A well laid-out tool grinding department. Note large drill grinder in foreground

CHAPTER VIII

Sharpening Miscellaneous High-Speed Steel Tools

Drills

Probably no tool is given as little thought in regard to its proper use and reconditioning as the common twist drill; yet no tool is more handicapped in its effectiveness by improper sharpening, or point grinding as it is sometimes called. Excessive drilling costs and imperfect holes can in most cases be traced directly to improper grinding of the point.

When properly *machine* ground, a drill will generally cut faster, last longer and produce more accurate holes than if ground by hand. Particularly drills larger than 3/8" should be machine ground.

In the sharpening of drills, the following precautions should be observed:

1. The lip clearance or relief behind the cutting edges should be sufficient for the drill to cut freely, yet not enough to weaken the cutting edges.

   If the lip clearance is insufficient, the drill will cut hard, heat excessively and may ultimately "split up the center." If the lip clearance is too great, the cutting edges will tend to chip and break down.

   A lip clearance of 12° to 15° at the periphery of the drill (figure 8), increasing constantly toward the center, is considered standard for the average class of work. When this angle is correct, the chisel point or web intersection will be at an angle of 130° to 135° to the cutting edge (figure 10).

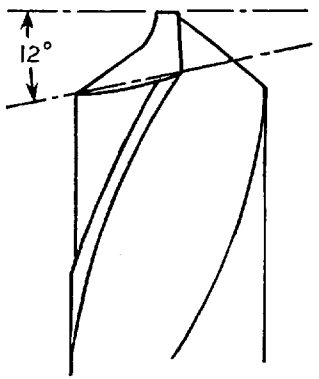


Figure 8—Lip clearance

2. The two cutting lips must be inclined at the same angle with the axis of the drill (figure 9) and must be of equal length. If

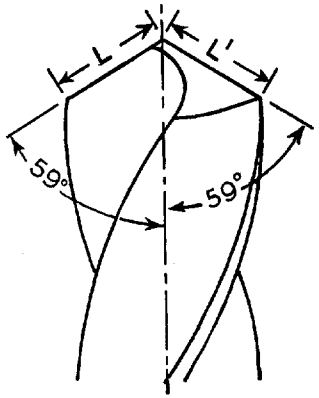


Figure 9—Both lips must be at same lip angle and equal length (L = L')

both lips are not ground at the same angle, the drill is subject to early failure as the lip having the larger angle is doing all the work; also the hole will be larger than the drill. If the lips are not exactly the same length, the point of the drill will, of necessity, be off-center and the drilled hole will be oversize.

For general purpose work an included angle of 118° (commercial standard) has been found most satisfactory. For soft cast iron, a somewhat more acute angle, about 90°, will give best results. For brass, the standard angle of 118° may be used but the face of the cutting lips should be ground slightly flat.

3. After grinding the cutting edges, it may be necessary to thin the point or web (figure 11). If the width of the point is too great, excessive pressure will be required to start the drill and it will tend to rub rather than cut. On the other hand, if the point is too thin, there is a tendency for the web to split. Proper pointing diminishes the power required to feed the drill, enabling it to cut more freely.

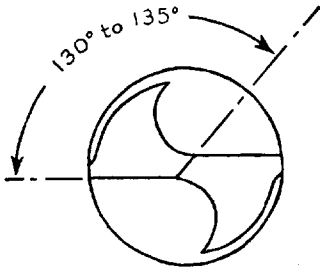


Figure 10—Lips properly ground but web requires thinning

Point thinning is specially necessary when the drill is worn down to a considerable extent inasmuch as the thickness of the web increases as the shank is approached. Care should be taken not to carry the ground portion too far up the flute, and to maintain

the exact center of the drill as otherwise it will cut oversize.

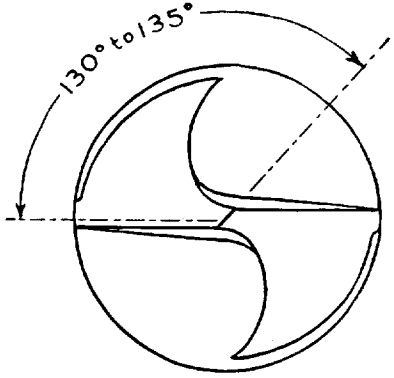


Figure 11—Web after point thinning

Procedure in Sharpening a Drill

1. Grind the two cutting lips so that they have the same length, the same and correct angle with the axis of the drill and the correct clearance behind the cutting edges.
2. Thin the point of the drill, if necessary, by grinding a short groove on each side of the web. The pointing may be done offhand on a round faced wheel or on a special drill point thinning machine which accurately controls the thickness of the web and automatically centers the point to insure the drill cutting true. Broken or otherwise ruined drills can often be reclaimed by cutting off the damaged section with a thin resinoid or rubber bonded cut-off wheel, and then grinding the cutting lips as in sharpening.

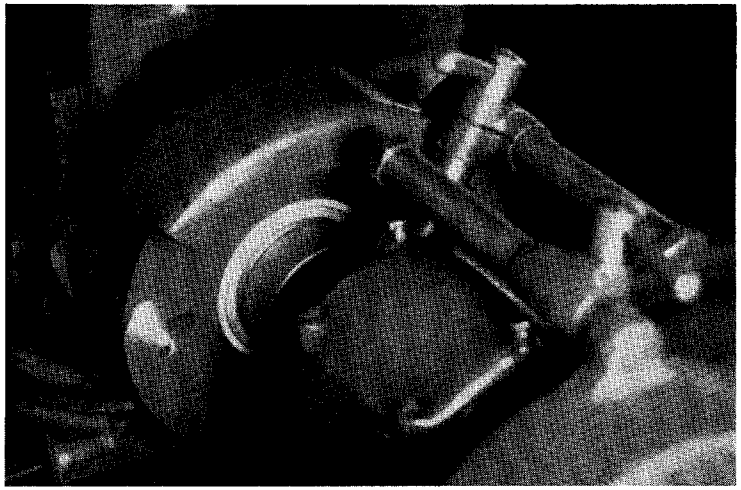
Grinding Wheels Recommended

Machine Sharpening:

Drills ¼" to 1"	19A60-L5VG	Alundum vitrified
Numbered sizes	A100-I8VG	Alundum vitrified

Point Thinning:

Dry	A60-N5VG	Alundum vitrified



Reclaiming a burned drill by cutting off the end and then repointing

Cutting Off:

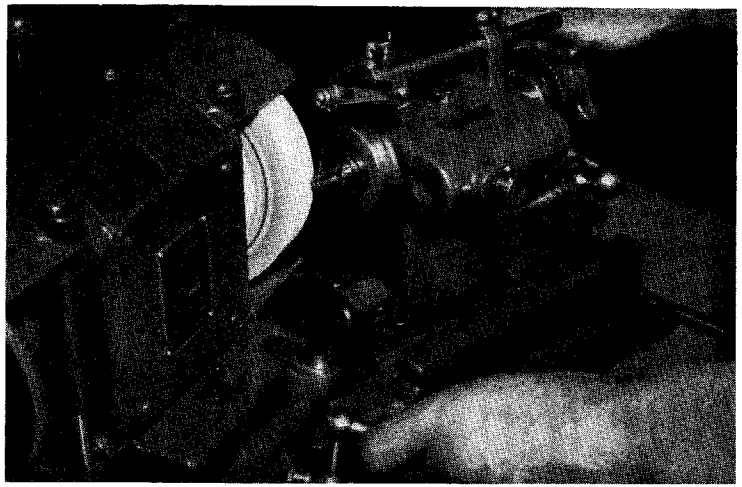
Dry	A60-M8B2	Alundum resinoid
Wet	A60-P0R30	Alundum rubber

Taps

A tap used after it becomes dull works under a great strain and is apt to chip or break, cut oversize, or produce rough and poor quality of thread. The remedy is to resharpen.

A tap grinder should always be used for this operation in order to duplicate the original uniform eccentric relief back of each cutting edge.

The amount of relief will vary with the length of the chamfer. Five degrees is ample for ordinary plug taps. Bottoming taps, which have a very short chamfer and steep taper, should be ground with correspondingly more relief in order

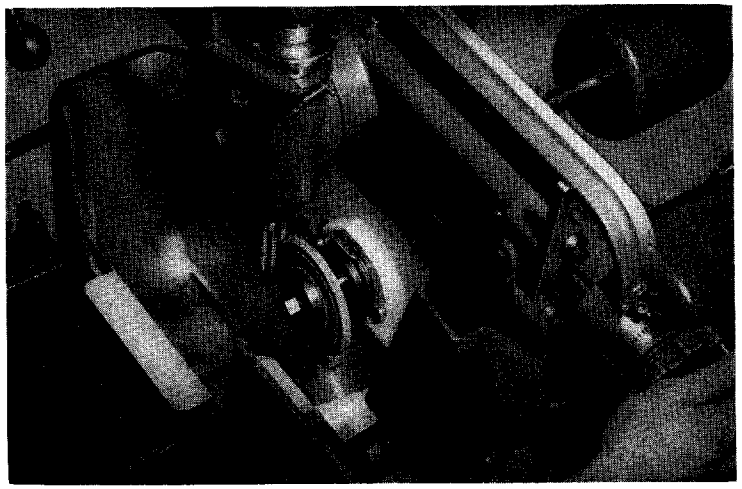


Regrinding the chamfer on a typical tap chamfer grinder

to cut freely. For tapping brass the chamfer is often ground flat instead of with an eccentric curve to insure sufficient relief.

The length of the chamfer varies with the type of tap. It may be long as in nut taps, short as in plug taps or almost none as in bottoming taps. On the plug style of hand taps the chamfer should be ground back four or five teeth from the end.

The chamfer and the accompanying relief on the top of the threads should be identical on all of the lands of the tap. If the chamfer is uneven, the result will be holes much larger than actual tap size, torn and misshapen threads, uneven wear and eventual breakage of the tap or chipping out of teeth. A good method of testing a tap to find if the lands are even is to turn about two threads through a nut and examine it from the opposite end. It can readily be seen if all of the lands are not engaging the thread.



Grinding the flutes insures accurate indexing of cutting edges and correct size tapped holes

The secret to obtaining long, useful life from taps lies simply in *keeping them sharp*. Once the face of a single tooth begins to wear, the performance and life of the entire tap begins to deteriorate very rapidly.

When the edges of the teeth begin to dull or become nicked, the flutes should be reground. A flute grinder providing accurate indexing of the cutting edges should be used; unless the indexing is accurate, the tap is apt to break or cut oversize.

Grinding Wheels Recommended

Grinding the chamfer (chamfer grinder):

Straight wheel	32A60-K8VG	Alundum vitrified
Cup wheel	19A46-L5VG	Alundum vitrified

Grinding the flutes (flute grinder):

Large taps	32A60-K8VG	Alundum vitrified
Small taps	A60-P0R30	Alundum rubber
Cutting off broken end	A60-N4E	Alundum shellac

Broaches

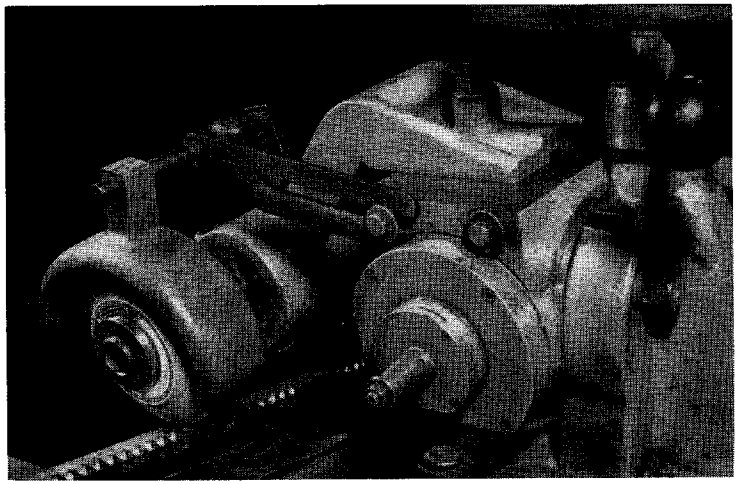
Cutter bars, cylindrical and surface broaches are usually sharpened by grinding on the face of the teeth with a dish wheel. A small cup wheel is used for backing off the teeth to provide proper relief.

Special grinding machines are available for the sharpening of broaches of all kinds, with precision and speed. Some of these machines are designed especially for handling round, spline and cylindrical broaches. Another style is designed to take care of flat or surface broaches while a third is of a universal type for sharpening both cylindrical and surface broaches.

For sharpening square or rectangular broaches the machines are equipped with a swivel head slide which can also be turned in a horizontal plane. Thus broaches with teeth cut at an angle can be sharpened as easily as those with the teeth cut straight. With the broach held stationary, the grinding wheel is moved back and forth across the face of the tooth, taking light cuts.

Round broaches are sharpened by revolving on centers. Depending on the type of sharpening machine, the grinding wheel is lowered, or fed horizontally, into position adjacent to the tooth to be ground and the table then moved to bring the tooth into contact with the wheel.

The manufacturer of the broach should be consulted in regard to the correct top relief and amount of rake or



Sharpening keyway broach on cutter and tool grinder with internal grinding spindle attached to tilting wheel head

undercut. These angles depend upon the material being cut. As a general rule, for cutting steel, the top relief is 1½° and the teeth are undercut 10° to 12°. For cast iron and nonferrous metals, the angles are usually less.

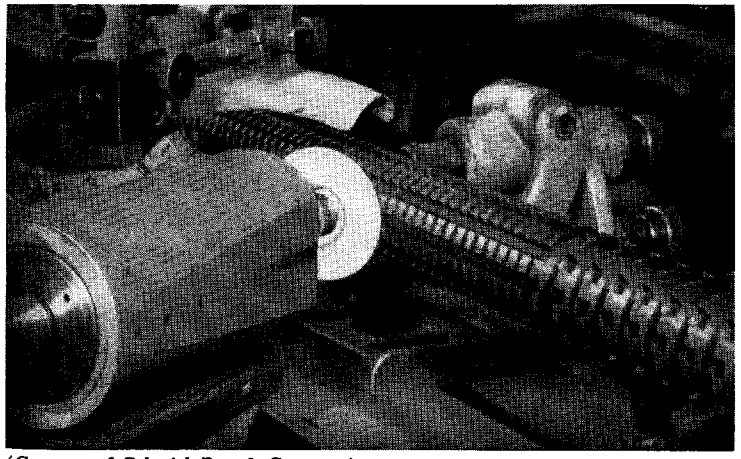
In the process of resharpening, it is quite important to grind the gullet between the teeth so that it is uniform, follows the original contour and blends into the back of the preceding tooth so as to permit the proper curling and disposal of the chips. Tearing of the surface being broached, creation of excessive heat, or unusual demands on the power required to pull the broach, may be caused by careless grinding of the gullet.

Grinding Wheels Recommended

Sharpening (dish wheel): 32A60-K8VG Alundum vitrified
Backing Off (cup wheel): 32A46-K8VG Alundum vitrified

(Courtesy of LaPointe Machine Tool Company)

Sharpening a flat broach



(Courtesy of Colonial Broach Company)

Sharpening a round broach

Thread Chasers

Nothing contributes more to the low cost of production of accurate threads than the frequent, accurate regrinding of the chasers that comprise the cutting tools in die heads and collapsing taps.

Careful judgment must be exercised as to the length of run permitted with a set of chasers before resharpening. It is false economy to run a set of chasers to the breakdown point without taking time to resharpen them. If allowed to become excessively dulled by such treatment, the cutting edges of the teeth are subject to excessive pressure, causing more rapid wear and eventual chipping or breakage. On hard materials, especially, it is good practice to regrind the chasers frequently.

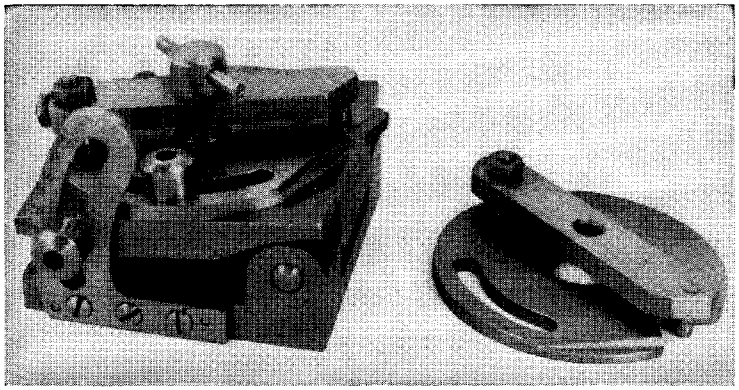
Thread chasers are of three types: tangential, radial and circular. Radial chasers in turn may be of the insert type, milled type or hobbed type.

While all of these types of chasers are sharpened by grinding either the chamfer or the cutting face (or both), the actual methods employed may vary with the design of the chaser.

Thread chasers should not be ground by hand. Recognizing this, practically all of the manufacturers of die heads and chasers also build a chaser grinding fixture to facilitate the correct grinding of the various angles and surfaces. In addition, charts or instruction manuals are furnished on how to grind their own types of chasers. These instructions should be followed implicitly to insure accurate and uniform grinding results. The pertinent rules are outlined in a general way in the following paragraphs, according to the type of chaser.

Insert Type Chasers

These types of radial chasers are sharpened by grinding at the chamfer. Should the cutting edges show dulling after pro-

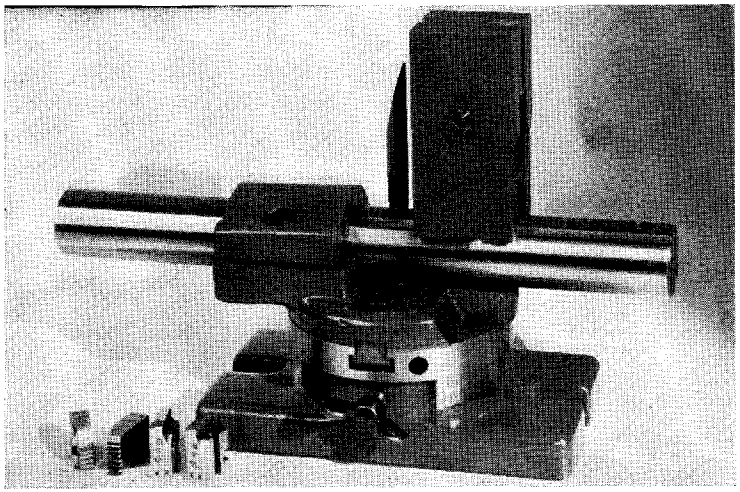


(Courtesy of The Eastern Machine Screw Corporation)

Fixture for grinding the chamfers of insert chasers. At right is extra disc and holddown strap

longed use, then touch them up very lightly, without removing all evidence of bearing; otherwise the chasers will chatter or possibly taper. Recommended hook or rake angles in insert type chasers are shown in the table on page 202. The Eastern Machine Screw Corporation emphasizes the following points in regrinding its insert type chasers:

1. Sharpen them at the first signs of dulling; otherwise the clearance will be worn away rapidly and the strain may cause teeth to break.
2. Grind at the chamfer, using a fixture that will locate the chasers in the same manner as they are located in the die head. Correct chamfer angle is important (see table on page 202). A long chamfer usually gives a better finish to the thread and longer chaser life.
3. Correct chamfer relief is also important. It varies according to die head sizes and thread diameters. Exces-



(Courtesy of Geometric Tool Company Div. Greenfield Tap and Die Corp.)

Fixture for grinding milled, ground and tapped die head chasers; also collapsing tap chasers

sive clearance will cause the chasers to chatter or chew; not enough clearance will make the chasers work hard and cause worn or poor threads.

4. After determining the proper setting and grinding the first chaser in a set, grind the other chasers with the same setting. Use a cup or dish wheel of fairly soft grade such as 32A80-I8VG.

Milled Type Chasers

Milled chasers are sharpened by grinding mostly on the chamfer or throat. Should the cutting edges show dulling, then touch up the cutting face lightly, removing only .002" to .003" stock.

1. Grind each chaser in a set an equal amount; otherwise each chaser will not do its share of the cutting and poor threading results will follow.
2. Follow the original chamfer angle as closely as possible.
3. Use the manufacturer's recommendation as to the proper angles (see tables beginning on page 202) and settings of chaser grinding fixture.
4. Feed the chaser forward carefully against the periphery of the grinding wheel and at the same time traverse the chaser back and forth across the wheel face, taking light cuts to be sure the chamfer angle is correct.

Grinding Wheels Recommended

With chaser grinding fixtures:

Chamfer or throat	32A80-K8VG	Alundum vitrified
Cutting face	32A60-J8VG	Alundum vitrified

On Geometric chaser grinders:

9" Straight wheel	38A46-K8VG	Alundum vitrified
9" Straight wheel (Model 1G only)	A60-K4E	Alundum shellac
9" Dish wheel	38A60-J8VG	Alundum vitrified

Hobbed Type Chasers

Hobbed type chasers are sharpened by grinding on either the chamfer or the cutting face. There is some difference of opinion as to whether it is better practice to grind entirely on the chamfer and only occasionally touch up the face, or vice versa. The chaser manufacturer's recommendations should be followed on this point.

1. Grind each chaser in a set an equal amount and to the same chamfer angle.
2. Follow the original chamfer angle for the material being threaded.
3. Maintain the curvature and clearance of the chamfer slightly concave—never convex, and approximately the same curvature as the material being threaded. The chamfer should have slightly more clearance than the threads on the chaser.
4. Use the manufacturer's recommendations as to the proper chamfer angles (see tables beginning on page 202) and settings of the chaser grinding fixture.
5. Take light cuts, particularly a light finishing cut, on each of the four chasers in a set with the same machine setting.

The chamfer angle is sometimes described by the terms 1½, 2, 3, etc., thread chamfer. The following table shows the relation between the number of threads and the chamfer angle and applies to milled as well as tapped chasers.

Approximate Chamfer Grinds in Relation to Threads Recommended by The Geometric Tool Company, Div. Greenfield Tap and Die Corp.

Number of Threads Chamfered	*Angle of Chamfer*	
	American National or V Thread Forms	*Acme and Similar Thread Forms*
1	45°	33°
1½	33°	22°
2	22°	15°
3	15°	...

A long chamfer should be used on all chasers wherever it is possible to do so. While a 2-thread chamfer is usually satisfactory, on certain tough materials a 3-thread, or even longer chamfer, will give better results. A short, 1-thread chamfer is usually used where it is required to thread close to a shoulder, but even under such circumstances it is often possible to use a 1½-thread chamfer. It is well to remember that the longer the chamfer, the less will be the stress thrown on the first full tooth of the chaser.

The hook or rake angle will vary with the class of material to be threaded. Unless otherwise ordered, hobbed chasers are generally furnished with a 15° hook angle for cutting steel.

The cutting edge must be the same height on each chaser in a set. In resharpening, if the cutting edge is ground down nearer to the center, the hook angle should be increased slightly to give the same effect as the original amount ahead of the center. See figure 12.

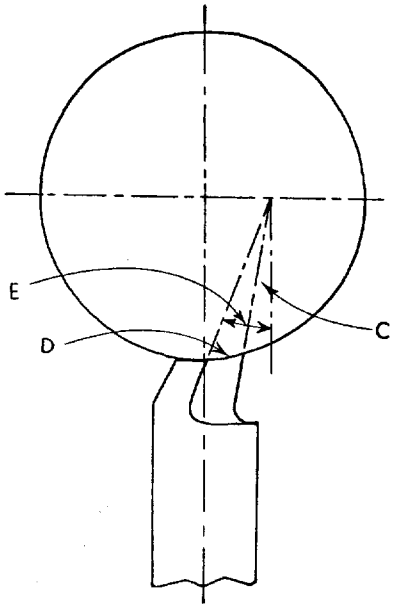


Figure 12—Showing increase of hook angle as face is ground down

For example, with a 15° hook (C), and the cutting edge originally 1/10 of the diameter ahead of the center (D), the hook should be increased to 25° (E), when ground down to the center.

Grinding Wheels Recommended

Use same wheels as recommended for milled chasers on page 124.

Collapsing Tap Chasers

Collapsing (or adjustable) tap chasers are sharpened in essentially the same manner as tapped die head chasers, previously discussed, except that the chamfer should be convex instead of concave.

Tangential Chasers

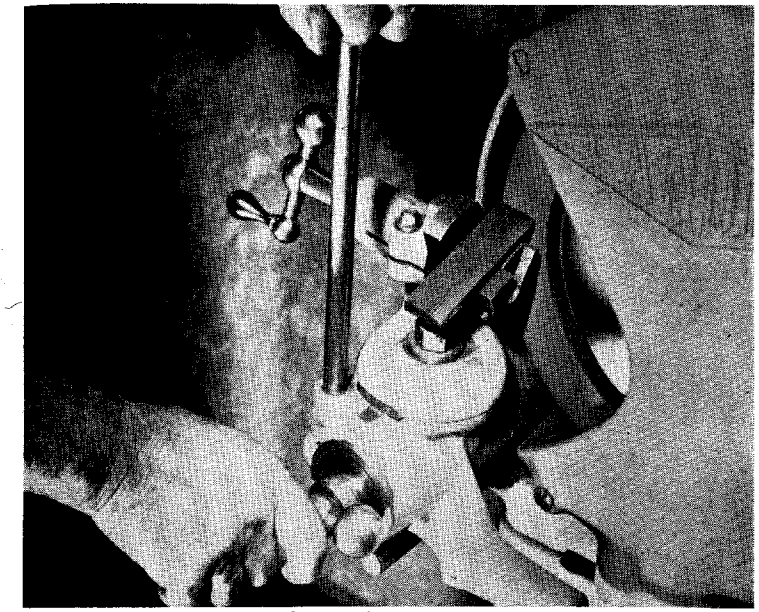
There are two angles involved in the sharpening of tangential chasers, namely, the lead angle and the rake or hook angle. A third angle, the throat angle, is extremely important in providing maximum chaser life and excellent thread finish. It does not require regrinding, however.

The rake angle varies with the machinability of the material to be threaded and can be determined accurately only by experiment. Tables of approximate rake angles to use as a guide are furnished by the various manufacturers of tangential chasers. (See page 208).

Landis Machine Company have made three general classifications affecting the grinding of their chasers which are of the non-helix type, that is, the threads are straight and the helix is in the chaser holder:

1. Straight threads cut *without* the lead screw.
2. Straight threads cut *with* the lead screw.
3. Tapered pipe threads.

The following instructions apply to the grinding of these three classifications of Landis chasers:



(Courtesy of Landis Machine Company)

Grinding the lead angles on a Landis chaser

1. Standard Grind for Cutting Straight Threads Without Lead Screw Feed

1. Grind the lead angle on the cutting end of the chaser as in figure 13. This grind is often referred to as a "lip rake" grind. For U. N. (N. C., Whitworth and S. I.) Standard Threads, the lead angle is 90°. For U. N. F. (N. F.) and B. S. F. Standard Threads the lead angle is 90° for chasers of 11 pitch and coarser, and 92° for chasers of 12 pitch and finer.

   In the case of chasers used for cutting Acme threads, the lead angle is established by subtracting the

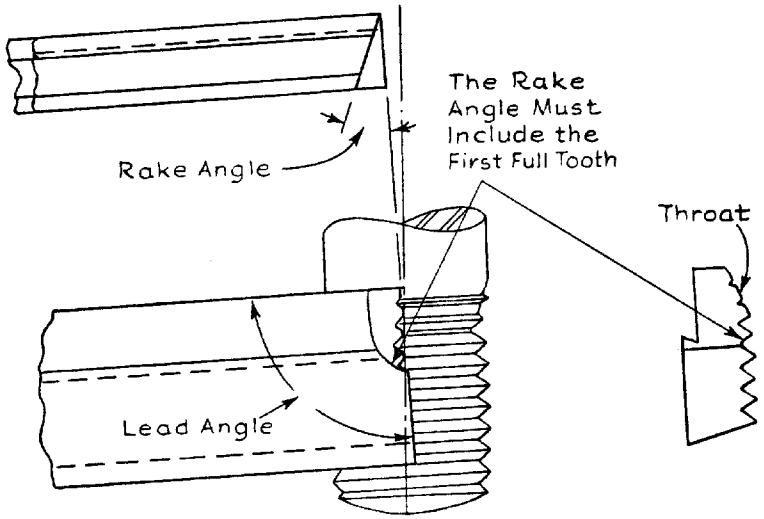


Figure 13—Chaser grind for cutting straight threads cut without lead screw feed

helix angle, as marked on the chaser base, from 90° and then adding 3°.

2. In grinding the rake angle, all the cutting edge of the chaser must be included. If the *crest* of the thread is not included, unsatisfactory cutting action will result. In the "lip grind," one *full* thread must be included in the rake angle. In the case of fine pitch threads (20 and finer), two full teeth should be included in the "lipped" section. For table of basic rake angles, see page 208.

2. *Chaser Grind for Cutting Straight Threads With Lead Screw Feed*

1. These are ground as in figure 14. The lead angle is

determined by subtracting the helix angle of the holder in which the chaser is to be used from 90°. The lead angle, for chasers used to cut Acme threads, is determined by subtracting the helix angle marked on the chaser minus ½° from 90°.

2. The rake angle extends from the stamped surface of the chaser across its entire width. For table of basic rake angles, see page 208.

3. *Chaser Grind for Cutting Tapered Pipe Threads*

Chasers for cutting tapered pipe threads, with the exception of Landmatic taper attachment heads, types C and Z, are ground as shown in figure 15.

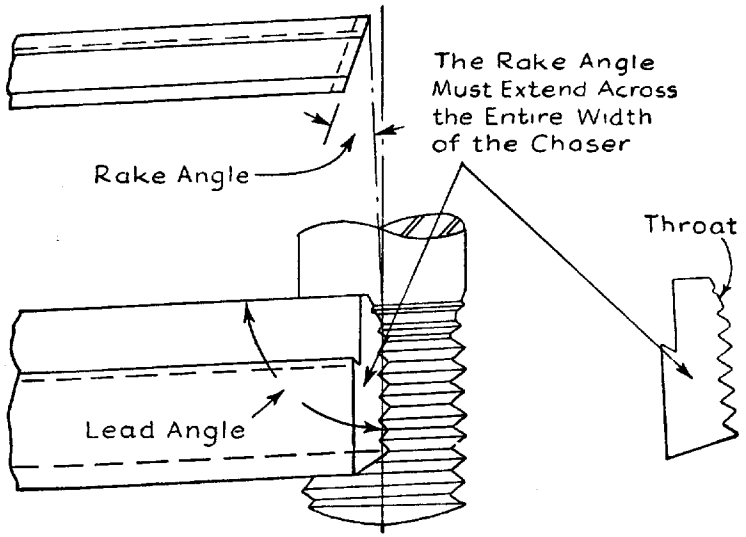


Figure 14—Chaser grind for cutting straight threads cut with lead screw feed

1. The lead angle is determined by subtracting the helix angle of the chaser holder from 90°. See table II in Landis chaser grind instruction booklet for specific lead angles in American National and Whitworth pipe

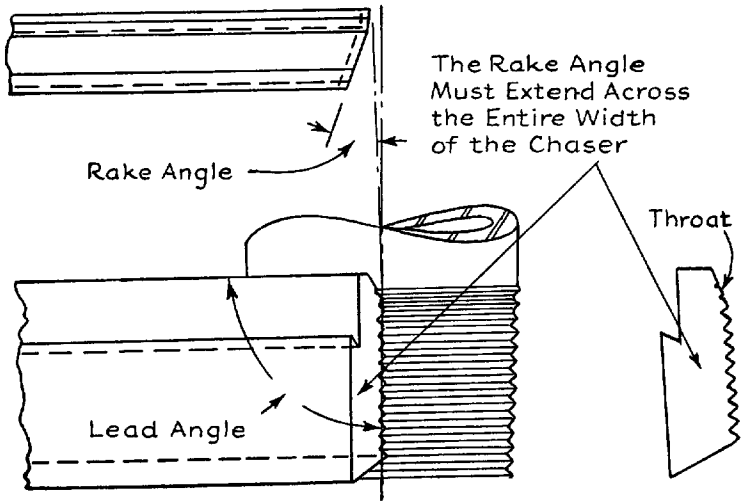


Figure 15—Chaser grind for cutting tapered pipe threads

threads. The rake angle extends from the stamped surface of the chaser across its entire width. See table of basic rake angles on page 208.

When producing tapered threads with a Landmatic taper attachment head, types C and Z, the "lip rake" grind is used.

Jones and Lamson Machine Company publish an operator's manual that covers the sharpening of their tangent chasers in detail. The surfaces which may require grinding are the following:

End Grind

This is done only when necessary to remove excessive stock (shaded area) from end of chaser, to prevent interference with adjacent chaser and to eliminate interference with coolant and chip flow.

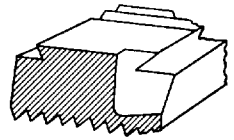


Figure 16

Top Rake

This grind is necessary in each resharpening operation; it removes stock from cutting area of chaser to restore full thread form and sharpness of cutting edge. See table on page 208.

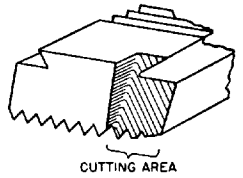


Figure 17

Chamfer Angle

The chamfer angles on J & L chasers are ground at the factory and need not be reground in normal resharpening.

There are several different methods which may be employed in resharpening J & L tangent chasers. They are described fully in the J & L operator's manual, Form No. 5304-OOM.

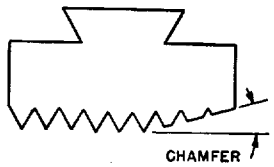
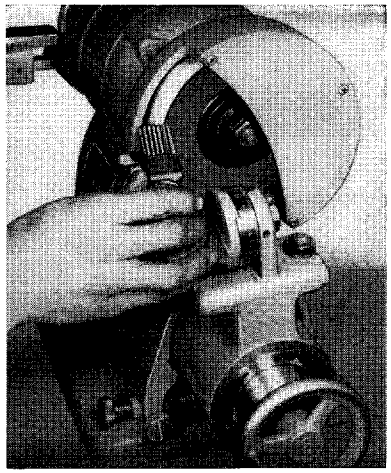


Figure 18



The accompanying photograph taken from this manual shows the set-up for grinding the important top rake angle, using a J & L Universal Chaser Sharpening Machine and grinding fixture.

Jones and Lamson also supply special micrometer measuring gages for checking the end grind and top rake grind on their tangent chasers. Figure 19 on next page shows such a gage with a chaser being measured for the amount above center it was ground.

Geometric Tool Company Div. Greenfield Tap and Die Corp. offers the following instructions for grinding their helix tangent chasers:

1. Set chaser grinding fixture to give the desired lip hook angle (see table of approximate angles on page 209) and the proper lead control angle as shown above. If the entire cutting face of the chaser requires sharpening, this should be done prior to grinding the lip hook.
2. For coarse threads, the lip hook must include one full tooth beyond the chamfer; for threads of 20 pitch and finer, two full teeth beyond the chamfer. All chasers of a set must be ground to the same length within .0015".
3. Use a micrometer setting gauge in order to properly set up and adjust the cutting face of all the chasers in

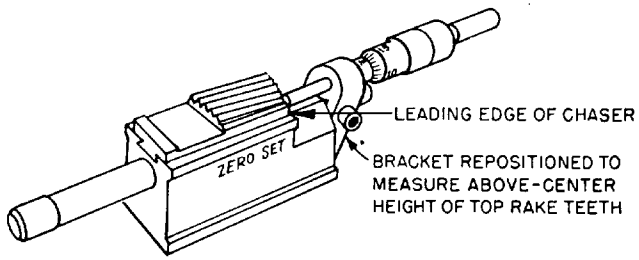


Figure 19

a set in relation to the center of the work. In using, select the chaser of the set having the foremost thread root at the chamfer. The micrometer point must contact the cutting face of the chaser just below this thread root and the same setting used for the remaining chasers of the set. The approximate distance ahead of center equals 1/10 of minor (root) diameter of thread to be cut. For taper threads use mean root diameter.

Grinding Wheels Recommended

Grinding Lead and Rake Angles

On chaser grinder fixtures:

Straight wheel		32A60-J8VG Alundum vitrified
Cup wheel	flaring	32A46-J8VG Alundum vitrified
	straight	32A46-J8VG Alundum vitrified

On Landis chaser grinders:

Straight wheel	32A60-M7VG Alundum vitrified
Cup wheel	32A46-L7VG Alundum vitrified

Circular Chasers

Circular chasers are sharpened by grinding the hook angle, the face or lead control angle and the chip clearance angle—all in one operation. See figure 20 for circular chaser terms.

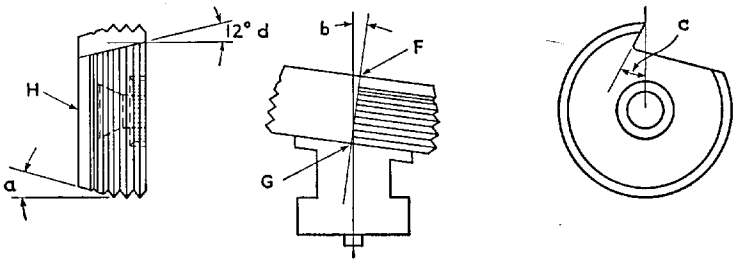
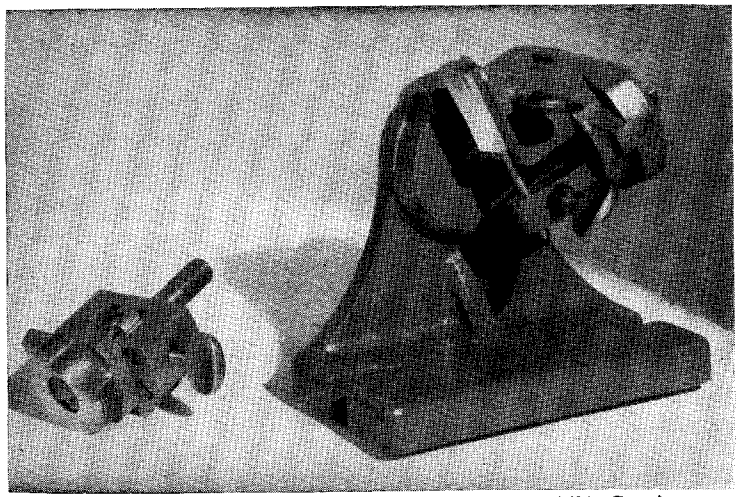


Figure 20—Angles to be ground on circular chasers (H is top of chaser). Face angle "b" (the lead control angle) brings the thread at the throat near center at F to cut freely, while threads behind the throat are over center (as at G) to rub slightly and hold lead. Hook angle "c" permits free cutting at points of contact. Chip clearance angle "d" (usually 12 degrees) allows room at the chaser throat for chip removal. Throat angle "a" should not be ground in resharpening—this angle is ground at the factory at 25 degrees, unless otherwise specified

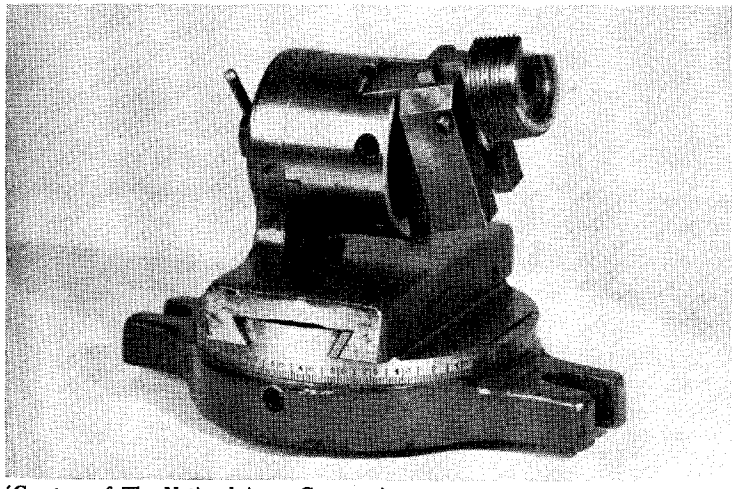


(Courtesy of Geometric Tool Company Div. Greenfield Tap and Die Corp.)

Fixture for grinding tangent and circular chasers

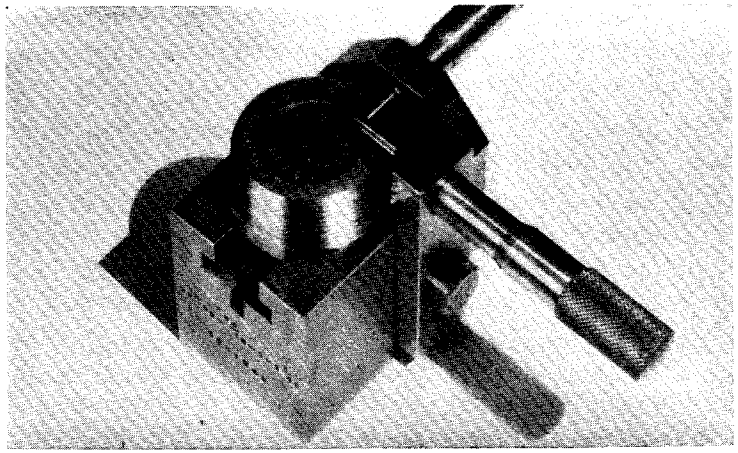
To facilitate sharpening, the chaser together with chaser block or holder is mounted in an adaptor which in turn is supported in a special grinding fixture.

1. Select the adaptor for the size of chaser to be ground and insert in the grinding fixture.
2. Set the grinding fixture to the desired chip clearance, cutting face and hook angles. Consult the chaser manufacturer's recommendations for the proper angles (see tables on pages 210 and 211) and machine settings.
3. Before grinding, take the micrometer reading of the face to be sure the chaser has been moved ahead enough to allow for grinding the face.
   Chasers that have been only slightly used will require from .005″ to .015″ to be ground off the face, but if the



(Courtesy of The National Acme Company)

Fixture for grinding circular chasers



(Courtesy of The National Acme Company)

Micrometer gage for checking the face grind

cutting edge has been worn, the chasers will have to be set ahead more.

4. When the proper settings on the grinding fixtures have been made, grind the chaser. Take light fast cuts to avoid burning the chaser. Grind only deep enough for sufficient chip clearance and do not grind too close serrated hole.
5. On machines that allow the die head to "float" a great deal, the chasers should have less ground off the face and vice versa. Rough threads can often be corrected by using a smaller face angle.

Grinding Wheels Recommended

Hook, Face and Chip Clearance Angles:

Cup wheel	32A46-K8VG	Alundum vitrified
Dish wheel	32A46-J8VG	Alundum vitrified

Dies

Die sharpening, or die grinding as it is often referred to, is an important branch of tool room grinding. Sharp, clean stampings can be produced only with sharp dies and punches. If a punch and die are sharpened at the first signs of dullness, from .002" to .003" stock removal generally is sufficient to restore the sharp cutting edges. On the other hand, if the tools are used for any length of time after they commence to get dull, it may be necessary to remove as much as .015" or more from both punch and die to put them in first class condition. Thus, it is a decidedly economical practice to sharpen these tools at frequent intervals.

Surface Grinding

Both horizontal and vertical spindle type surface grinders are employed for sharpening blanking dies and punches. The new light and fast traverse hydraulic surface grinders, such as the popular Norton 6" x 18", S-3 Type equipped with magnetic chuck, are particularly adapted to surfacing small dies.

Wheels for surface grinding present-day hard, sensitive die steels must be selected with unusual care. The abrasive must be sharp and free cutting, the grade of hardness in the soft range and the structure open, to avoid overheating and cracking the die. The more wear-resistant the steel, the softer the grade of wheel that is required. The list of grain and grade recommendations at the end of this section may be used as a guide in selecting the proper wheel for a given die grinding job.

When surfacing with the periphery of straight wheels, the wheel speed should be in the vicinity of 5000 s.f.p.m., vertical feed .0005" to .001" per pass, table speed 20 to 30 feet per minute, cross feed about $\frac{1}{32}$" per pass. Dry grinding is recommended in preference to wet, as it has been found that

less burning and discoloration occurs than when grinding with a coolant. If a coolant is used, the supply must be generous and constant in flow to prevent localized heating and possible checking or cracking.

Cylindrical Grinding

Cylindrical grinding of dies is confined almost entirely to punches, both straight and tapered. The operation may be done wet or dry, on either a universal tool and cutter grinder or on a small cylindrical machine. If wet grinding is employed, a copious supply of coolant must be used to avoid checking and cracking the steel.

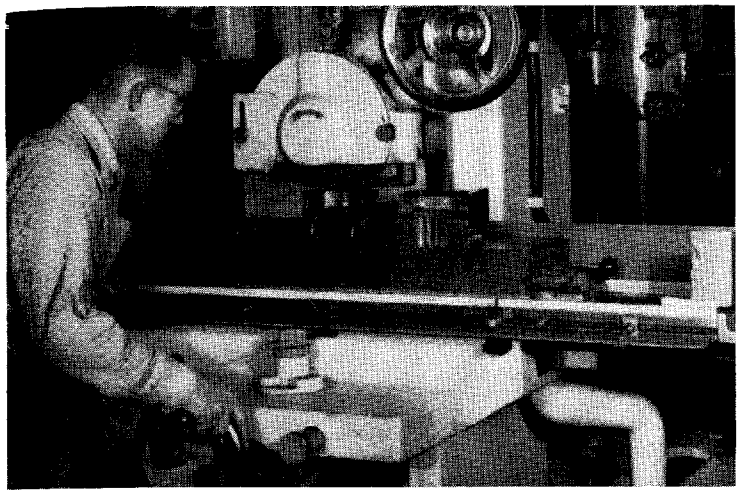
Internal Grinding

Internal grinding is employed on blanking and forming dies where accurate internal surfaces are required. The operation may be either straight or tapered and serves two purposes: to provide proper clearance between the die and the punch and to grind out any irregularities caused by distortion in the hardening process.

Finish desired and the hardness and character of the die steel largely determine the grinding wheel selection. Similarly, the size of the die will govern the type of machine to use. Tool post grinders or internal grinding attachments mounted on lathes are commonly used for internal work on large and heavy dies.

Offhand Grinding

Mounted wheels in a great variety of sizes and shapes are used for miscellaneous offhand grinding operations on all kinds of blanking and drop forging dies. These extremely useful



Reconditioning a die by surface grinding. Splash guard removed to show magnetic chuck

little wheels generally are driven by light flexible shaft or motor driven portable grinders. Surplus material can be removed in much less time than by filing or scraping, and a better finish is obtained.

Choice of wheel specifications depends largely upon the finish desired. Standard specifications of wheels carried in stock are grains 38A60, 38A90 and 38A120, grades M and O, Alundum vitrified. A catalog listing the various shapes and sizes of mounted wheels available will be mailed upon request. Ask for Catalog 1052.

Grinding Wheels Recommended

Surface Grinding—Hardened Dies:

Straight wheels (dry) ..... 32A46-H8VG Alundum vitrified

Wall chart with useful information on mounted wheels

Straight wheels (fast traverse, wet)	32A46-I8VG	Alundum vitrified
Cup wheels (wet)	32A46-G8VG	Alundum vitrified

Surface Grinding—Annealed Dies:

Straight wheels (dry)	32A46-I8VG	Alundum vitrified
Cup wheels (wet)	32A24-I8VG	Alundum vitrified

Cylindrical Grinding:

Cylindrical grinding (dry)	32A60-J8VG	Alundum vitrified
Cylindrical grinding (wet)	19A60-L5VG	Alundum vitrified

Internal Grinding:

Internal grinding	32A60-K8VG	Alundum vitrified

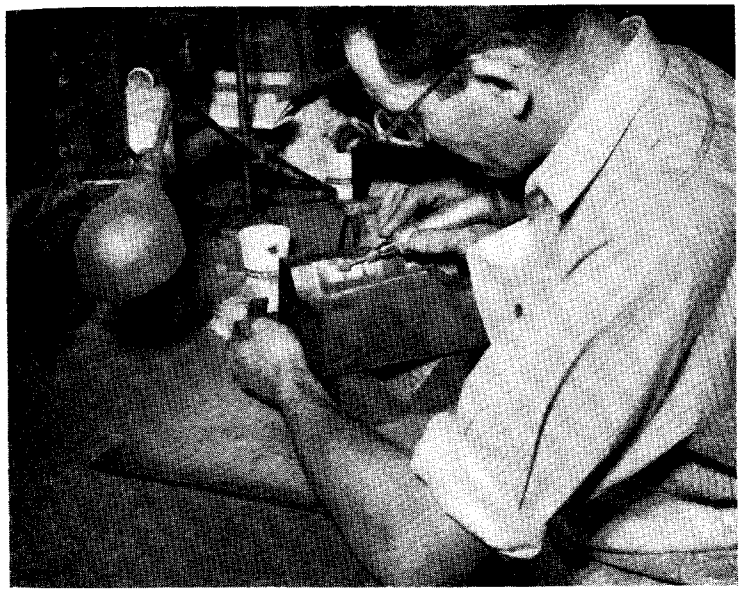
Offhand Grinding—

Die Forgings, using portable grinders:

Mounted wheels (coarse)	38A60-OV	Alundum vitrified

Mounted wheels (medium)	38A90-MV*	Alundum vitrified
Mounted wheels (fine)	38A120-MV*	Alundum vitrified
Straight wheels, rough grinding	grain A36 to A60, grade P to R	Alundum vitrified
	A36-Q5B5 (high speed)	Alundum resinoid

*In the very small sizes grade O is recommended.



Mounted wheels are indispensable to the die maker