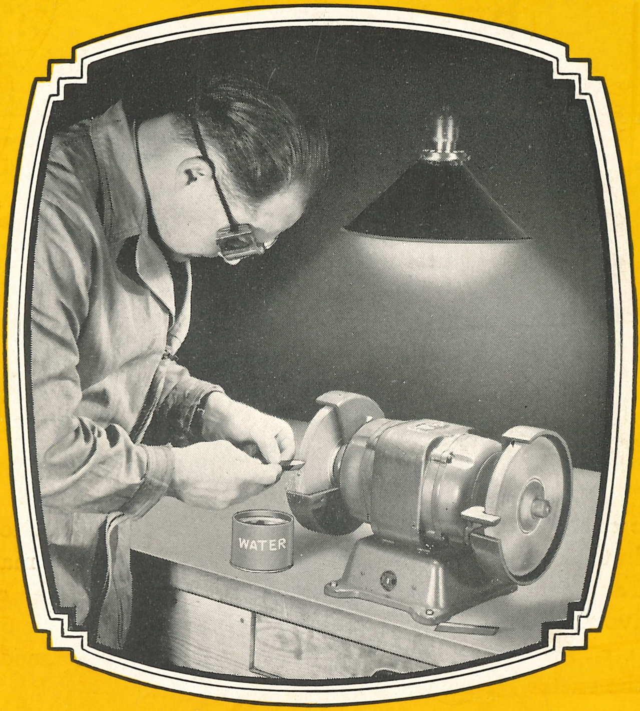
BULLETIN NO. 35

How to Grind Lathe Tool Cutter Bits



Grinding a Lathe Tool Cutter Bit.

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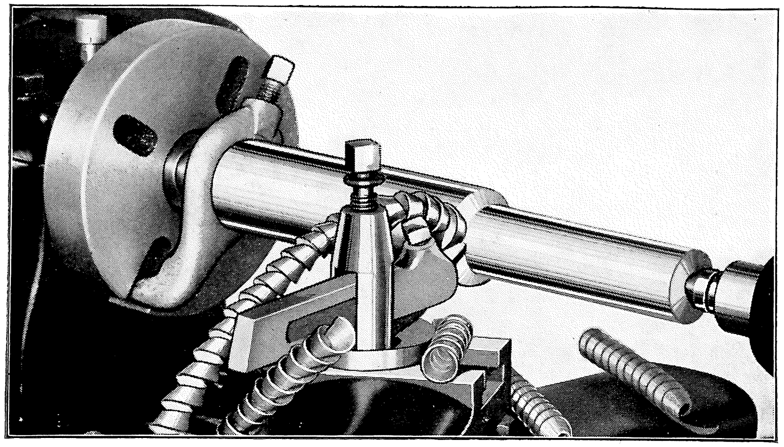


Fig. 1. A bar of steel being machined in the lathe with a correctly ground cutter bit inserted in a lathe tool holder.

Bulletin No. 35

Modern Shop Practice for Grinding Lathe Tool Cutter Bits

The cutting tool is one of the most important things to consider in the machining of metal in the lathe. In order to machine metal accurately and efficiently it is important that the cutter bit have a keen cutting edge, ground with the correct clearance, rake, etc., for the particular kind of metal being machined, and that the cutter bit be set at the correct height.

In this booklet the latest shop practice for grinding various types of lathe tool cutter bits is outlined. The methods shown are used in our own shop, where we operate about sixty Back-Geared, Screw Cutting Lathes on all kinds of machine work.

South Bend Lathe Works

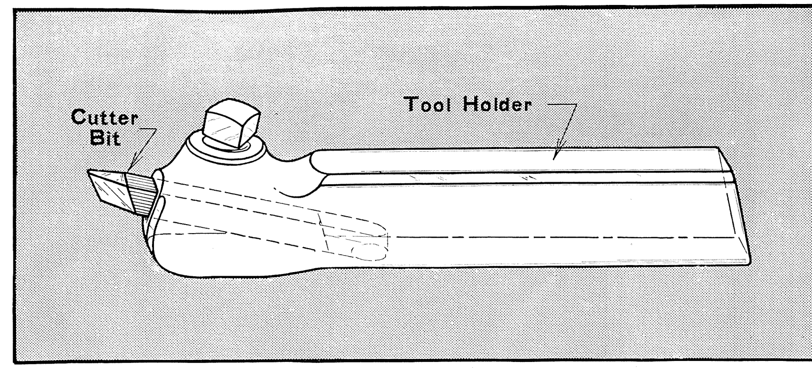


Fig. 2. Lathe tool holder with high speed steel inserted cutter bit.

How to Grind Lathe Tool Cutter Bits

The cutter bit is that part of the lathe tool which cuts the metal that must be removed to bring the work to the desired size and shape. The cutter bit is usually made of high speed steel and held in a lathe tool holder as shown in Fig. 2 at the top of the page.

High speed steel cutter bits are hardened and are ready for use when properly ground. Fig. 3 at the right shows an unground cutter bit and Fig. 4 shows the same cutter bit after grinding. In Fig. 5 the cutter bit is shown mounted in the lathe tool holder, ready for use.

Correct grinding of the lathe tool cutter bit is essential for good lathe work, because a properly ground cutter bit will produce better results, last longer and cut more freely than one improperly ground.

The forged steel tool holder as shown at the top of the page is made in three types, straight, right hand, and left hand, as shown at the right in Figs. 6, 7 and 8. These tool holders are also made in various sizes so they may be used in various size lathes. These different size tool holders also accommodate high speed steel cutter bits of the most practical size for the work they are intended to do. It is advisable when obtaining a tool holder to specify the size lathe on which it is to be used.

Fig. 3. Unground cutter bit.

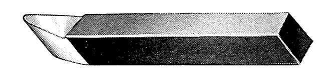


Fig. 4. Cutter bit after grinding.

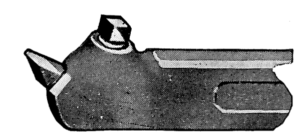


Fig. 5. Cutter bit inserted in tool holder ready to use.

Fig. 6. Straight tool holder.

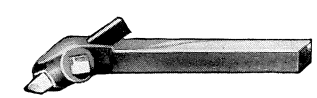


Fig. 7. Right hand tool holder.

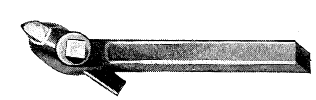


Fig. 8. Left hand tool holder.

Lathe Tools and Their Applications

The illustrations below show the application of nine shapes of ground cutter bits commonly used for machining metal in the lathe. See page 3.

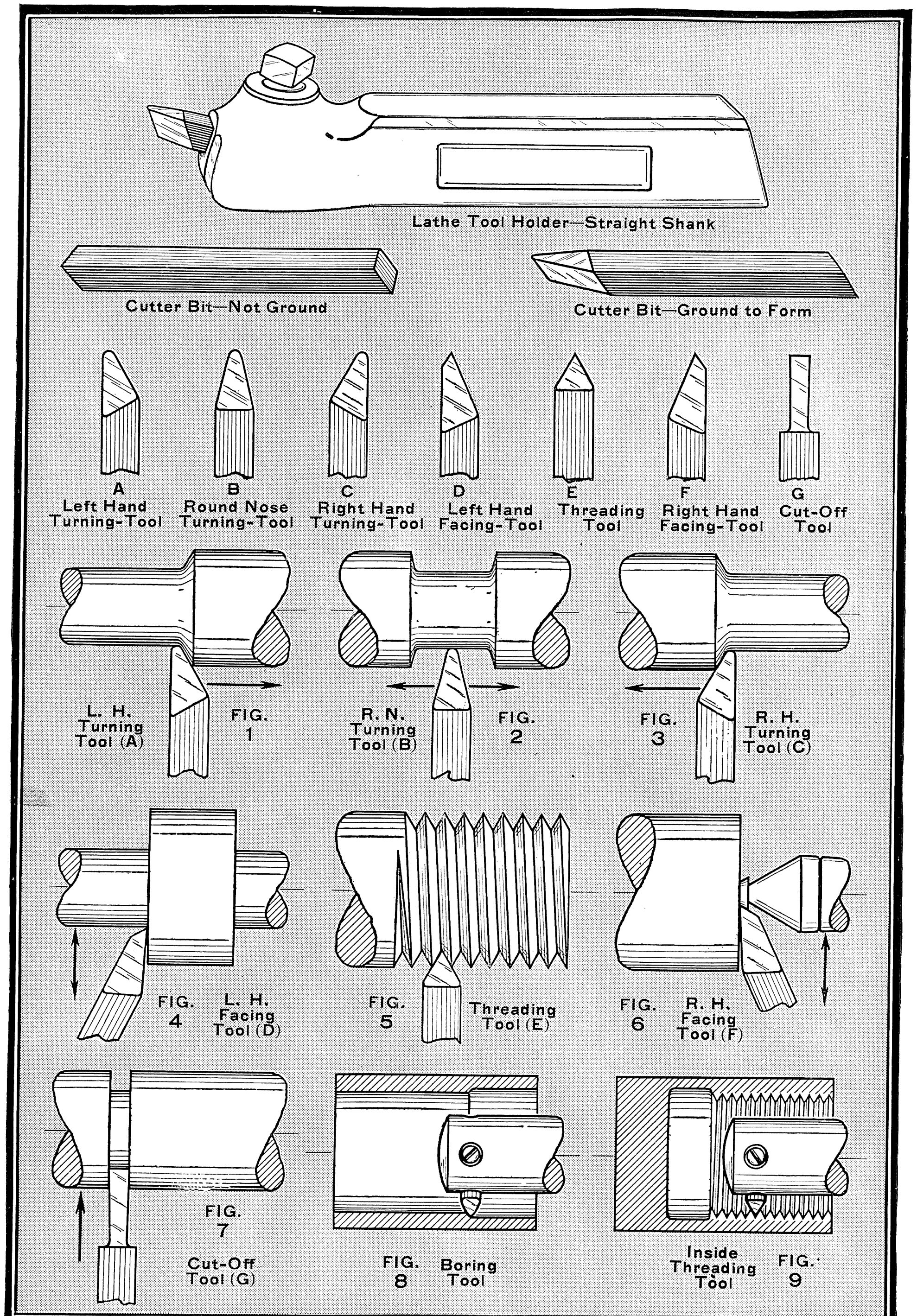


PLATE I

Popular Types of Lathe Tool Cutter Bits

(Illustrated on Page 2)

For Figure Numbers on This Page Refer to Plate I, Page 2

The illustrations on the opposite page show the most popular shapes of ground lathe tool cutter bits and their application. More complete information on grinding the cutter bits will be found on pages 5 to 10.

In each of the following paragraphs one of the seven ground cutter bits shown is described, beginning with cutter bit "A," Left Hand Turning Tool. A sample set of cutter bits already ground to shape may be purchased and used as patterns, if desired. This will be a big help to the beginner.

A—Left Hand Turning Tool—This tool is ground for machining work when fed from left to right, as indicated by Fig. 1, Plate I, at left. The cutting edge is on the right side of the tool and the top of the tool slopes down away from the cutting edge. The right side and front of the tool are ground with sufficient clearance to permit the cutting edge to advance when the feed is engaged without the heel of the tool rubbing against the work.

B—Round Nosed Turning Tool—This tool is for general all around machine work and is used for taking light roughing cuts and finishing cuts. Usually, the top of the cutter bit is ground so that the tool may be fed from right to left although sometimes this cutter bit is ground flat on top so that the tool may be fed in either direction. (See Fig. 2, Plate I.)

C—Right Hand Turning Tool—This tool is just the opposite of Tool A and is designed to cut when fed from right to left. (See Fig. 3, Plate I.) The cutting edge is on the left side. This is an ideal tool for taking roughing cuts and for general all around machine work.

D—Left Hand Facing Tool—This tool is intended for facing on the left hand side of the work, as shown in Fig. 4, Plate I, page 2. The direction of feed should be away from the lathe center. The cutting edge is on the right hand side of the tool and the point of the tool is sharp to permit machining a square corner.

E—Threading Tool—The point of the threading tool is ground to a 60° included angle for machining United States or American National Form screw threads. (See Fig. 5, Plate I.) Usually, the top of the tool is ground flat and there is clearance on both sides of the tool so that it will cut on both sides.

F—Right Hand Facing Tool—This tool is just the opposite of Tool D, Left Hand Facing Tool, and is intended for facing the right end of the work and for machining the right side of a shoulder. (See Fig. 6, Plate I.)

G—Square Nosed Parting Tool—The principal cutting edge of this tool is on the front. (See Fig. 7, Plate I.) Both sides of tool must have sufficient clearance to prevent binding and should be ground slightly narrower at the back than at the cutting edge. This tool is convenient for machining necks and grooves, squaring corners, etc. It may also be used for cutting off.

Fig. 8—Boring Tool—The boring tool is usually ground the same shape as the Left Hand Turning Tool A, so that the cutting edge is on the front side of the cutter bit and it may be fed in toward the headstock.

Fig. 9—Inside Threading Tool—The inside threading tool is ground exactly the same as Threading Tool E, except that it is usually much smaller in size.

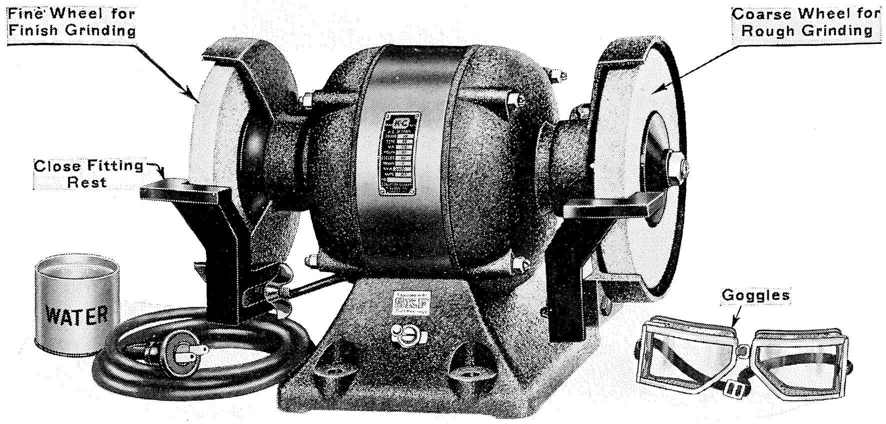


Fig. 9. A bench grinder suitable for grinding lathe tool cutter bits.

Equipment for Grinding and Sharpening Lathe Tool Cutter Bits

Good grinding equipment is essential for satisfactory grinding of lathe tool cutter bits. The illustration above shows an excellent type of grinder for this class of work. The grinder is motor driven and has two grinding wheels, one for rough grinding and the other for finish grinding the cutter bits. The wheels are 7 inches in diameter and have ¾-inch face. A 36-grain vitrified wheel is used for rough grinding and a 60-grain wheel for finish grinding.

The peripheral speed of the grinding wheel is approximately 5000 feet per minute. The grinding wheels are enclosed in close fitting guards, and the tool rest is convenient for some classes of grinding. The operator should wear goggles while grinding cutter bits if the grinder does not have glass spark shields.

The grinding wheels should be balanced so that they will run smoothly, and the wheel must be dressed frequently to keep it true. A Huntington type emery wheel dresser is usually used, although a fair job of wheel truing can be done with a broken piece of an old grinding wheel.

The water pot at the left of the grinder should be filled with water in which the cutter bit may be cooled when it becomes heated from grinding.

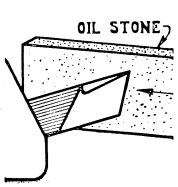


Fig. 10. Oil stone for honing cutting edge of cutter bit.

In addition to the grinder, a good oil stone is necessary. After grinding, the cutting edge of the cutter bit should always be honed with an oil stone, as shown in Fig. 10. Honing will not only improve the cutting quality of the cutter bit, but it will produce a better finish on the work and the cutting edge of the tool will stand up much longer than if it is not honed.

Grinding a Round Nosed Turning Tool for General Machine Work

The illustrations on this page, Figs. 11 to 15, inclusive, show each step in the grinding of a round nosed turning tool for general machine work. The various steps in grinding the cutter bit are as follows:

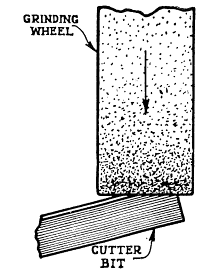


Fig. 11

Fig. 11—Grind the left side of the cutter bit, holding the cutter bit at the correct angle against the wheel to form the side clearance, as shown in Fig. 20 on page 7. Use a coarse grinding wheel to remove most of the metal, and then finish on the side of the fine grinding wheel to produce a straight surface. (If ground on the periphery of a small diameter wheel the cutting edge will be undercut and will not have the correct angle.) Dip the cutter bit into water frequently while grinding to prevent overheating.

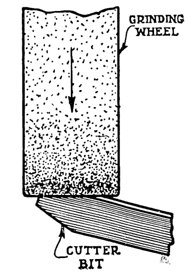


Fig. 12

Fig. 12—Grind the right side of the cutter bit, holding at the required angle to form the right side. This angle is not important as it has very little to do with the cutting edge of the tool, except too much of the bit should not be removed, as the more metal left on the bit the better it absorbs the heat.

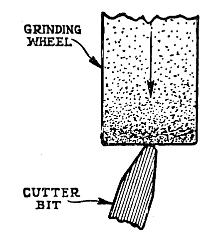


Fig. 13

Fig. 13—Grind the radius or rounding on the end of the cutter bit. A small radius (approximately 1/32″) is preferable as a large radius may cause chatter. Hold the cutter bit lightly against the side of the wheel and turn from side to side to produce the desired radius. Be careful to hold the cutter bit at the correct angle to obtain the proper front clearance, as shown in Fig. 14 and also Fig. 21 on page 7.

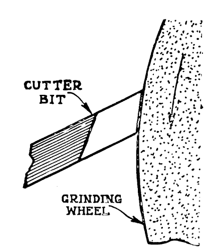


Fig. 14

Fig. 14—Hold the cutter bit at an angle as shown while grinding the radius on the end of the cutter bit in order to form the required front clearance. See Fig. 21 on page 7.

Fig. 15—Grind the top of the cutter bit, holding the cutter bit at the required angle to obtain the necessary side rake and back rake, as shown in Figs. 20 and 21 on page 7.

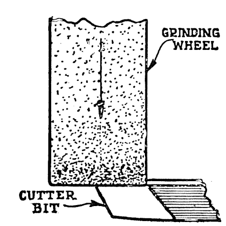


Fig. 15

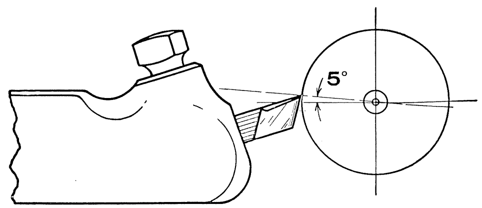
Hone the cutting edge all around and on top with an oil stone, as shown in Fig. 10, Page 4, until the cutting edge is very keen. The cutter bit will cut better and will last longer than if it is used without honing.

Be careful not to get the tool too hot—dip tool in cold water occasionally to avoid burning.

Correct Height of the Cutting Edge

Straight Turning

The cutting edge of the cutter bit should be about 5° above center, or 3/64″ per inch in diameter of the work, as shown in Fig. 16 at right, for ordinary straight turning. The position of the cutter bit must be taken into consideration when grinding the various angles, as the height of the cutter bit determines the amount of front clearance necessary to permit free cutting.

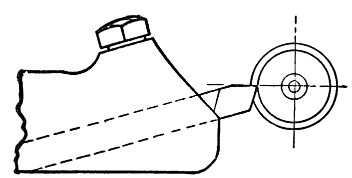


For Cast Iron, Steel, etc.

Fig. 16. The cutting edge of the cutter bit should be 5° or 3/64″ per inch in diameter of the work above center for straight turning on cast iron, steel, etc.

Taper Turning, Thread Cutting, Brass Turning

The cutting edge of the cutter bit should always be placed exactly on center, as shown in Fig. 17, for all types of taper turning and boring, and for cutting screw threads, also for turning brass, copper and other tenacious metals.



For Brass, Copper, etc.

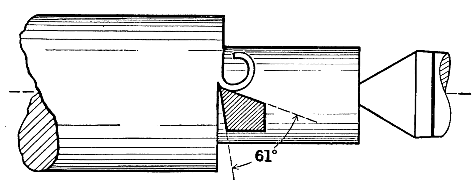
Fig. 17. The cutting edge of the cutter bit should be placed exactly on center for thread cutting, taper turning, machining brass, copper, etc.

Tool Angle Varies With Texture of Work

The included angle of the cutting edge of the cutter bit is known as the tool angle or angle of keenness and varies with the texture of the work to be machined. For example, when turning soft steel a rather acute angle should be used, but for machining hard steel or cast iron the cutting edge must be well supported and therefore the angle is less acute.

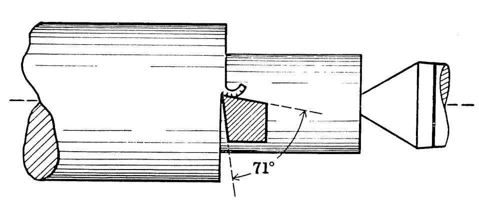
It has been found that an included angle of 61° is the most efficient tool angle for machining soft steel. This is the angle of the cutter bit as shown in Fig. 18.

For machining ordinary cast iron, the included angle of the cutting edge should be approximately 71°, as shown in Fig. 19. However, for machining chilled iron or very hard grades of cast iron, the tool angle may be as great as 85°.



For Soft Steel

Fig. 18. The tool angle or included angle of cutting edge for machining soft steel should be approximately 61°.



For Cast Iron

Fig. 19. The tool angle or included angle of the cutting edge for machining ordinary cast iron should be approximately 71°.

Correct Angles for Grinding Cutter Bits

In order that the cutter bit may cut freely, it must be ground with side clearance, front clearance, side rake and back rake at the correct angles, as shown in Figs. 20 and 21.

Side Clearance—The side clearance should be from 3° to 10°, depending on the amount of feed used and the nature of the work, and is ground on the side of the cutter bit to permit the cutting edge to advance freely without the heel of the tool rubbing against the work. (See Fig. 20.)

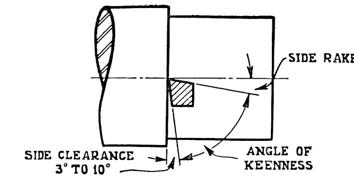


Fig. 20. Correct side clearance and side rake of cutter bit.

Front Clearance—The front clearance should be from 3° to 15°, depending on the nature of the work and height of the cutter bit, and is ground on the end of the cutter bit to permit the cutting edge to cut freely as it is fed to the work. (See Fig. 21.)

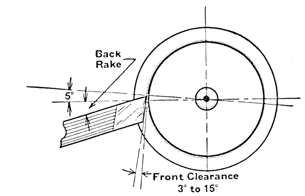


Fig. 21. Correct front clearance and back rake of cutter bit.

Back Rake—The back rake is ground on the top of the cutter bit to facilitate free cutting. (See Fig. 21).

Side Rake—The side rake is ground on the top of the cutter bit to facilitate free cutting. (See Fig. 20.)

Tool Angle—The tool angle or angle of keenness is the included angle of the cutting edge which is formed by the top and side of the cutter bit. (See Fig. 20).

Cutter Bit Grinding Gage

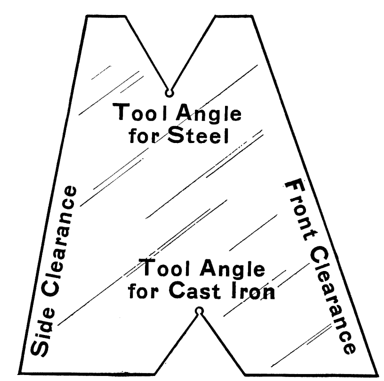


Fig. 22. Pattern for making cutter bit grinding gage.

A cutter bit grinding gage as shown in Fig. 22 at the left, is helpful for the beginner in grinding the correct angle on the various faces of the cutter bit. This gage can easily be made of sheet metal, using Fig. 22 as a pattern, which is full size.

Figs. 23, 24 and 25 show the gage in use checking the side clearance, tool angle and front clearance of a cutter bit.

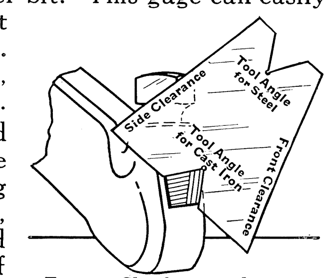


Fig. 24. Checking tool angle of cutter bit.

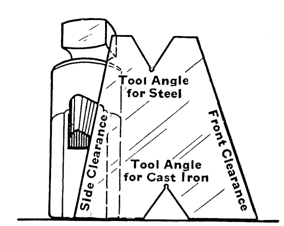


Fig. 23. Checking side clearance of cutter bit.

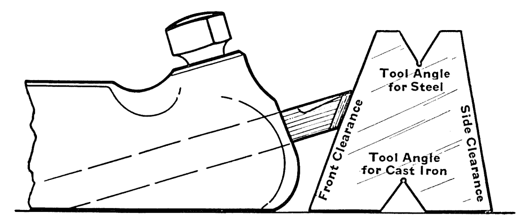


Fig. 25. Checking front clearance of cutter bit.

Two Popular Tools for Turning Steel

Tool for Roughing Cuts

Figs. 26 and 27 illustrate an excellent tool for taking heavy roughing cuts to reduce the diameter of a steel shaft to the approximate size desired. This tool will cut freely but does not produce a very smooth finish. When using this type of tool it is advisable to leave sufficient stock for a finishing cut with the round nosed tool shown at the bottom of the page.

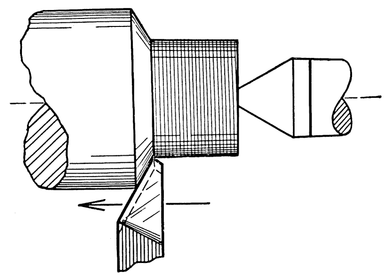


Fig. 26. Application of roughing tool.

Grind the tool to the shape shown in Fig. 27 and use the cutter bit grinding gage shown in Fig. 22, page 7, for grinding the correct front clearance, side clearance, etc.

The cutting edge of the tool is straight and the point is only slightly rounded. A very small radius at the point (approximately 1/64") will prevent the point of the tool from breaking down but will not impair the free cutting quality of the tool.

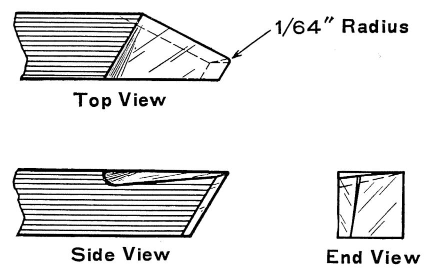


Fig. 27. Detail of roughing tool.

The tool angle or included angle of the cutting edge of this tool should be approximately 61° for ordinary machine steel. If a harder grade of alloy or tool steel is to be machined, the angle may be increased, and if free cutting Bessemer screw stock is to be machined, the angle may be slightly less than 61°.

Round Nosed Tool for Finishing Cuts

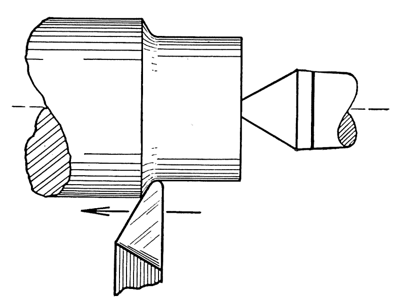


Fig. 28. Application of finishing tool.

Figs. 28 and 29 illustrate a round nosed turning tool for taking finishing cuts. The tool is very much the same shape as the sharp pointed tool for rough turning shown above, except that the point of the tool is rounded. (Approximately 1/32" to 1/16" radius.)

This tool will produce a very smooth finish if, after grinding, the cutting edge is well honed with an oil stone and a fine automatic feed is used.

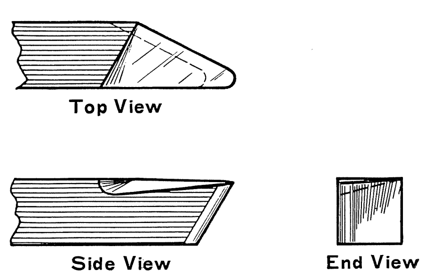


Fig. 29. Detail of finishing tool.

If you would do accurate machine work—keep your cutting tools sharp.

Grinding Lathe Tool Cutter Bits

Round Nosed Turning Tool

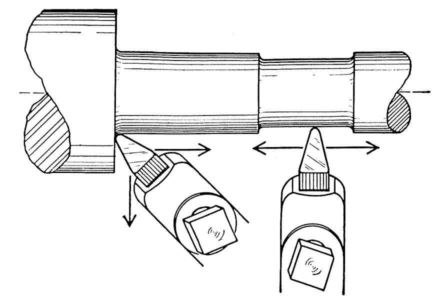


Fig. 30. Application of round nosed tool bit.

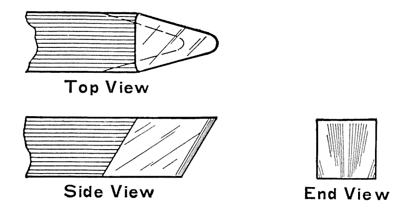


Fig. 31. Detail of round nosed tool bit.

The round nosed turning tool shown above is ground flat on top so that the tool may be fed in either direction, as indicated by the arrows in Fig. 30. This is a very convenient tool for reducing the diameter of a shaft in the center. The shape of the cutter bit is shown in Fig. 31, and the correct angle for the front clearance and side clearance can be obtained by grinding to the gage shown in Fig. 22 on page 7.

Right Hand Turning Tool

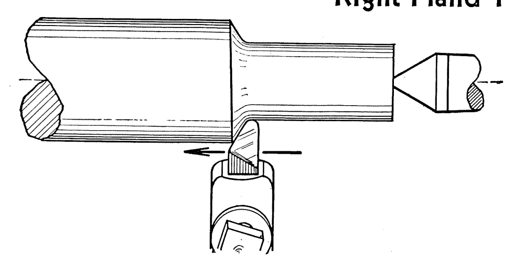


Fig. 32. Application of right hand turning tool.

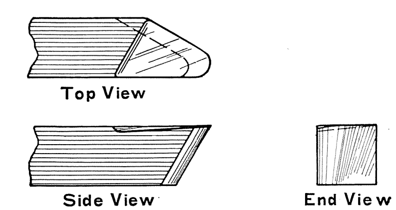


Fig. 33. Detail of right hand turning tool.

The right hand turning tool shown above is the most common type of tool for general all around machine work. This tool is used for machining work from right to left, as indicated by the arrow in Fig. 32. The shape of the cutter bit is shown in Fig. 33. See page 7 for correct angles of clearance.

Left Hand Turning Tool

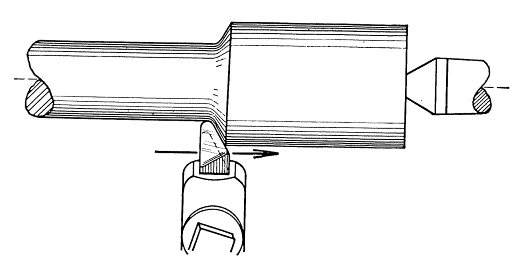


Fig. 34. Application of left hand turning tool.

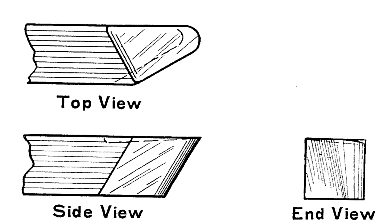


Fig. 35. Detail of left hand turning tool.

The left hand turning tool illustrated in Figs. 34 and 35 is just the opposite of the right hand turning tool shown in Figs. 32 and 33. This tool is designed for machining work from left to right.

Grinding Lathe Tool Cutter Bits

Right Hand Side Tool

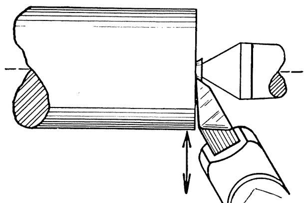


Fig. 36. Application of right hand side tool.

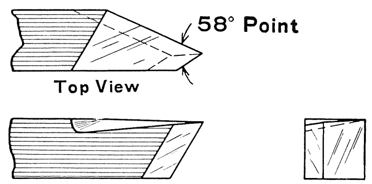


Fig. 37. Detail of right hand side tool.

The right hand side tool is intended for facing the ends of shafts and for machining work on the right side of a shoulder. This tool should be fed outward from the center, as indicated by the arrow in Fig. 36. The point of the tool is sharp and is ground to an angle of 58° to prevent interference with the tailstock center. When using this cutter bit care should be taken not to bump the end of the tool against the lathe center, as this will break off the point. See page 7 for correct angle of side clearance and front clearance.

Left Hand Side Tool

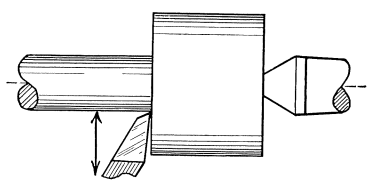


Fig. 38. Application of left hand side tool.

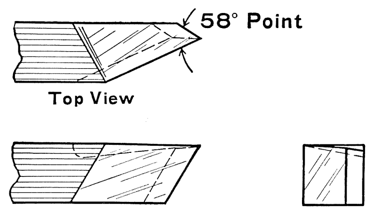


Fig. 39. Detail of left hand side tool.

The left hand side tool shown in Figs. 38 and 39 is just the reverse of the right hand side tool shown in Figs. 36 and 37. This tool is used for facing the left side of the work, as shown in Fig. 38.

Screw Thread Cutting Tool

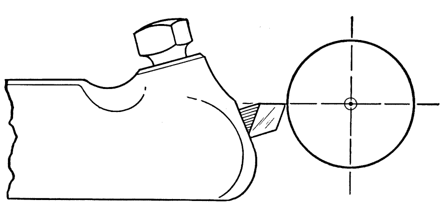


Fig. 40. Application of screw thread cutting tool.

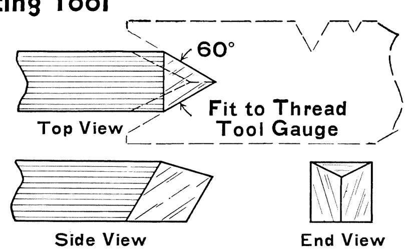


Fig. 41. Detail of thread cutting tool.

Figs. 40 and 41 show the standard type of cutter bit for cutting United States or American National Form screw threads. The cutter bit is usually ground flat on top, as shown in Fig. 40, and the point of the tool must be ground to an included angle of 60°, as shown in Fig. 41. Careful grinding and setting of this cutter bit will result in perfectly formed screw threads. When using this type of cutter bit to cut screw threads in steel, always keep the work flooded with lard oil in order to obtain a smooth thread. Machine oil may be used if no lard oil is available. Some operators do not use any oil, but for a smooth thread oil is essential. It is not necessary to use oil when cutting screw threads in cast iron.

Grinding Lathe Tool Cutter Bits

Brass Turning Tool

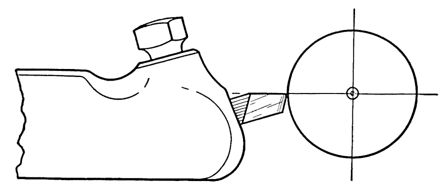


Fig. 42. Application of brass turning tool.

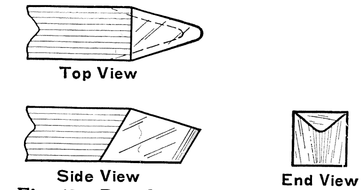


Fig. 43. Detail of brass turning tool.

The brass turning tool shown above is similar to the round nosed turning tool illustrated in Figs. 30 and 31 on page 9, except that the top of the tool is ground flat so that there is no side rake or back rake. This is to prevent the tool from digging into the work and chattering. The rounding on the end of the bit depends on the nature of the work being machined. A very small radius may be used on long slender work to reduce the tendency to chatter. However, a fairly large radius, as shown in the illustration, will produce a better finish.

Cutting Off Tool

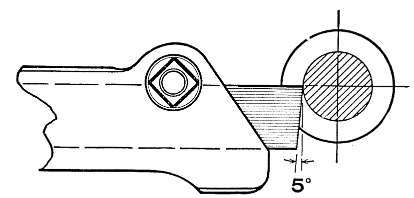


Fig. 44. Application of cutting off tool.

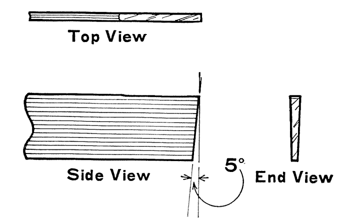


Fig. 45. Detail of cutting off tool.

The cutting off tool should always be set exactly on center, as shown in Fig. 44. This type of tool may be sharpened by grinding the end of the cutter blade to an angle of 5° as shown in Fig. 45. The sides of the blade have sufficient taper to provide side clearance, so do not need to be ground. When cutting off steel always keep the work flooded with oil. No oil is necessary when cutting off cast iron.

Boring and Inside Threading Tool

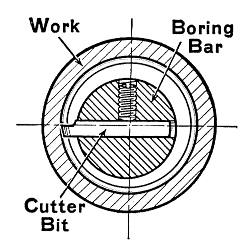


Fig. 46. Application of boring tool.

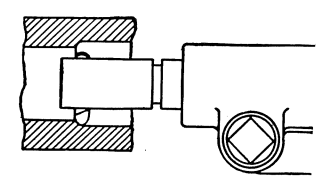


Fig. 47. Detail of boring tool.

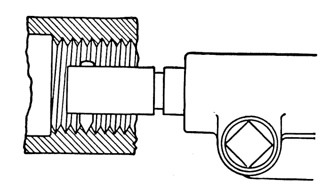


Fig. 48. Inside threading tool.

The boring tool is ground exactly the same as the left hand turning tool shown in Figs. 34 and 35 on page 9, except the front clearance of boring tool must be ground at a slightly greater angle so that the heel of the tool will not rub in the hole of the work. The inside threading tool is ground the same as the screw thread cutting tool, shown in Figs. 40 and 41 on page 10, except that the front clearance must be increased for the same reason as for the boring tool.

Grinding Stellite Cutter Bits

Stellite cutter bits are used in manufacturing plants where mass production is necessary because they will stand higher cutting speeds than high speed steel cutter bits. Stellite is also used for machining hard steel, cast iron, bronze, etc.

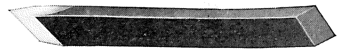


Fig. 49. Stellite cutter bit.

Fig. 49 illustrates a Stellite cutter bit which may be used in place of the regular high speed steel cutter bit. Stellite is a non-magnetic alloy which is harder than ordinary high speed steel. It will stand very high cutting speeds and the tool will not lose its temper even though heated red hot from the friction generated by taking the cut.

On account of the extreme hardness of Stellite, this metal is more brittle than high speed steel, and for this reason should not have quite as much clearance, side rake, back rake, etc. There should be just enough clearance to permit the tool to cut freely, as the cutting edge must be well supported to prevent chipping and breaking. Because of the tendency of this type of cutter bit to chip and break on the cutting edge, it is limited to certain types of work and is not as widely used for general machine work as high speed steel cutter bits.

Grinding Tungsten Carbide Cutter Bits

Tungsten carbide tipped cutter bits are used for manufacturing operations where maximum cutting speeds are desired, also for machining very hard or abrasive materials, such as chilled cast iron, hard bronze, steel, rubber and compositions containing abrasive materials.

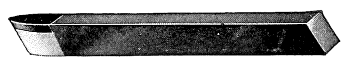


Fig. 50. Tungsten carbide tipped cutter bit.

Tungsten carbide is so hard and brittle that it is not practical to use it alone, so a small tungsten carbide tip is brazed onto the point of a carbon steel bit or shank, as shown in Fig. 50 above.

Tungsten carbide tipped cutter bits must be ground on a special grade of grinding wheel, as they are so hard that they cannot be satisfactorily ground on the ordinary grinding wheel. Just enough clearance should be ground on the cutting edge to permit the cutter bit to cut freely, because if the tool has too much clearance the cutting edge will not be properly supported and will chip and break away. After grinding, the cutting edge of the tungsten carbide tipped cutter bit should be finished by lapping on a cast iron lapping disc charged with diamond dust.

Grinding Forged Carbon Steel Lathe Tools

Forged carbon steel lathe tools are ground very much the same as the high speed steel cutter bits shown on pages 1 to 11, but care must be taken not to overheat the tool and draw the temper. The illustration Fig. 51 at the right shows a set of twelve hand forged carbon steel lathe tools.

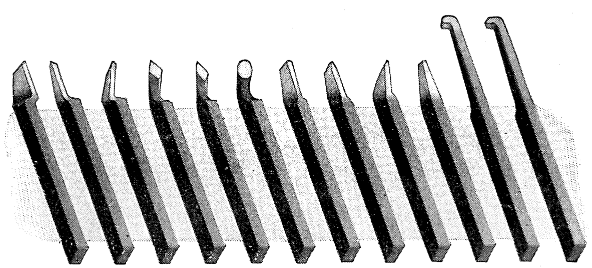


Fig. 51. Set of 12 hand forged carbon steel lathe tools.

One advantage of the forged carbon steel lathe tool is that it absorbs the heat better and is a little more solid than the patent tool holder with inserted type cutter bit. However, the carbon steel lathe tool has been almost entirely replaced by the high speed steel cutter bit.

To harden and temper a forged carbon steel lathe tool, heat the forged part of the tool slowly to a cherry red, being careful not to burn the steel. When the steel shows a bright cherry red, quench the end of the tool in water, leaving the shank of the tool still hot. After the point of the tool is cooled, withdraw from the water and polish the cutting edge with emery cloth and wipe with an oily rag. Watch the polished part carefully, and as the heat in the shank passes into the polished portion the surface will assume a straw color, which indicates the correct temper. Just as soon as the straw color reaches the point of the tool, the entire tool should be plunged into the water and thoroughly cooled. After grinding the tool is ready for use.

"How to Cut Screw Threads in the Lathe"

BULLETIN NO. 36-A

Shows How to Set Up the Lathe, Adjust the Tool, Etc.

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The book provides a handy reference for the amateur machinist on screw thread cutting. Contains 24 pages, size 6″ x 9″ and over 50 illustrations.

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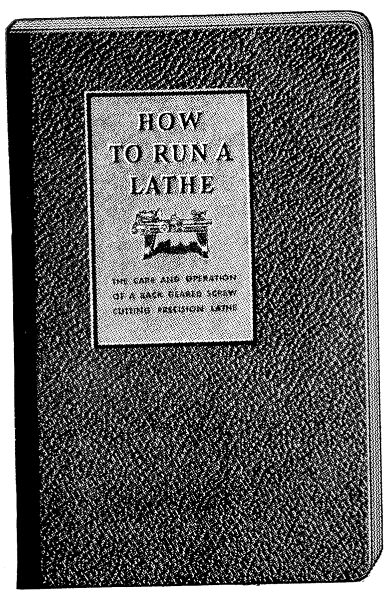
32nd EDITION

A Valuable Reference Book on Lathe Work



Contains 160 pages, size 5¼″ x 8″ and more than 300 illustrations.

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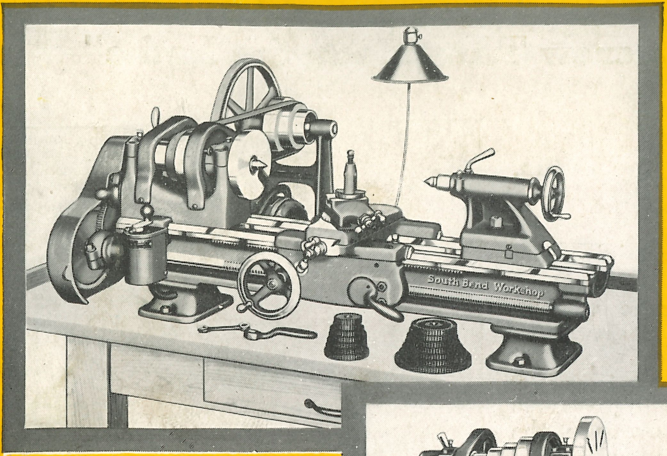
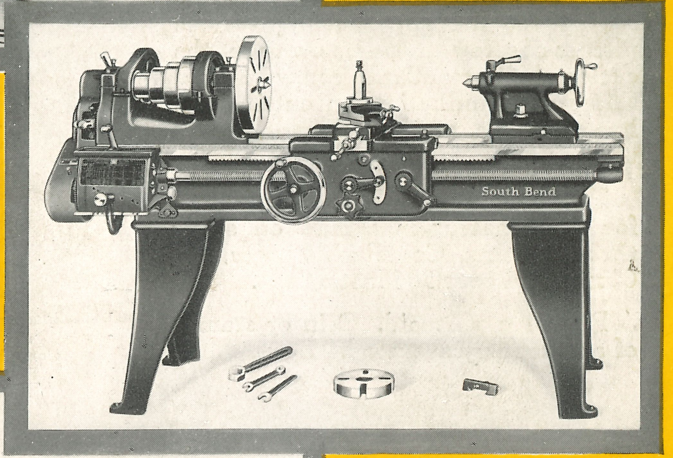


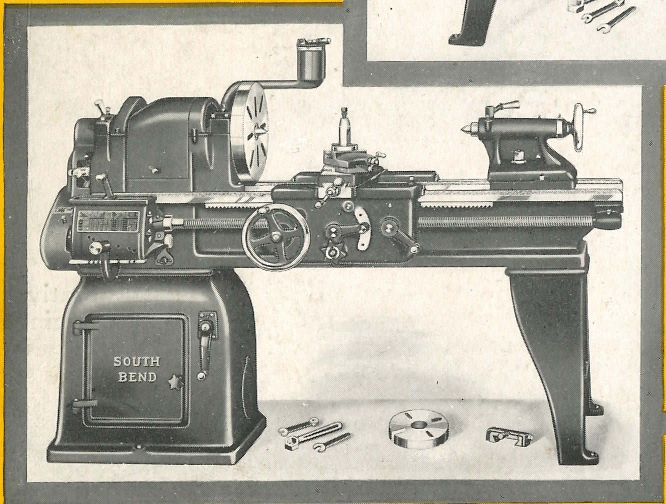
At Left—No. 415-Y 9″ x 3′ 1936 Model South Bend "Workshop" Horizontal Motor Driven, Back-Geared Screw Cutting Precision Bench Lathe.

One of the finest small lathes we have ever built.

At Right—No. 17-C 16″ x 6′ 1936 Model South Bend Overhead Countershaft Driven, Quick Change Gear, Back-Geared Screw Cutting Precision Lathe.

A popular type high quality precision lathe.





At Left—No. 117-C 16″ x 6′ 1936 Model South Bend Underneath Belt Motor Driven, Quick Change Gear, Back-Geared Screw Cutting Precision Lathe.

A practical, efficient and popular motor driven lathe.

Below—The plant of the South Bend Lathe Works at South Bend, Indiana. This organization was founded in 1906 and has grown and developed to an enterprise occupying the buildings shown here, which have a floor space of 180,000 square feet and with a ground area of 4½ acres devoted exclusively to the manufacture of South Bend Back-Geared Screw Cutting Precision Lathes.

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