GETTING THE MOST OUT OF YOUR ABRASIVE TOOLS

- THE BELT SANDER
- THE DISK SANDER
- THE GRINDER
- THE BUFFING HEAD

Published by
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GETTING THE MOST OUT OF YOUR ABRASIVE TOOLS

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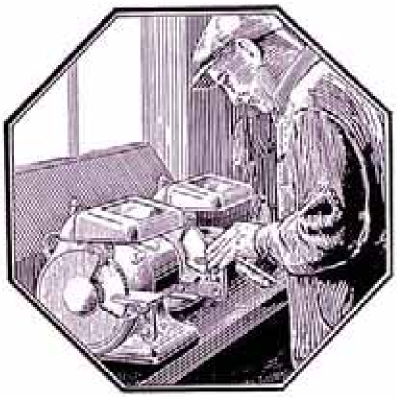

Edited by
SAM BROWN

A Complete Manual Covering the Use of Abrasive Tools in the Home Workshop, Illustrated with Over Two Hundred Photographs and Line Drawings.

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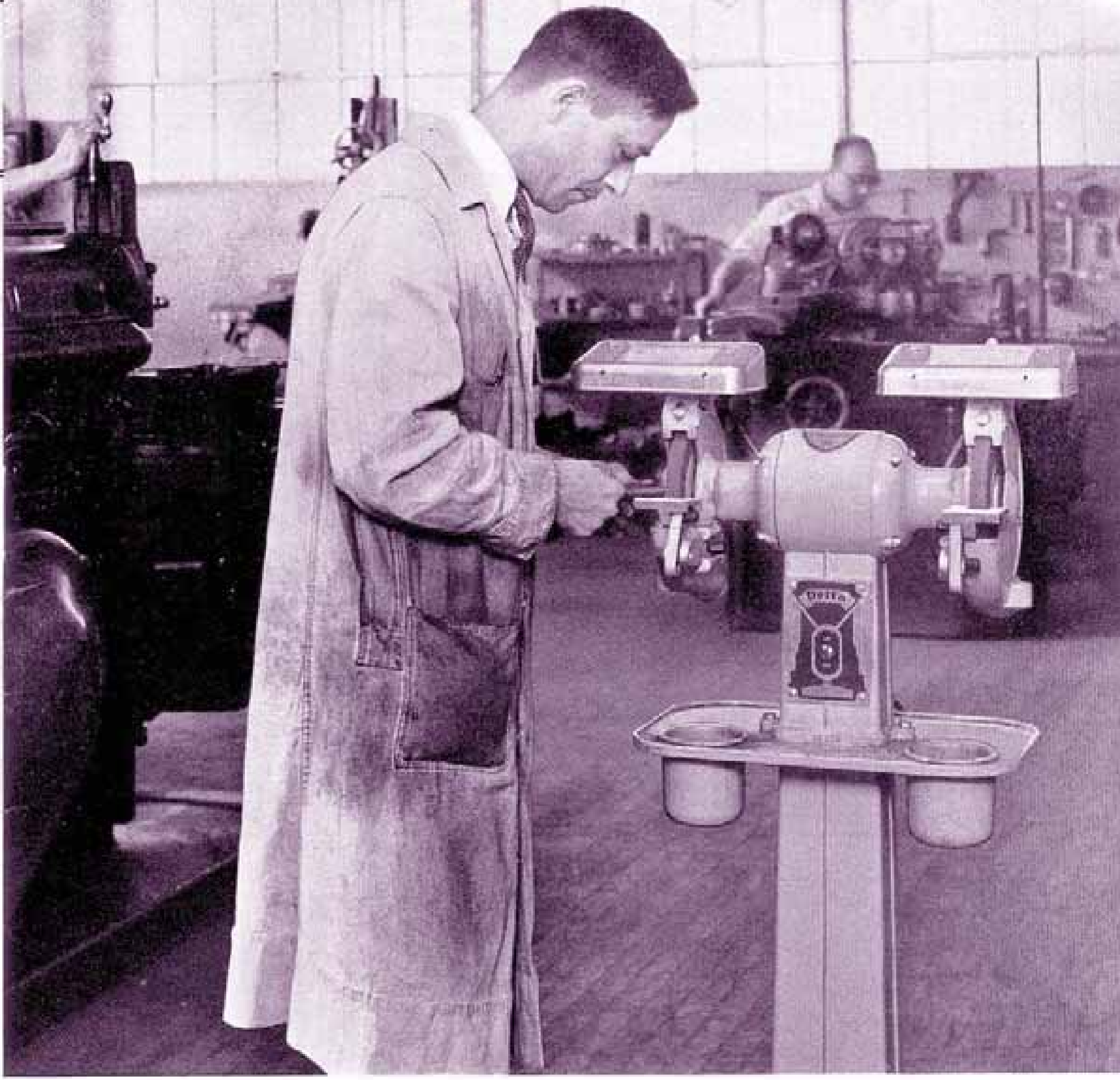
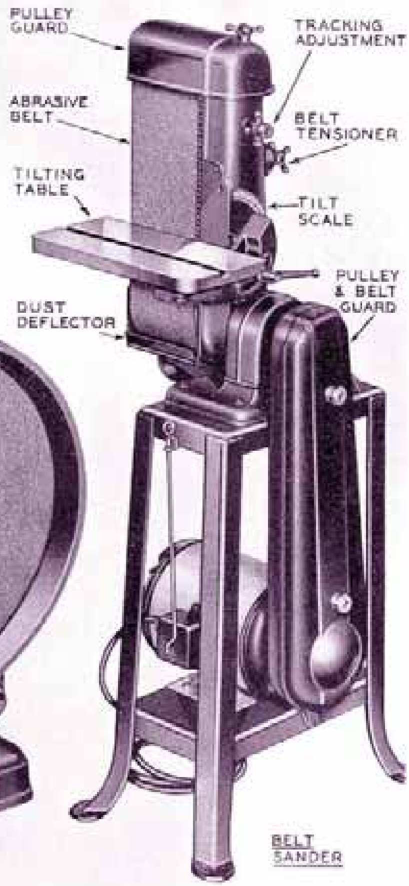
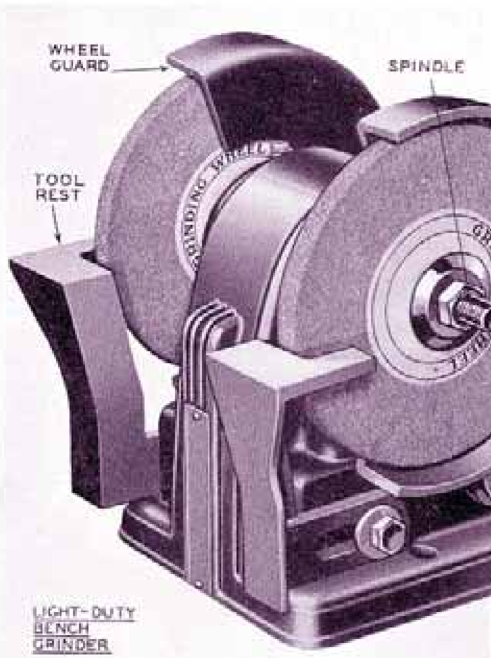


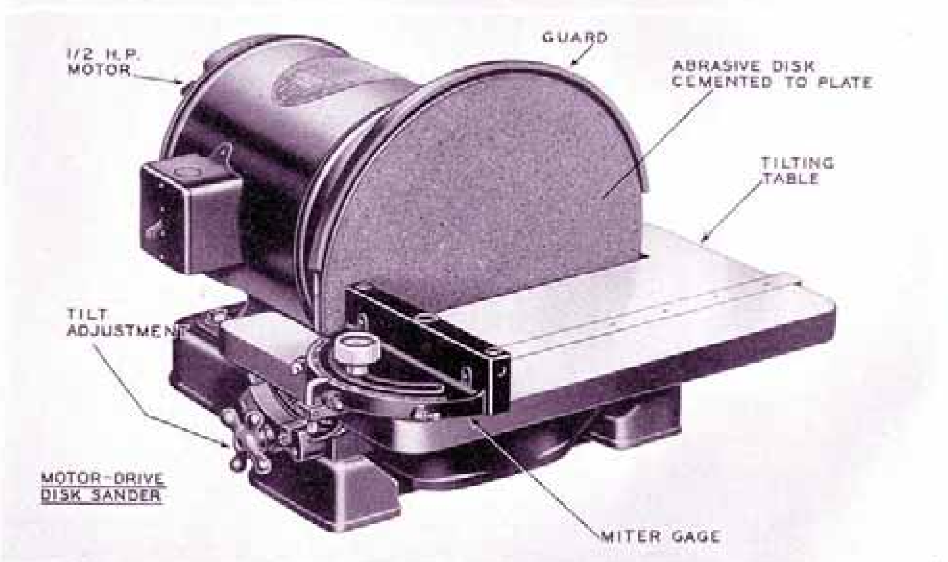
• **ABRASIVE TOOLS** play an important role in industry and in the homeshop. Machines specifically designed for abrading include the grinder, the belt sander, the disk sander and the buffing head, but practically every other tool in the shop can be set up for abrasive work. Typical operations which are done on one or more of these machines include sharpening tools, sanding wood and metal, polishing metals and plastics, gumming circular saws, drilling holes in glass, cutting metals and so on through a long list of everyday shop operations. A working knowledge of abrasives and abrasive methods is essential for the successful practice of such work, and it is the aim of this book to supply this information in a simple non-technical style readily applied to average equipment in the small shop.

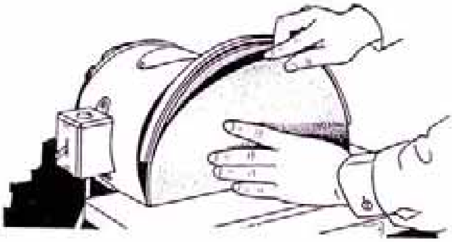
ABRASIVE TOOLS

These photos show three typical abrasive tools—The Bench Grinder, the Belt Sander, and the Disk Sander. The grinder is a light-duty model and is belt-driven. The belt sander is a medium-size unit using six inch wide abrasive belts. The disk sander is direct-motor drive and uses twelve inch diameter abrasive disks. All units are commonly described according to the abrasive area—a *six inch* grinder (wheel diameter), a *six inch* belt sander (belt width), a *twelve inch* disk sander (disk diameter).





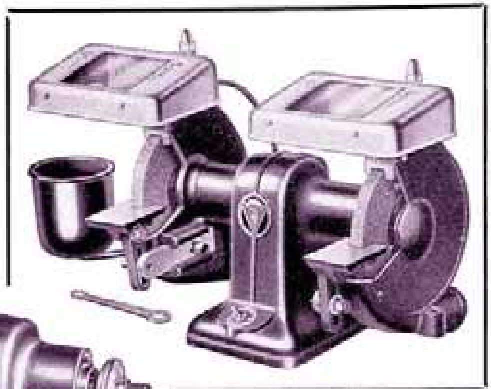




CHAPTER ONE

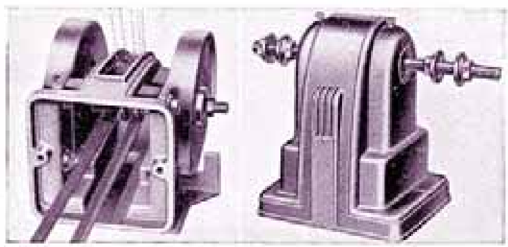
ABRASIVE TOOLS

The Grinder.—The Grinder is a double end horizontal spindle, the ends of the spindle being threaded and fitted with flanges to take the grinding wheels. The spindle is often a continuation of the motor shaft, in which case the unit is direct-driven. Other models employ a conventional belt drive. The size of the grinder is commonly taken from the diameter of the abrasive wheel used in connection with it, that is, a grinder swinging a 7-inch wheel would be called a 7-inch grinder. Units are further described as bench or pedestal, the latter indicating a floor model.



Above, belt-drive bench grinder fitted with safety hoods as well as wheel guards. The buffing head, left, is similar to a grinder except guards and tool rests are omitted. Lower photos show a light-duty buffing head. Like most similar belt-drive units, it can be driven from either bottom or back as desired.

An essential feature of all grinders is the wheel guards. These should enclose the wheel as fully as possible in order to prevent abrasive chips or larger fragments of the wheel from being thrown at the operator. The tool rests should be adjustable to allow for wheel wear, and, in precision grinders, are also adjustable for tilt. The power required to operate a 6 or 7-inch grinder is approximately 1/3 h. p. Where the unit is direct-driven, the motor must be a 3400 r. p. m. type in order to give the grinding wheel an efficient rim speed. 5500 surface feet per minute is a fair standard for average grinding, although much higher speeds are sometimes used for special work.

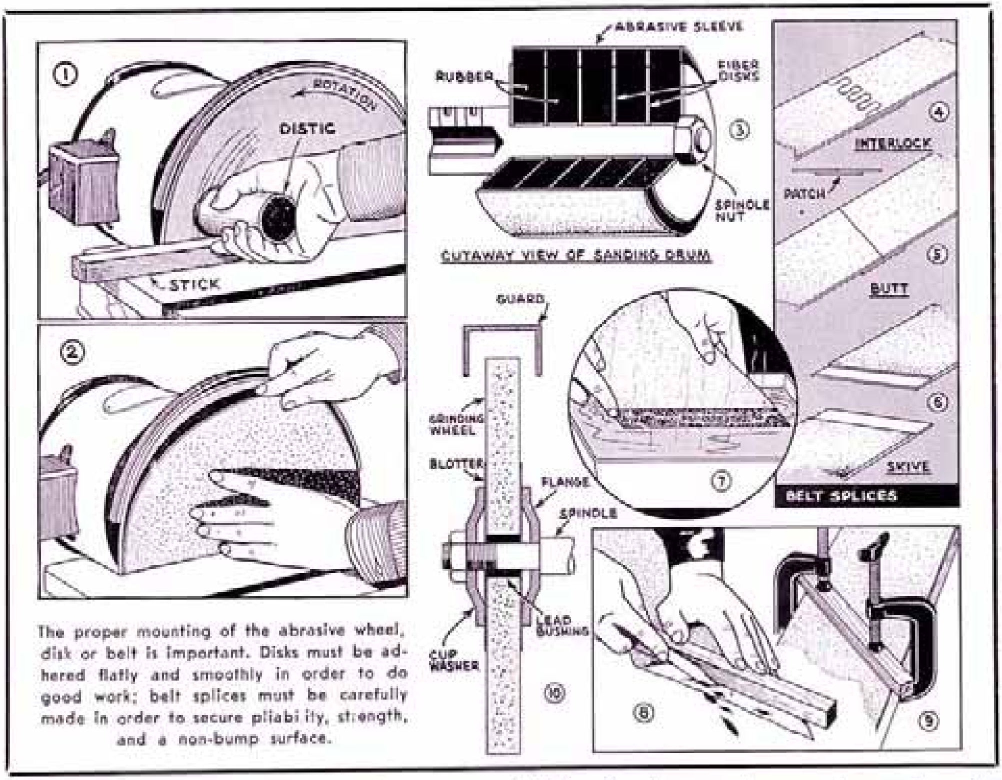


The Buffing Head.—The buffing head is mechanically similar to the grinder except that guards and rests are not required. A surface speed of about 6500 f. p. m. is suitable for average work.

The Belt Sander.—The belt sander features a continuous abrasive belt which works over pulleys at either end of a main sanding table. Adjustments are provided for tensioning and tracking the belt. The size of the unit is commonly designated the same as the width of the sanding belt which it uses. One-half to three-quarter horsepower is required to operate the belt sander. Pulleys should be such as will give a surface speed between 2800 and 3200 feet per minute.

The Disk Sander.—The disk sander comprises a circular plate which operates in a vertical position. Cloth or paper backed abrasive disks are cemented or otherwise fastened to the plate. The diameter of the abrasive disk indicates the size of the machine, a common size being twelve inches. A plate of this diameter should be run at about 1725 r. p. m. (standard motor speed). This will give a surface speed ranging from zero at the center of the disk to about 5500 f.p.m. at the rim. Materials likely to clog the abrasive should be worked more toward the center of the disk.

Sanding and Grinding Attachments. — Accessories for sanding or grinding are used on the drill press, lathe, scroll saw and other machines. The sanding drum, used on the lathe or drill press, is the best known and most used. The surface speed of such drums is best held to a comparatively low figure, say 1200 f. p. m. as compared with an average of about 3000 f. p. m. for long belts. A simple test for efficient speed is indicated by the abrasive drum itself, which will glaze quickly when operated at too high a speed.



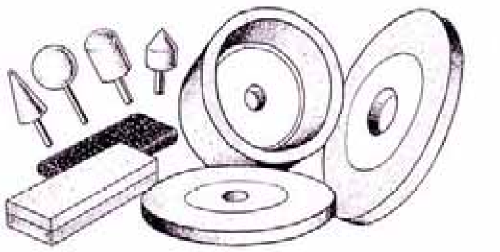
The proper mounting of the abrasive wheel, disk or belt is important. Disks must be adhered flatly and smoothly in order to do good work; belt splices must be carefully made in order to secure pliability, strength, and a non-bump surface.

Mounting Sanding Disks.—In order to present a true, flat abrasive surface to the work, sanding disks are mounted on an accurately-machined metal plate. Glue can be used as the adhesive, in which case the plate and disk must be clamped between boards and allowed to dry overnight. Special types of adhesive are also used, one of the most common being "Distic." Distic is a stick shellac which melts under heat and then quickly hardens. To apply Distic, a softwood stick is placed flat against the bare revolving disk and held firmly in place for about half-a-minute in order to heat the plate. The stick shellac is then held against the revolving disk, as in Fig. 1, and is moved over the surface until a thin even coat is applied. The abrasive disk is then pressed into position, as shown in Fig. 2.

Fitting Abrasive Sleeves.—Abrasive sleeves are mounted on special drums in which alternate layers of rubber and fiber, as shown in Fig. 3, can be expanded by turning the spindle nut, thus securing the sleeve in place.

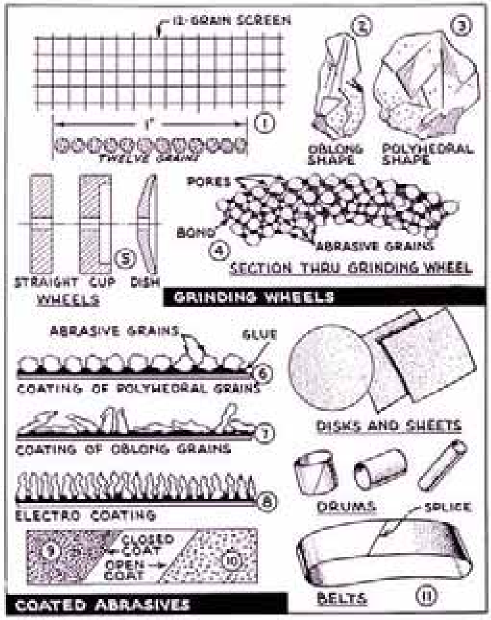
Sanding Belts.—Sanding belts can be purchased readymade for most belt sanders. The worker can also make his own belts by splicing the sandpaper to form a belt of the proper length. Several varieties of belt splices are in common use. The interlocking splice, Fig. 4, is made with an inexpensive cutter. A cloth patch is necessary to retain the two ends in position. This splice is very strong and easy to make, but has the disadvantage of a bump at the joining point caused by the patch. The plain butt splice, Fig. 5, is made without special cutting equipment, the cut ends of the belt being simply patched together at either 45 or 90-degrees. The skived joint, Fig. 6, is the one most commonly used. If one end only of the belt is skived, the joint is a single skive; if both ends are skived, the joint is a double skive. Any suitable angle can be used in making the joint. The grain can be skived from the belt ends by using an abrasive stick about three sizes coarser than the belt. Where a suitable abrasive brick is not available, the skive can be made by dipping the belt end into hot water, as shown in Fig. 7, after which the abrasive and glue can be readily removed from the cloth backing. The joint is put up with a light coat of medium thick hot glue, and is held in a suitable press until dry, as in Fig. 9.

Mounting Grinding Wheels.—Good quality grinding wheels are metal bushed and should be a snug fit on the spindle. Disks of blotting paper should be used on either side of the wheel to serve as shock absorbers. The washer which holds the wheel in place should be of the cup type—never a flat washer. The spindle nut should be turned up securely, and the thread of the spindle must be such that the nut locks against the direction of rotation.



CHAPTER TWO

ABRASIVES



Abrasive grains are graded by passing through screens and are then made into various abrasive products.

Natural Abrasives.—Natural abrasives are found ready made in the earth and include sandstone, emery, flint, garnet, etc. Each has its own particular use. Flint is the least expensive and is the type of abrasive commonly associated with "sandpaper." Garnet is much harder and tougher than flint and is the abrasive most used by the woodworker. Emery is commonly used for sanding metals. For a complete list of abrasives and their characteristics, see the table in the appendix.

Artificial Abrasives.—Artificial abrasives are a product of the electric furnace. The two main groups are (1) aluminum oxide abrasives, (2) silicon carbide abrasives. Aluminum oxide is made by fusing bauxite, a highly aluminous clay, in an electric arc furnace at about 3,000 degrees F. The crystals are usually brown in color, but some types are made gray and white. They are not as hard as silicon carbide but are much tougher. Silicon carbide is made by fusing sand and coke at a high temperature. The resulting crystals are next in hardness to the diamond, but are brittle as opposed to the toughness of aluminum oxide. The color ranges from black-gray to blue-green. Both aluminum oxide and silicon carbide are sold under various trade names such as Aloxite, Alundum and Lionite (aluminum oxide), and Carborundum, Crystolon and Carsilon (silicon carbide).

Grain Size.—The grain size or grit is determined by passing the crushed ore over various wire and silk screens. Fig. 1 shows a 12-grain screen. Grains passed by this screen are called No. 12, twelve grains measuring about 1 inch if laid end to end. Scientific control methods eliminate flat and slivery grains, Fig. 2, unless desired for some specific purpose, retaining only the ideal polyhedral-shaped grain shown in Fig. 3. Sizes range from No. 6 to No. 240. Since it is difficult to make a screen of more than 240 meshes to the inch, finer grains up to No. 600 are graded by an elaborate water flotation system.

Grinding Wheels.—Abrasive grains fused with a bond of flux and clay or other substance can be cast into any convenient shape, such as the familiar grinding wheel. Each grain thus becomes a miniature cutting tool, as shown in Fig. 4. As the grains wear down and become dull, they are torn loose from the bond, exposing a new, sharp set of cutting edges. Grinding wheels are made in hundreds of different shapes, a few of the most common styles being the straight, cup and dish wheels shown in Fig. 5.

Coated Abrasives. — Abrasive grains glued to sheets of cloth or paper are known as coated abrasives. Disks and sheets, drums, and belts are common examples of coated abrasives. The polyhedral grain shape is always used when coated abrasives are made by ordinary methods, producing a surface similar to that shown in Fig. 6. It can be seen that any method of gravity coating with oblong grains would result in an unsatisfactory surface, many of the grains being almost completely embedded in the glue coating, as shown in Fig. 7. If the oblong grains are placed on end, as in Fig. 8, the result is quite differerent, the abrasive particles being fully exposed and capable of clean, uniform, high speed sanding. This vertical coating of abrasive grains is done by an electrostatic method, and the greater portion of all coated abrasives used today are made in this manner.

Coated abrasives are divided into many different classes, depending upon the abrasive used, the kind of backing, whether for

CLASSIFICATION OF GRINDING WHEELS

GRAIN SIZES: Number of Abrasive Grains to the Inch.

VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	FLOUR SIZES
8	12	30	70	150	200
10	14	36	80	180	320
	16	46	90	220	400
	20	60	100	240	500
	24		120		600

GRADE: Strength of Bond.

	VERY SOFT	SOFT	MEDIUM	HARD	VERY HARD
Carborundum	W, V, U	T, S, R, P, O, N	M, L, K, J, I	H, G, F	E, D
Norton	E, F, G	H, I, J, K	L, M, N, O	P, Q, R, S	T, U, W, Z

wet or dry sanding, etc. In any of these, the normal coating is put on in a close, packed formation, hence the general descriptive term "closed coat." The closed coat is fast-cutting and durable, but has the disadvantage of clogging under certain conditions. Where the coating is spaced to show a slight separation between the abrasive grains, the coating is described as "open coat." Open coated abrasives are not as durable as close coated, but they are useful for finishing certain materials where the abrasive dust tends to clog the disk or belt.

In a somewhat similar manner, the grains in a grinding wheel are spaced, the word "structure" being generally used to indicate this abrasive spacing. For all average usage, grinding wheels are supplied in a medium structure.

Grinding Wheel Selection.—Most grinders are supplied with a general-purpose grinding wheel and this wheel will handle most of the work encountered in the home or small production shop. Where, for any reason, a special wheel is required, the user can arrive at a workable selection by following a few simple rules. Every grinding wheel has five distinguishing features: (1) Abrasive (aluminum oxide, silicon carbide, etc.), (2) Grain (size of abrasive grains), (3) Grade (strength of bond), (4) Structure (grain spacing), (5) Bond (what kind of material used).

The abrasive should be considered first. Only the aluminum oxide and silicon carbide abrasives need be considered. Aluminum oxide is used for grinding all materials of high tensile strength, such as carbon steels, high speed steel, malleable iron, wrought iron, etc. Silicon carbide is used for grinding materials of low tensile strength, such as gray iron, brass and soft bronze, aluminum, copper, etc. Either type of abrasive will, generally speaking, give workable results in either class.

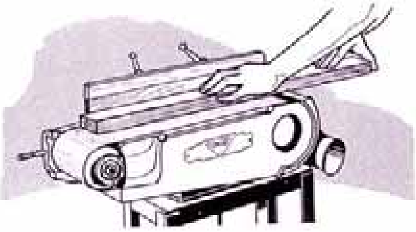
The grain selection is comparatively simple. For soft, malleable materials, a coarse grain gives best results; for hard, brittle materials, the abrasive grains should be fine. The general run of work is done with 60-grit wheels.

The grade of a grinding wheel describes the bond as being hard, medium or soft. Grains are easily loosened from a soft wheel, making it practically self-dressing, while the hard wheel holds together under extreme pressure. Hard wheels are generally used for grinding soft materials, while soft wheels are used for grinding hard materials. For all average work, a medium hard grade will wear well while retaining a sharp edge.

The selection of the proper structure is determined by the nature of the material to be ground. Generally, soft materials, which tend to clog any abrasive wheel, require a wheel with abrasive grains widely spaced. Opposite to this, hard, brittle materials require a wheel with closely-spaced abrasive grains. The wide spacing gives a coarse finish; the close spacing, fine.

Vitrified wheels are the common selection as to bond. Cut-off wheels subject to deflection strains are generally bonded with resin, shellac or rubber.

Special Types of Abrasives.—Both aluminum oxide and silicon carbide abrasives are made to special formula other than standard. The pure white aluminum oxide wheel is not as tough as regular aluminum oxide, and hence fractures under mild pressure. This feature prevents overheating, making white aluminum oxide suitable for grinding high speed steel. The principal variation from regular silicon carbide is the green crystal, which features a low order of toughness but is extremely hard and brittle. This feature makes green silicon carbide ideal for cutting and grinding glass and extremely hard alloys. The hardest of all abrasive grains is the diamond, and this type of grinding wheel, made from genuine diamond chips, is extensively used for cutting and grinding glass, and for cutting shapes from blocks of silicon carbide and aluminum oxide.

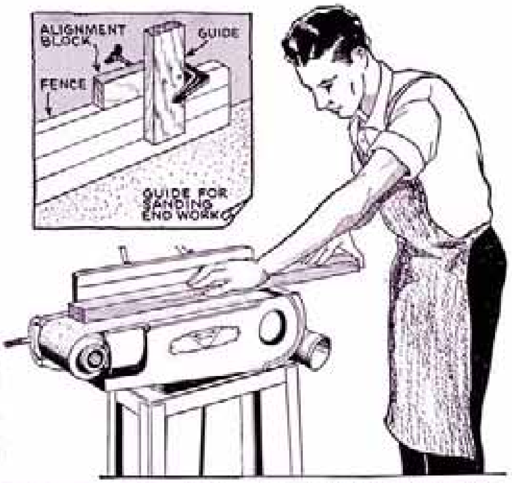


CHAPTER THREE

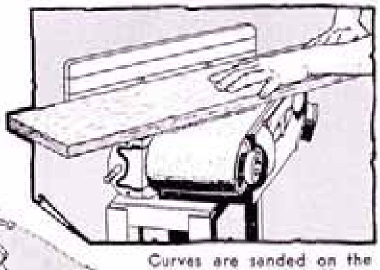
OPERATING THE BELT SANDER

Surfacing.—The sanding table should be in a horizontal position for surfacing. Work can be done freehand, that is, the piece to be surfaced is simply placed on the table. A light but firm pressure should be used to keep the work in the proper position. Excessive pressure against the belt is unnecessary and should be avoided. If the work is longer than the table, it is started at one end and gradually advanced in much the same manner as surfacing on the jointer. Where long work is to be surfaced, it is advisable to use the sanding fence as a guide, especially if the board is close to 6 inches wide.

End Work.—End sanding is best done with the sanding table in a vertical position, but can be done on the horizontal table by using a guide clamped to the fence, as shown in the drawing. The work is pushed down alongside the guide until it contacts the sanding surface. The alignment block permits rapid attachment of the guide at proper right angle position.



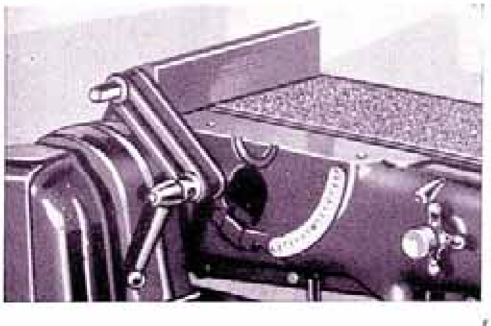
Above, surfacing long work. Left, use of diagonal feed.

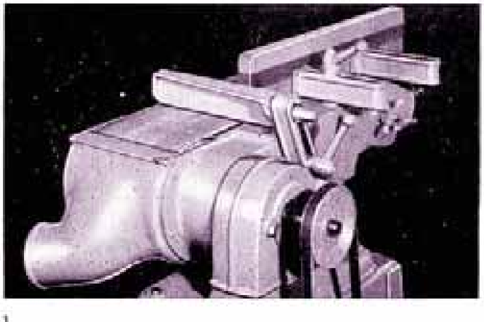


Curves are sanded on the outer drum, left. Photos show use of backstop.

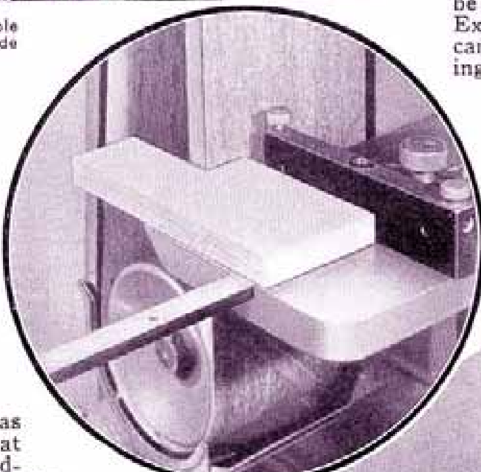
Diagonal Feed. — The use of a diagonal feed, as shown in the center drawing, permits the surfacing of work considerably wider than the 6-inch capacity of the belt. The angle of the fence should be kept as small as possible in order to minimize cross grain sanding. A fine belt should be used.

Sanding Inside Curves.—Inside curves can be sanded on the end drum, as shown in the lower drawing. The table can be either vertical, horizontal, or at an angle. The fence is used as a guide, being held by one bracket only so it





Above, using the tilting table Photo at right shows how inside corners are sanded.



extends beyond the sanding belt.

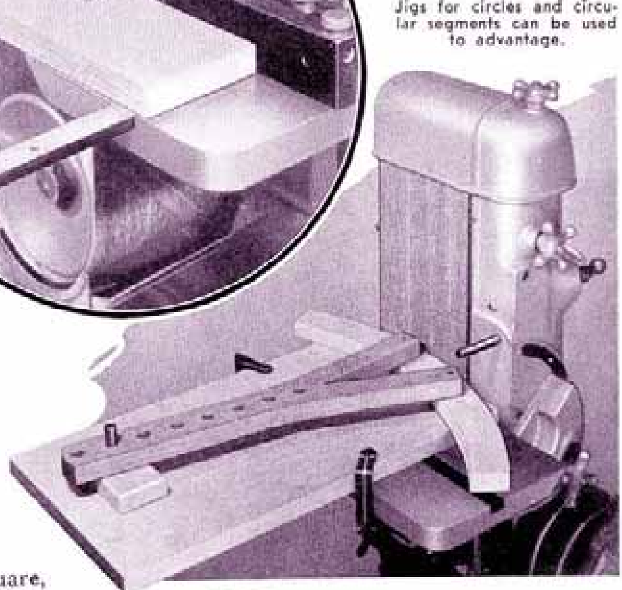
Short Work. — No feed is required on short work up to about 12 inches long, since the full length of such work is in positive contact with a level surface. This permits the use of a backstop to simplify sanding operations. The backstop can be used alone or in connection with the fence, as shown in the photos at the bottom of the preceding page. The fence itself can also be used as a stop by swinging it at right angles across the sanding surface.

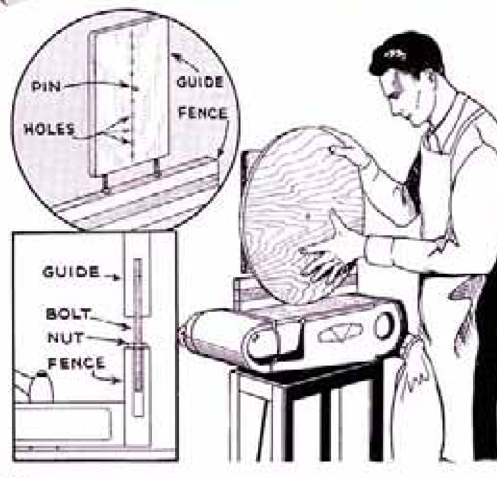
Use of Sanding Table. — Every kind of edge or end work can be done by using the belt sander in a vertical position in connection with the sanding table. With the table level and with the work guided by the miter gage, ends and edges can be sanded true and smooth, either square, mitered, beveled or compound beveled as required. A typical operation showing use of the miter gage with tilted table is shown in upper photo. Other work is done in the same manner as described in following chapter on use of the disk sander.

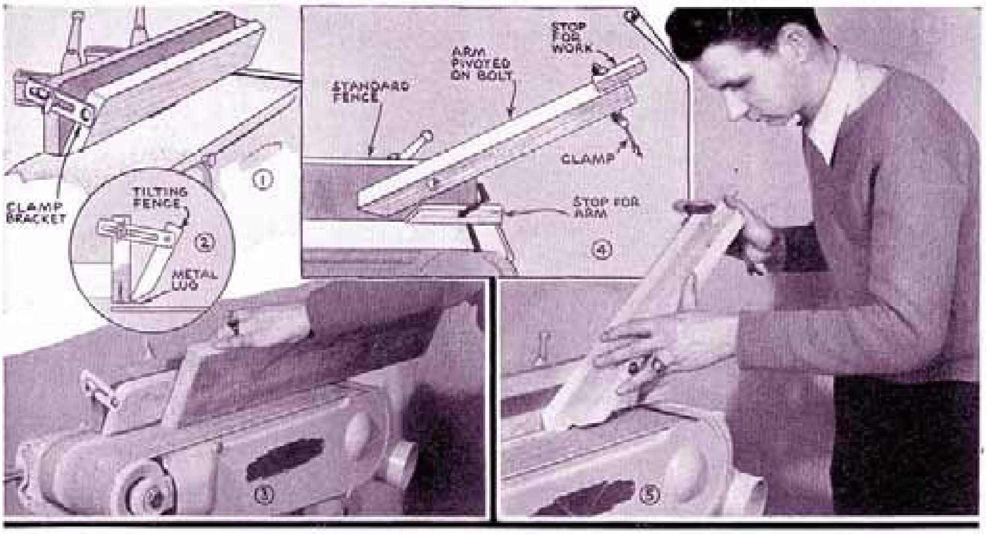
Inside Corners. — Inside corners can be sanded after tracking the belt so that it runs exactly flush with the edge of the main sanding table. The side guard plate must be removed to permit feeding the work. The work is advanced to the belt alongside the miter gage, as shown in the center photo. A cut can be taken on both edges of the corner in one operation, or, each edge can be worked in turn on the flat surface of the belt.

Circle Jigs.—All of the various styles of circle jigs using a pivot point can be adapted for use on the belt sander. The lower photo shows the use of a pivot arm for segment work. In this form of jig, the work is secured to the forks of the pivoting arm by means of anchor points. A master form should be used to locate the work at the proper position. The lower drawing shows a simple jig for sanding circles when the sanding table is horizontal. Holes in the fence to take the bolts are for a slide fit so that the nuts can be turned to obtain adjustments for circles of a diameter between the one-inch spacings on the guide board. Normally, circle work is done with the sander in a vertical position, using the sanding table as a support. The same jigs as described for use on the disk sander can be used on the belt sander. Extremely large circles can be worked by mounting the pivot point on any convenient bench or on the table of the drill press.

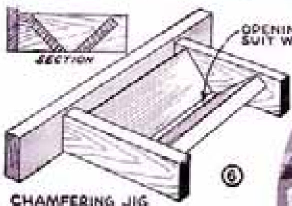
Jigs for circles and circular segments can be used to advantage.







A tilting fence and pivot arm are aids to accuracy in production work.



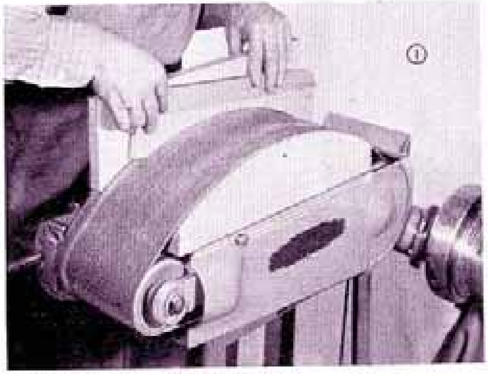
The sander affords one of the best methods of working bevels.

Tilting Fence. — For some types of sanding work, such as beveling, a tilting fence can be used to good advantage. Within certain limits the regular sander fence can be tilted by placing wedges under the bracket arms. More extreme bevels can be sanded by using the simple fence shown in Fig. 1. This consists of a wood fence of the same size as the regular fence. The tilting fence is fastened to the regular fence by means of two metal arms, which are slotted to permit adjustments being made. A thin but rigid strip of metal screw-fastened to the underside of the regular fence, as can be seen in Fig. 2, supports the tilting fence above the sanding belt. One of the metal arms can be fitted with a scale reading in degrees.

Pivoted Arm.—A pivoted arm, as shown in Fig. 4, can be used for various jobs where the end of the work is to be pointed or cut off on an angle. The arrangement is simply a fairly heavy piece of wood, which is bolted to the regular sander fence. A washer between the pivoted arm and the fence permits the arm to be tilted or swung to any position. A block clamped to the fence limits the amount of swing while a second block clamped to the arm furnishes a stop for the end of the work. In use, the work is placed on the pivoted arm, one end contacting the stop block. The arm is then tilted down to make the cut, Fig. 5, the operation being completed when the arm comes in contact with the fence stop.

Beveling Jig. — One of the cleanest and most accurate methods of beveling, especially on short pieces and end grain, is done with the use of a simple vee-shaped jig. Fig. 6 shows the general construction. The two pieces forming the vee groove are fitted together at right angles, and are separated at the bottom a suitable distance to make the required cut. Fig. 7 shows the jig in use. The work is simply placed in the vee groove and held there until the sanding belt ceases to cut. If the jig is mounted close to the belt, the width of the bevel will be wider than in the case where the jig is mounted higher. Even wear on the sanding belt is accomplished by moving the fence. Overcutting is impossible, and, providing the jig is parallel with the sanding belt surface, the bevel will be perfectly uniform and straight from one end of the work to the other.

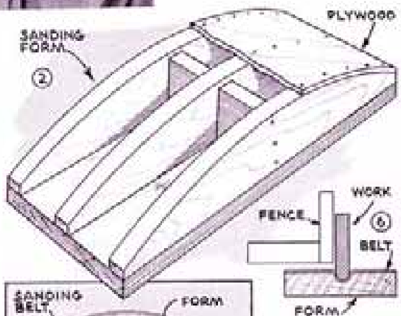
Use of Forms. — Sanding in production work can often be done more quickly with the use of forms. These are made from wood to the proper curvature, the form being screw-fastened to the regular sanding table. It is necessary in most cases to make a sanding belt to fit, although a very shallow form can be used with the regular sanding belt. A common shape is the circular form, (see Fig. 3, p. 12). This form is a portion of a true circle, hence, the work can be pushed along it since the curve is the same at all

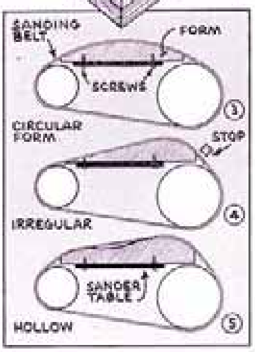


Curved forms of almost any shape can be fitted to the regular sanding table.

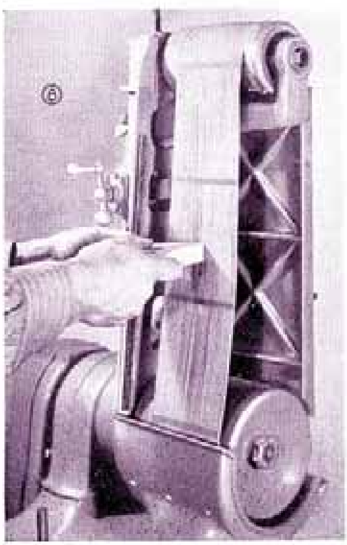
points. Fig. 1 shows work being sanded over a circular form. A suitable fence is made up and clamped to the regular fence, thus providing a side support for the work and insuring square edges. The irregular form, Fig. 4, is not a part of a circle, and work sanded over this type of form must be set down at a certain position, placement being controlled by means of a stop block. Hollow forms, Fig. 5, have curves which do not conform to the belt shape. The belt in this case is run rather loose so that it will be fashioned to the same shape as the form when the work presses against it.

Forms can be built up, the work surface being covered with plywood, as shown in Fig. 2, or the shape may be cut from a solid piece of wood. The preferable abrasive belt for use with forms is the cloth-backed style. A heavy weight backing can be used for most work, the exception being very abrupt curves where a light backing gives better results. Forms of the type shown in Fig. 7, always require a light, flexible belt in order to conform to the shape. The manner in which forms of this kind work can be seen in Fig. 6. The fence is aligned with the shaped portion of the form so that the work will be in the proper position when it is pressed against the fence and projected into the belt. Under pressure, the belt takes on the same shape as the form and sands the work to the desired shape. A certain nicety in knowing just when to lift the work from the belt must be acquired by practice. With a light-weight backing surfaced with a fine-grit abrasive,



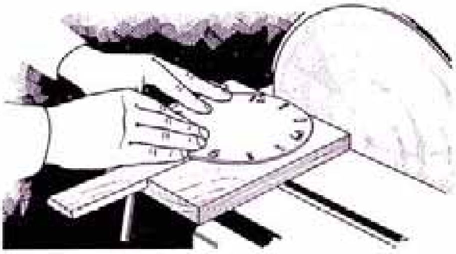


Above, using a grooved form to sand a round edge. Photo at left shows a slashed belt being used to sand abrupt edge curves.



sanding of practically any moulded shape is possible. Where the shape of the form is composed of very abrupt curves, slashed belts should be used. This type of belt, as the name implies, is not a solid surface but is slashed into strips about ⅛-inch wide. Short sections of the belt are left uncut and these uncut portions serve to hold the numerous narrow belts together.

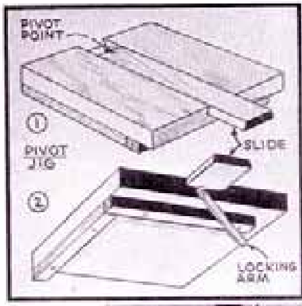
Slashed belts are ideal for sanding odd-shaped edges. This type of work is done without a backing plate, hence either the sander table must be removed or the work done on the back side. The latter is preferable for occasional work since it is much easier to remove the back plate than the table. In use, the belt is run rather slack so that the work, when projected into it, as shown in Fig. 8, will cause the belt to assume the proper shape. Edges finished in this manner will show a very slight curvature, but for all practical purposes the effect is a right-angle cut. Production runs are best done with the use of the sander table, since this provides a rest for the work while insuring proper contact with the belt. It is necessary, of course, to remove the main sander table before the tilt table can be used.



CHAPTER FOUR

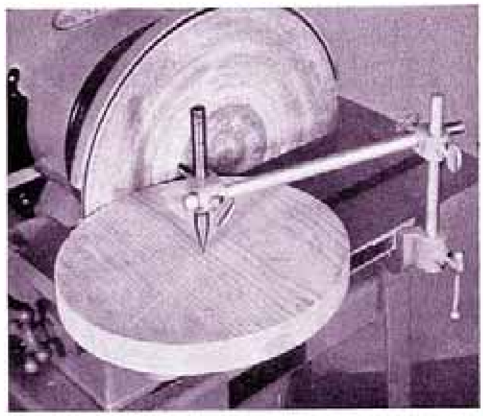
OPERATING THE DISK SANDER

Freehand Sanding. — Sanding on the disk sander is usually done freehand, the work being held flat on the table and projected into the sanding disk. A smooth, light feed should be practiced. Avoid heavy pressure. Best results on curved work can be obtained by going over the work two or three times with light cuts. Sanding is always done on the "down" side of the disk; working on the opposite side would, of course, push the work away from the sanding table.



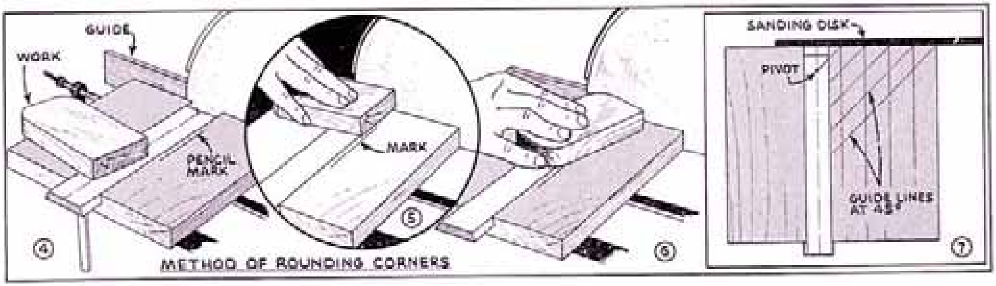
Pivot Jigs.—Circular work which is to be sanded should always be worked with the use of a pivot jig. Top and bottom views of a simple jig are shown in Figs. 1 and 2. Cleats on the underside provide a positive stop against the front and side of the standard table. The sliding strip can be set at any position, and is locked in place by pushing down on the locking lever, the end of which works like a cam. In use, the work is first band sawed to shape, after which it is mounted on the pivot point. The sliding strip is locked at the required distance from the sanding disk. Pushing the table into the disk sets the cut, and rotation finishes the entire edge to a perfect circular shape. The jig can be clamped to the sander table or simply held with one hand while the other hand rotates the work.

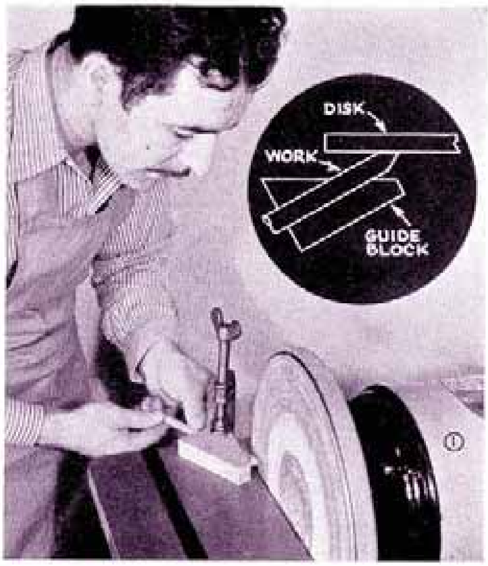
Any other style of pivot jig will work equally well, the simplest set-up being a brad driven into a board which is clamped to the sander table at the required distance from the sanding disk. An overhead pivot point, as shown at the right, can be made from circular saw hold-down parts. This type of jig is fully adjustable and has the advantage of a visible pivot point which can be accurately set in the center of the work.



A pivot jig is almost a necessity in sanding circular pieces if accurate work is to be done.

Rounding Corners.—The sanding of corners is allied to circular work in that the edge being worked is part of a true circle.

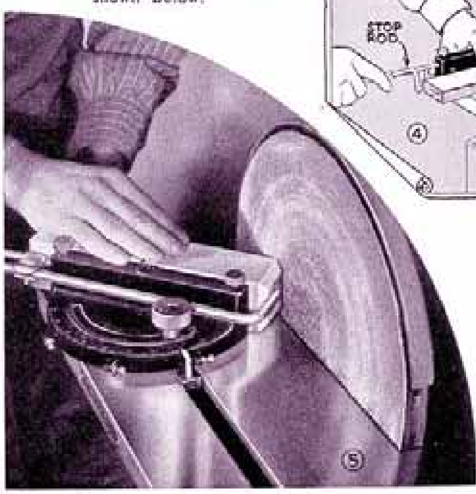




Above, pointing dowels on the disk sander. Right, how to use the miter gage.

Most work of this nature can be done freehand, sweeping the corner of the work across the face of the sanding disk two or three times until the desired round is obtained. More accurate results are possible if the pivot jig is used in the manner shown in the drawings at the bottom of the preceding page. The sliding strip is first locked in place at the required distance from the face of the sanding disk.

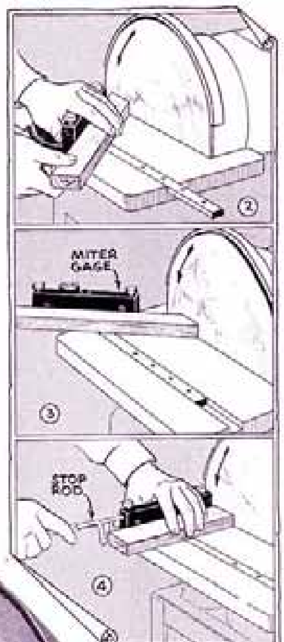
Square posts are easily beveled by using the gage and stop rod as shown below.



A pencil mark is then drawn on the table of the jig, this mark being the same distance from the pivot point as the pivot point is from the sanding disk, as shown in Fig. 4. The work is placed against a guide fastened to the rear edge of the jig, as shown in Fig. 5, and is brought down on the pivot point in alignment with the pencil mark. Rotating the work rounds the corner, see Fig. 6. Fig. 7 shows how the jig table can be marked with pencil lines as a guide to placing work of any radius.

Pointing Dowels. — A hole of the same diameter as the dowel stock is drilled through a scrap piece of wood which is clamped to the sanding table at the required angle, as shown in Fig. 1. The work is pushed through the hole until it contacts the sanding disk, after which it is rotated to finish the point.

Use of Miter Gage.—A circular saw miter gage can be used to advantage in sanding square or mitered ends. Where miters are being sanded, the preferable position is as shown in Fig. 2, which permits better handling than the reverse position shown in Fig. 3. Square ends are sanded by projecting the work along the miter gage until it contacts the disk. Sanding to exact length can be done by pre-setting the stop rod at the required distance. The rod is free to slide in the hole in the end of the gage, as shown in Fig. 4, the exact length being set when the rod comes to a stop at the bottom of the hole. The beveling of square posts is easily done by using the miter gage with stop rod in the manner shown in Fig. 5.



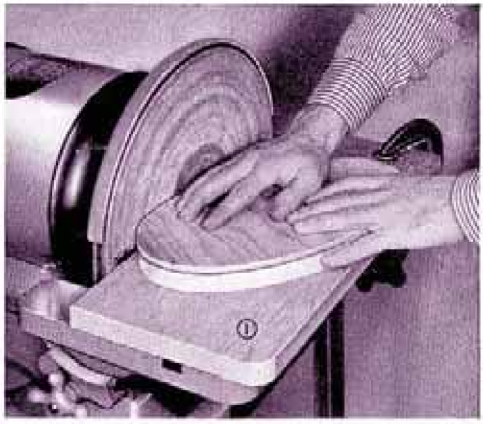
Grinding Metal. — Finishing metals and plastics on the disk sander is practically the same as similar operations on wood with the exception that an aluminum oxide abrasive disk should be used instead of garnet.

Large Work.—Where the work being sanded is so large that it cannot be easily held on the sander table, an auxiliary wood table of suitable size should be made, this being clamped or otherwise fastened to the standard sanding table.

Sanding with Pattern.—In production work, sanding with the use of a pattern can be used to advantage and insures perfect work. A wood table, to one side of which is screw-fastened a thin but rigid strip of metal, is clamped in place over the regular sanding table, as shown in Fig. 2 on the opposite page. The guiding edge of the metal strip should be about ⅛ inch from the surface of the sanding disk, and the pattern should be made ⅛ inch undersize to correspond. Anchor points permit fastening the pattern to the work, after which the work is band sawed about

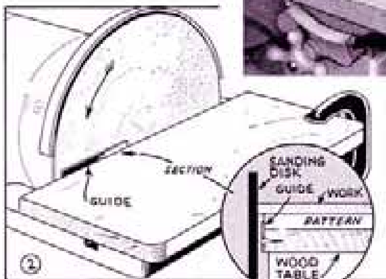
⅛ inch outside the edge of the pattern. The work is then sanded smooth, the pattern being held in contact with the metal guide, as shown in Fig. 1, as the work is projected into the sanding disk.

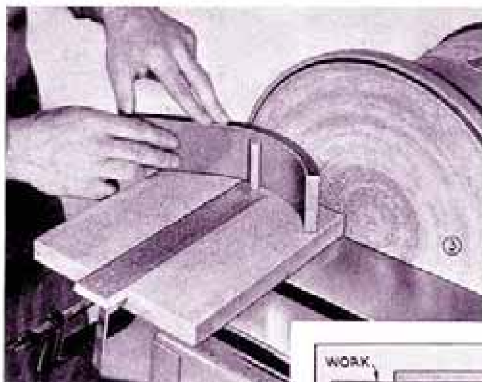
Sanding to Width.—Curved surfaces can be sanded to uniform width by first band sawing and smoothing one side, and then using a spacer pin, as shown in Fig. 3, to set the finish cut on the opposite side. While the photo shows the pivot jig used for this purpose, it can be seen that any scrap piece of wood with one corner rounded can be clamped to the sanding table to serve as a guide.

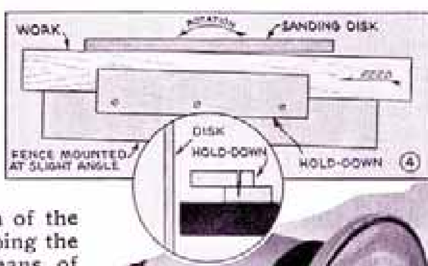


Clean, accurate work in production runs can be done by sanding with the use of a pattern.

Use of Double Disk.—When working small wooden or plastic parts requiring two grades of abrasive for finishing, good use can be made of a double sanding disk. This is made by cutting out the center of the coarser disk, cementing a smaller disk of finer abrasive in the opening thus provided. The work is first sanded on the outer portion of the disk and then without stopping the machine, is finished by means of the finer abrasive disk.



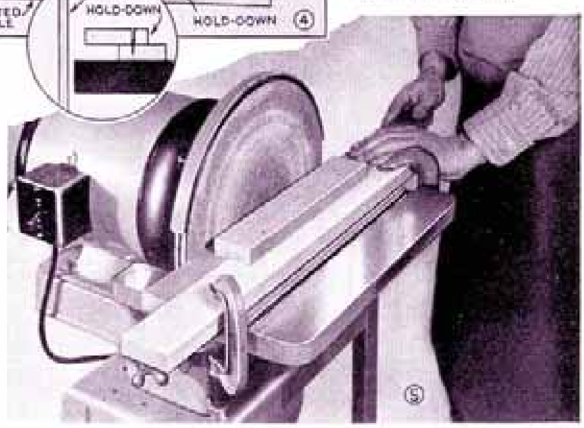




Above, using a spacer pin to sand curved work to exact width. Right, method used in sanding long, straight edges.

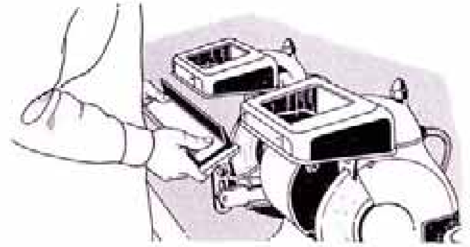
Sanding Long Edges.—While the disk sander is not particularly suited for sanding long straight edges, good work can be done by using the set-up shown in Figs. 4 and 5. A wood fence to which is fastened a hold-down block is clamped to the sander table at the required distance from the sanding disk. The wood fence should be mounted at a slight angle to make sure that the work, which is fed from the "up" side of the disk, will not come in contact with the sanding surface until it reaches the "down" side. The angle should be very slight and is purposely exaggerated in the illustrations to show the method of working. A smooth feed is essential. Any length of work can be handled in this manner, or, short pieces can be run through one after another.

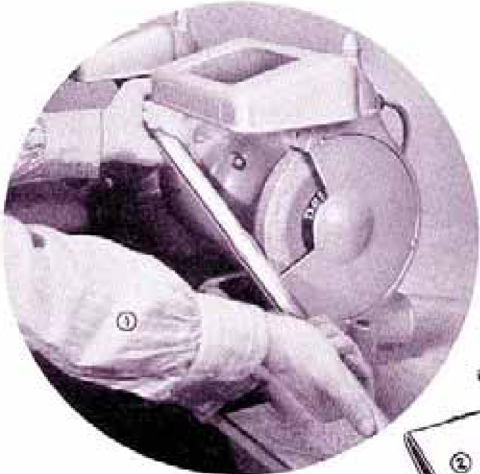
Selection of Abrasive.—The abrasive used on the disk sander will depend upon the work. As on all other abrasive machines, garnet is used for wood while aluminum oxide and silicon carbide disks are used for metal. Since the disk sander is commonly employed for edge work, the abrasive generally can be somewhat coarser than for surfacing. A ½ or 1/0 disk cuts rapidly to a fairly smooth surface. Fine cabinet work, however, requires final sanding with a 2/0 or 3/0 disk so abrasive scratches will not show.

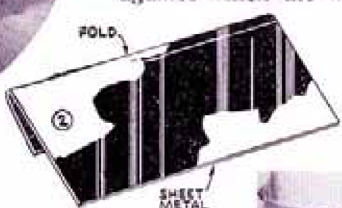


CHAPTER FIVE

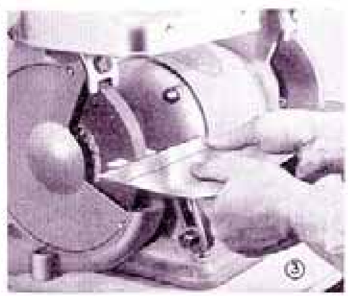
GENERAL GRINDING

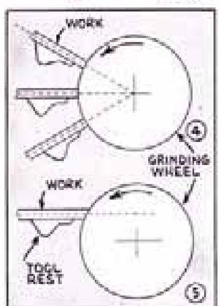


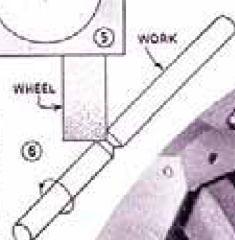


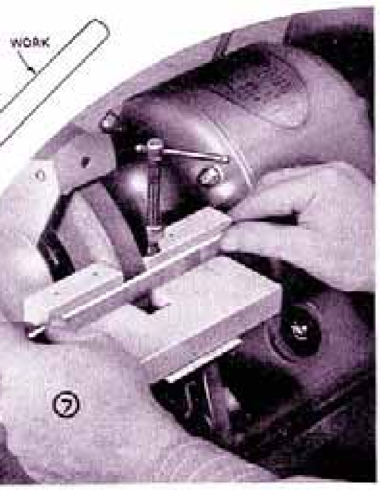


The grinder plays an important part in hundreds of odd jobs around the shop. Smoothing welded joints and cutting sheet metal are typical examples.







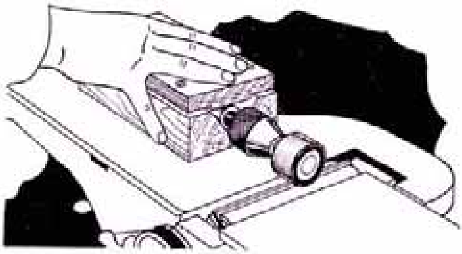


Safety Suggestions.—The grinder is a safe tool to operate providing a few simple rules are followed. Always use the guards. If guards are not provided, wear suitable goggles as a protection against flying fragments of abrasive. Keep the wheels round by dressing whenever required. Do not force work against a cold wheel, but exercise light pressure until the wheel becomes warm. Always use a tool rest when the work permits. Present the work to the wheel either straight in or at a "drag" angle, reserving the "gouge" angle for sharpening and other operations demanding a minimum burr.

Odd Jobs.—An almost endless number of odd jobs are done on the grinding wheel. Smoothing a welded joint, as in Fig. 1, is typical of this class of work. Cutting thin metal by first folding it, as in Fig. 2, and then grinding through the fold, as in Fig. 3, is another example. Fig. 6 shows how the edge of the wheel is used to nick rod stock preparatory to chiseling or sawing. Most offhand grinding is done on the face of the wheel. When grinding is done on the flat sides of a straight wheel, use care to wear the wheel smooth since a rough or grooved side can be very dangerous on certain jobs.

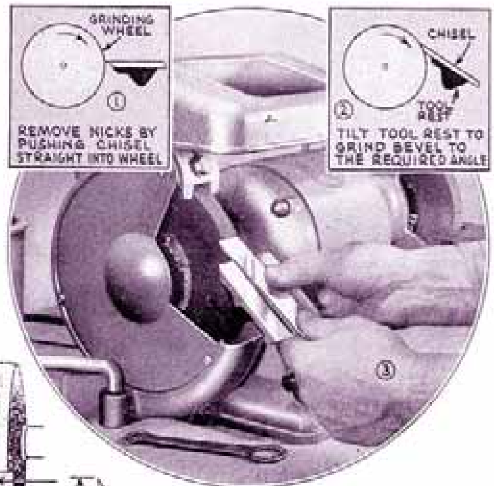
Position of Tool Rest.—A level tool rest set a little below the center of the wheel, as shown in Fig. 4, is in the most practical and safest position for general work. Work ground in this position, or any other position when the work points to the center of the wheel, will be finished with a square edge. It can be seen, Fig. 5, that work presented in any position other than pointing to the wheel center, will be ground more or less on a bevel. Freehand grinding without the use of a rest should always be done on the lower quarter of the wheel.

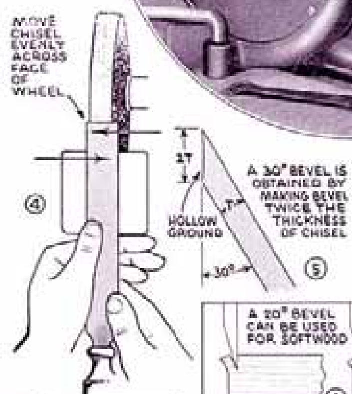
Use of Guides.—Guides clamped to the regular rest insure accuracy and should be used on all precision work. Fig. 7 is an example. The exact bevel and depth of cut is controlled by means of the simple fence against which the work is placed.



CHAPTER SIX

HOW TO SHARPEN TOOLS

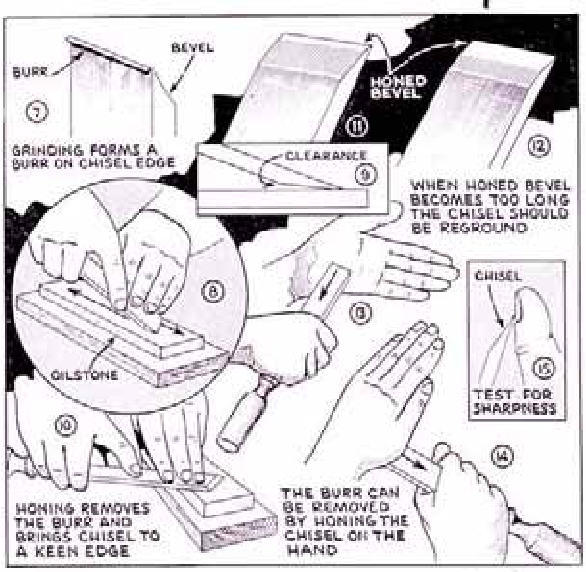




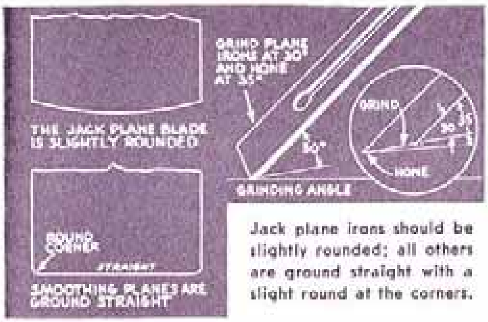
Tool grinding is done on an aluminum oxide wheel, with the edge of the tool against the direction of rotation. Lower drawing shows honing methods.

General. — Two operations are necessary in sharpening most tools: (1) the edge is ground to the proper shape on the grinder, (2) the edge is honed to perfect sharpness on a suitable oilstone. The grinding wheel used should be an aluminum oxide wheel, about 60-grit, and of medium hardness. Keep the wheel properly dressed. A revolving disk type dresser (see page 24) can be used satisfactorily. In grinding, keep the tool cool by constantly dipping in water; temper is being drawn when blue spots appear on the edge of the tool. High speed steel is best ground entirely dry, using a very light feed and stopping between cuts to allow the tool to air cool. The use of a white aluminum oxide wheel will permit a heavier feed without overheating.

Wood Chisels. — Wood chisels should be hollow ground. Project the chisel straight into the wheel to remove nicks, as shown in Fig. 1; then, adjust the tool rest to the required position to grind the bevel, Fig. 2, working the chisel squarely across the face of the wheel, as shown in Fig. 4. Worked on the face of the wheel, the bevel will have a slight hollow, making it easy to hone to a perfect edge several times before regrinding again becomes necessary. The bevel should be about 30 degrees, this being obtained by making the bevel twice the thickness of the chisel, as shown in Fig. 5. A 20 degree bevel can be used for softwood, but this thin wedge will crumble on hardwood, as pictured in Fig. 6.



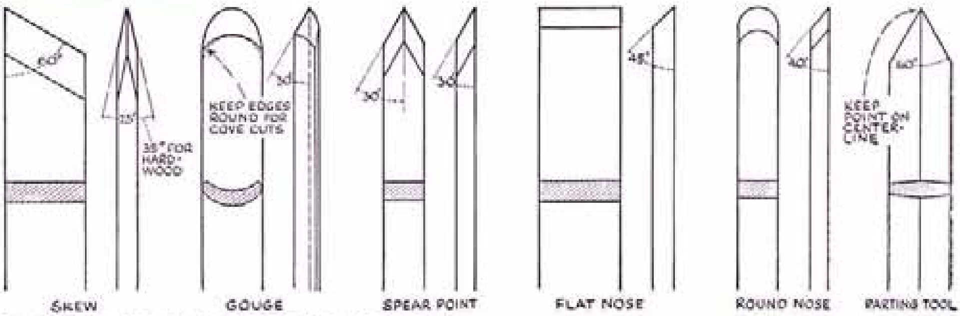
Honing. — Either an aluminum oxide or a silicon carbide oilstone will give good results in honing or whetting the chisel edge after grinding. The sharpening stone should always be oiled, the purpose of this being to float the particles of metal so that they will not become embedded in the stone. Use a thin oil or kerosene. Wipe the stone after using. Honing is necessary because grinding forms a burr at the chisel edge, as shown in Fig. 7. To remove the burr, place the chisel diagonally across the stone, as shown in Fig. 8, and stroke backward and forward.



Jack plane irons should be slightly rounded; all others are ground straight with a slight round at the corners.

in Fig. 11 on the previous page and this is the correct technique for chisels, plane irons, knives, etc. This method gives a clean edge with a minimum amount of labor. When the honed bevel becomes too long through repeated whettings, Fig. 12, chisel should be reground. Figs. 13 and 14 picture the common method of hand honing. Fig. 15 shows standard test for sharpness—the chisel should "bite" on the thumb nail.

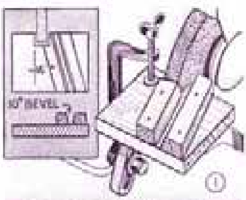
Plane Irons.—Plane irons are sharpened the same as wood chisels. A bevel of 30 degrees and a honing angle of 35 degrees is satisfactory in most cases. The corners of the plane iron should be slightly rounded. Mechanical devices to hold the plane iron or chisel at the proper angle when grinding are advantageous.

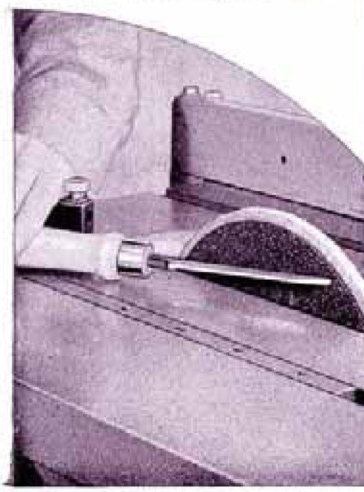


GRINDING ANGLES FOR WOOD TURNING TOOLS

bearing down with both hands. The heel of the chisel should be a slight distance above the surface of the stone, as shown in Fig. 9. Next, turn the chisel over and stroke the back on the stone, making certain to keep the tool perfectly level, as shown in Fig. 10. Alternate the honing on bevel and back until the burr is completely removed.

It will now be noted that honing puts a secondary bevel on the chisel, as shown



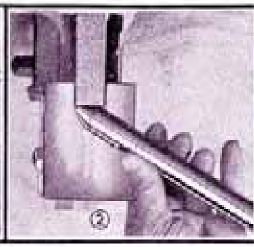


Bevels on wood turning tools should be ground flat. Simple jigs, as at left, simplify the work.

Wood Turning Tools. — Some wood turning tools are not hollow ground. Instead, the bevels are perfectly flat and should be kept flat during honing. Any secondary bevel on a skew, for example, will prevent it from being used satisfactorily in turning, where the heel of the bevel must act as a fulcrum.

The Skew Chisel.—The bevel of the skew chisel is double and has an included angle of 25 to 35 degrees. Grinding can be done on the disk sander, or on the side of a straight or recessed grinding wheel. The chisel can be held freehand, but better results will be obtained with a simple guide block, as shown in Fig. 1. Holding the chisel first against one of the beveled guide blocks and then the other, as shown in Figs 2 and 3, will bring each of the bevels to the required angle. In honing, maintain the same bevel.

The Parting Tool.—Make a suitable guide block to present the parting tool to the side of the grinding wheel. A grinding wheel mounted on the circular saw offers a convenient method of working since the bevel angle can be set on the miter gage.

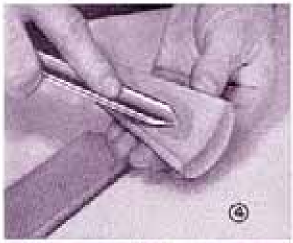


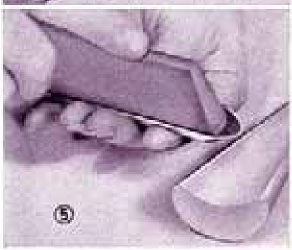
The gouge is sharpened by rolling on either a cup or straight wheel.

as shown in the lower photo on the opposite page. The parting tool can also be hollow ground if desired.

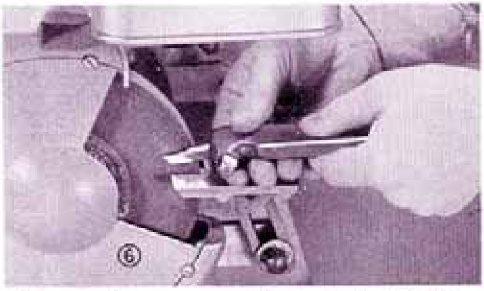
The Gouge.—Simplest of all methods of sharpening the gouge is to use a cup wheel on the lathe, rotating the chisel inside the wheel, as shown in Fig. 1. The curved surface of the cup wheel lessens the amount of rolling necessary and makes grinding quite simple. Lacking the cup wheel, the same general method can be employed by turning a wedge-shaped recess in a block of hardwood. Fed with 60-grit abrasive grains combined with grease, the wood block works just the same as a cup grinding wheel. The gouge can also be ground by rolling the bevel on the face of the wheel, as in Fig. 2 or on the side of the wheel, Fig. 3. In all cases the roll must be just a little less than that of a full half-circle.

Special sharpening stones are required for honing the gouge. The best type is hollow on one side and round on the other side—made especially for honing gouges. Fig. 4 shows this stone in use. The round edge of the stone can be conveniently used to cut the burr on the inside flat edge of the gouge, or a slip stone can be used for this purpose, as shown in Fig. 5.

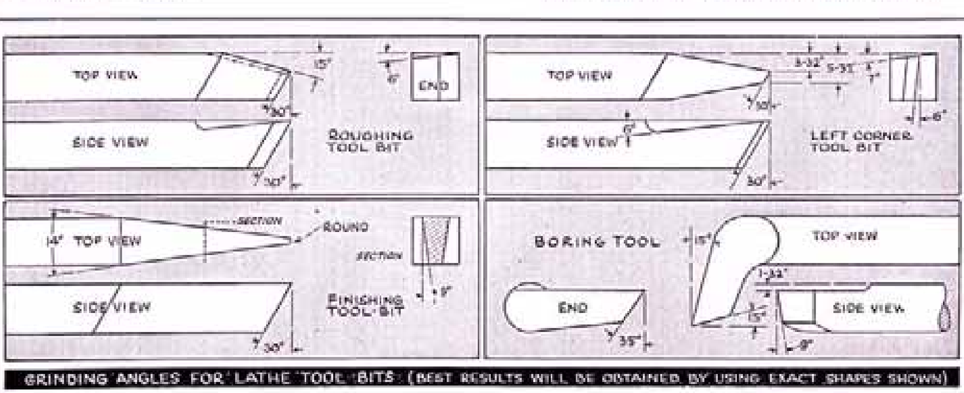




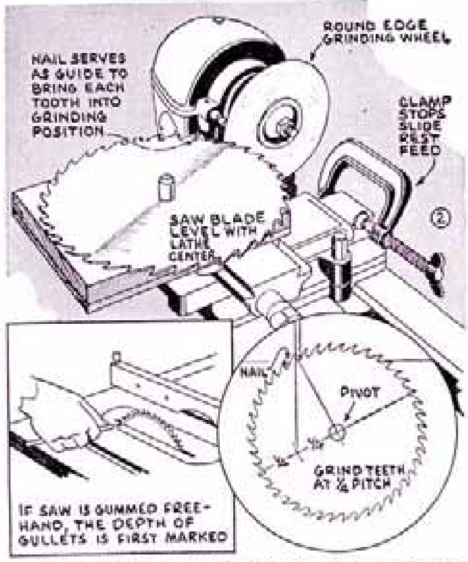
Lathe Tool Bits—Lathe tool bits are sharpened offhand, being held in the hand to present the tool at the proper angle to the side of the grinding wheel. A light touch on the grinding wheel is all that is usually required to bring the bit to a keen edge. Maintain the original bevels, or, if working blank stock, follow the angles for 1/4 inch bits given in the drawing below. Handling during grinding is simplified if the bit is held in the tool holder, as shown in Fig. 6. Small abrasive sticks can be used to advantage for touch-up sharpening, especially when this is done during the course of a lathe job.



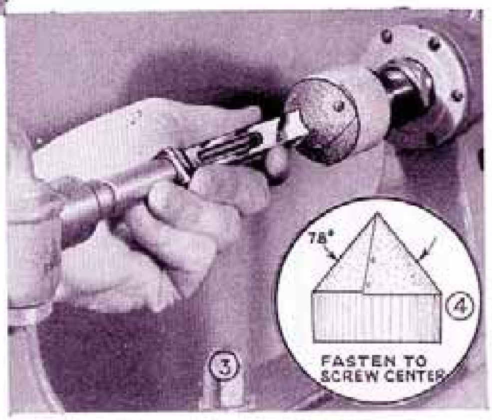
Lathe tool bits are ground freehand, the bit being mounted in the tool holder as shown above. Drawing below shows grinding angles for lathe tool bits.



GRINDING ANGLES FOR LATHE TOOL BITS (BEST RESULTS WILL BE OBTAINED BY USING EXACT SHAPES SHOWN)



Above, simple automatic method of gumming and grinding circular saw blades. Below, grinding a mortising chisel on the lathe.



Circular Saws. — Saw blades can be gummed free hand by simply holding the saw to the wheel. A pencil mark should be made around the rim of the saw, as shown in Fig. 2, to indicate the depth to which the gullets are to be ground. Grinding is done on a narrow, round-edge wheel.

An automatic set-up for grinding and gumming can be made on the lathe with the use of the slide rest, as shown in Fig. 1. The grinding wheel should be dressed to the required gullet shape, and the slide rest adjusted so that the wheel will be in alignment to cut a quarter-pitch tooth, as shown in the circle inset, Fig. 2. Grinding is done by feeding the saw into the wheel by means of the slide rest feed. A nail in the work table provides a stop so that each tooth is accurately aligned for grinding. A clamp fitted across the slide rest base provides a stop for depth. Each tooth is ground in turn. The saw should be free from gum which might cause an inaccurate setting against the guide pin. After the gullets and tooth faces are ground, the position of the slide rest can be changed to grind the backs of the teeth. Throughout the whole operation of sharpening the circular saw by grinding, caution must be used to prevent burning.

Mortising Chisels.—The internal surface of the mortising chisel should be ground to an included angle of 78 degrees. The simplest method of working is to use a small grinding wheel with end shank, dressing the wheel to the required angle. Lacking the wheel, a wood form can be turned and then coated with glue and rolled in abrasive, or, the form can be covered with 120-grit wet-or-dry abrasive paper. The method of working is shown in Fig. 3, the chisel being centered on the lathe tailstock center and projected into the revolving wheel or abrasive-covered wood form. A square abrasive stick or file can be used to clean out the corners.

Grinding Jointer Knives. — Jointer knives are ground on an angle of 35 degrees, as shown in Fig. 1 on the opposite page. When mounted in the cutterhead, the rear edge of the bevel should be about 1/16 inch from the surface of the cutterhead, as in Fig. 2. Since the knives are quite narrow, it is necessary for grinding purposes to make a holding block, this being made by running in a saw cut with the block in one of the positions shown in Fig. 3, depending on the method which will be used in grinding. The saw kerf usually will be a snug fit for the knife, but if any looseness is apparent, the knife can be held secure by means of screws.

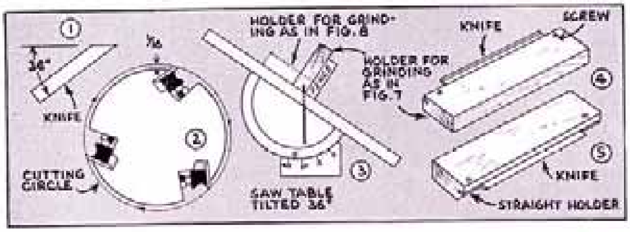
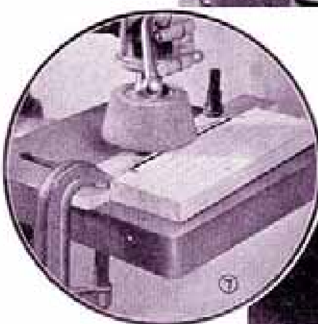
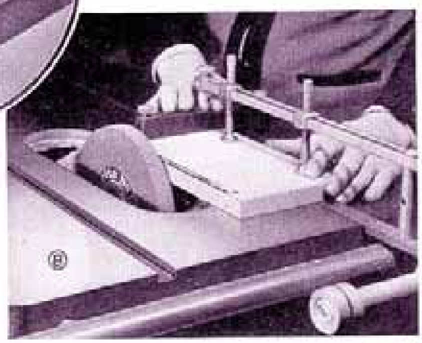


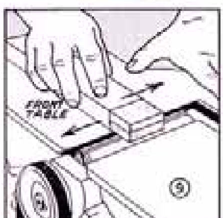
Fig. 6 shows one of the knives being sharpened on the grinder. The tool rest is adjusted to the required angle, and a guide block is clamped in position to insure a straight cut across the knife. Each knife is worked in turn, making a single, very light cut. A strip of paper is then pasted to the holding block, the purpose of this being to set the next cut without changing the original position of the guide block. Two or three very light cuts will usually bring all of the knives to a perfect edge. It cannot be stated too strongly that abrasive cuts on high speed steel knives must be light; heavy cuts will invariably burn the knife and render it useless.

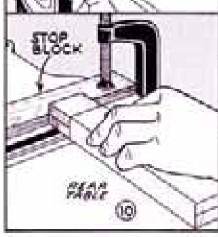


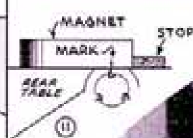
A number of different methods can be used in grinding jointer knives. In each case, grinding is done dry. Very light cuts must be taken to avoid burning. Cuts are made in rotation on all knives until a final cut brings each of the knives to a perfect edge.

The method of grinding jointer knives on the drill press with a cup wheel is shown in Fig. 7, while Fig. 8 shows the operation as performed on the circular saw. The latter method can also be used in connection with the belt or disk sander. Whatever method is used, best results will be obtained if the grinding is done with successive light cuts, taking each knife in turn until all edges come up sharp.



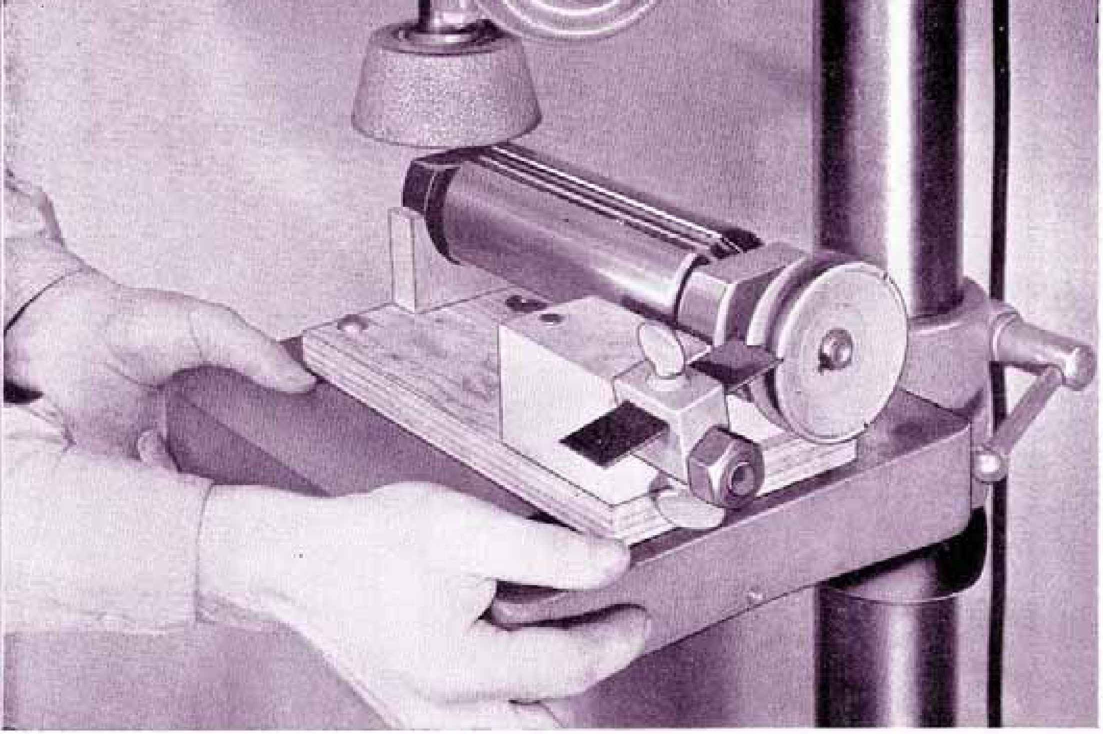






Honing Knives.—Grinding is not always necessary to sharpen the jointer since careful honing at regular intervals will maintain a sharp head for some time. To hone the knives, partly cover a fine carborundum stone with paper so it will not mark the table, and place it on the front table, as shown in Fig. 9. Turn the cutterhead until the stone rests flat on the bevel, and fix the head in this position by clamping the belt to the stand. Whet the knife by stroking the stone lengthwise with the blade, treating each knife with the same number of strokes.

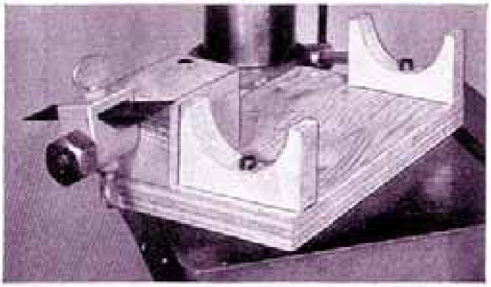
Jointing Knives.—Knives can be sharpened and brought to a true cutting circle by jointing their edges while the head is revolving. In this operation, the stone is placed on the rear table, as shown in Fig.

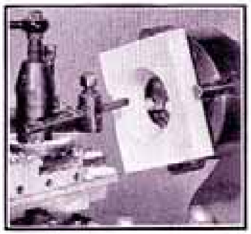


10, and the table lowered until the stone barely touches the knives. After two or three jointings of this nature, it will be necessary to recondition the knives by grinding in order to maintain back clearance.

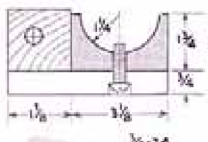
Setting Jointer Knives. — After grinding, knives must be carefully mounted in the head. One of the best methods of doing this is with a magnet, as shown in Figs. 11 and 12 on the previous page. An index mark should be scribed on the magnet and a stop block should be clamped to the front table at such a position as to bring the index mark in line with the cutting edge of the knife when it is at its highest point. The knife is placed in its slot and is pulled up to the required level by the magnet, after which the setscrews are tightened. Once the initial set-up has been made, this method of adjusting knives will be found both accurate and convenient, and faster than where a plain straight edge is used.

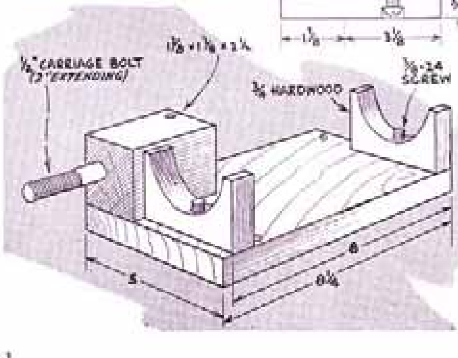
Grinding Knives in Head.—Knives can be ground without removal from the head by the method shown on this page. The complete head is mounted on the jig. Saw cuts in the pulley serve to bring each of the knives into the required position for grinding. The jig is bolted to the drill press table, grinding being done by swinging the table which is supported on a column collar. Another method of grinding the complete head is shown in the heading to this chapter. This makes use of a flexible shaft fitted with a small grinding wheel. The head is fixed at the proper position to maintain the bevel by clamping the belt to the side of the machine stand.





Top, grinding jig in use. Above, the jig with jointer head removed. Pillow blocks should be turned to exact diameter.





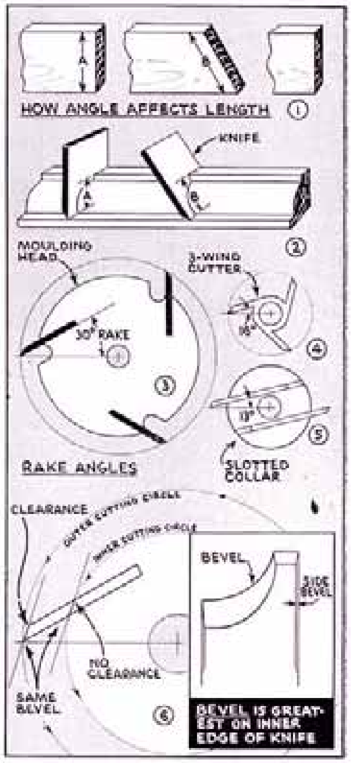
CHAPTER SEVEN

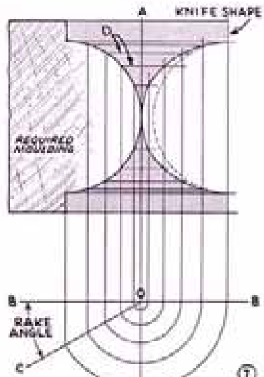
GRINDING SHAPER CUTTERS

Rake Angle.—The rake angle of any cutter determines its shape and other characteristics. As shown in Fig. 1, a slanting line across a piece of wood is necessarily longer than a straight one. Applied to shaper cutters, it can be seen, Fig. 2, that the length of the cutter working on an angle, B, must be greater than if the cutter worked straight across the work, as at A. This rake angle is present in all shaper cutters and is greatest when knives are mounted in a moulding head, as shown in Fig. 3, where the angle is approximately 30 degrees. It is obvious that the greater the rake angle, the greater the difference between the shape of the knife and the moulding it cuts.

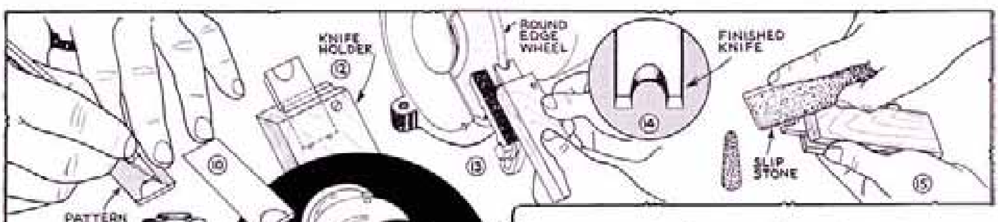
Amount of Bevel.—Knives are beveled at an angle between 30 and 45-degrees. It can be seen, Fig. 6, that a bevel which will provide clearance at the outer cutting circle may not be enough to give clearance at the inner cutting circle. Examination of a factory-sharpened cutter will show that the bevel is greatest at the inner edges of the knife, thus maintaining the same amount of clearance. Portions of the knife parallel with the line of travel, such as the sides, demand only a minimum amount of bevel to provide clearance.

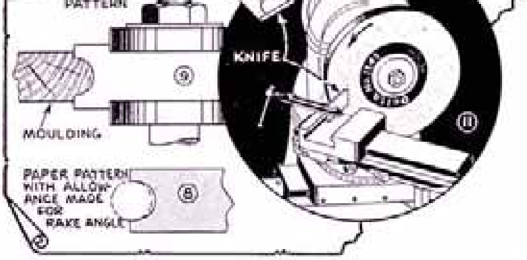
Projected Shape. — The required shape of any cutter to produce a certain shape can be obtained by drawing the moulding full size on a piece of paper, as shown in Fig. 7. Along the edge of the moulding erect a vertical line, A. Below the moulding, draw a horizontal line, B, and where A intersects B draw a line, C, at the same angle as the rake angle of the cutter. Drop lines from the moulding shape to the line C, and, using O as a center, carry these lines around to line B on the opposite side and then project them upward. Lines D located at all points where the vertical lines cut the moulding are carried across the center line and establish a series of marks, which, when joined, show the shape of the cutter required to cut the moulding.

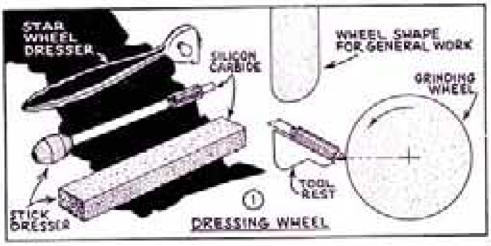


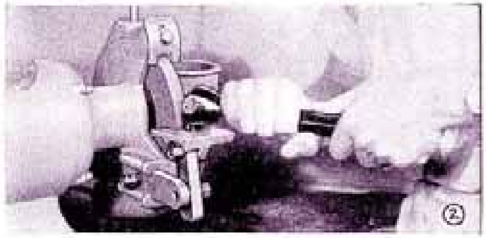


Above, factors governing the knife shape. Left, a knife projection. Drawing below shows knife making.





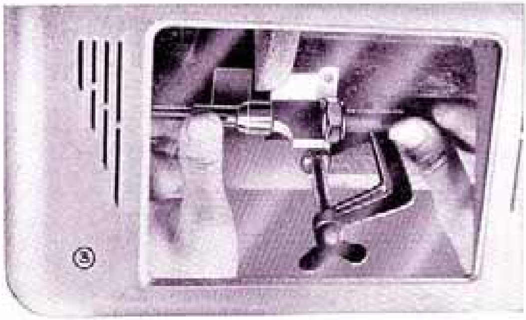


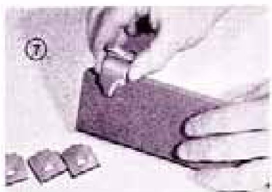


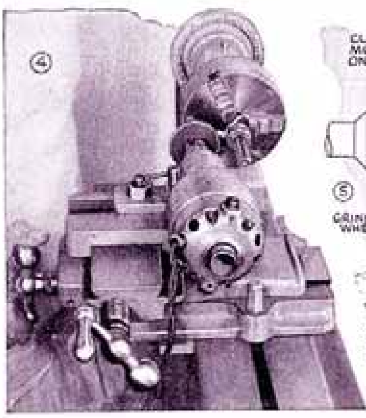
A star wheel dresser is fast-cutting while stick and diamond dressers provide for precision work.

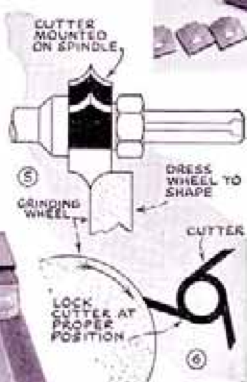
The difference amounts to about 1/16 inch in depth where moulding head cutters are being plotted and about half of this for three-wing cutters and slotted collars. For average work, the projected shape can be judged with fair accuracy without drawing. The basic rules to remember are (1) knives for cutting beads must be ground deeper, and (2) knives for cutting coves must be ground fuller.

Making a Knife.—Figs. 8 to 15 on the previous page show the various steps in making a pair of knives for use with slotted collars. The required shape is a full half-circle, as shown in Fig. 9. A paper or metal pattern is made, as shown in Fig. 8, and, following the basic rule, this is cut slightly deeper than the shape of a true circle. Fig. 10 shows the pattern shape being transferred to the knife blanks. The outer straight bevel is then ground, a suitable method being as shown in Fig. 11 which uses the lathe slide rest to set the required angle. The curved portion of the knife is then ground on a round edge wheel, as shown in Fig. 13, the tool rest being adjusted to provide the proper bevel. After grinding both knives, the shape is compared and checked, readjustments made as required, after which the bevel is lightly honed, as in Fig. 15, to remove any burr left by the grinding. On certain shapes, good use can be made of a cut-off wheel to remove excess knife stock, thereby eliminating tedious grinding.



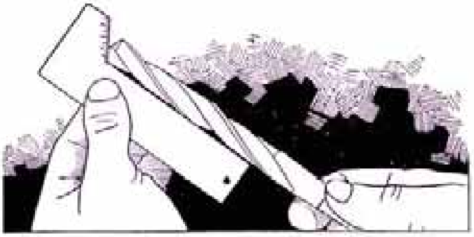






Use of Shaped Wheels.—Wheels can be fashioned to any required shape by using a suitable dresser. The revolving wheel type is the fastest cutting, but does not permit the precision which is possible with the silicon carbide stick type or the diamond dresser. The wheel type should be pushed straight into the wheel, while the stick or diamond work best at a drag angle, as can be seen in Fig. 1. With a wheel properly shaped, it is a simple matter to grind any cutter to the same contour. Fig. 3 shows a three-wing cutter being ground. Stops and guides insures all wings being ground exactly the same. The use of a shaped wheel in a tool post grinder used on the lathe is shown in Figs. 4, 5 and 6. The cutter is turned to the required position for the bevel, as in Fig. 6, and is then locked in this position by means of the index pin, after which the cut can be made.

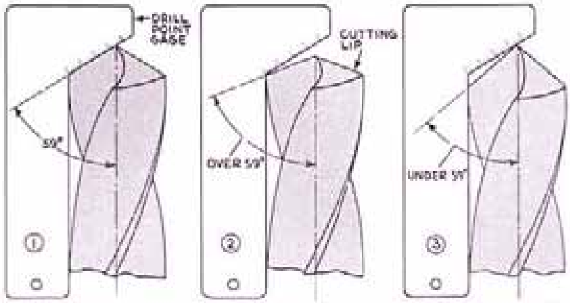
Sharpening Knifes. — Factory - ground shaper knives with involute bevels should be sharpened by honing the flat side of the cutting edge, as shown in Fig. 7. The involute bevel will retain the same shape regardless of metal removed from the back side. Knives ground in the homeshop with a straight bevel can be resharpened in the same way, or, the bevel itself can be honed. Where the knife has an involute or curved bevel, however, no grinding or honing should be done on the bevel.



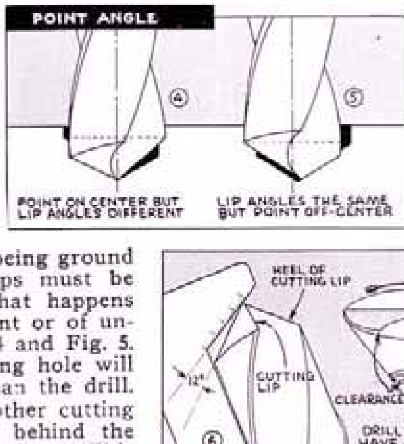
CHAPTER EIGHT

GRINDING TWIST DRILLS

Point Angle.—The two most important features of drill grinding are (1) the point angle, and (2) the lip clearance. The point angle has been established at 59 degrees for general work, and this angle should be maintained. It is easily checked with a drill-point gage. Gages in a variety of styles can be purchased at a nominal cost, or, the worker can make his own from sheet metal. The markings on the edge, which can be seen in Figs. 1, 2 and 3 need not be exact since they are used only to check the length of one lip against the other. In use, the drill body is held against the edge of the gage, and in such a position that the angular edge is over the cutting lip of the drill. The gage will then show whether or not the point, or, rather, one edge of the point, is "on the 59." Fig. 1 shows a drill with the correct point angle. Fig. 2 shows drill with point angle which is too great; Fig. 3 shows a drill with a point angle too small. Besides being ground to the correct angle, both lips must be exactly the same length. What happens when the lip angles are different or of unequal length is shown in Fig. 4 and Fig. 5. It can be seen that the resulting hole will be out of round and larger than the drill.

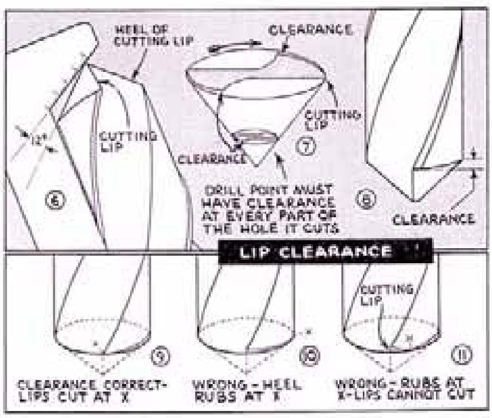


CORRECT POINT ANGLE IS 59°. THIS IS MOST EFFICIENT POINT FOR ALL-AROUND WORK — POINT ANGLE TOO GREAT - DOES NOT CENTER EASILY - DOES NOT TRACK IN PUNCH MARK — POINT ANGLE TOO SMALL - REQUIRES MORE POWER TO OPERATE

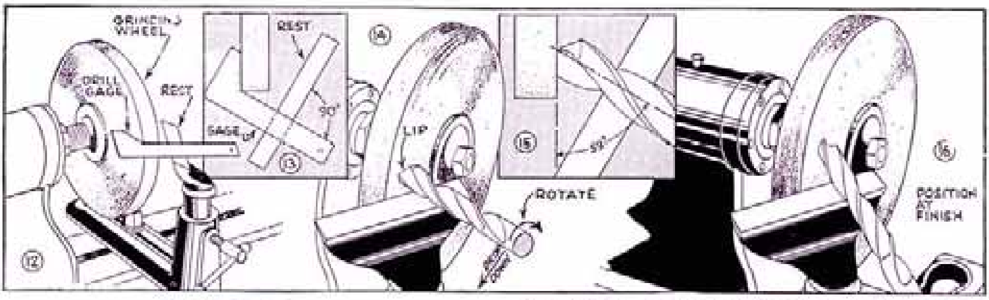


Point angle and lip clearance are the two factors which enter into the grinding of drills. A point angle of 59 degrees and a lip clearance of from 12 to 15-degrees give best results for general work.

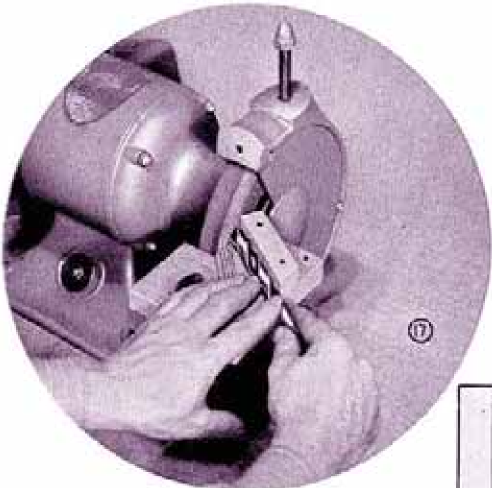
Lip Clearance. — Like any other cutting tool, there must be clearance behind the cutting edge before the drill can cut. This clearance can be readily seen on a properly-ground drill by using the drill-point gage, placing it over the heel of the point, as shown in Fig. 6. It will be noted that the angle here is 12 degrees less than the lip angle, and this is the proper clearance for the average drill—from 12 to 15 degrees. Clearance can also be observed by holding the drill as in Fig. 8 and noting the difference between the lip and heel of the point. Two horizontal sections of a drill point are shown in Fig. 7. It can be seen that there must be clearance behind the cutting lips at every part of the conic recess which the drill cuts. With clearance properly ground on, the drill cuts at the cutting lips, leaving every part of the point behind the lips in the clear. Fig. 9 shows the correct clearance. Fig. 10 shows just the reverse of correct clearance—the drill rubs at the heel and the lips cannot cut. Likewise, if any part of the heel rubs against the conic recess, Fig. 11, the lips cannot cut.



Drill Grinding.—With a fair understanding of point angle and lip clearance, the worker can now attempt to grind a drill. Even though the theory has been mastered, it is still somewhat of a trick to grind a drill offhand and arrive at the proper point. Experienced mechanics, through long practice, go through the motions almost mechanically, grinding points which are extremely ac-



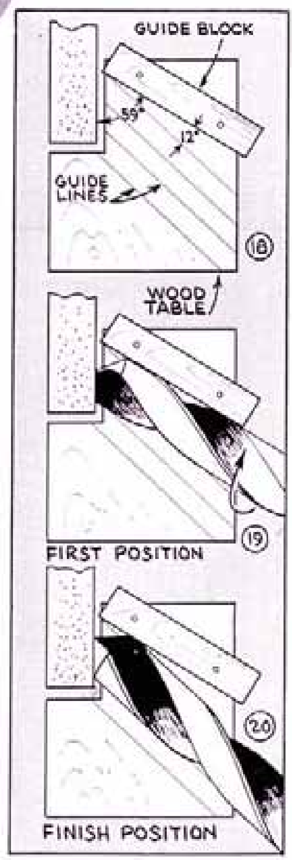
Drawing above shows successive steps in sharpening a drill on a wheel mounted in the lathe.

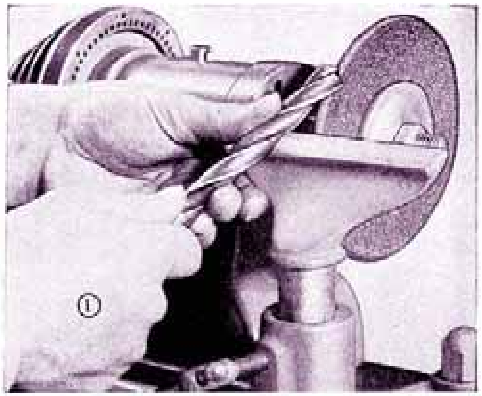


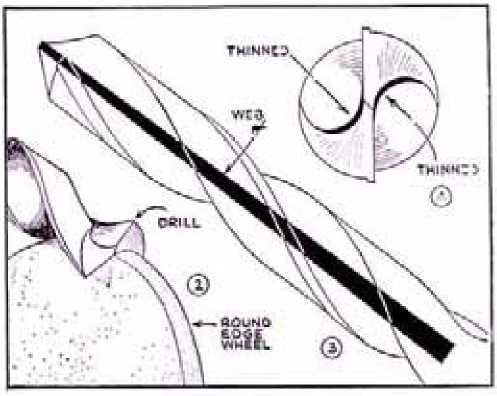
A simple method of grinding utilizes a guide block to set the point angle.

curate without the use of any mechanical guides or other aids. The worker who only occasional grinds a drill should always use some form of guide. Figs. 12 to 16 inclusive show one method of working. In this example, grinding is done on the lathe. The tool rest is first set by using the drill gage in the manner shown in Figs. 12 and 13. Now, if the lip of the drill is presented to the wheel while the body of the drill is at right angles to the rest, the point angle will be exactly as required, as can be seen in Figs. 14 and 15. From this starting position, the drill is rotated about one-sixth of a full turn, at the same time dropping the end about 12 degrees to give the required clearance. The proper swing is best acquired by swinging a properly-ground drill against the wheel, keeping the ground surface in contact with the wheel and noting the movements required to produce this surface.

Instead of dropping the drill to grind the lip clearance, the drill can be swung horizontally to produce the same effect. To grind drills in this manner, clamp a wood table to the tool rest of the grinder and on this table nail a guide block at an angle of 59 degrees with the side of the grinding wheel, as shown in Fig. 18. Mark off a series of parallel guide lines, each of these being on an angle of 12 degrees (the clearance angle) with the guide block, as shown. Now, if the cutting lip is placed against the side of the grinding wheel, with the body of the drill against the guide block, as shown in Fig. 19, the proper point angle will be obtained. From this position the drill is rotated about one-sixth of a full turn, at the same time moving to a position parallel with the penciled guide lines, as shown in Fig. 20. Each lip is treated in turn, checking with the drill gage to see that both are the same exact length. If desired, the grinding procedure can be reversed, starting at the position shown in Fig. 20. This has the advantage that the surface being ground can be seen at all times, but it has the disadvantage of producing a heavier burr at the cutting lips. In any case, care must be exercised not to rotate the drill too much, since over rotation will bring the lip on the opposite side into contact with the wheel, with the result that the grinding must be done all over again. One or two light twists on each lip will usually bring the drill to a sharp point. Touch-up grinding can be done by grinding the lips lightly and rotating about one-eighth of a turn for clearance. This will give a clean edge and can be done several times before the condition shown in Fig. 11 results, when the drill will demand grinding over the entire surface.

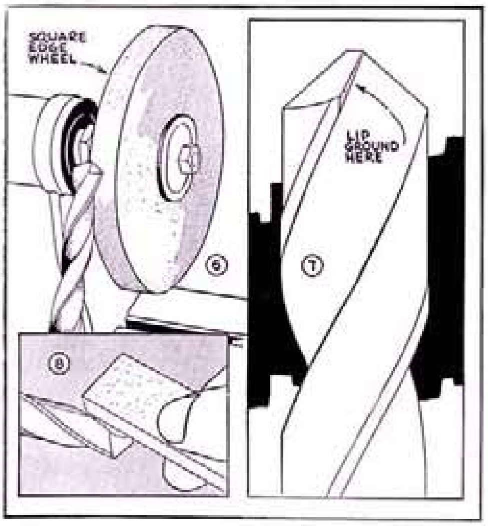






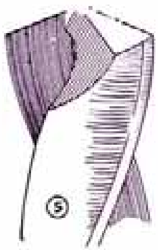
Above, web thinning with round-edge wheel. Right, web thinned on square-edge wheel.

Various mechanical drill grinders, both self-powered and for attachment to a standard grinder, can be purchased. Where considerable drill grinding must be done, it is usually a savings of both time and money to use one of these units. The usual device will handle drills from 1/32 to ½-inch diameter.



Drilling in brass and other soft metal is best done with a drill ground in the manner shown above.

Web Thinning.—As shown in Fig. 3, the web of the drill becomes thicker as it approaches the shank. It follows, therefore, that the point of the drill becomes thicker as the drill is ground down and resharpened, necessitating more power to force it through the work. To partly eliminate this heavy end thrust, the web of the drill should be thinned, as shown in Fig. 4. This operation is usually done on a round-face grinding wheel, the drill being held so that the wheel cuts in the flutes. The web can be thinned to about one-half its original thick-



ness, providing the metal is removed from the immediate point only. Where the shop owner does not possess a suitable round-edge wheel, the web can be thinned on an ordinary square-face wheel. In this form of web thinning, most of the grinding is done on the back of the lips, the grind being carried up to the center of the point on each side, as shown in Fig 5.

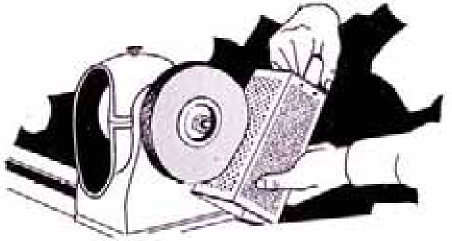
Drill for Brass.—For drilling brass and copper it will be found advantageous to modify the cutting edges of the drill. The effect to be obtained is shown somewhat exaggerated in Fig. 7, which shows how the cutting edge of the lip is ground off. This makes the edge scrape rather than cut, and reduces the tendency of the drill to "dig in" in brass and other soft metals. This form of grinding can be done on a fine-grit wheel, as shown in Fig. 6. Very little metal is ground off, just a few thousandths of an inch, and for this reason it is often better to flatten the cutting edge with a small sharpening stone.

Special Grinding.—While a point angle of 59 degrees and a clearance angle of from 12 to 15-degrees has been found best for average work, best efficiency is obtained if drills are specially-ground for the work to be done. For example, fiber takes a drill with a point angle of but 30 degrees, while manganese steel requires a 75-degree point angle. The countless drill-grinding variations now in general use are of undoubted value to the production shop worker, but are seldom useful in the home shop.

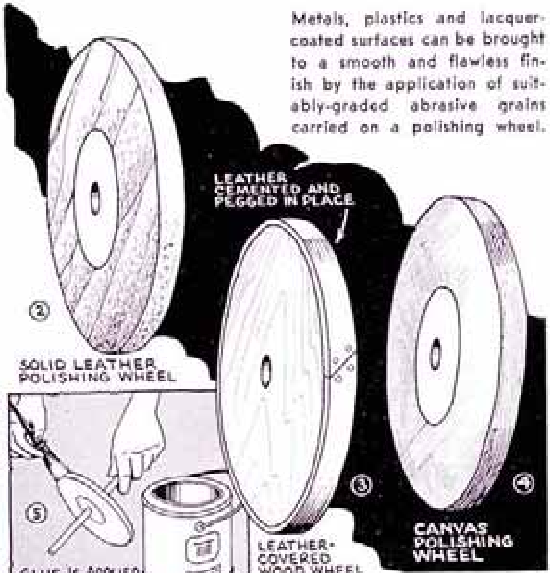
Wheels for Drill Grinding.—As listed in the appendix, the purified form of aluminum oxide (white in color) makes the best wheel for grinding high speed drills. It is not as tough as regular aluminum oxide, but runs cooler and is practically self-dressing. Second choice for high speed drills and first choice for general drill grinding is the regular type of aluminum oxide. In either case, the grit should be about No. 60 and the grade medium hard. The best wheel shape is a recessed center, but good work can be done on the side of a straight wheel.

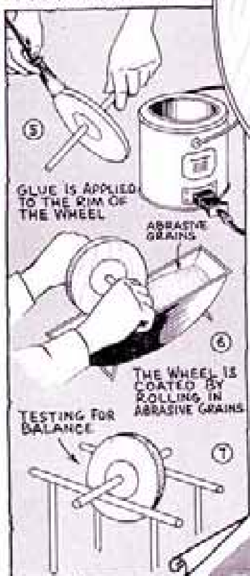
CHAPTER NINE

BUFFING and POLISHING



Metals, plastics and lacquer-coated surfaces can be brought to a smooth and flawless finish by the application of suitably-graded abrasive grains carried on a polishing wheel.

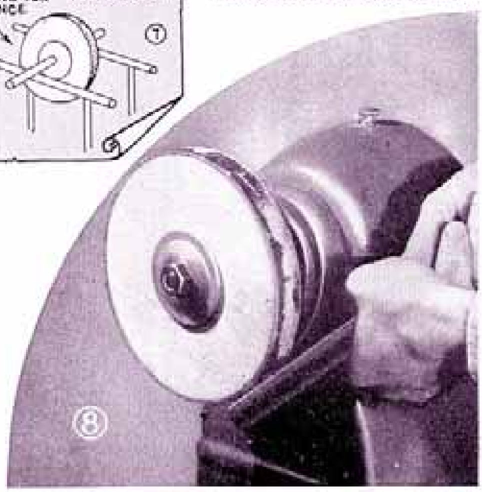


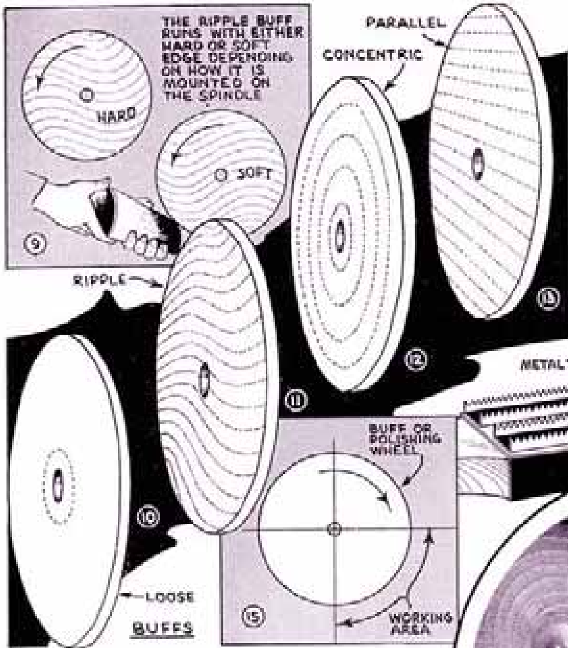


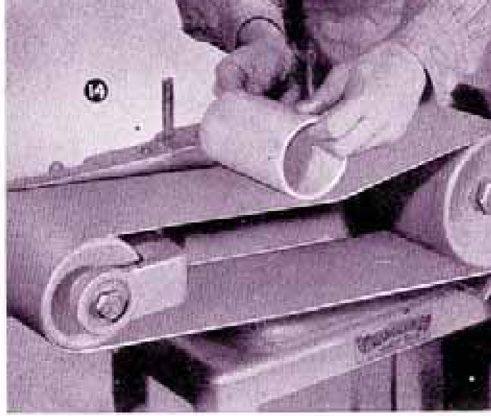
Polishing.—Polishing is the general term applied to the complete process of removing tool marks, scratches, etc., from metals and other substances to produce a high-luster finish. The process is divided into three distinct parts. First of these is roughing. Roughing is done dry with abrasives in grit numbers from 40 to 80. Dry fining or fine wheeling, as the second operation is called, can also be done dry, but is often done on a greased wheel. Grits used are from No. 120 to 180. Finishing, also called oiling and buffing, is the final operation. It is done with fine grain abrasives combined with lard oil, tallow, beeswax, water, etc. The exact size of grain used in all operations will depend upon the original finish on the work and the desired finish on the completed product.

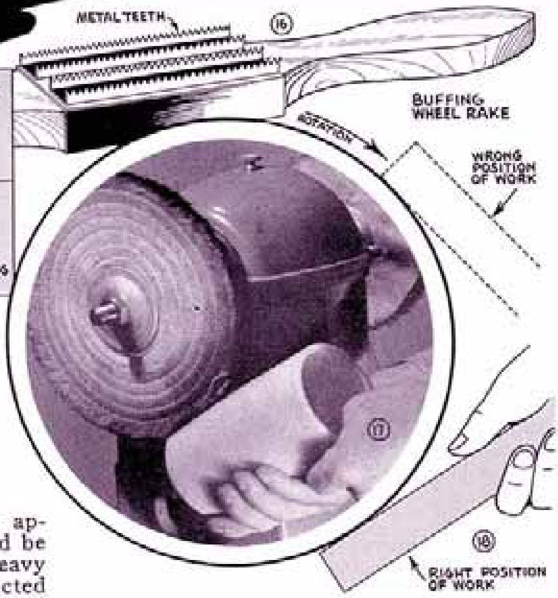
Polishing Wheels.—The first operation of roughing can be done on a solid grinding wheel. However, because this is hard and has no flexibility, polishing is usually done on leather or canvas wheels made especially for this purpose. If the work is a flat surface, a solid leather or leather-covered wood wheel can be used; if the work is curved, it will demand a cemented canvas wheel or other type which has the required flexibility.

Setting Up Polishing Wheels. — The old abrasive is first cleaned off by applying an abrasive stick about three numbers coarser than the abrasive on the wheel, as shown in Fig. 8. The wheel is then coated with









Buffing is the final polishing operation and is done with soft cloth or leather wheels.

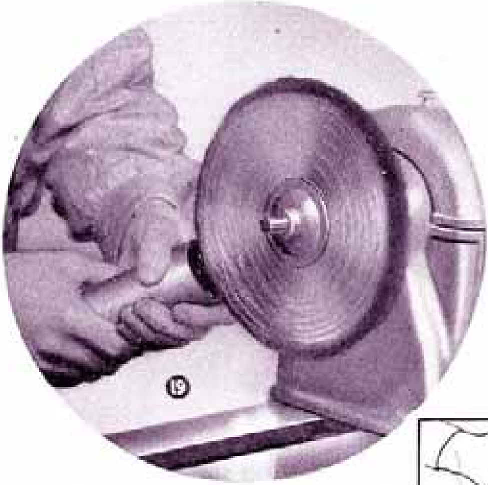
glue, as in Fig. 5, after which it is rolled and pounded in the abrasive grains, as shown in Fig. 6. Ordinarily, one coat of abrasive is enough, but two or more coats can be applied to roughing wheels to lengthen their period of service. Each coat should be completely dry before the next is applied. After the wheel is dry, it should be balanced, as shown in Fig. 7. If any heavy spots are found, they should be corrected by nailing small pieces of lead to the wheel or by any other method which gives the desired result.

Concerning Glue. — Animal hide ground glue is commonly used for applying abrasives to polishing wheels. It should be soaked in cold water from two to four hours, and is then brought to a heat of 140 degrees F. in a suitable gluepot. Use definite weights of water and glue. Equal parts, by weight, is the right consistency for abrasive grains from No. 20 to No. 50. Finer grains demand a thinner glue. 60 to 70-grit takes a 40-60 mix (glue-water), 80 to 120-grit takes 33-67, while very fine abrasives from 150 to 220-grit will require 20 percent glue to 80 percent water. Wheels should set at least 48 hours before they are used. Instead of using glue, many workers prefer special polishing cements made for this purpose. These have the advantage of being already mixed, and require a shorter drying time.

How to Polish. — The work is presented freehand to the wheel and on the outer quarter area of the wheel surface, as shown in Figs. 1 and 15. Avoid using too much pressure, as this tears out the abrasive grains and shortens the life of the wheel. Apply grease or other lubricant if required. An occasional application of lump pumice will clean the wheel if it becomes clogged. Work systematically over the area to be polished, inspecting the work frequently for defects which must be worked out.

Fine Wheeling.—Fine wheeling is done the same as roughing except finer abrasive grains are used. Also, at this stage there is a greater use of the softer polishing wheels, and frequent use of grease or other lubricant to prevent the wheel from clogging.

Buffing.—Buffs are made of disks of muslin, felt, flannel, leather, etc., and are sewed in a wide variety of patterns as shown in Figs. 10 to 13, to produce hard or soft wheels. The loose buff (stitched once around the hole) as shown in Fig. 10, is a popular style. The ripple buff can be made to run with either a hard or soft edge by reversing it on the spindle, as shown in Fig. 9. As in polishing, the work must be done on the lower side of the wheel, as shown in Fig. 18. Work presented as shown



The buffing compound is applied lightly and frequently to the revolving buffing wheel.

by the dotted lines, Fig. 18, will be torn from the hands with considerable force. The edges of the buff should be kept clean and round. Frayed edges can be dressed down with a buffing wheel rake, Fig. 16, while the buff is running. Any rough edge, such as a household food grater, can be used to dress buffs.

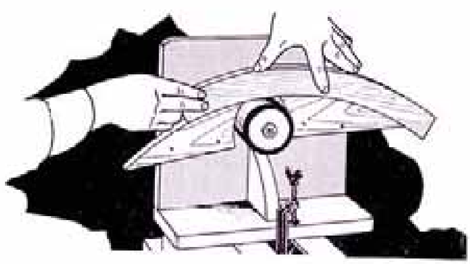
Strapping Belts.—Belts of muslin, felt, leather, etc., can be run on the belt sander, as shown in Fig. 14, either with or without the backing plate depending on the nature of the work. In all respects, the belt can be treated the same as a polishing wheel, and can be coated with abrasive grains or buffing compound.

Buffing Compounds. — Buffing compounds are various natural abrasives, such as emery, tripoli, pumice, crocus, lime and rouge, which are combined with a suitable wax or grease to form a mixture which can be readily applied to the revolving buff. The compound should be applied lightly and frequently to the buff as the work progresses, as shown in Fig. 19. The worker can make his own buffing compounds by melting beeswax in a double boiler, as shown in Fig. 20, and then adding the abrasive until a thick paste is formed. The molten mass is then poured into cardboard tubes, as in Fig. 21, or made into cakes, and when cold is ready for use. All of the various standard abrasives can also be purchased ready made. Very fine abrasives can be bonded with oil or water.

Other than polishing metals, buffing wheels charged with suitable compounds are used for polishing plastics, lacquered surfaces, bare wood, ivory, horn, etc. In all cases, such easily-obtained abrasives as pumice and rouge will usually do good work. Benzine or lacquer thinner will remove any film of compound left on the work after buffing.

BUFFING AND POLISHING SCHEDULES

MATERIAL	METHOD OF WORKING
ALUMINUM	Polish at 5,500 s.f.m. using Nos. 80, 120 and 180-grits. All wheels over 120-grit should be well greased. Buff at 7,500 s.f.m., using tripoli for the first buffing and finishing with red rouge.
BRASS	Polish at 6,000 s.f.m. using Nos. 80, 120 and 180-grits. The 80-grit is necessary only for rough castings. Buff with tripoli or emery at a speed of about 5,500 s.f.m.
COPPER	Same schedule as brass. Fine-grit wheels should be greased. Avoid heavy pressure since copper heats quickly and holds heat longer than other metals.
CAST IRON	Use grits 120, 150 and 180. The two coarser grits can be run dry. Buff at 7,500 s.f.m. Buff with 220 to 240-grit silicon carbide applied to a greased rag wheel.
LACQUERED SURFACES	Use a lacquer suitable for buffing. Buff at 6,000 s.f.m., using any reliable brand of lacquer buffing compound.
NICKELED SURFACES	Buff at 7,500 s.f.m. using tripoli and lime. A perfect finish is necessary if the work is to be chromium plated.
PLASTIC	Polish with 280-grit silicon carbide. Buff with 400 and 500-grit silicon carbide on greased wheels. Finish with red or green rouge.
STEEL	Polish at 7,500 s.f.m., using aluminum oxide grits Nos. 90 and 120 dry and 180 greased. Buff with tripoli or a very fine grit aluminum oxide. For a mirror finish, buff with green rouge. For satin finish, buff with pumice on a Tampico brush.

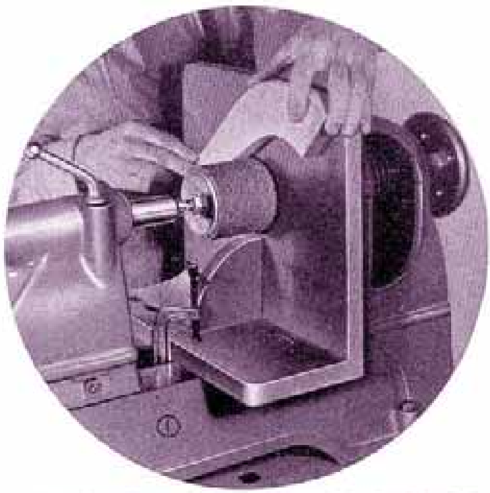


CHAPTER TEN

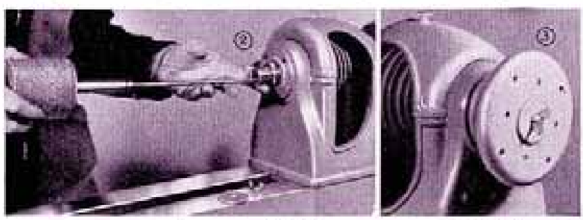
HOW TO USE SANDING DRUMS

Sanding Drums.—Sanding drums of various sizes are extensively used for edge work, and can be satisfactorily worked on the drill press, lathe, flexible shaft, or direct-coupled to a motor shaft. The size most commonly used measures 3 inches in diameter and should be run at a speed of about 1800 R. P. M. Within reasonable limits, the higher the drum speed the smoother the finish. Excessive speed, however, causes overheating, and, where wood is being finished, the heat extracts a gummy pitch from the work which quickly clogs the abrasive sleeve.

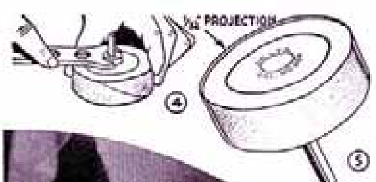
Sanding on Lathe. — Drums used on the lathe are fitted with taper shanks or screw-on fittings to permit fastening to the lathe headstock. Sanding can be done freehand, but where edge work is being done, as in Fig. 1, a vertical support greatly simplifies the work. Drums with taper shanks should be safeguarded from coming loose by supporting the end with the tailstock, using a sixty degree plain center. Another method of fastening uses a 1/4 inch diameter stud which is turned into the hole in the end of the shank, the opposite end being held secure by means of a washer and wing nut, as shown in Figs. 2 and 3.

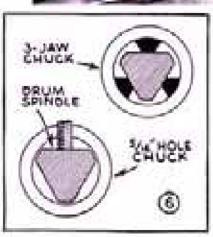


A vertical sanding table clamped to the bed of the lathe permits accurate sanding of curved edges.

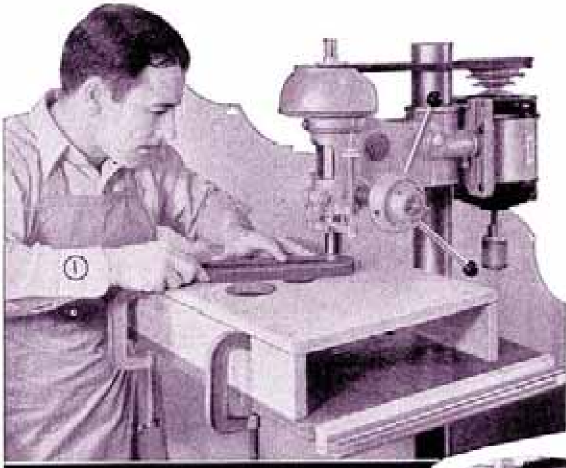


Taper shank drums are securely held by means of a stud fitting through the headstock.



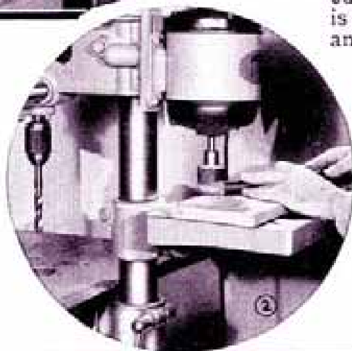


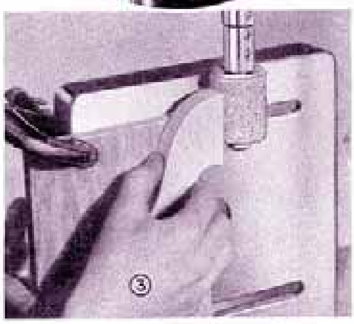
Narrow-Face Drums. — Standard sanding drums measure 3 inches long and have a projecting nut on the free end. Narrow-face drums are 1 inch wide and are flush on the bottom, the tightening nut being on the shank end, as shown in Fig. 4. All standard operations can be done with these drums, the face width of 1 inch being sufficient to handle average 3/4 inch thick work. The flush bottom also permits the finishing of inside corners, as shown in the lower photo. When doing this kind of work, it is advisable to mount the sleeve so that it projects about 1/32 inch beyond the bottom of the drum, as shown in Fig. 5, in order to prevent the drum bottom from burning the work. Narrow-face drums are fitted with a special tri-shape shank which permits mounting in either 5/16 inch collets or three-jaw chucks, as shown in Fig. 6.



Above, using a sanding table. Right, drum mounted direct to motor shaft.

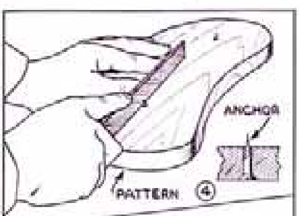
Sanding on Drill Press. — Drums used on the drill press run in a vertical position most useful for average work. Good use can be made of fences, pivot pins, and other jigs to guide the work although most operations can be done freehand. Small drums will work inside the opening in the drill press table, while larger sizes can be worked by swinging the drill table to one side. Fig. 1 shows a useful sanding table. It has holes in it to accommodate the various size drums, so that the whole surface of the drum can be utilized by projecting the drum through the hole provided for it. Another worthy idea is shown in Fig. 2, which shows how a sanding drum can be carried on the lower end of the drill press motor spindle. A second table can be used, or the regular table can be swung around under the drum. Fig. 3 shows work being sanded with the drill table in a vertical position. Furniture legs which are to be fitted to a round column can be cut to shape by using a sanding drum in this manner.

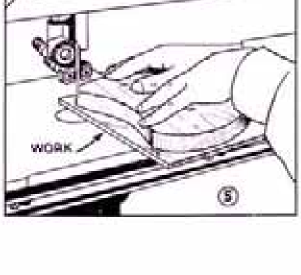


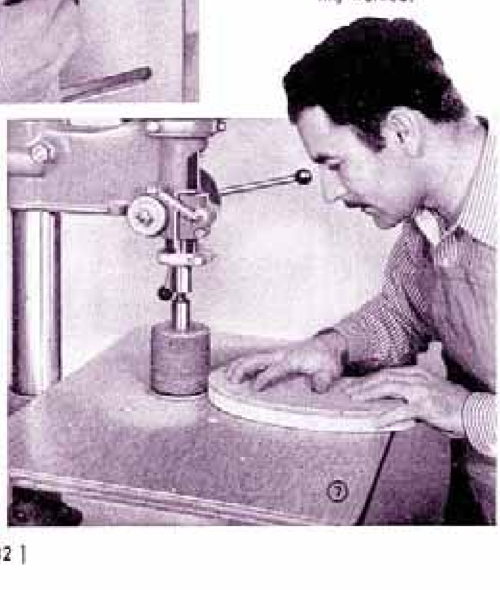


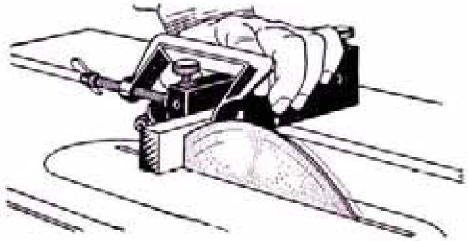
Pattern Sanding.—The most troublesome feature in edge sanding with a drum is that if the operator holds the work a moment too long at any one spot, the drum immediately cuts into the work, causing a ridge. This can be avoided and perfect work done if a pattern is used as a guide, as shown in Fig. 7. The pattern is a full-size template of the desired shape, with edges perfectly finished. It is fitted with two or more anchor points. These can be wood screws, with the projecting end filed to a thin, flat point, as shown in Fig. 4. The work is fitted to the pattern, the anchor points holding it in place. Band sawing is then done, keeping about [illegible] inch outside the pattern, as shown in Fig. 5. Fig. 6 shows how the drill press table is fitted with a hardwood or metal ring. When the pattern is pressed against the collar, the drum cuts the work down to the same size as the pattern.

Pattern sanding, as shown below, eliminates ridge marks when irregular curves are being worked.







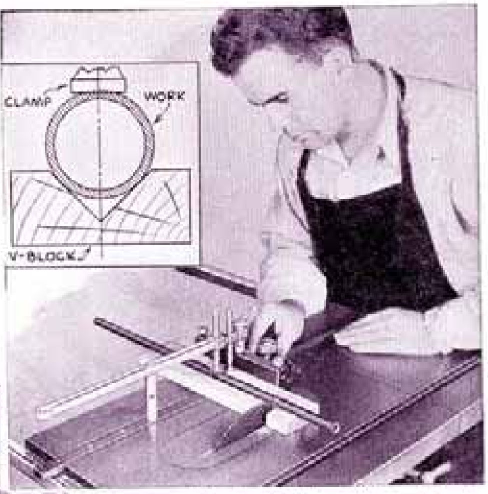


CHAPTER ELEVEN

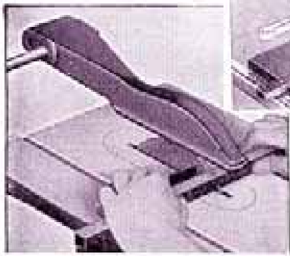
How to Use CUT-OFF WHEELS

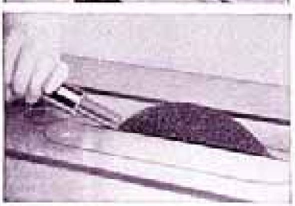
General Use.—Cut-off abrasive wheels in thicknesses from 1/32 to 5/32-inch are used for sawing all types of materials including metals, stone, and glass. The wheels are resinoid, shellac or rubber bonded to permit a slight measure of flexibility. The work can be done either wet or dry. The wet method is considerably faster and shows less wheel wear, but the dry method of cutting is quite suitable for average homeshop work. The surface speed of dry wheels should be about 7,500 feet per minute, while wet wheels show best results at 6,000 s.f.m. Wheels can be run on any spindle providing only that they are properly mounted and well guarded. In every case, however, washers of blotting paper should be used on either side. These are generally furnished as part of the wheel.

Cutting Thin - Wall Tubing. — One of the most common uses of abrasive cut-off wheels is the cutting of tubing. In this operation, as done on the circular saw, it is advisable to hold the tubing in a suitable vee block, the block being held to the miter gage by means of the miter gage clamp attachment, as shown in the photo and diagram above. Notice that the work is supported on both sides, a slot in the block permitting passage of the wheel.



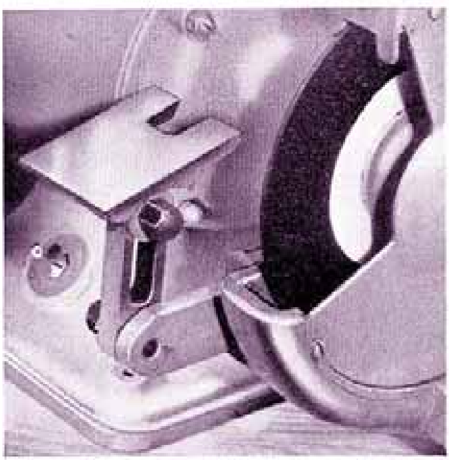
Above, cutting steel tubing with an abrasive wheel on the circular saw.

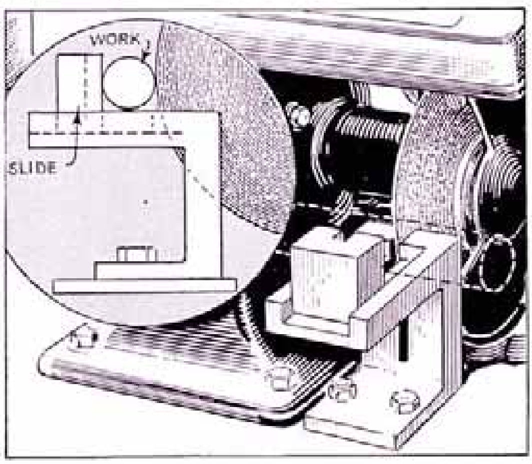




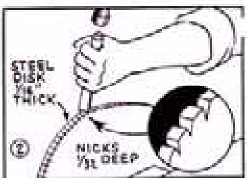
Some form of guide must always be used when cutting-off on the grinder.

Cutting Solid Stock.—Solid stock is cut in much the same manner as wood is sawed on the circular saw. Some form of guide is always necessary. A suitable guard should be used. If a special abra-





A bread pan fitted below the grinder holds the coolant when wet cutting or grinding is to be done.



sive wheel guard is not available, the regular saw guard can be fitted with a sheet metal hood to serve the purpose. Any metal cut with a dry wheel will discolor through heat generated by the wheel, but this surface film is easily removed by sanding with fine abrasive paper.

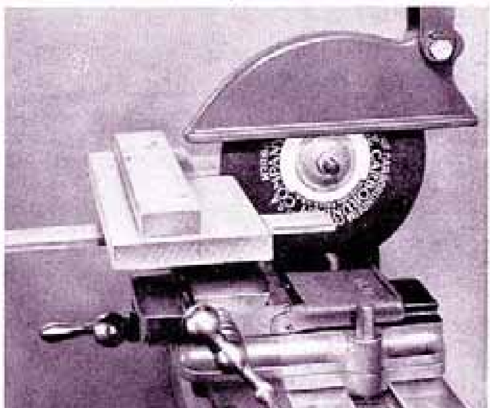
True Wheels Essential.—A balanced wheel with a clean edge is necessary for good cutting. Wheels out of round will wobble and cut considerably wider than their own thickness. The use of a stick type dresser at regular intervals will keep the wheel in good condition. In using a stick dresser on cut-off wheels, do not be afraid to apply considerable pressure against the wheel. Wheel dressing is not a cutting operation, but a tearing away of the abrasive grains by pressing against the wheel with an abrasive which is somewhat harder than the wheel itself.

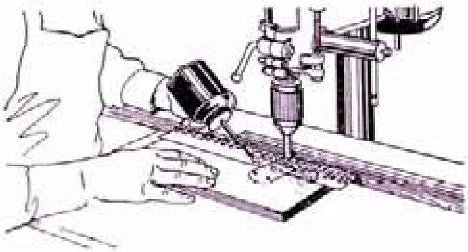
Cutting-Off on Grinder. — Cut-off wheels can be used successfully on the grinder. The work must never, however, be worked freehand. A simple method of working is to turn the center link of the tool rest upside down, allowing it to pivot at the bottom. Work can then be clamped to the tool rest and swung into the wheel, as shown in the lower photo on the previous page. In another method of working, a table with a slot to accommodate a sliding block can be fitted to the tool rest or clamped to the workbench, as shown on the previous page. This provides a guide similar to the miter gage used on the circular saw. A simple method of wet cutting is shown in the photo above, and is quite clean in operation. The water pan is a bread pan, obtainable at any dime store. The guard plate is used in actual operation and is removed in the picture only to show how the bottom of the wheel runs in the coolant. The use of the grinder for cutting-off has one serious drawback in that the projection of the motor limits the size of stock which can be worked to about 1½ inches square. The belt-drive grinder, however, has much more clearance.

Diamond Blades.—Glass, hard alloys and gems are commonly cut with the use of a diamond cut-off wheel. This is a metal wheel with diamond chips impregnated around the rim. Ready-made wheels, six inches in diameter, cost about $5. One carat of diamond bort (value about $2) will charge the home-made wheel. This is made from a disk of 1/16 inch thick steel. Nicks cut around the wheel receive the bort mixed with vaseline, the chips then being sealed in place by rolling with a hardened steel roller, as shown in Figs. 2 and 3. Diamond blades are generally run at somewhat lower speeds than other types of cut-off wheels, and must always be run wet. The grain size for average work should be 50-grit.

Cutting-Off on Lathe.—The lathe performs excellently as a cut-off machine, especially on small work which permits the use of the slide rest for feeding, as shown in Fig. 4. Either the slide rest feed can be used or the work table can be advanced by hand, guided by the bar which works in the slot of the slide rest. A special table can be made if desired so that work can be cut at the top of the blade, much the same as on the circular saw. Wet cutting is more readily done on the lathe than on any other machine.

Right, making a diamond blade. Below, cutting-off on the lathe.





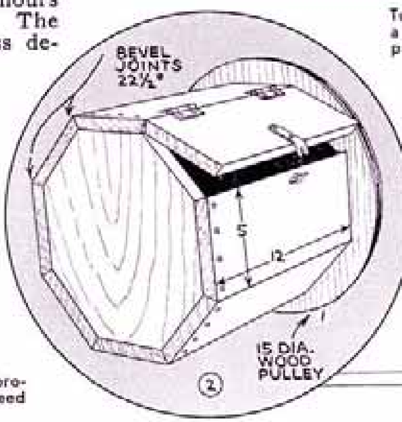
CHAPTER TWELVE

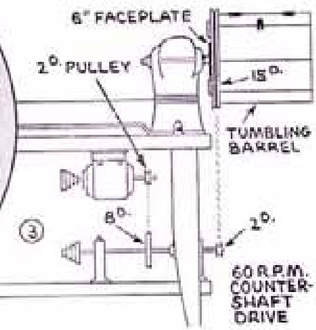
Miscellaneous ABRADING OPERATIONS

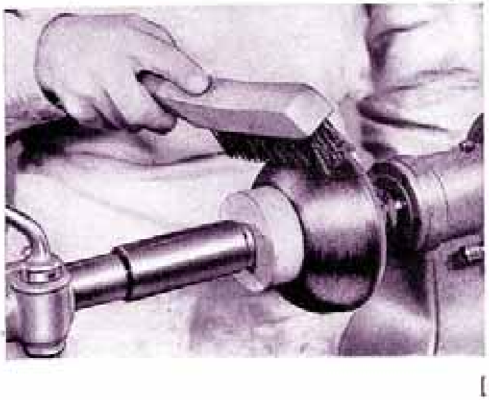
Tumbling.—Tumbling is extensively used in industry for finishing small metal parts. The process can be worked successfully in the small shop, using a wooden barrel driven on the outboard end of the lathe. The barrel should be made from hard maple, as shown in Fig. 2, and must be solidly constructed, especially if castings of fair size are to be tumbled. If tumbling is done wet, as is sometimes the case, the barrel must also be watertight. One section is hinged to form a lid. The barrel is fastened to a 15-inch diameter hardwood pulley.

Tumbling with abrasive grains makes a good finish for metal or plastic parts. A cycle of three operations is generally required.

The work is generally processed through a cycle of at least three operations. The first is an ashing or scouring operation which removes all tool marks and roughness on the surface of the article and renders it smooth. The second stage is the burnishing or semi-polishing operation, while the final stage is the true polishing operation. The time required to tumble finish runs from 16 to 48 hours for the three operations. The first stage of the process demands the most time; the final polish can be done in a very short time providing the previous abrading has been done thoroughly. The abrasive used is in loose grain form, the grit being somewhat coarser than used in wheel polishing. Nos. 24 to 36 are used for roughing; 40 to 80 for semi-polishing; 100 and 120 for polishing. The exact abrasive varies considerably, depending upon the work being tumbled. The barrel is loaded between one-third and two-thirds full, the work comprising about 60 percent of the load while the balance is made up with the abrasive grains and small pegs of the material being tumbled. Slow speed is absolutely essential and should never exceed 90 R. P. M. A suitable drive which does not interfere with the lathe drive proper is shown in Fig. 3.

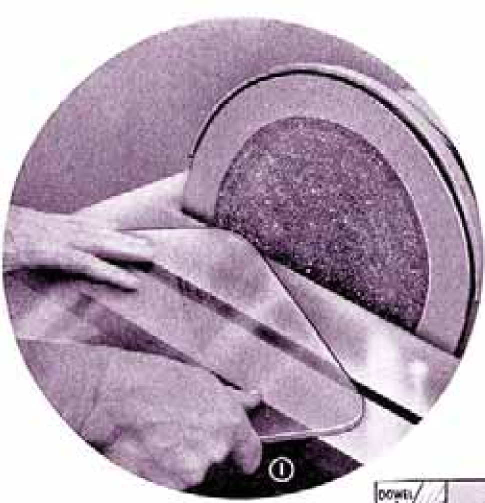






Scratch brushing at slow speed produces a serrated finish. A high speed gives a satin finish.

Spun Finish.—An attractive finish for metal work is obtained by scratch brushing at slow speed, as shown in the lower photo. A stick coated with coarse abrasive grains can also be used. The finish consists of a

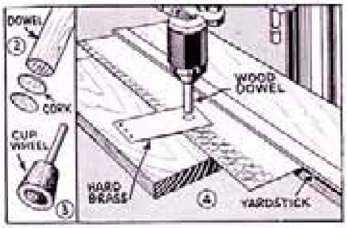


Above, grinding glass edges. Drawing at right shows various methods used in producing an engine finish.

series of minute rings spun around the work, the depth of the serrations depending upon the softness of the metal itself and the grit of the abrasive used. This abrasive treatment is extensively used as a finish for spun aluminum projects.

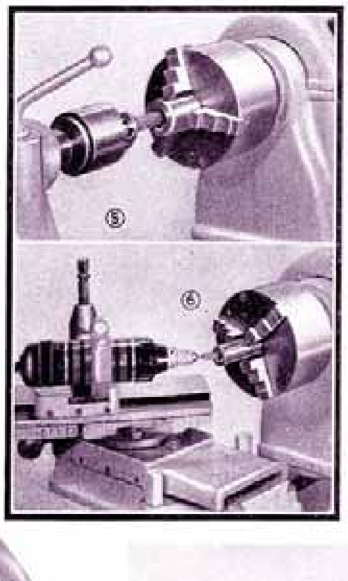
Grinding Glass.—Glass edges can be ground to an almost perfect polish with the use of silicon carbide abrasive papers used on the disk sander, as shown in Fig. 1. Standard 9 by 11 inch sheets of wet-or-dry paper can be cut into disks for occasional work of this nature. 120-grit gives a smooth, mat edge, while 220 to 320-grit brings up a very good polish. The glass should air cool between cuts.

Engine Finish.—An engine or spot finish is produced on the drill press by the methods shown in Figs. 2, 3, and 4. Fig. 2 shows how a dowel stick is capped with an abrasive disk for this purpose. Instead of using an abrasive disk, the tip can be leather and the abrasive bonded with wax or grease and fed to the work. The drill press should run about 1200 r.p.m. Solid abrasive sticks can be used, but require careful alignment. A tiny cup wheel, Fig. 3, makes a ring pattern. Fig. 4 shows a good method of working the engine finish. A softwood dowel is used. A strip of thin, hard brass with a hole through it is located on the drill table immediately below the dowel. The work is fed with a mixture of abrasive grains and oil or water, the dowel abrading this into the metal.

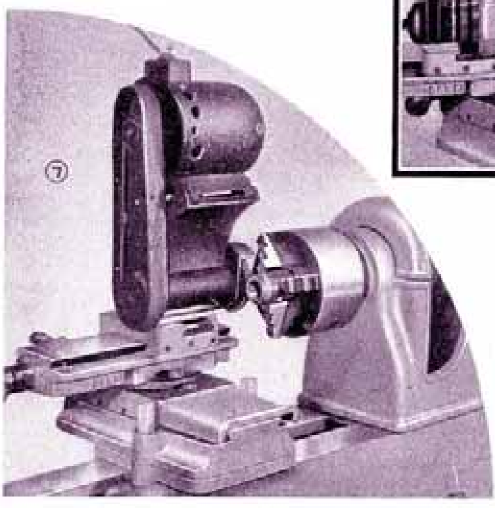


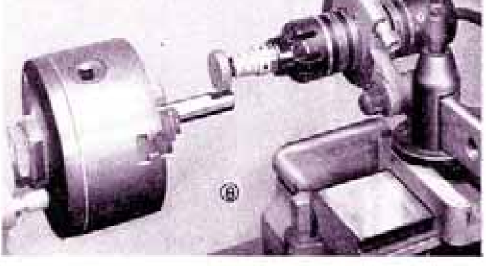
Internal Grinding.—Small holes can be ground by mounting an abrasive stick in a chuck held in the lathe tailstock, as shown in Fig. 5. The setover tailstock sets the depth of cut. A small hand grinder can be used for the same job, and also for a wide variety of other work.

Other Lathe Operations. — Other examples of grinding jobs which can be done on the lathe are shown in Figs. 7 and 8. Fig. 7 shows a groove being run in on a bushing, using a round edge wheel. The same set-up with straight wheel and slide rest feed is used for surfacing cylinders. Fig. 8 shows a flat being worked on the end of a shaft. The lathe does not turn in this instance, but is locked by means of the index pin.

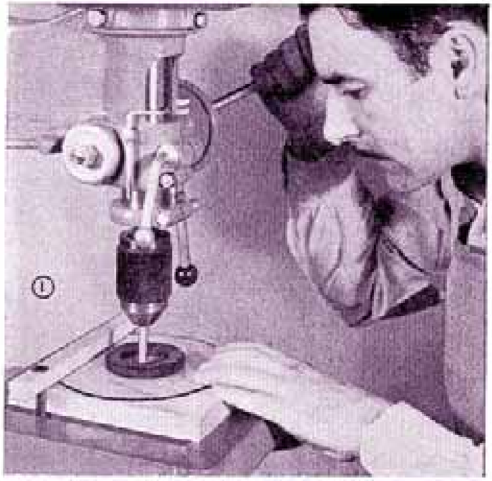


Tool post grinders worked on the slide rest are used for a wide variety of lathe grinding jobs.

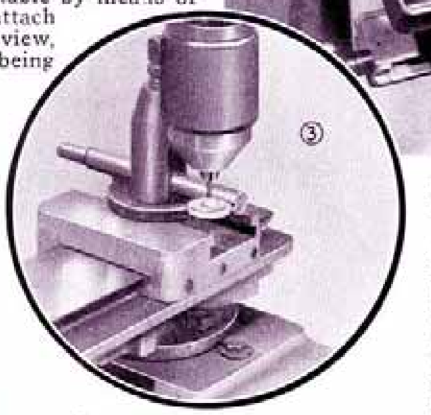




Drilling Glass.—The drilling of glass is an operation that may be done with ease on the drill press, although difficult by any other method. The drill employed is a piece of brass tubing with an outside diameter equal to the size of the hole to be drilled. The tubing should be slotted with one cut, using a very narrow saw. The cut need not extend more than about ¼ inch from the end of the tube. Similar results are effected by notching the end of the tube in two or three places. The tube is not sharpened in any way — it is simply cut square on the end, and then slotted or notched as mentioned. The glass should be supported on a perfectly flat piece of wood, or, better, on a piece of felt or rubber. A dam of putty is built around the place where the hole is to be drilled, or a felt ring can be used for the same purpose. The well is fed with a mixture of 80-grit silicon carbide abrasive grains combined with machine oil or turpentine.

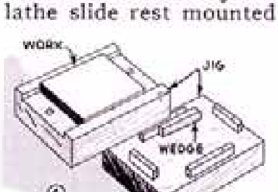


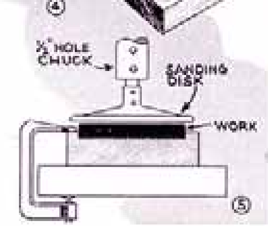
Grinding Keyways.—Keyways and similar work can be done with small abrasive wheels mounted in the drill press. The best method of holding and feeding the work is to employ the lathe slide rest. This is easily fitted to the lathe table by means of the same bolts used to attach it to the lathe. An under view, showing the slide rest being fitted, is shown in Fig. 2. Fig. 3 shows the keyway being cut. A speed of 5,000 R. P. M. should be used. Wheel shapes in any size, abrasive, or grit can be obtained ready mounted on shanks which can be held in the drill press chuck.



Top, drilling glass. Photos above and at left show use of slide rest in drill press grinding.

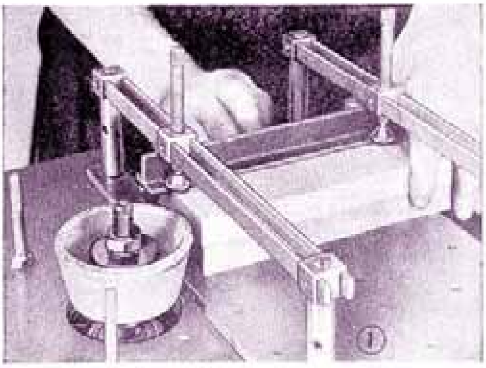
Surface Grinding.—A 3-inch cup wheel worked in the drill press offers one of the best methods of surface grinding. The work can be held by the lathe slide rest mounted as already described or in any suitable jig. The slide rest permits feeding the work to the wheel, while work held stationary in a machinist's vise or simple wood fixture, Fig. 4, is surfaced by feeding the wheel to the work. Fairly large surfaces can be covered by using a drill press column collar and swinging the work below the abrasive wheel, the same method as described for grinding jointer knives (see page 22). Large work can also be handled by using a sanding disk in the manner shown in Fig. 5.

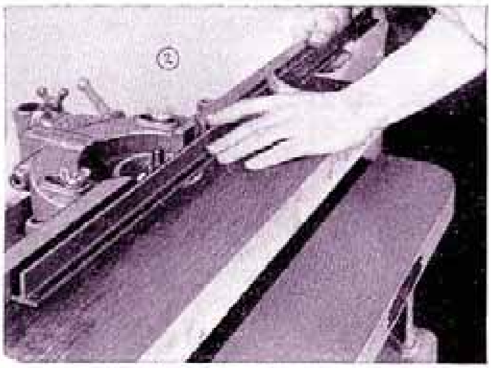




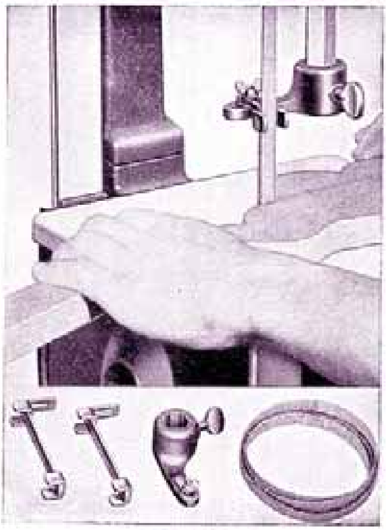
A cup wheel mounted in the drill press will handle a wide variety of surfacing operations.

Grinding on Shaper. — Sanding and grinding can be done on the wood shaper, using sanding drums, straight wheels, cup wheels, and any other form of grinding stone which can be fitted



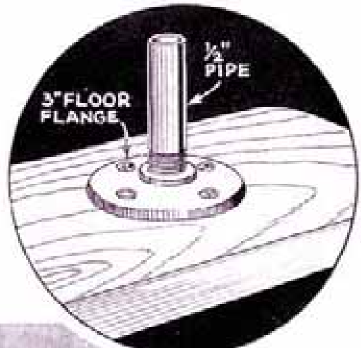


Almost any tool can be adapted for abrasive work. Photos on this page show the shaper, band saw and lathe set up for sanding and grinding.



to the spindle. For most work, the speed is excessive and should be reduced to about 5,000 R. P. M. This can be done by belting the shaper pulley to a pulley fitted to the lower end of the drill press motor, lowering the drill head to suit. Figs. 1 and 2 above show typical set-ups. The operation shown in Fig. 2 requires the use of a wood table to bring the work approximately level with the top of the cup wheel which is being used. Final adjustment as well as feed is provided by the standard travel of the shaper spindle.

Sanding on Band Saw.—The use of narrow abrasive belts on the band saw provides an excellent method of sanding edge work. Belts up to 1 inch wide can be used. Guides are provided for some band saws to permit the use of belts, but on other saws the worker can improvise simple guides. As far as guides are concerned, the belt will work perfectly well without them. Ribbon abrasive belts in all standard widths and grain sizes are obtainable and are easily spliced to suit the size of the band saw. Perfect tracking is assured by the upper tilting wheel of the saw, while the standard band saw adjustment permits tensioning.



Sanding on Lathe.—The use of a sanding disk on the lathe is so well known as to require little description. Where the lathe is not fitted with a sanding table, a table can be made from wood, as shown in the drawing at right, and fitted with a pipe shank which can be accommodated in the tool rest base. All operations described in the chapter on the disk sander can be worked with equal facility on the lathe with this addition. A groove to take the miter gage can be run in on the table surface if desired.

Sanding on Other Tools.—Almost any shop tool can be used for sanding and grinding. Sanding disks work perfectly when mounted on the circular saw arbor; small sanding drums are commonly used on the scroll saw; simple jigs can be made for the lathe to permit the use of sanding belts. Where the work cannot be taken to the machine, a flexible shaft suitable for handling sanding disks and grinding wheels can be used to advantage for many operations.

APPENDIX

ABRASIVES AND ABRASIVE TERMS

Aluminum Oxide . . . An artificial abrasive, with a base of the natural clay-like mineral, Bauxite. Color, brown-gray to black; in pure form, white. Hardness, 9.*

Bond . . Clay or other substance which holds abrasive grains together to form wheels, etc.

Crocus . . A natural abrasive formed from oxide of iron. Color, purple. Used for fine polishing. Hardness, 2.

Emery . . . A natural abrasive, being an impure form of crystalline alumina. Much softer than aluminum oxide. Color, dull black. Hardness, 8.

Garnet . . A natural abrasive mined in the United States. Extensively used in woodworking. Color, red. Hardness, 7.

Glazed . . Said of a wheel or stone which has become clogged with metal particles so that it will not cut.

Grade . . . The resistance of the bond in a grinding wheel to any force tending to pry the abrasive grains loose. Has nothing to do with the hardness of the abrasive itself.

Grit . . . The size of the abrasive grains, determined by the number of grains which, end to end, equals one inch.

Lime . . . A fine natural abrasive, used extensively in the final polishing of brass and nickel. Color, white. Hardness, 1.

Oilstones . . . General descriptive term applied to all abrasives when made into stones for bench use.

Pumice . . . A natural abrasive. Used for final polishing, cutting down finishing coats of varnish, etc. Several grades of fineness. Color, off-white. Hardness, 4.

Quartz . . Commonly called Flint. A natural abrasive. Least expensive of all abrasives but very soft. Color, yellow. Hardness, 6.

Rottenstone . . . A natural abrasive. Negligible cutting action but good polisher. Color, off-white. Hardness, 3.

Rouge . . . A natural abrasive in powder form. Graded fine, very fine, extra fine. Color, red; also, green (chromium oxide). Hardness, O.

Silicon Carbide . . . An artificial abrasive made by fusing silica sand. Color, gray, green or black. Hardness, 10.

Structure . . The spacing of abrasive grains in a grinding wheel. Usually represented by a number from 1 to 12, the smaller numbers indicating closer spacing of grains.

Tripoli . . . A silicious powder consisting of tiny skeletons. Color, pink. Graded. Used in fine polishing. Hardness, 5.

**Numbers given in this table list the hardness of the abrasives in sequence, from 10 (the hardest) to 0 (the softest). The number has no grading value, but is simply used to indicate the hardness of the abrasives in descending order.*

COATED ABRASIVE SELECTION

MATERIAL	ABRASIVE	ROUGH	FINISH	FINE
Hard Woods	Garnet or Alum. Oxide	2½-1½	½-1/0	2/0-3/0
Soft Woods	Garnet	1½-1	1/0	2/0
Aluminum	Alum. Oxide	40	60-80	100
Bakelite	Alum. Oxide	36-40	60-80	100
Cast Brass	Silicon Carbide	36-40	60-80	80-120
Comp. Board	Garnet	1½	½	1/0
Copper	Alum. Oxide	40-50	80-100	100-120
Cork	A. O. or Garnet	3	1	1-0
Fiber	Alum. Oxide	36	60-80	100
Glass	Silicon Carbide	50-60	100-120	120-320
Horn	Garnet	1½	½-1/0	2/0-3/0
Iron (Cast)	Silicon Carbide	24-30	60-80	100
Ivory	Alum. Oxide	60-80	100-120	120-280
Paint (removing)	Flint	3-1½	½-1/0	. . .
Plastic	A. O. or Garnet	50-80	120-180	240
Steel	Alum. Oxide	24-30	60-80	100

COMPARATIVE GRAIN SIZES

NO.	GARNET	FLINT	EMERY	NO.	GARNET	FLINT	EMERY	NO.	GARNET	FLINT	EMERY
400	10/0	. . .	. . .	150	4/0	2/0	½	40	1½	2½	. . .
320	9/0	. . .	FF	120	3/0	1/0	1	36	2	3	. . .
280	8/0	. . .	F	100	2/0	½	1½	30	2½	. . .	. . .
240	7/0		3/0	80	1/0	1	2	24	3	. . .	. . .
220	6/0	4/0	2/0	60	½	1½	2½	20	3½	. . .	. . .
180	5/0	3/0	1/0	50	1	2	3	16	4	. . .	. . .

GRINDING WHEEL SELECTION*

WORK	ABRASIVE	GRIT	GRADE	BOND
Aluminum (surfacing)	Alum. Oxide (White)	46	Soft	Vitrified
Aluminum (cutting-off)	Alum. Oxide	24	Hard	Resinoid
Brass (surfacing)	Silicon Carbide	36	Medium	Vitrified
Brass (cutting-off)	Alum. Oxide	30	Very Hard	Resinoid
Cast Iron	Silicon Carbide	46	Soft	Vitrified
Chisels (woodworking)	Alum. Oxide	60	Medium	Vitrified
Copper (surfacing)	Silicon Carbide	60	Medium	Vitrified
Copper (cutting-off)	Silicon Carbide	36	Hard	Rubber
Cork	Alum. Oxide (White)	60	Soft	Vitrified
Cutters (moulding)	Alum. Oxide	60	Medium	Vitrified
Drills (sharpening)	Alum. Oxide (White)	60	Medium	Vitrified
Glass (grinding)	Silicon Carbide (Green)	150	Hard	Vitrified
Glass (cutting-off)	Silicon Carbide (Green)	90	Hard	Rubber
Glass (cutting-off)	Diamond	60	Medium	Copper
Leather	Silicon Carbide	46	Soft	Vitrified
Plastic	Silicon Carbide	60	Medium	Rubber
Rubber (hard)	Silicon Carbide	46	Medium	Resinoid
Saws (gumming)	Alum. Oxide	60	Medium	Vitrified
Steel (soft)	Alum. Oxide	60	Medium	Vitrified
Steel (high speed)	Alum. Oxide (White)	60	Soft	Vitrified
Tile (cutting-off)	Silicon Carbide	30	Hard	Resinoid
Tubes (steel)	Alum. Oxide	60	Hard	Rubber
Welds (smoothing)	Alum. Oxide	36	Hard	Vitrified
Wood (hard)	Silicon Carbide	30	Soft	Vitrified

*Adapted from tables by The Norton Company.

Recommended WHEEL SPEEDS

Chisel Grinding	5,000-6,000 s.f.m.
Cut-off Wheels	6,000-8,000 s.f.m.
Surface Grinding	4,000-6,000 s.f.m.
Polishing	6,000-9,000 s.f.m.
Polishing (soft rubber wheels)	4,000 s.f.m.
Buffing	6,000-9,000 s.f.m.
Scratch Brushing (rough finish)	600 r.p.m.
Scratch Brushing (satin finish)	4,000-6,000 s.f.m.
General Grinding	5,000-6,500 s.f.m.
Internal Grinding	2,000-6,000 s.f.m.

Recommended BELT and DRUM SPEEDS

48 inch abrasive belts	3,100 s.f.m.
6 to 10-ft. abrasive belts	2,800 s.f.m.
10 to 16-ft. abrasive belts	2,400 s.f.m.
48 inch polishing belts	4,000 s.f.m.
3 inch drums (coarse grit abrasive)	1,800 r.p.m.
3 inch drums (fine grit abrasive)	2,400 r.p.m.
1 inch drums (closed coating)	1,200 r.p.m.
1 inch drums (open coating)	1,800 r.p.m.
10 to 12 inch abrasive disks	1,800 r.p.m.
Abrasive disks	4,500 s.f.m.

GRINDING WHEEL SPEEDS IN R. P. M.

DIAMETER OF WHEEL	R. P. M. FOR STATED SURFACE SPEED							
	4000 s.f.m.	4500 s.f.m.	5000 s.f.m.	5500 s.f.m.	6000 s.f.m.	3500 s.f.m.	7000 s.f.m.	7500 s.f.m.
1	15,279	17,189	19,098	21,008	22,918	24,828	26,737	28,647
2	7,639	8,594	9,549	10,504	11,459	12,414	13,368	14,328
3	5,093	5,729	6,366	7,003	7,633	8,276	8,913	9,549
4	3,820	4,297	4,775	5,252	5,723	6,207	6,685	7,162
5	3,056	3,438	3,820	4,202	4,584	4,966	5,348	5,730
6	2,546	2,865	3,183	3,501	3,820	4,138	4,456	4,775
7	2,183	2,455	2,728	3,001	3,274	3,547	3,820	4,092
8	1,910	2,148	2,387	2,626	2,865	3,103	3,342	3,580
10	1,528	1,719	1,910	2,101	2,232	2,483	2,674	2,865

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