood mounted on the single screw center. The assembly should be carefully assembled in order to be in alignment with the headstock spindle. The crotch center is used for boring holes crosswise through round stock.

Reaming. — Reaming provides the best method of producing a smooth and accurate hole, as required for bushings and other precision fits. The operation in general is carried out in the same way as a drilling operation except the lathe speed should





Top, drilling a large turning supported with center rest. Above, a tapping operation. Drawing below shows styles of taps used.

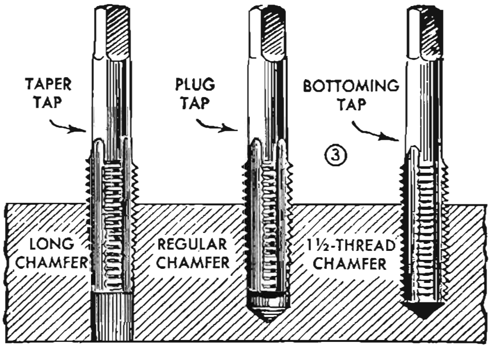
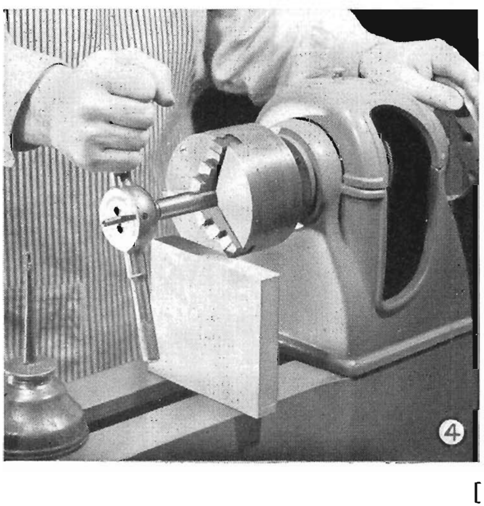


Photo below shows die being used to cut a ¼-20 thread. After a start has been made, the die is reversed to run the thread up to the shoulder.

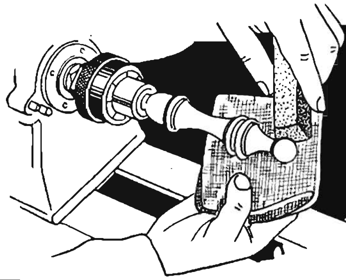


be reduced to about two-thirds of what would be correct for a similar size drill. Drills and reamers having shanks too large to fit in the Jacobs chuck can be worked on a 60° center, as shown in Fig. 5, the lathe dog riding the slide rest preventing the reamer or drill from turning. Holes for reaming should be drilled or bored to within 1/64 inch of the required size, leaving just enough stock for the reamer to make a finishing cut.

Use of Center Rest.—When long work is mounted in a lathe chuck for end boring, the free end is supported by the center rest. Methods used are described on other pages. Fig. 1 on this page shows how work beyond the capacity of the center rest is worked by nailing a wooden ring to the end of work.

Tapping.—The common tapping job done in the lathe is pictured in Fig. 2, the tap being advanced by hand pressure against the tailstock while the tap wrench is used for rotation. The lathe is not under power. Tool rest under chuck jaws, as shown, provides a positive stop and permits the tap to be given a backward turn as needed to break the chip. Always use plenty of threading or cutting oil when doing thread work. The tap used is usually a plug tap, as shown at center of Fig. 3. This has a normal chamfer at end. The bottoming tap has a full thread almost to the end, and must be used if a blind hole is to be threaded right to the bottom. The taper tap is usually used for hand tapping without a guide, the long taper providing accurate entry into the drilled hole. All tap holes should be drilled in accordance with tap and drill tables, as given in the appendix.

Use of Dies.—Dies are used for cutting external threads, and can be obtained in round and square styles. The die is held in a stock, which consists of a collet to hold the die and a guide to center it on the work, together with two handles by which the stock is turned. Better quality dies usually have a screw adjustment so that they can be made slightly larger or smaller than normal. This provides for tight or running thread fits, and also allows large threads to be cut in two bites. Work for die threading should be turned to nominal size, that is, a few thousandths less than the specified thread diameter. The end of the piece should be chamfered to provide easy starting. As in tapping, plenty of threading oil should be used, and the die should be given a reverse twist after each full turn to break the chip.

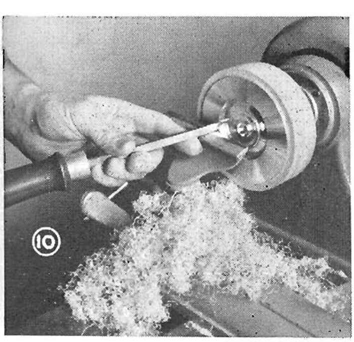


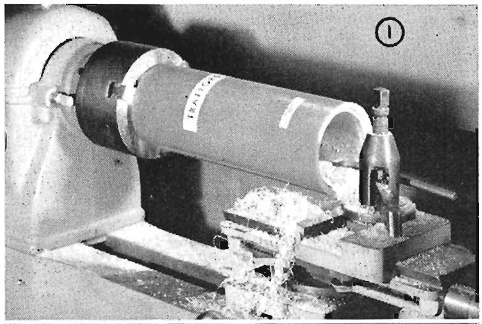
How to Turn PLASTICS

MOST plastics are easy to turn, being midway between wood and the soft metals in hardness and general machinability. Two varieties are commonly used in craftwork: (1) Cast resins or *phenolics*, as represented by Catalin, Bakelite Cast Resinoid, Trafford, Marblette, Gemstone, and Opalon; (2) Methyl methacrylate or *acrylics*, which are sold trade named Plexiglas and Lucite. Other varieties sometimes encountered are the *laminates* consisting of resin and cloth or paper laminated, represented by such products as Formica, Insurok, Micarta, and the *molded phenolics* incorporating a filler, such as Bakelite, Textolite, Durez and Durite. Laminates and filled plastics are usually very abrasive and are best turned with carbide tools; the more common cast resins and acrylics are readily turned with ordinary wood turning chisels.

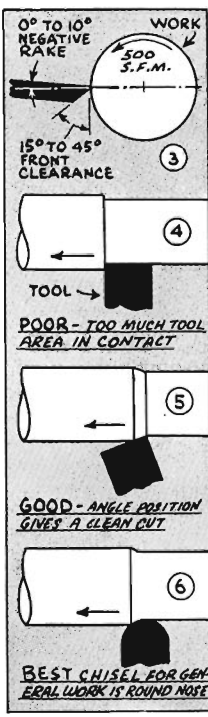
How to Turn.— Practically all plastics should be turned with a tool having negative rake, Fig. 3. If you are using handled chisels, this means the handle end is held a little higher than the cutting point. The speed of the work should be about 500 surface feet per minute (see table on page 61 to convert to r.p.m.). The area of tool contact must be held to a minimum. Fig. 4, for example, shows a wide, ½ inch flat nose chisel in full contact with the work. The result is difficult cutting and chatter, and the evidence is a powdery or sandy chip. When plastic is properly turned, the chip is always like a thin ribbon—if you don't get this ribbon chip, stop the lathe and figure out what is wrong. Fig. 5 shows the right

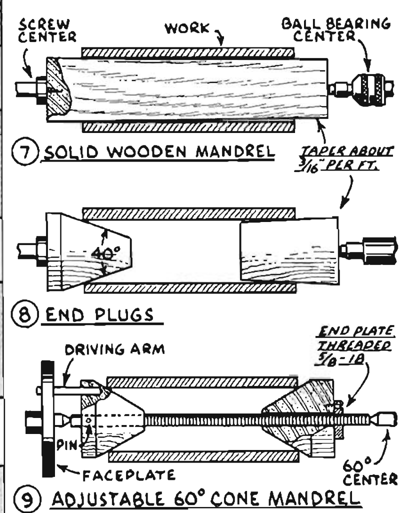
Recessed chucks, below, and other methods used in faceplate turning in wood can be used for mounting plastics.



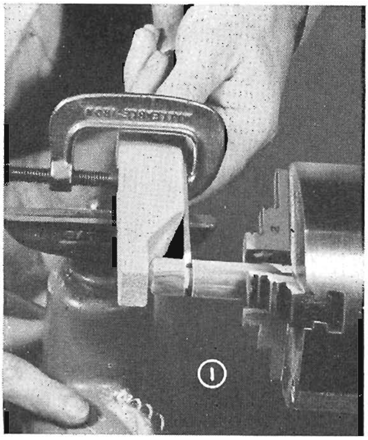


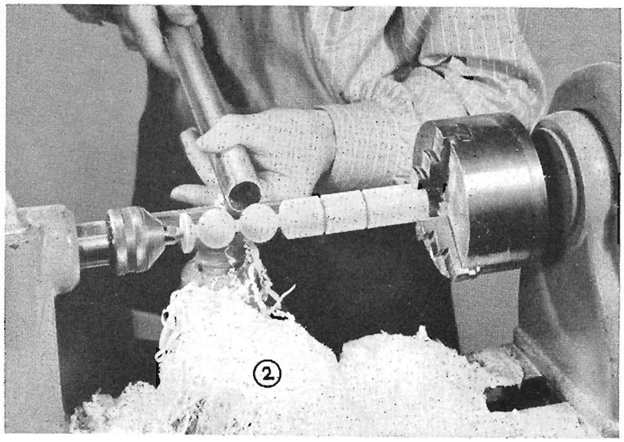
Above, use of three-jaw chuck and collet chuck in turning plastics. Below, three methods of mounting cylinders.



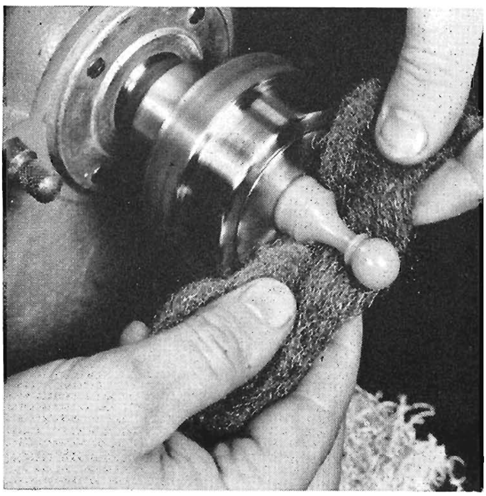


3 WAYS TO CHUCK A CYLINDER





Ball tool made from a length of tubing cut square across the end does excellent work in turning round plastic balls. Below, polishing with steel wool.

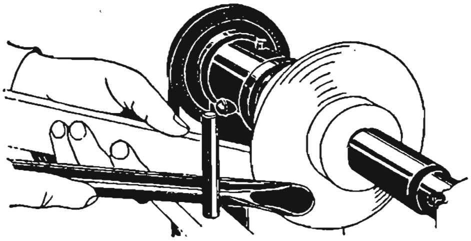


way to work a flat nose chisel. Fig. 6 on previous page shows the round nose chisel in use—it is the best chisel for general work. The spearpoint is also useful, but should always be slightly skewed to reduce the cutting area to about 1/8 in., like Fig. 5. Carbide chisels are almost a must for laminates and molded phenolics, both of which are so abrasive as to turn the edge of a standard woodturning chisel in less than two minutes. They are also useful for some of the harder cast resins.

Mounting the Work. — Plastic rods are mounted in the same manner as similar metal work, that is, between centers or held in a chuck. Fig. 1 on previous page shows a cylinder in the three-jaw chuck. Fig. 2 pictures a large rod held in the collet chuck. Lacking a chuck, cylinders are usually mounted on a solid wooden mandrel tapered about 3/16 inch per foot, as shown in Fig. 7. The plastic cylinder itself has a slight inside taper and should be fitted to the mandrel with large end toward headstock, the same as the mandrel. Fig. 8 is a somewhat similar method of working, but has an advantage in that the driving plug can be used for a number of different sizes of cylinders. The tail plug, however, must be a tight taper fit. Fig. 9 pictures an adjustable cone mandrel which is worthwhile making if you do a lot of turning on plastic cylinders. It should be made up with a 5/8 in. threaded spindle about 12 in. long. Flat plastic stock is usually mounted by screwing to a wood backing block. The use of a recessed chuck, Fig. 10, and in general all methods used for faceplate work in wood can be used.

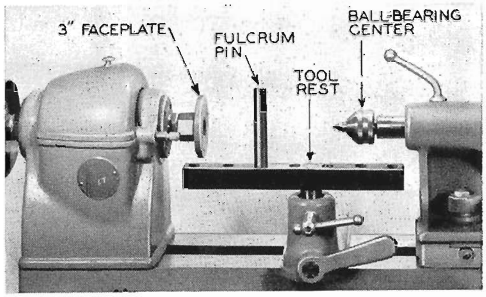
Plastic Balls.—Plastic balls are rough-turned in the usual manner and are then brought to a perfect round by using a tube tool, as shown in Fig. 2 above. The tube should be a little less in diameter than the ball. The tool can be brass or steel and is sharpened with a simple square-across cut. Balls can be worked in series, as shown, or each ball can be worked up separately. Fig. 1 shows how to use a spacer clamped to the parting tool to set the work length. After rough turning with spearpoint chisel, the ball tool is used and it will smooth the whole surface except the small neck needed for driving.

Polishing.—This requires the successive use of various grades of sandpaper, followed by buffing compounds. Various schedules can be followed. Usually, 150-grit is as coarse an abrasive as ever needed, even for deep turning marks. This should be followed by 240, 320 and 400-grit, these grits preferably wet-or-dry paper, used wet. Dry sanding throughout is practical, but it wastes a lot of paper by clogging whereas the water lubricant keeps the paper clean. Fine steel wool can be used for final polishing, and also does a fair job when used following 240-grit sandpaper. The highest polish is obtained with fine buffing compounds applied with a cloth to the revolving work.



METAL SPINNING

METAL SPINNING is an enjoyable and novel branch of lathe work. Unlike either wood or metal turning, the work is not cut away to form a desired shape, but is formed by means of "spinning" the metal blank over wood or metal forms or chucks. The work is not difficult, especially with soft metals such as pewter and aluminum. Any lathe with substantial headstock bearings can be used provided it has a speed range covering 900 to 1400 r.p.m. The power unit is preferably ½ h.p., although satisfactory light spinning can be done with less power.

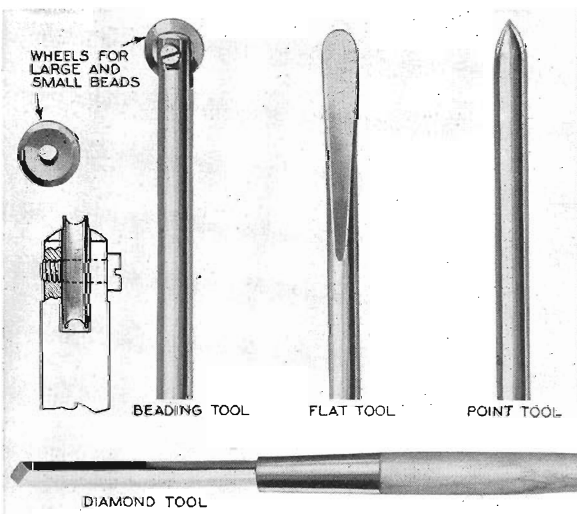


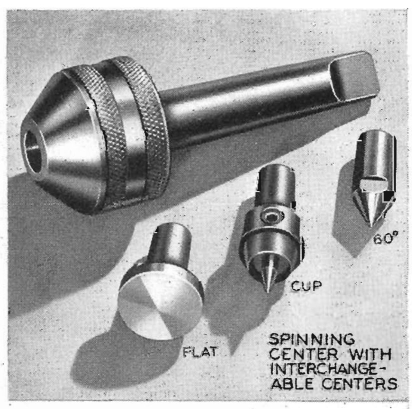
Any substantial wood lathe can be used for metal spinning. Photo shows special center and tool rest required. Tools are shown in lower photo.

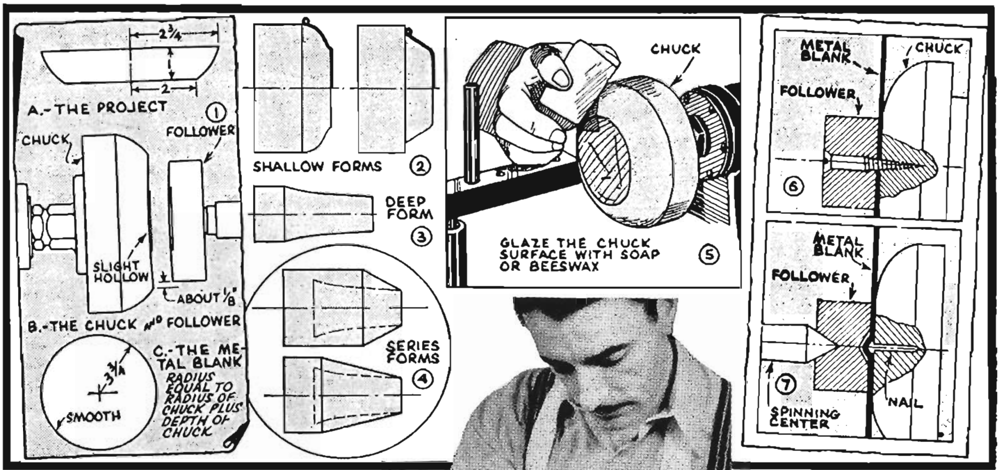
Accessory Equipment.—Accessory equipment required includes a ball-bearing or "live" center and a special type of tool rest with fulcrum pin, as shown in upper photo. Although there are many styles of ball-bearing centers, the type recommended for homecraft work is one having interchangeable centers, as shown in lower photo. This is useful for a wide variety of work other than metal spinning.

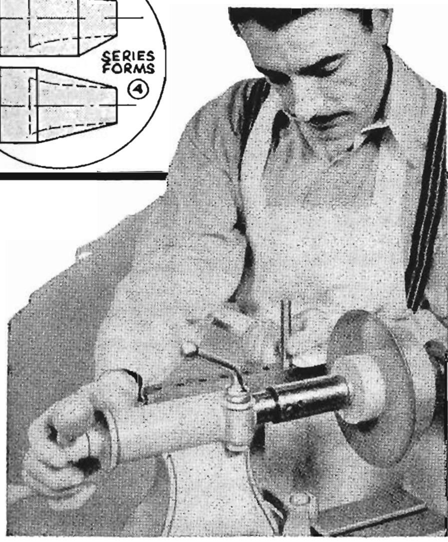
Tools.—Many tool shapes are used in forming the metal to shape, but the four patterns pictured in lower photo will cover most operations. The *flat tool* is the most important. It is a double-faced tool, being round on one side and flat on the other. The round side is used to break down the metal blank almost to the chuck surface, while the flat side is used for smoothing operations. The *point tool* is both a forming and finishing tool, being particularly useful on small work. The *beading tool* is used to turn the rim of the metal disk into a lip or true bead. The forming wheel rotates freely within the holder, and is interchangeable with other sizes to suit the dimensions of the required bead. The *diamond tool* is a cutting tool, used for cutting-off or trimming the metal.

All spinning tools must be hardened steel and must be highly polished in order to avoid friction or marking the work. The overall length of each tool is 24 to 30-inches. Soft metals can be successfully spun with the use of oval or round tools of hickory or maple. The *back stick* (not shown) is also made of wood, and can be a length cut from an old broom









Drawing above shows types of chucks and methods of centering. Photo at left shows centering with the back stick.

handle and sharpened to a dull, flat point like a chisel. This is used to back up the metal during the spinning operation.

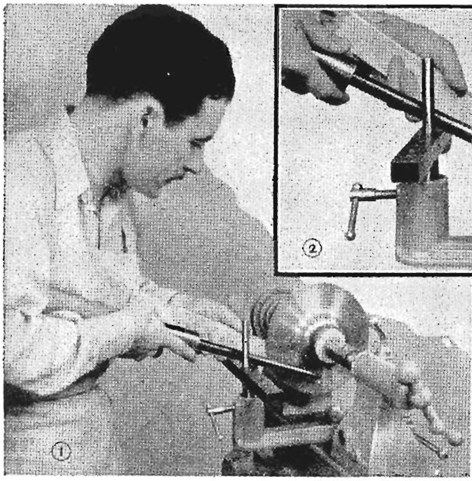
Setting-Up.—Any spinning demands (1) a chuck, (2) a follow block, (3) the metal blank. Fig. 1-A shows a typical simple project—a shallow tray. A wood chuck must be made up to the exact shape of the proposed tray, using any good-grade hardwood. It is good practice to turn the chuck an inch or so longer than the proposed spinning so there will be some space between the finished spinning and the faceplate. The follow block or follower is now turned to shape, either on a separate faceplate or by simply gripping it between the chuck and the spinning center. It should be at least 1 in. thick, and of a diameter from ⅛ to ¼-in. less than the base diameter of the project, as shown in Fig. 1-B. The drawing shows the base of the chuck slightly concave and the end of the follower slightly convex. This form of shaping should be followed wherever practical, since it affords better gripping of the metal blank while adding to the stability of the finished spinning. Fig. 1-C shows the metal blank for this particular spinning. In all metal spinning, the radius of the blank should be equal to the radius of the project plus the depth of the project. The blank should form a perfect circle with a smooth edge all around.

Fig. 2 shows other representative forms of shallow chucks or forms. Fig. 3 shows a deep form, such as would be required for a metal cup. It is evident that the deeper form is more difficult to spin than the shallow form since the metal must be drawn to a greater extent. Series chucks are sometimes employed in spinning deep forms, as shown in Fig. 4, the metal being successively spun over three or four different shapes to gradually result in the finished form. The idea, of course, is to afford a positive support for the metal throughout the various stages of spinning.

All wood chucks should be glazed with soap or beeswax, as shown in Fig. 5. This is done after sanding, the soap or wax being forced into the pores of the wood with the flat tool while the chuck is revolving.

Centering.—The final operation before spinning is to center the metal blank. Where a hole in the center of work is permissible, direct fastening, Fig. 6, is recommended. Another way is to indent the center of the disk and fit it over a round-head nail, as shown in Fig. 7. In the ordinary method of centering, the clamping pressure is backed-off while the back stick is pressed firmly against the slowly revolving disk. The photo above shows the operation being done. If the disk is round and smooth, it will center perfectly, after which the follower is again set firmly. Lubricate the metal on each side with cup grease and you are all set to spin.

Spinning the Metal.—The first operation in spinning calls for the flat tool. This is placed on the rest, to the left of the fulcrum pin. Now, with one or two sweeping strokes of the round side of the flat tool, the disk is seated against the base of the chuck. The back stick is now brought into play, holding up the metal on one side while the flat tool



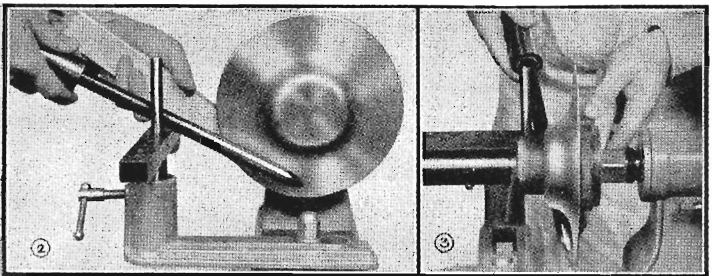
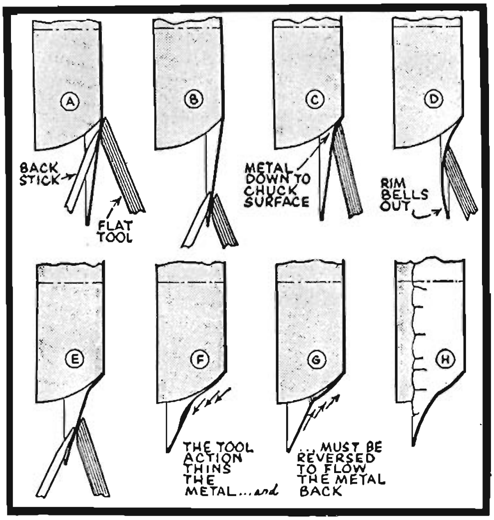


Photo at left shows the general position of the operator in doing metal spinning. The pictures above show two views of proper tool placement. Diagram below shows various points in spinning.

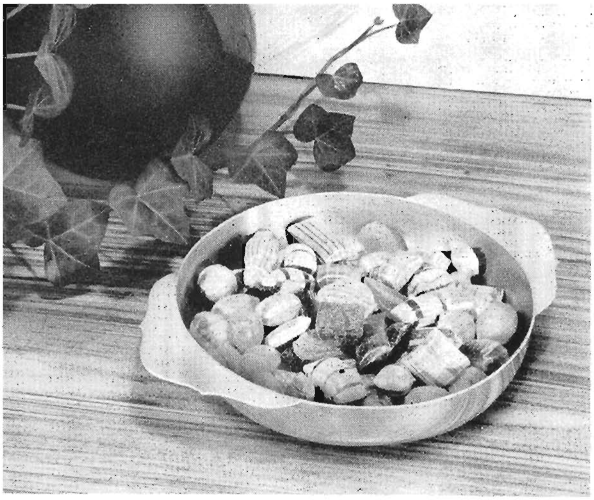


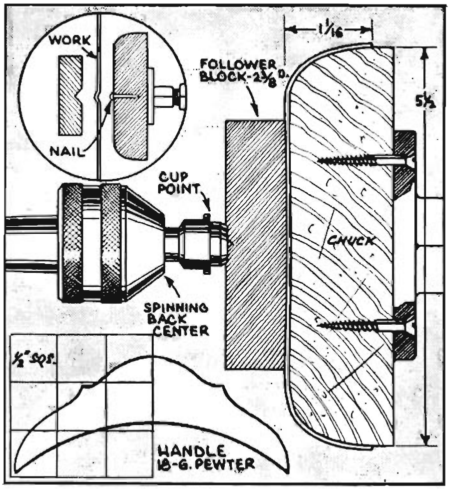
presses against the opposite side. The general position of the worker can be seen in Fig. 1. Figs. 2 and 3 show how the tool contacts the work well below center. The tool action is a sweeping stroke, effected by a hunching movement of the shoulders.

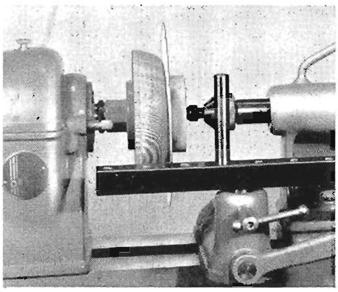
Various points essential to good spinning are shown in the d.agram. At A is shown the first operation, the flat tool pressing against the disk while the back stick supports the opposite s.de. B shows tool and back stick at outer end of stroke. After shape B is obtained, the flat tool alone is used to force a small portion of the metal into contact with the chuck. The outer part of the metal must be kept straight, like a shallow funnel, and should not be allowed to bell out, as at D. As quickly as any tendency to bell is noted, attention should be given to spinning the rim to a straight funnel shape, as at E. The two essential operations—crowding a small portion of the metal to the chuck surface and keeping the rest of the disk funnel-shaped—are carried out in successive operations until the whole shape is complete. The work must be kept lubricated at all times. The general stroking action should be reversed at intervals (see F and G) in order to prevent thinning of the metal. Buckling, H, is usually caused by rushing the work. That is, in attempting to get an immediate finished shape, the operator will press the work hard at the position shown at D. This causes the rim to bell out, and later attempts to spin it back to a true funnel-shape usually results in a buckled edge. Keep in mind that spinning takes time—you don't bear down and form the shape in a couple minutes. If you are working brass or copper, anneal frequently (see table in appendix). It is easy to detect stiffness and resistance of the metal during spinning, and that means annealing is in order.

Metals to Use.—Soft metals suitable for spinning include pewter, gold, silver, brass, copper, aluminum, zinc and magnesium. Harder metals include monel, German silver and steel. The most popular selections are pewter, aluminum, copper and brass. Gold and silver are easy to spin, but high cost makes them prohibitive—in any event, don't tackle this work until you are an expert.

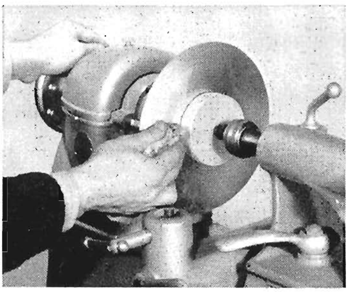
Pewter is a good starting choice because it spins easily and does not require annealing. Its only fault is that it is a bit too yielding to stand rough treatment. The gage commonly used is No. 18, which is .040 in. thick and weighs 25 oz. per square foot. Aluminum is another metal which spins easily without annealing. There are many different aluminum alloys and it is important that you get the dead soft spinning grade (Alcoa 2S-0 or equivalent). From dead soft this spins up just about right during the course of an average job. The gages commonly used run from 16 to 22. Copper is an excellent spinning metal, but must be annealed. Gages used are from 22 to 26, the lighter metal (No. 26) being used for shallow forms. Within the gages listed, the lighter metal is the more difficult to spin because it yields more readily and a bit too much pressure may force it hopelessly out of shape. Brass runs about the same as copper except it requires annealing more frequently. Pewter, aluminum, brass and copper disks suitable for spinning can be purchased from metal supply houses.



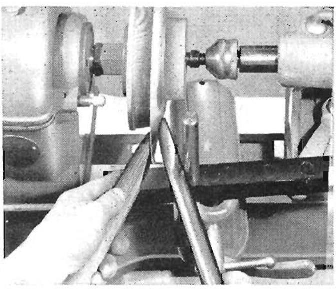




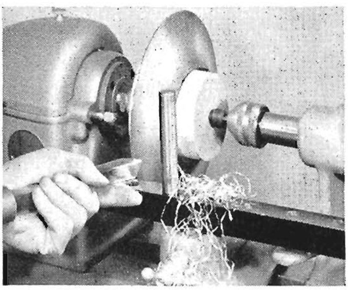
1—Center the disk between chuck and follower. An optional nail centering method is shown.



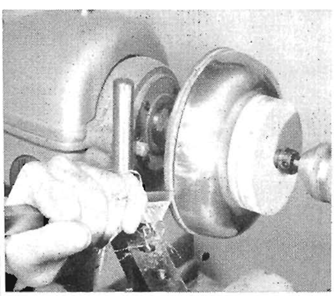
2—Lubricate the surface of disk with a mixture of soft soap and machine oil. Cup grease can be used.



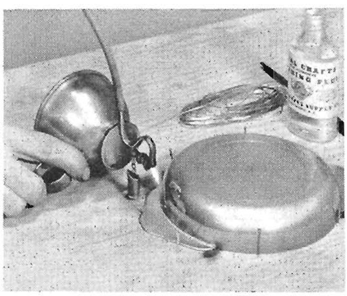
3—Make a back stick by sharpening a length of 1 in. dowel to a blunt point. Use this as a support when spinning.



4—Keep the disk round by trueing it up at intervals with the cut-off tool. Uneven edges cause distortion and warping.



5—After spinning down tight to the chuck surface, cut the disk free with diamond tool and dress to a smooth square edge.



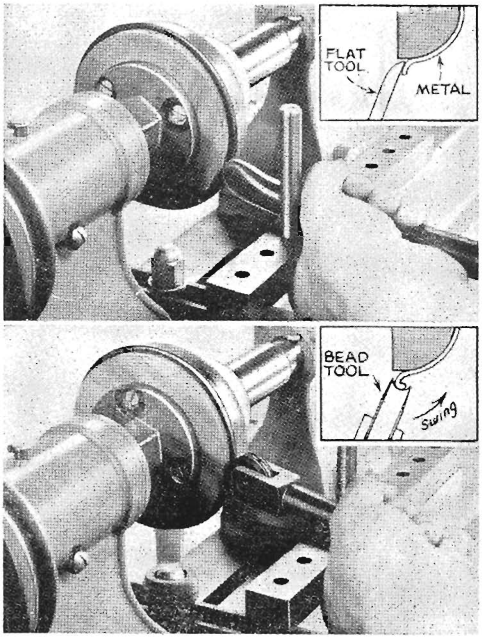
6—Solder the pewter handles in place, using pewter solder and applying heat carefully with an alcohol blow-pipe.

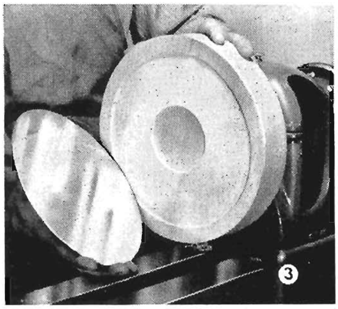
Pewter Nut Bowl.—This project makes a good starting piece in metal spinning. You will need a 7-inch disk of 18-gauge pewter. Steps in the mounting and forming of the metal are shown in photos at left and drawing above. The two handles are cut from similar metal and are soldered in place. Pewter is one of the nicest metals to solder since well-made joints are easy to make and are invisible after the work has been polished. To solder, place a length of wire pewter solder along the joint after painting the joining parts with flux. The flux can be purchased or made by adding 10 drops of hydrochloric acid to 1 ounce of glycerin. Heat is applied to the solder by means of an alcohol lamp. The solder will first form into little bubbles and then suddenly become completely liquid and run into the joint. Care should be used in applying the heat since the melting point of pewter is very close to that of pewter solder. Solder should be used sparingly—too much makes a sloppy job which must be filed smooth.

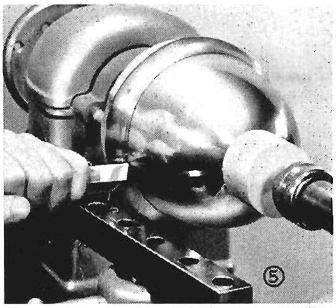
Spinning itself is quite simple since the form is comparatively shallow. A lathe speed of about 900 r.p.m. is satisfactory. Pewter shapes up easily and no great amount of pressure need be applied on the spinning tool. The back stick should be used during early stages of spinning to support the work. Polish the finished dish with fine steel wool, pumice or other fine abrasive. It will sparkle almost like chromium and will not tarnish.

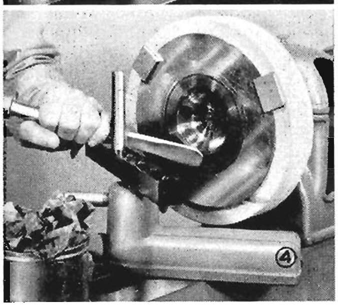
Spinning a Bead. — Projects in thin metal sometimes have beaded instead of plain edges. This operation is done with a beading tool. The raw edge of the metal is first trimmed square, using the diamond cut-off tool. The point of the flat tool is then used to lift a small portion of the metal from the chuck surface, as shown in top photo at right. Some trimming of the chuck may be needed in order to permit lifting the metal. It is a good idea to again trim the metal after lifting the edge. Once the edge is lifted, the beading tool is used as shown in second photo to turn the metal over. A little experience is required for good work.

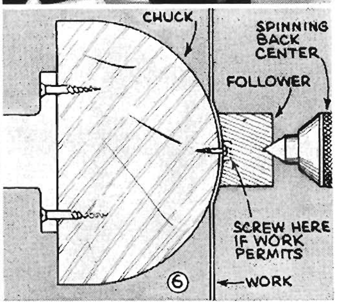
Spinning a Ball.—Two chucks are required in spinning the ball shape. It can be seen that the immediate use of the ball-shaped chuck is impossible since the work cannot be centered or held by a follow block against the curved end surface. Instead, a starting chuck must be made and used, as shown in Fig. 3. This has a recessed rim which serves to hold and center the metal blank. The center is hollowed out to the same contour as the ball chuck, and the edges of the hollow should be feathered-off to prevent making a hard ridge on the work. Fig. 4 shows the metal being spun into the hollow of the starting chuck. Note the small







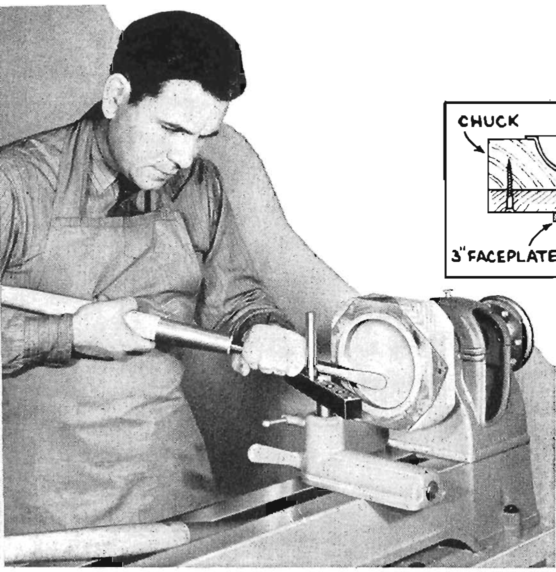




Above, how the edge of the work is turned over to form a bead. Left, spinning the ball shape with starting chuck.

blocks of wood nailed around the rim of chuck to keep the work in position. After spinning the starting shape, the work can be transferred to the ball chuck, Fig. 6, for spinning in the usual manner. If the work permits a center hole, it is good practice to use this hole to screw-fasten the partially spun work to the ball chuck. Fig. 5 shows the work being cut to size with the cut-off tool. Spinnings will usually show slight irregularities and tool marks. These should be worked out by using the flat side of the flat tool. The tool must be highly polished to do good work. A speed of about 1800 r.p.m. can be used for this operation. Heavy pressure should not be used—stroke lightly and keep the tool moving. Final polishing is done with steel wool, followed by fine pumice and oil applied with a cloth.

Hollow Chucks.—Shallow projects such as ash trays and plates can be worked entirely on a hollow chuck, the job being similar to the starting chuck used for the ball shape. Fig. 1 on the following page shows a hollow chuck for an ash tray. In common with all spinning chucks, the wood should be hard, even grain, such as maple, birch or cherry. Avoid yellow pine, fir, and other grainy woods—the grain patterns will show on the finished work. Fig. 3 shows the chuck being glazed with soap; Fig. 4 shows how the metal blank is screw-fastened to the chuck. After that, it is simply a matter of spinning the work down to the chuck surface, using hardwood sticks or the conventional spinning tools. A smooth even pressure should be used. The metal which covers the face of the chuck should be kept flat and smooth. Stroke from rim to center

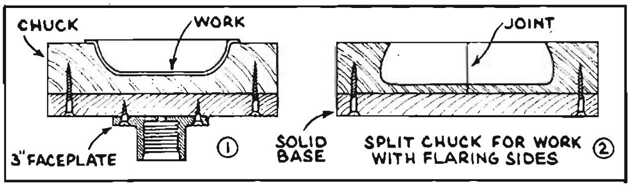


Either standard or homemade hardwood tools can be used in spinning shallow forms on hollow chucks.

and then back to rim again. After the metal is down tight to the chuck surface, the work can be polished and then cut free with the cut-off tool, as shown in Fig. 5. If you have a spinning center, it is advisable to use it with a round block of wood at this stage, since otherwise the work will be unsupported when finally cut free. If a spinning center is not available, a dowel stick should be pressed against the center of the work as the cut nears completion.

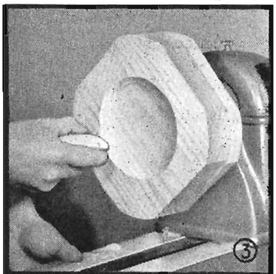
A depth of about one-quarter the diameter of work is the maximum which can be worked with a hollow chuck. The sample piece shown in the photos is 22-gauge (18 oz.) copper. In a shallow form, this will require one anneal, which is done by bringing the work to a dull red and then quenching in water. The scale coating which forms can be cleaned off with a pickling solution of 5 to 10 percent sulphuric acid in water, as shown in Fig. 7.

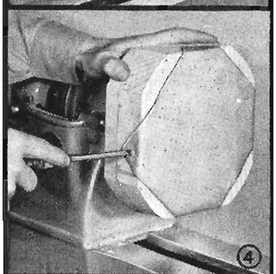
Split Chucks.—Hollow chuck spinning of work with flaring edges requires the use of a split chuck. The construction of this can be seen in Figs. 2 and 6. The joint is made

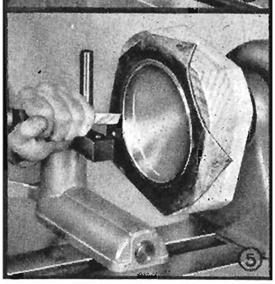


previous to turning, and must be a clean fit to prevent mark-off on the metal disk. After the spinning is complete, the screws holding the chuck together can be removed to permit disassembly of chuck and removal of work, Fig. 6.

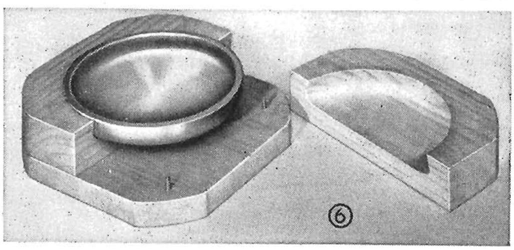
Sectional Chucks.—Any form having a neck or opening smaller in diameter than some other portion of the work (see Fig. 1 on opposite page) must be spun on a sectional chuck. The sectional chuck is simply a built-up form, so arranged that the various pieces can be removed one by one from the inside of the finished work. A starting chuck is always used in connection with the sectional chuck, the metal being spun over this and then switched to the built-up form. As far as it goes, which is to the widest part of the proposed project, the shape of the starting chuck must be identical with the shape of the sectional chuck. The sectional chuck itself consists of a main body which carries the shape from the mouth of the project to its narrowest part, as can be seen in Fig. 3. At this point, the main body is reduced to a cylindrical core having a diameter from 1/2 to 3/4-in. less than the smallest diameter of the project. Around this core are grouped the various segments, all of which are wedge-shaped with the exception of the key piece which is straight sided. The annular groove in the main body of the chuck takes a corresponding rim turned on the segment portion.

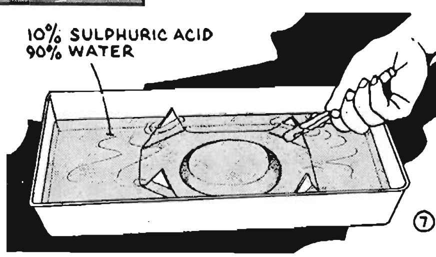

③


④

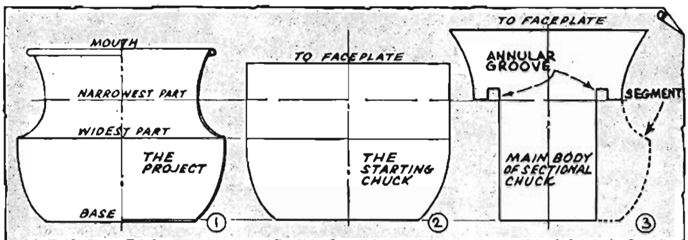

⑤

In making a sectional chuck, the main body is


⑥



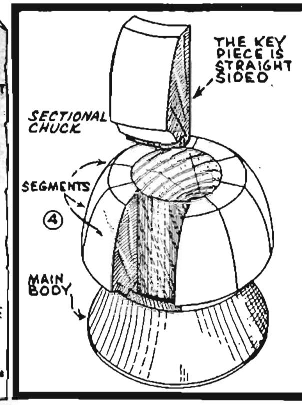
⑦



① A TYPICAL FORM WHICH CANNOT BE SPUN ON A ONE PIECE CHUCK, BUT MUST BE SHAPED OVER A SECTIONAL OR BUILT-UP CHUCK.

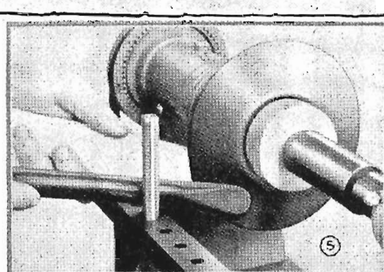
② THE STARTING CHUCK IS USED FOR THE INITIAL SHAPING OF THE METAL BLANK. IT CARRIES OUT THE SHAPE OF THE PROJECT FROM THE BASE TO THE WIDEST PART. IT MUST BE THE SAME SHAPE AS THE SECTIONAL CHUCK.

③ THE MAIN BODY OF THE SECTIONAL CHUCK CARRIES THE SHAPE FROM THE MOUTH TO THE NARROWEST PART OF THE PROJECT WHERE IT IS REDUCED TO A CORE ½ TO ¾-IN. LESS THAN THE SMALLEST DIAMETER OF THE PROJECT.

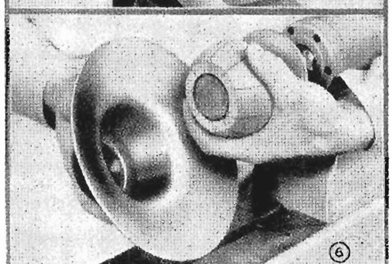


④

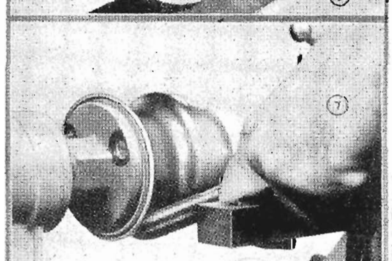
turned first. The segment portion, in a solid block, is then rough turned to approximate dimensions. A ¾ in. hole is drilled through the center. The turning is then removed from the lathe for the cutting of the various segments. These range in number from 6 to 12 pieces, depending upon the size of the opening through which they must be withdrawn. The saw cuts are then sanded smooth and the segments glued back in their original position, using glazed paper at the joints. The turning is then finished to exact size, carrying out the shape of the project externally and fitting the main body of the chuck internally. After sanding and glazing, the various segments are again separated.



⑤



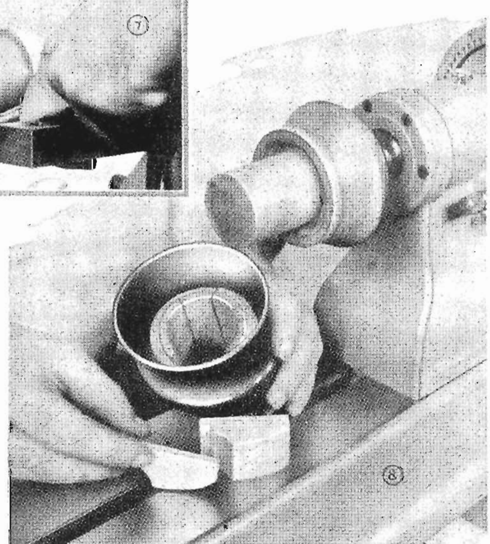
⑥



⑦

Spinning over a sectional chuck is carried out in much the same manner as spinning over a one-piece chuck. Fig. 5 shows the initial shaping over the starting chuck. After this is finished, the sectional chuck main body is mounted in place, with the segments held in place by hand, as shown in Fig. 6. It is apparent that the partly-formed spinning will hold the segments securely in place so that the rest of the shape can be formed, as shown in Fig. 7. After the spinning is completed, it can be slipped bodily from the main body of the sectional chuck, after which the key piece and then the other segments can be withdrawn, as shown in Fig. 8.

For the average work, the gluing of the sectional chuck can be dispensed with by simply turning the segment portion to finished size and then sawing with a very fine scroll saw or band saw blade. By allowing a little for the various saw kerfs, a sufficiently accurate form can be made in this manner. If the chuck is to be made in metal, the same general procedure as first described is followed, sweating the segments together with solder. Much of the success of spinning on a sectional chuck depends on the chuck itself. If it is a poorly fitted assembly and shifts under tool pressure, it is almost impossible to produce a good spinning. When the chuck is well-made, spinning on a sectional chuck is no more difficult than a similar draw over a one piece chuck.



⑧

APPENDIX

TAP DRILL SIZES FOR 75 PER CENT THREAD

Tap	Threads	Drill
1/8	40 N.S.	38
3/16	24 N.S.	26
1/4	20 N.C.	7
1/4	28 N.F.	3
5/16	18 N.C.	1/4
5/16	24 N.F.	17/64
3/8	16 N.C.	5/16
3/8	24 N.F.	21/64
7/16	14 N.C.	3/8
7/16	20 N.F.	25/64
1/2	13 N.C.	27/64
1/2	20 N.F.	29/64
9/16	12 N.C.	31/64
9/16	18 N.F.	33/64
5/8	11 N.C.	17/32
5/8	18 N.F.	37/64
11/16	11 N.S.	19/32
11/16	16 N.S.	5/8
3/4	10 N.C.	21/32
3/4	16 N.F.	11/16
13/16	10 N.S.	23/32
7/8	9 N.C.	49/64
7/8	14 N.F.	13/16
7/8	18 N.S.	53/64
15/16	9 N.S.	53/64
1	8 N.C.	7/8
1	14 N.F.	15/16

FOR MACHINE SCREW THREADS

Tap	Threads	Drill
0	80 N.F.	3/64
1	64 N.C.	53
1	72 N.F.	53
2	56 N.C.	50
2	64 N.F.	50
3	48 N.C.	47
3	56 N.F.	45
4	40 N.C.	43
4	48 N.F.	42
5	40 N.C.	38
5	44 N.F.	37
6	32 N.C.	36
6	40 N.F.	33
8	32 N.C.	29
8	36 N.F.	29
10	24 N.C.	25
10	32 N.F.	21
12	24 N.C.	16
12	28 N.F.	14
1/4	20 N.C.	7
1/4	28 N.F.	3
5/16	18 N.C.	1/4
5/16	24 N.F.	17/64
3/8	16 N.C.	5/16
3/8	24 N.F.	11/32

DECIMAL EQUIVALENTS

	1/64	=	.015625	
	1/32	=	.03125	
	3/64	=	.046875	
1/16 =	4/64	=	.0625	
	5/64	=	.078125	
	3/32	=	.09375	
	7/64	=	.109375	
1/8 =	8/64	=	.125	
	9/64	=	.140625	
	5/32	=	.15625	
	11/64	=	.171875	
3/16 =	12/64	=	.1875	
	13/64	=	.203125	
	7/32	=	.21875	
	15/64	=	.234375	
1/4 =	16/64	=	.250	
	17/64	=	.265625	
	9/32	=	.28125	
	19/64	=	.296875	
5/16 =	20/64	=	.3125	
	21/64	=	.328125	
	11/32	=	.34375	
	23/64	=	.359375	
3/8 =	24/64	=	.375	
	25/64	=	.390625	
	13/32	=	.40625	
	27/64	=	.421875	
7/16 =	28/64	=	.4375	
	29/64	=	.453125	
	15/32	=	.46875	
	31/64	=	.484375	
1/2 =	32/64	=	.500	
	33/64	=	.515625	
	17/32	=	.53125	
	35/64	=	.546875	
9/16 =	36/64	=	.5626	
	37/64	=	.578125	
	19/32	=	.59375	
	39/64	=	.609375	
5/8 =	40/64	=	.625	
	41/64	=	.640625	
	21/32	=	.65625	
	43/64	=	.671875	
11/16 =	44/64	=	.6875	
	45/64	=	.703125	
	23/32	=	.71875	
	47/64	=	.734375	
3/4 =	48/64	=	.750	
	49/64	=	.765625	
	25/32	=	.78125	
	51/64	=	.796875	
13/16 =	52/64	=	.8125	
	53/64	=	.828125	
	27/32	=	.84375	
	55/64	=	.859375	
7/8 =	56/64	=	.875	
	57/64	=	.890625	
	29/32	=	.90625	
	59/64	=	.921875	
15/16 =	60/64	=	.9375	
	61/64	=	.953125	
	31/32	=	.96875	
	63/64	=	.984375	

COMPOUND SETTING FOR TAPER CUTS

Taper per Foot (in inches)	Taper per Inch (in inches)	Compound Swivel (from parallel)
1/8	.010	0° 18′
3/16	.016	0° 27′
1/4	.021	0° 36′
5/16	.026	0° 45′
3/8	.031	0° 53′
7/16	.036	1° 02′
1/2	.042	1° 11′
9/16	.047	1° 21′
5/8	.052	1° 30′
11/16	.057	1° 39′
3/4	.062	1° 47′
13/16	.068	1° 56′
7/8	.073	2° 06′
15/16	.078	2° 14′
1	.083	2° 23′
1-1/4	.105	2° 59′
1-1/2	.125	3° 34′
1-3/4	.146	4° 10′
2	.166	4° 46′
2-1/2	.208	5° 57′
3	.250	7° 07′
3-1/2	.292	8° 18′
4	.333	9° 27′
4-1/2	.375	10° 50′
5	.417	12° 02′
6	.500	14° 03′

Note: In working with this table, set compound parallel with lathe bed. Then, swivel the compound the number of degrees and minutes indicated in third column. The minute part of the setting must be judged by eye.

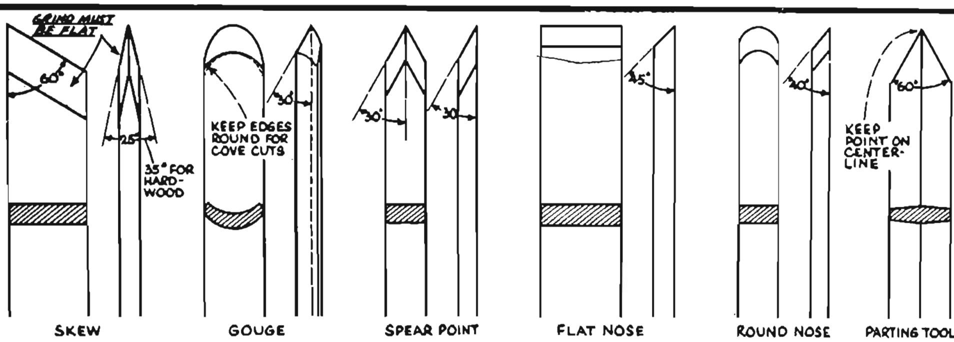
SPECIAL SIZES

Name of Taper	Taper per Foot	Compound Swivel
Brown & Sharpe	.500″	1° 11′
Morse No. 1	.598″	1° 26′
Morse No. 2	.599″	1° 26′
Jarno	.600″	1° 26′
Morse No. 3	.602″	1° 26′
Jacobs No. 6	.621″	1° 30′
Morse No. 4	.623″	1° 30′
Jacobs No. 1	.923″	2° 12′
Jacobs No. 2	.978″	2° 20′

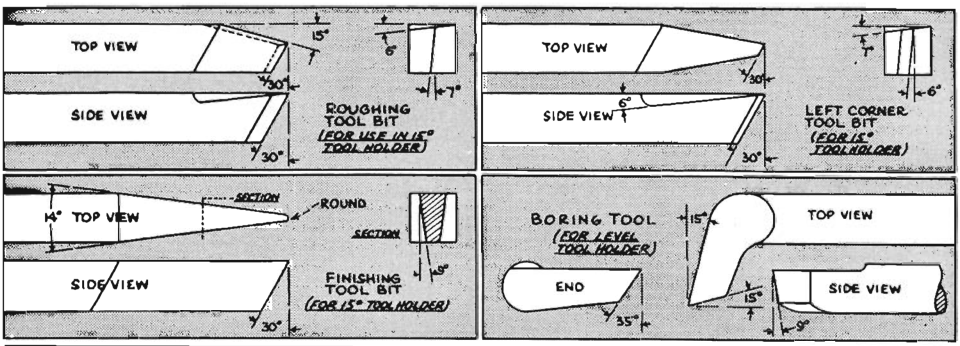
Note: Setting must be made as closely as possible by eye and then adjusted to suit after testing work. The use of a taper reamer of the required size is recommended for finishing internal bores.

ANNEALING TABLE FOR METAL SPINNING

Metal	Heat	Temperature Color or Test, etc.
ALUMINUM	650 F.	Barely chars white pine. Air cool.
BRASS	1000 F.	Dull red, barely visible. Air cool.
COPPER	1000 F.	Dull red. Plunge in cold water.
MAGNESIUM	550 F.	Avoid open flame. Cool slowly.
PEWTER	0 F.	No annealing required.
ZINC	212 F.	Anneal in boiling water. Spin hot.



GRINDING ANGLES FOR WOOD TURNING CHISELS



TOOL SHAPES FOR METAL TURNING (¼" BLANKS – FULL SIZE)

LATHE SPEEDS

WOOD TURNING:

DIA. OF WORK	ROUGHING OFF	GENERAL CUTTING	FINISHING
Under 2 In. Diameter	900 to 1300 R. P. M.	2400 to 2800	3000 to 4000
2 In. to 4 In. Diameter	600 to 1000 R. P. M.	1800 to 2400	2400 to 3000
4 In. to 6 In. Diameter	600 to 800 R. P. M.	1200 to 1800	1800 to 2400
6 In. to 8 In. Diameter	400 to 600 R. P. M.	800 to 1200	1200 to 1800
8 In. to 10 In. Diameter	300 to 400 R. P. M.	600 to 800	900 to 1200
Over 10 In. Diameter	300	300 to 600	600 to 900

METAL TURNING:

Material	High Speed Steel Tools	Carbide Tools
TOOL STEEL	80 F. P. M.	200 F. P. M.
CAST IRON	100 F. P. M.	250 F. P. M.
ALL MILD STEELS	140 F. P. M.	400 F. P. M.
BRONZE	120 F. P. M.	350 F. P. M.
BRASS	200 F. P. M.	400 F. P. M.
ALUMINUM	300 F. P. M.	400 F. P. M.

METAL SPINNING:

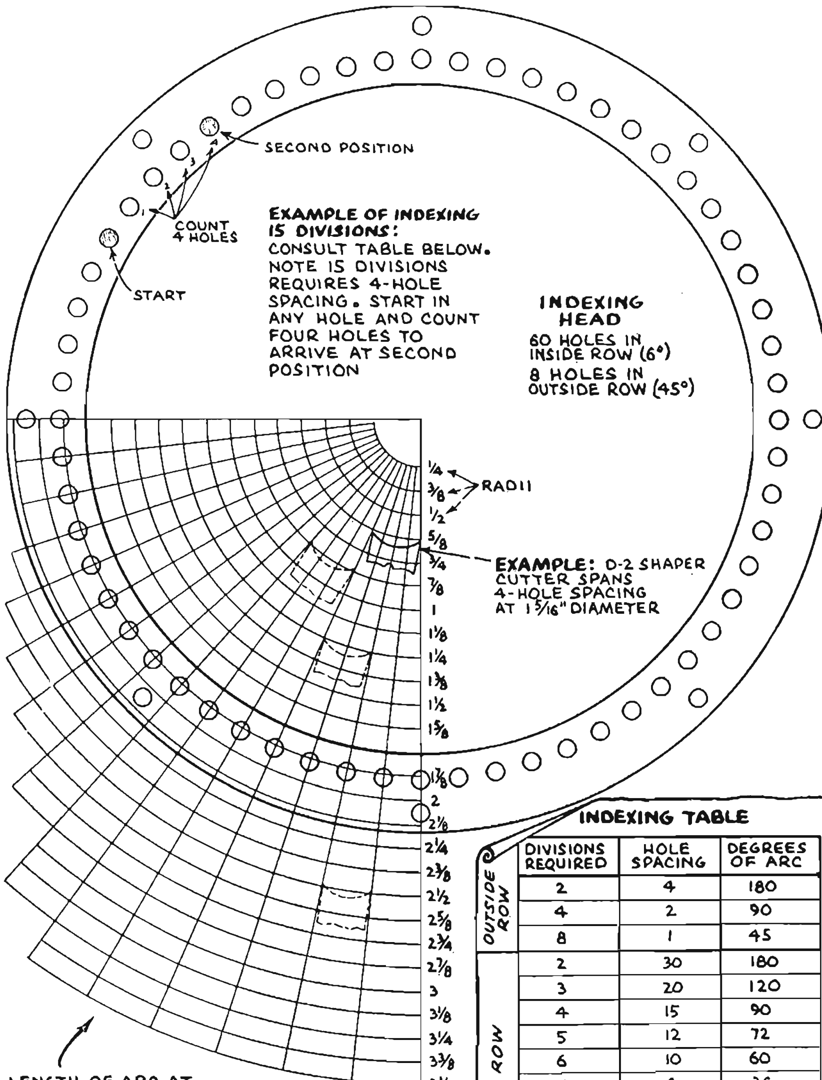
Material	Speed	Lubricant
PEWTER	600 to 800 R.P.M.	Cup Grease
ALUMINUM	800 to 1000 R.P.M.	Cup Grease
COPPER	800 to 1000 R.P.M.	Cup Grease
BRASS	800 to 1000 R.P.M.	Yellow Soap
ZINC	1000 to 1200 R.P.M.	Tallow Candle

F. P. M. TO R. P. M.

Work Diameter	FEET PER MINUTE					
	80	100	120	140	200	400
	Revs. per Minute					
¼ In.	1222	1528	1833	2139	3056	6112
½ In.	611	764	917	1070	1528	3056
¾ In.	407	598	611	713	1016	2032
1 In.	306	382	458	535	764	1528
1¼ In.	244	306	367	428	612	1224
1½ In.	204	254	306	357	508	1016
1¾ In.	175	218	262	306	436	872
2 In.	153	192	229	267	384	768
2½ In.	122	152	183	213	304	605
3 In.	102	128	154	179	256	502
3½ In.	88	110	132	154	220	440
4 In.	76	96	115	134	192	384
5 In.	62	76	91	107	152	304
6 In.	52	64	77	90	128	256

Delta Craftsheet

No. L2 INDEXING HEAD



LENGTH OF ARC AT VARIOUS RADII. USE THESE LINES TO DETERMINE SPACING OF CUTS FOR FLUTING OR REEDING. **EXAMPLE:** D-2 SHAPER CUTTER AT FOUR-HOLE SPACING (15 DIVISIONS) WILL REED A COLUMN 1 5/16 IN. DIA. OTHER SPACINGS FOR THE SAME CUTTER ARE SHOWN BY THE DOTTED LINES IN DIAGRAM.

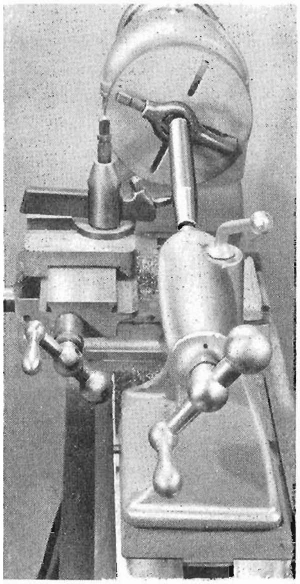
D-2 SHAPER CUTTER

INDEXING TABLE

	DIVISIONS REQUIRED	HOLE SPACING	DEGREES OF ARC
OUTSIDE ROW	2	4	180
	4	2	90
	8	1	45
INSIDE ROW	2	30	180
	3	20	120
	4	15	90
	5	12	72
	6	10	60
	10	6	36
	12	5	30
	15	4	24
	20	3	18
	30	2	12
	60	1	6

Delta Craftsheet

No. L1
TAPER TURNING
Setover Method



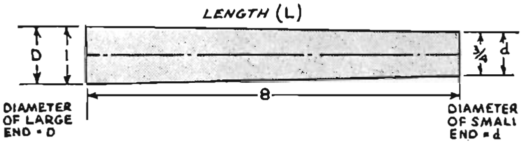
·I· DEFINITION OF TAPER:

THE DIFFERENCE IN DIAMETERS OF THE TWO ENDS OF A TAPERED PIECE OF WORK, STATED IN INCHES PER FOOT OF LENGTH, IS KNOWN AS "TAPER PER FOOT"

·II· TO FIND TAPER PER FOOT:

FORMULA:

$$\text{TAPER PER FOOT} = \frac{12 \times (D - d)}{L}$$



EXAMPLE:

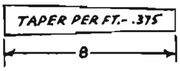
$$\text{TAPER PER FOOT} = \frac{12 \times (1 - .75)}{8}$$

$$\text{TAPER PER FOOT} = \frac{\overset{3}{\cancel{12}} \times .25}{\underset{2}{\cancel{8}}} = \frac{.75}{2}$$

$$\text{TAPER PER FOOT} = \frac{.75}{2} = .375 = 3/8''$$

·III· TO DETERMINE AMOUNT OF SETOVER

1. WHEN TAPER IS GIVEN

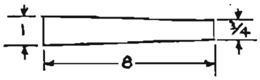


$$\text{SETOVER} = \frac{\text{TAPER} \times \text{LENGTH}}{24}$$

$$\text{SETOVER} = \frac{.375 \times \cancel{8}}{\underset{3}{\cancel{24}}} = \frac{.375}{3}$$

$$\text{SETOVER} = \frac{.375}{3} = .125 = 1/8''$$

2. TAPER FULL LENGTH

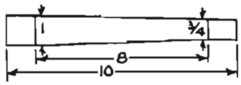


$$\text{SETOVER} = \frac{\text{LARGE DIA.} - \text{SMALL D.}}{2}$$

$$\text{SETOVER} = \frac{1 - .75}{2} = \frac{.25}{2}$$

$$\text{SETOVER} = \frac{.25}{2} = .125 = 1/8''$$

3. TAPER PART LENGTH

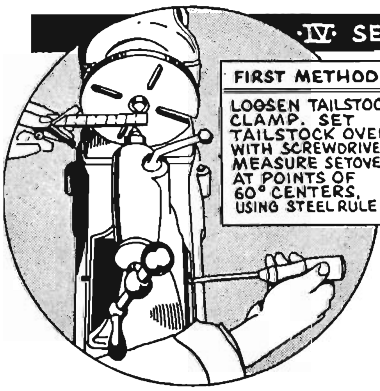


$$\text{SETOVER} = \frac{\text{TOTAL LENGTH}}{\text{LENGTH OF TAPER}} \times \frac{D - d}{2}$$

$$\text{SETOVER} = \frac{\overset{5}{\cancel{10}}}{8} \times \frac{.25}{\cancel{2}} = \frac{1.25}{8}$$

$$\text{SETOVER} = \frac{1.25}{8} = .156 = 5/32''$$

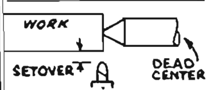
·IV· SETTING TAILSTOCK



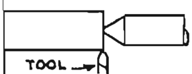
FIRST METHOD

LOOSEN TAILSTOCK CLAMP. SET TAILSTOCK OVER WITH SCREWDRIVER. MEASURE SETOVER AT POINTS OF 60° CENTERS, USING STEEL RULE.

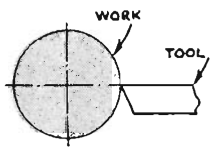
SECOND METHOD



MOUNT WORK. SET TOOL FROM END OF WORK A DISTANCE EQUAL TO SETOVER



MOVE TAILSTOCK SO WORK TOUCHES TOOL

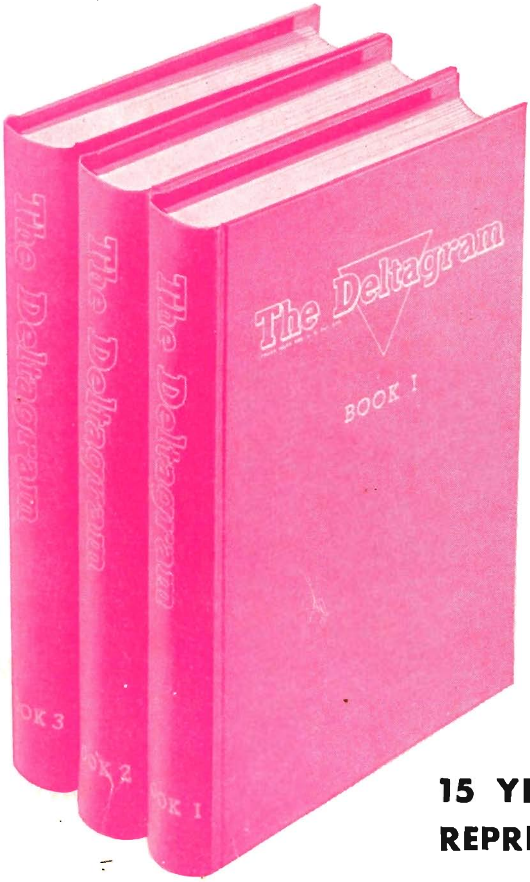


·V· TOOL POSITION

THE TOOL MUST BE EXACTLY CENTERED ON WORK TO CUT STRAIGHT - IF ABOVE CENTER, WORK WILL BE CURVED.

INDEX

ACCESSORIES 4, 34, 40
ANGLE PLATE 46
BACK REST 36
BALLS, PLASTIC 52
BALLS, SPINNING 57
BALLS, WOOD 15
BEAD, SPINNING 57
BEAD, WOODTURNING 8
BORING, METAL 48
BORING WITH LATHE CHISELS 13
BOXES 16
BOWLS 29
BUFFING 15
BUILT-UP TURNINGS 24-32
Selection of Wood—Laminations—Solid Segments—Sawing and Assembly—Segment Rings—Monotone Bowl—Pattern Effects—Post Blocking—Overhangs—Designing—Eight-side Blocking
CABRIOLE LEG 19
CARBIDE TOOLS 48, 51
CENTERING, METAL TURNING 43
CENTERING, WOOD TURNING 5
CLUB FOOT 18
COLLET CHUCK 14, 41
COMBINATION TURNINGS 22
COMPOUND SETTING FOR TAPERS . . . 48
CUTTING-OFF 45
DOWEL JIGS 36
DRILLING AND THREADING 49-50
Drilling—Drilling Accessories—Reaming—Use of Center Rest—Tapping—Use of Dies
FACEPLATE AND CHUCK TURNING . . . 12-16
Mounting the Work—Turning—Large Turnings—Deep Boring—Chucking Methods—Spindle Chucking—Plug Chucking—Turning a Ring—Rabbeted Frame—Turning a Ball—Turned Boxes
FACING, METAL TURNING 45
FILING AND POLISHING 45
FINISHING LATHE WORK 39
FLEXIBLE SHAFT 35
FLUTING JIG 38
FRENCH POLISHING 39
HAND POSITION 6
HOLLOW CHUCKS FOR SPINNING 57
HOLLOW SPIRAL 21
INDEXING HEAD 3, 62
KNURLING 47
LAMINATIONS 25
LATHE SPEEDS 41, 61
MANDRELS 46, 51
METAL TURNING 43-48
Center Drilling—Mounting Between Centers—Turning a Shaft—Application of Tools—Mounting of Tools—Tool Terms—Common Operations—Tapers—Knurling—Boring—Compound Tapers—Freehand Turning
METAL TURNING EQUIPMENT 40-42
METALS FOR SPINNING 55
OVAL TURNING 17
OUTBOARD TURNING 13
PEWTER NUTBOWL 56
PICTURE FRAME 14
PLASTICS, HOW TO TURN 51-52
How to Turn—Mounting the Work—Plastic Balls—Polishing
PLUG CHUCKING 14, 15
POST BLOCKING 17, 30
RECESSED CHUCKS 14
RING, TURNING A 14
ROTARY TOOL 34
SANDING 33, 34
SECTIONAL CHUCKS 58
SEGMENTS 26
SEMAPHORE JIG 38
SHOULDERS, WOODTURNING 8
SLIDE REST ADJUSTMENTS 42, 48
SPINDLE CHUCKS 14
SPINDLE TURNING 5-11
Centering—Mounting—Tool Rest Position—Roughing a Cylinder—Hand Position—Smoothing a Cylinder—Using Parting Tool—Squaring an End—Cutting a Shoulder—Beads—Vee Grooves—Long Cuts—Cove Cuts—Making a Turning—Square Sections—Master Spindle
SPINNING 53-59
SPINNING EQUIPMENT 53
SPLIT CHUCKS 58
SPLIT TURNINGS 21
SPIRAL TURNING 19
SPOOL TURNINGS 23
SQUARING AN END 7
STEADY REST 36, 50
TABLES, DECIMAL, ETC. 60-61
TAPER TURNING, METAL 47, 63
TAPERS, WOODTURNING 9
THREAD CHASING 23
THREAD TAPS, WOOD 23
THREADING TAPS AND DIES 50
TURNING A SHAFT 44
WIRE BRUSH 4, 35



RARE VOLUMES

☆ Here at last are the books which you have asked for — the ones which were promised in Issue No. 3, Vol. 17. These books will give you a chance to own reproductions of every copy of the Deltagram which has been printed for the last fifteen years. For the most part the older issues of the Deltagram and even many of the new ones are not available and would not otherwise be reprinted. Act now—Don't miss this rare opportunity.

15 YEARS OF DELTAGRAMS REPRINTED IN FULL FOR YOU

The Deltagram has become the standard for the home workshop person who wants to make good, practical projects with the least amount of delay, fuss or bother. All plans are accurately dimensioned, every project has been made in our own shop, which is your guarantee that you can press right along and complete these same projects with ease. You save valuable material, valuable time, and turn out excellent projects when you use the Deltagram.

Here is your opportunity to obtain all of the Deltagrams at one time, handsomely bound in dark red buckhorn cloth with gold title imprints. This is a set which you will be proud to own and use.

$3.75 EACH VOLUME — OR COMPLETE SET $10.00

DELTA MANUFACTURING DIVISION
ROCKWELL MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

Printed in the U. S. of A.