CHAPTER 15

Other Lathe Operations

Chapter Outline

Learning Objectives

After studying this chapter, you will be able to:
- Perform boring, drilling, reaming, and knurling operations on a lathe.
- Describe how filing and polishing operations are performed on a lathe.
- Properly set up steady and follower rests.
- Explain how and when to use mandrels.
- Perform grinding operations on a lathe.
- Describe other attachments for the lathe.
- Demonstrate familiarity with industrial applications of the lathe.

Technical Terms

automatic screw machine	knurling
boring	mandrel
boring mill	steady rest
follower rest	turret lathe

In addition to the basic lathe operations you learned about in the previous chapter, a number of other applications are possible on a lathe, such as boring, drilling, reaming, knurling, filing, polishing, grinding, and milling. Some of these operations require additional attachments, rests, or work-holding devices.

15.1 Boring on a Lathe

Boring is an internal machining operation in which a single-point cutting tool is used to enlarge a hole, **Figure 15-1**. Boring may be used to enlarge a hole to a specified size when a drill or reamer will not do the job. When properly set up, the lathe produces a hole that is concentric with the outside diameter of the work.

15.1.1 Boring Difficulties

While the machining technique remains essentially the same as for external turning, you may encounter several conditions that could cause difficulty. When boring on a lathe, you must make allowances for the following:

- Movement of the cross-slide screw is reversed.
- The machinist must work "by feel" because the cutting action cannot always be observed.
- Additional front clearance must be ground on the cutting tool to avoid rubbing, **Figure 15-2**. Other than that, the shape of the cutting tool is identical to that used for external turning.
- Boring a deep or small-diameter hole requires a long, slender boring bar. The overhang makes the tool more likely to spring away from the surface being machined. It is also necessary to take several light cuts, instead of one heavy cut, to remove the same amount of material.
- Some people find that internal measuring tools are more difficult to use than those for making external measurements.

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Figure 15-1. Boring or machining internal surfaces is sometimes done on a lathe.

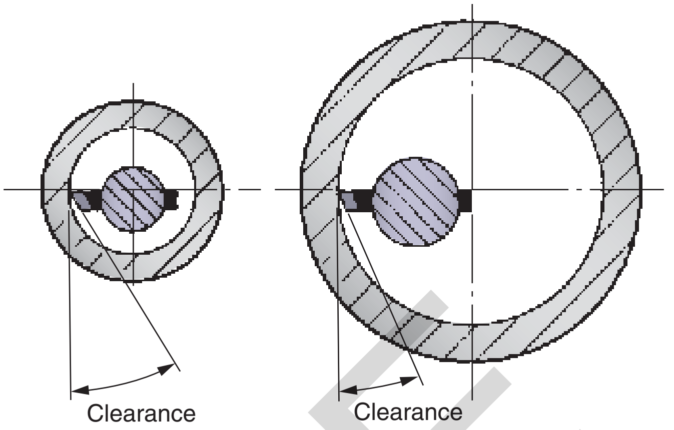

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Figure 15-2. A cutting tool used to bore small-diameter holes requires greater front clearance to prevent rubbing.

15.1.2 Boring the Hole

The hole size to be bored determines the type and size of boring bar required. Always use the largest bar possible to give maximum tool support, **Figure 15-3**. The bar should extend from the holder only far enough to permit the tool to cut to the required hole depth, **Figure 15-4**.

The boring bar is set on center or slightly below center, with the bar parallel to tool travel, **Figure 15-5**. Check for adequate clearance when the tool is at maximum depth in the hole.

Begin by making a light cut in the same manner as you would for external machining. When the cut is complete, stop the machine. Set the cross-slide micrometer dial to zero and back the tool away from the work. Remove the boring bar from the hole.

Check the hole diameter with an inside micrometer or with a telescoping gage and micrometer. After checking hole accuracy, bring the cross-slide back to zero, and advance the tool to make another cut. The amount of infeed is determined by the boring bar being used and the material being bored. Make additional cuts, checking the hole size frequently, until the desired diameter is attained.

When making the final cut, it may be necessary to reverse tool travel after reaching the desired depth. Reverse the carriage feed, not the spindle rotation. Let the tool feed out of the hole without changing the tool setting. This will compensate for any tool spring.

When boring holes with long, slender boring bars, it may be necessary to run the tool into the hole without changing its setting after every second or third cut to compensate for tool spring. With such long, slender boring bars, chatter is more likely to occur than when doing external work. Chatter can usually be eliminated by using one of the following methods:

- Using the largest boring bar practical for the hole size.
- Using a slower spindle speed.
- Reducing tool overhang.
- Grinding a smaller radius on the cutting tool nose.
- Placing a weight on the back overhang of the boring bar.
- Placing the tool slightly below center.
- Using a dampened boring bar.

Dampened boring bars are specifically designed to reduce vibration. The center of the bar is hollow and filled with lead shot or another material designed to absorb vibration.

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Figure 15-3. A set of carbide-tipped boring bars with 1/2″ (12.5 mm) diameter shanks.

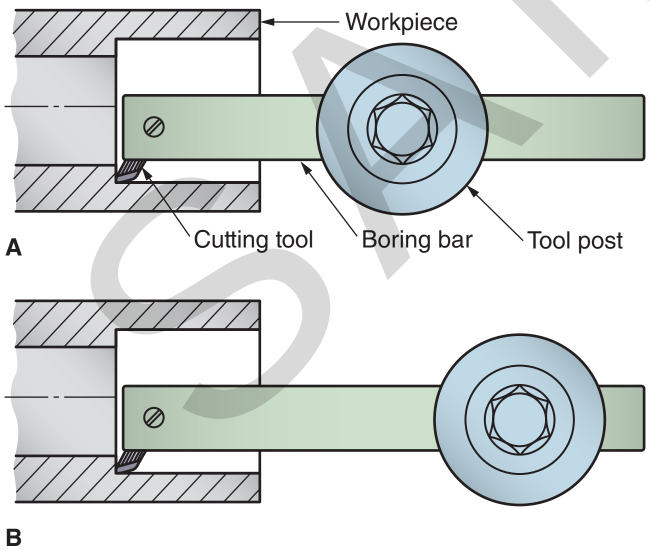

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Figure 15-4. Keep the cutting tool as close to the tool post as possible for maximum tool support. A—Properly positioned boring bar. B—Boring bar projecting too far from the tool post. The resulting vibration and chatter could produce a rough machined surface.

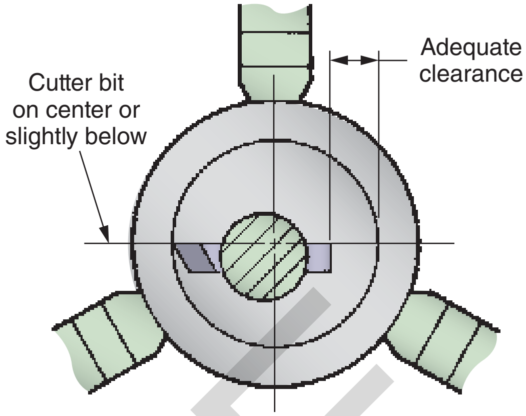

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Figure 15-5. The tool is set on, or slightly below, center when boring. Be sure to check for adequate clearance between the boring bar and hole.

15.2 Drilling on a Lathe

When a hole is to be cut in solid stock, the usual practice is to hold it in a suitable chuck and mount the drill in the tailstock. Drilling is accomplished on a lathe by feeding the stationary drill into the rotating workpiece, **Figure 15-6**.

When using standard twist drills to drill holes that are 1/2″ (12.5 mm) or less in diameter, a straight shank drill is placed in a Jacobs chuck. The Jacobs chuck is then fitted into the tailstock spindle. Holes larger than 1/2″ (12.5 mm) in diameter are made with taper shank drills, **Figure 15-7**.

Drills that have taper shanks too large to be fitted in the tailstock can be used if mounted as shown in **Figure 15-8**. A dog is fitted to the neck of the drill. The tool is set up to permit the tailstock center to press into the center hole in the drill tang.

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Figure 15-6. When drilling on a lathe, the workpiece is held in the headstock and rotated while the stationary drill, held in the tailstock, is advanced into the work. The cutting fluid helps to reduce heat and flush away chips.

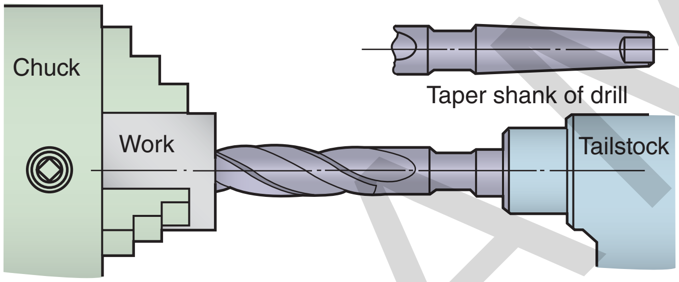

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Figure 15-7. Drills larger than 1/2″ (12.5 mm) in diameter are usually fitted with a self-holding taper that fits into the tailstock spindle of the lathe.

The drill's cutting point bears against the rotating work. The drill is prevented from revolving by the dog bearing against the compound rest. The tailstock center keeps the drill aligned and enables it to be fed into the material by the tailstock handwheel. The makeshift lathe dog setup can be avoided by using a commercial drill holder, **Figure 15-9**.

SAFETY NOTE

Extreme care must be used to prevent the drill from slipping off the tailstock center after it breaks through the work.

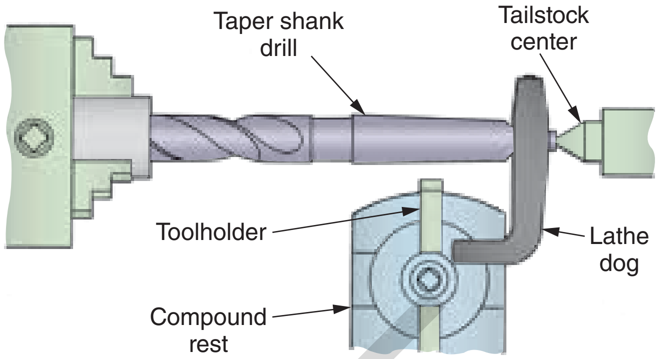

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Figure 15-8. When a drill shank is too large to be fitted into the tailstock, a lathe dog can be used to keep it from revolving. The tail of the lathe dog is supported by the compound rest. This type of drilling requires care to prevent the drill from slipping off the tailstock center when the full drill diameter breaks through the work.

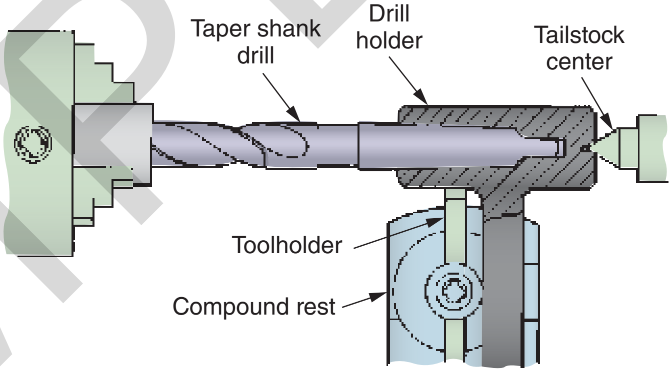

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Figure 15-9. Large taper shank drills can be used on the lathe by fitting them in a commercial drill holder.

Accuracy in drilling requires a centered starting point for the drill. A starting point made with a combination drill and countersink is adequate for most jobs. Holes over 1/2″ (12.5 mm) in diameter require a pilot hole. The pilot hole should have a diameter equal to the width of the larger drill's dead center. See **Figure 15-10**. Ample clearance must be provided in back of the work so that the drill will not strike the chuck or headstock spindle when it breaks through, **Figure 15-11**.

15.3 Reaming on a Lathe

Reaming is an operation used to make a hole accurate in diameter and finish, **Figure 15-12**. The hole is drilled slightly undersized to allow sufficient stock for reaming. The allowance for reaming depends on the hole size, as follows:

- For hole sizes ranging up to 1/4″ (6.5 mm) in diameter, allow 0.010″ (0.25 mm) of material for reaming.
- For hole sizes from 1/4″ (6.5 mm) to 1/2″ (12.5 mm) in diameter, allow 0.015″ (0.4 mm).
- For hole sizes from 1/2″ (12.5 mm) to 1.0″ (25.0 mm) in diameter, allow 0.020″ (0.5 mm).
- For hole sizes from 1.0″ (25.0 mm) to 1.5″ (37.5 mm) in diameter, allow 0.025″ (0.6 mm).
- For hole sizes above 1.5″ (37.5 mm) in diameter, allow 0.030″ (0.8 mm) for reaming.

When reaming, use a cutting speed about two-thirds the speed you would use for a similar size drill with the material being machined. Also, use a slow, steady feed with an adequate supply of cutting fluid. Remove the reamer from the hole before stopping the machine.

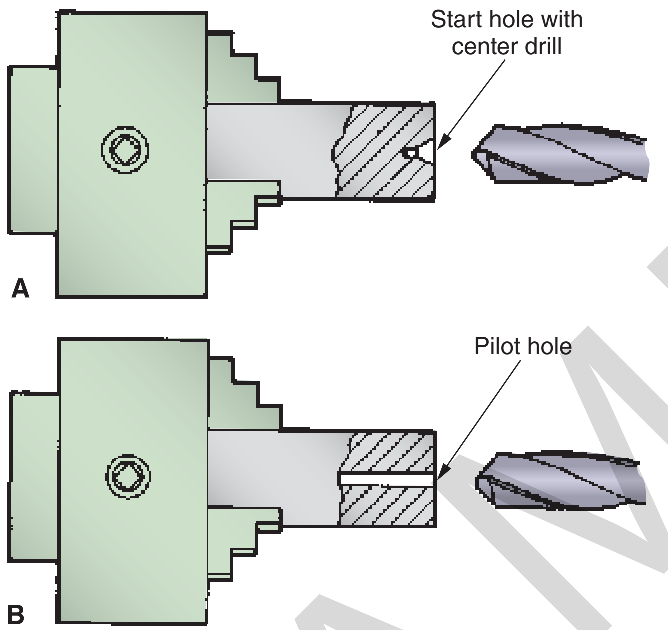

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Figure 15-10. Centering the drill. A—The drill will cut exactly on center if the hole is started with a center drill. B—Holes larger than 1/2″ (12.5 mm) in diameter require a pilot hole.

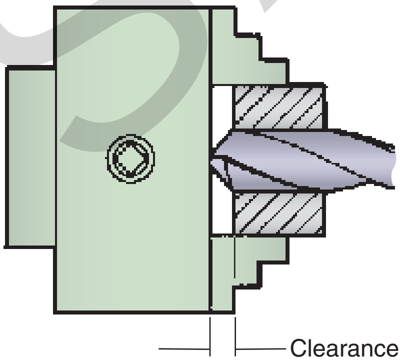

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Figure 15-11. There must be enough clearance between the back of the work and the chuck face to permit the drill to break through the work without damaging the chuck.

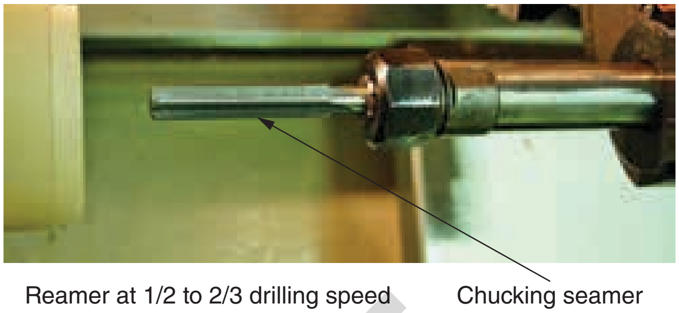

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Figure 15-12. A straight-flute reamer mounted in an extension holder being used to finish a hole in a plastic workpiece.

If you are using a hand reamer, do not apply power to the workpiece mounted in the chuck. Fit the reamer into the hole, supporting the shank end with the tailstock center. Use an adjustable wrench to turn the reamer in a clockwise direction, **Figure 15-13**.

When removing a reamer from the hole, continue to rotate the tool clockwise. Avoid turning it counterclockwise because that would ruin the tool's cutting edges.

15.4 Knurling on a Lathe

Knurling is the process of forming horizontal or diamond-shaped serrations (raised grooves or teeth) on the circumference of the work, **Figure 15-14**. Knurling is used to provide a gripping surface, change the appearance of the work, or increase the work's diameter. It is done with a knurling tool mounted in the tool post, **Figure 15-15**. The knurled pattern

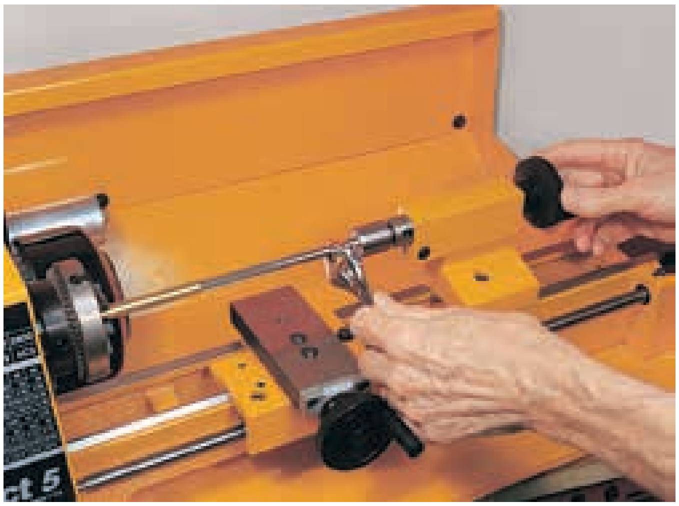

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Figure 15-13. Using a hand reamer on the lathe. Never turn on the power when performing hand reaming operations.

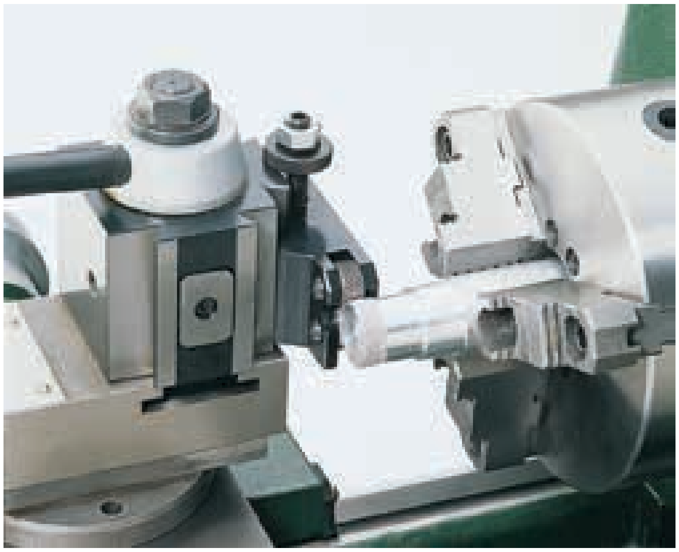

Photo courtesy of Grizzly Industrial, Inc. www.grizzly.com

Figure 15-14. Knurling rollers are being used to form serrations on a part.

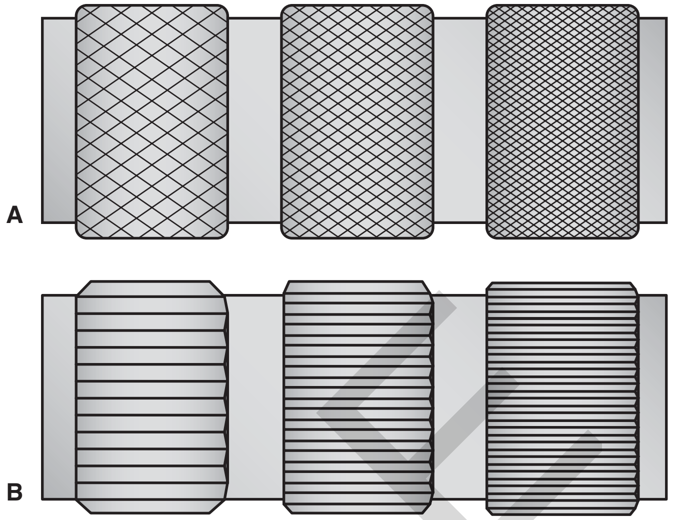

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Figure 15-16. Knurling patterns. A—Diamond knurl in coarse, medium, and fine pitch. B—Straight knurl in coarse, medium, and fine pitch.

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Figure 15-15. One type of knurling tool.

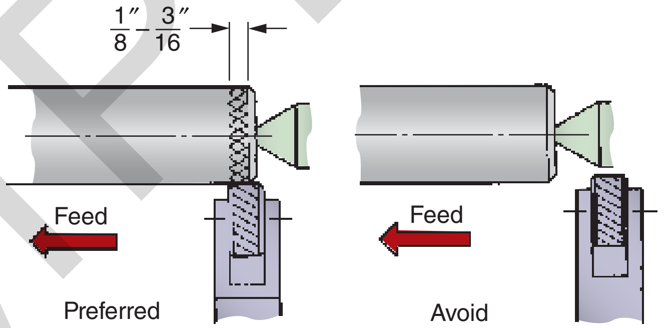

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Figure 15-17. Always start the knurl on the work.

is raised by rolling the knurls against the metal. This displaces the metal into the required pattern.

Angular knurls raise a diamond pattern, and a straight knurl produces a straight pattern along the length of the work. The patterns can be produced in coarse, medium, and fine pitch. See **Figure 15-16**.

15.4.1 Knurling Procedure

If a knurling tool is not properly set up, the knurls will not track and will quickly dull. The following procedure is recommended:

1. Mark off the section to be knurled.
2. Adjust the lathe to a slow back-geared speed and a fairly rapid feed.
3. Place the knurling tool in the tool post. Bring it up to the work. Both wheels must bear evenly on the work with their faces parallel with the centerline of the piece, **Figure 15-17**.
4. Start the lathe and slowly force the knurls into the work surface until a pattern begins to form. Tool travel should be toward the headstock whenever possible. Engage the automatic feed and let the tool travel across the work. Flood the work with cutting fluid.
5. When the knurling tool reaches the proper position, reverse spindle rotation and allow the tool to move back across the work to the starting point. Apply additional pressure to force the knurls deeper into the work.
6. Repeat the operation until a satisfactory knurl is formed.

15.4.2 Knurling Difficulties

If knurling is not performed properly, problems can arise and destroy the work. A common problem is the double-cut knurl, **Figure 15-18**, in which one wheel of the knurling tool makes twice as many ridges as the other. A double-cut knurl is usually caused by one wheel being dull. Raising or lowering the knurling tool to put more pressure on the dull wheel frequently eliminates the trouble. Pivoting the tool slightly

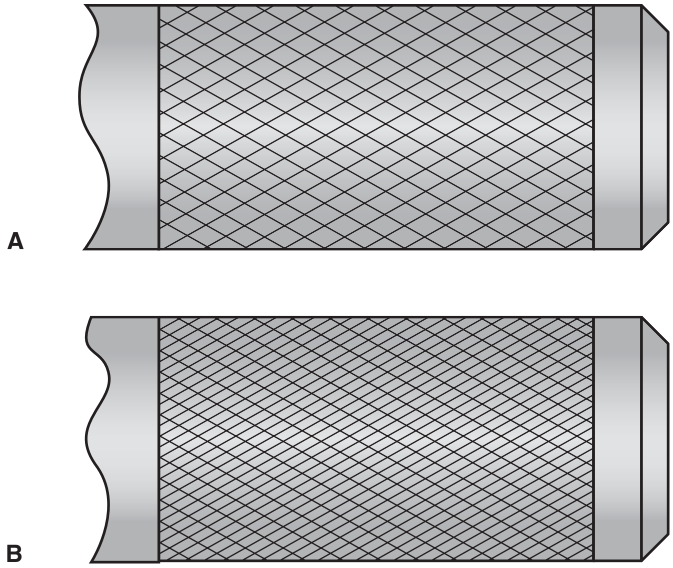

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Figure 15-18. Double-cut knurl. A—This is a correctly made diamond knurl pattern. B—A double-cut diamond knurl results when one knurl wheel is slightly above or below center.

to allow the right side of the wheels to apply more pressure may also help.

Considerable side pressures are developed during knurling operations. Watch the tool carefully. Do not permit the work to slip in the chuck or loosen on the tailstock center. If a ball-bearing center is not used, keep the tailstock center well lubricated.

Perform knurling before turning a shaft to a smaller diameter. If knurling is done after the smaller diameter has been machined, the work will spring away from the tool, giving the surface a superficial (light, nonpenetrating) knurl. It may also cause a permanent bend in the workpiece. See **Figure 15-19**.

Avoid applying too much pressure to the knurling tool. The work surface becomes hardened during the operation and the knurled section could "flake off." High pressure also tends to bend the shaft.

SAFETY NOTE

Never stop the lathe with the knurls engaged in the work. The piece will take on a permanent bend.

15.5 Filing and Polishing on a Lathe

Lathe filing is done to remove burrs, round off sharp edges, and blend in form-cut outlines. A file is not intended to replace a properly sharpened cutting tool and should not be used to improve the surface finish on a turned section.

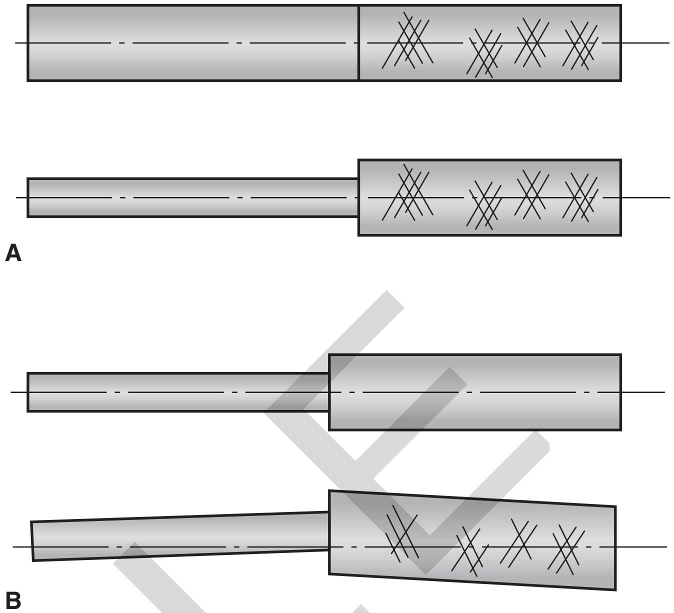

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Figure 15-19. Knurling problems. A—Do knurling before turning a shaft to a smaller diameter. B—If knurled after being turned to a smaller diameter, the shaft may take on a permanent bend and receive only a superficial (very light) pattern.

15.5.1 Filing on a Lathe

When filing on a lathe, avoid holding the tool stationary against the work. Keep the tool moving across the area being filed. If the file is held in one position, it will load with metal particles and score the surface of the work. An ordinary mill file produces satisfactory results. However, a long-angle lathe file produces a superior cutting action. See **Figure 15-20**.

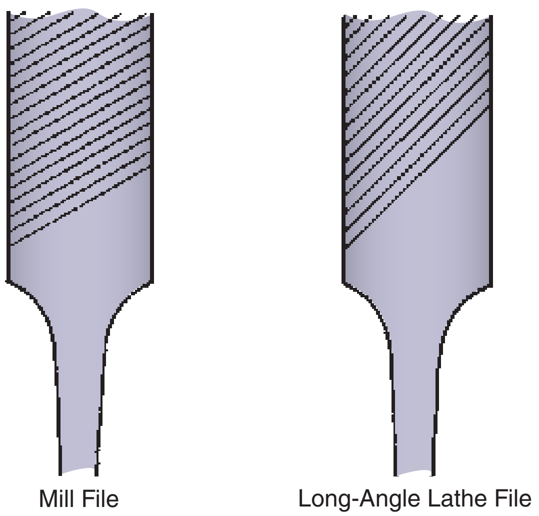

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Figure 15-20. The cutting edges on a long-angle lathe file are at a different angle from those on a standard mill file.

Operate the lathe at high spindle speed and apply long, even strokes. Release pressure on the return stroke. If uneven pressure is applied, out-of-round work will result. Clean the file often.

As simple as filing may appear, it can be quite dangerous if the following precautions are not observed:

- Move the carriage out of the way and remove the tool post.
- Use the left-hand method of filing, **Figure 15-21**. This involves holding the file handle in the left hand. The right hand is then clear of the revolving chuck or faceplate.

SAFETY NOTE

- Avoid the right-hand method of filing. The right-hand method places your left arm over the rotating chuck or faceplate. This method can result in serious injury.
- Never use a file without a handle. It is too easy to drive the unprotected tang into your hand.

15.5.2 Polishing on a Lathe

Polishing is sometimes done on a lathe using a strip of abrasive cloth suitable for the material to be polished. Grasp the strip between your fingers and hold it across the work, **Figure 15-22**. If more pressure is required, mount the abrasive cloth on a strip of wood or on a file, **Figure 15-23**. A high spindle speed is used for polishing.

The finer the abrasive used, the finer the resulting finish. A few drops of machine oil on the abrasive will improve the finish. For the final polish, reverse the cloth so the cloth backing, rather than the abrasive, is in contact with the work surface. Like filing, polishing is not a substitute for a properly sharpened tool bit.

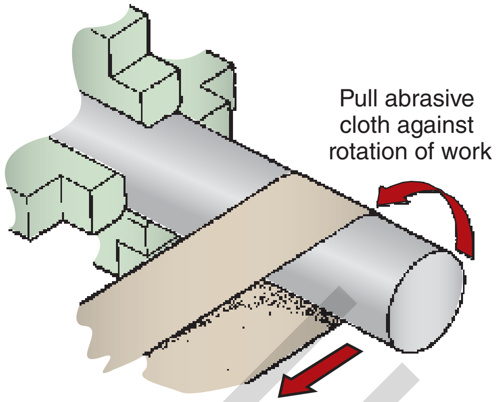

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Figure 15-22. Polishing with an abrasive cloth held in the hands. Keep your hands away from the revolving chuck or dog.

Carefully and thoroughly clean the lathe after polishing operations. If not removed, abrasive particles from the cloth will cause rapid wear of the machine's moving parts.

15.6 Using Steady and Follower Rests

The steady rest and the follower rest are needed to provide additional support when the workpiece is long and thin. This additional support keeps the work from springing or bending

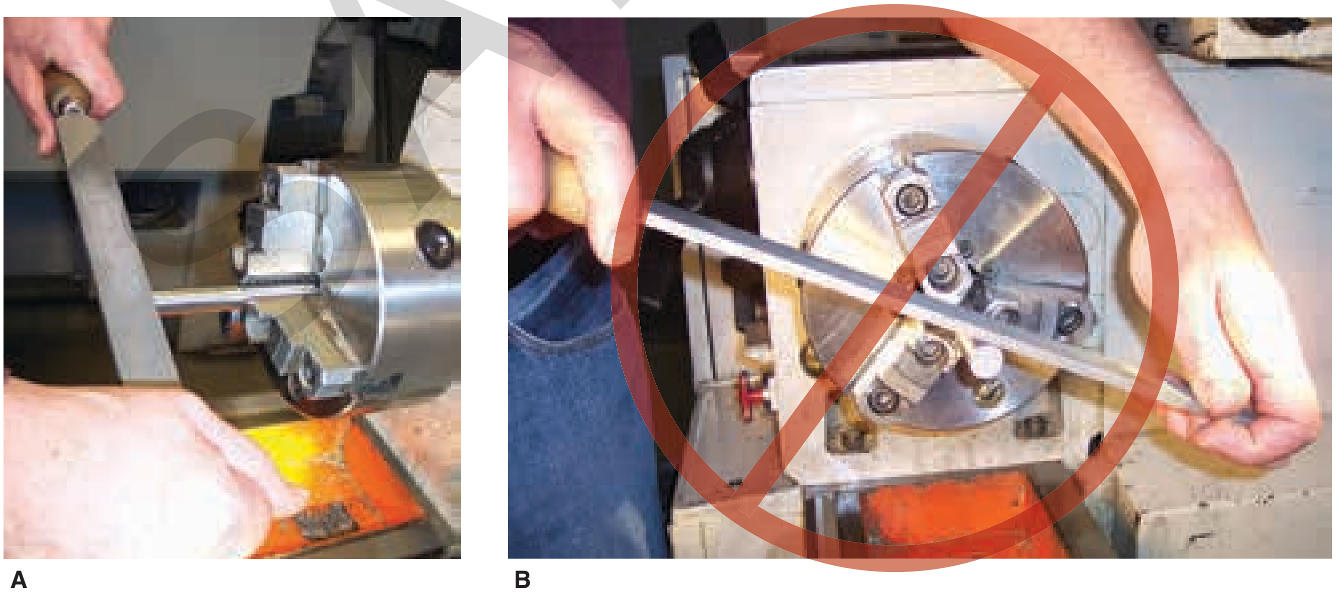

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Figure 15-21. A—The left-hand method of filing on the lathe is preferred. B—Avoid using the right-hand method as shown here. Notice that the machinist's left hand and arm are extended over the revolving chuck, which can cause injury.

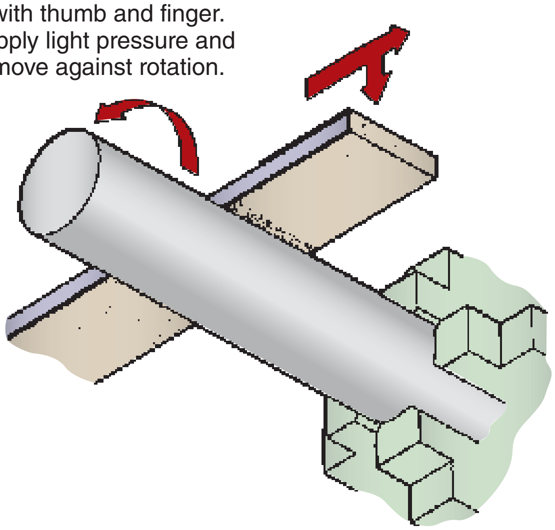

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Figure 15-23. More pressure can be applied if the abrasive cloth is supported by a file or block of wood.

away from the cutting tool. The support is also needed to reduce chattering when long shafts are machined. See **Figure 15-24**.

GREEN MACHINING

Reducing Chips

Managing waste from chips is critical for eco-conscious machine shops. Optimum cutting produces long, curling chips. Leaving these chips intact makes collection more difficult and wasteful. Cut the chips at intervals to make gathering and recycling easier. Chips can then be repurposed into new objects, like wire brushes and scouring pads, or pressed into bricks for pick-up by industry recyclers.

Before collection or bricking, treat all chips to remove excess cutting fluid. To remove cutting fluid, drain the chips or use centrifugal force to separate the fluid from the chips. Careful removal of cutting fluid from chips may allow the fluid to be reused as well.

15.6.1 Steady Rest Setup

The ***steady rest***, sometimes called a *center rest*, is bolted directly to the ways. It has three adjustable jaws, each with individual locking screws. The upper portion of the attachment is fitted with a single jaw that can be opened to place the work in position, **Figure 15-25**.

To set up a steady rest, use the following procedure:

1. Bolt the attachment to the ways at the desired position.

Photo courtesy of Grizzly Industrial, Inc. www.grizzly.com

Figure 15-24. When the nature or shape of work prevents it from being mounted between centers, devices called "rests" are used to provide support. This lathe is equipped with a steady rest.

2. Back off all jaws and open the upper section.
3. Mount the work between centers or in a chuck. Support the free end with the tailstock center.
4. Lower and lock the upper segment in place.
5. Adjust the jaws up to the work and lock them into position. The jaws act as bearing surfaces where they contact the work. They must be well lubricated.
6. If the shaft being machined is unsuitable as a bearing surface (rough surface, out-of-round, square), use a cat head (a device that provides a bearing surface). Take care to center the shaft within the cat head. See **Figure 15-26**.
7. When machining at the end of a long shaft that cannot be supported with the tailstock, center the work in the chuck. Adjust the center rest to the work as close to the chuck as possible, then move it to a point where the support is needed. You can use the same technique when performing drilling, reaming, tapping, or other operations on the end of a long shaft.

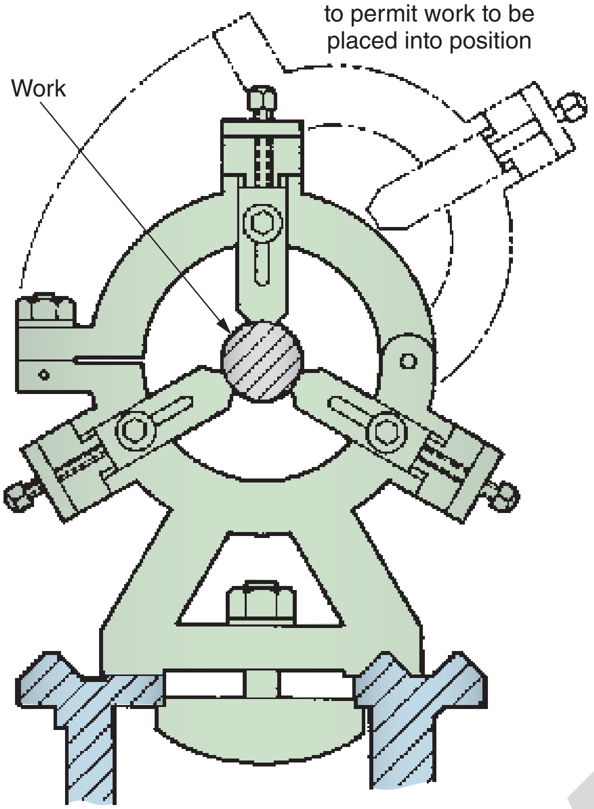

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Figure 15-25. To permit easy installation of work, the top of the steady or center rest swings open. Take care to accurately center the work.

15.6.2 Follower Rest Setup

The ***follower rest*** operates on the same principle as the steady rest and is used in a similar manner. The follower rest differs slightly in that it provides support directly in back of the cutting tool and follows along during the cut. See **Figure 15-27**.

The follower rest bolts directly to the carriage and the jaws adjust in the same way as on the steady rest. The jaws must be readjusted after each cut.

15.7 Using Mandrels

At times, it is necessary to machine the outside diameter of a piece concentric with a hole that has been previously bored or reamed. This is a simple operation if the material can be held in the lathe by conventional means. There are, however, times when the material cannot be gripped solidly to permit accurate machining. In such cases, the work is mounted on a ***mandrel*** (a slightly tapered, hardened steel shaft) and turned between centers, **Figure 15-28**.

A solid mandrel is made from a section of hardened steel that has been machined with a slight taper (0.0005″ per inch), **Figure 15-29A**. These mandrels are made in standard sizes starting at 1/8″ in diameter. The size is stamped on the large end. The other end is slightly smaller than the specified size to permit easy installation in the work.

An expansion mandrel permits turning work in which the opening is not a standard size. See **Figure 15-29B**. The shaft and sleeve have corresponding tapers and are machined

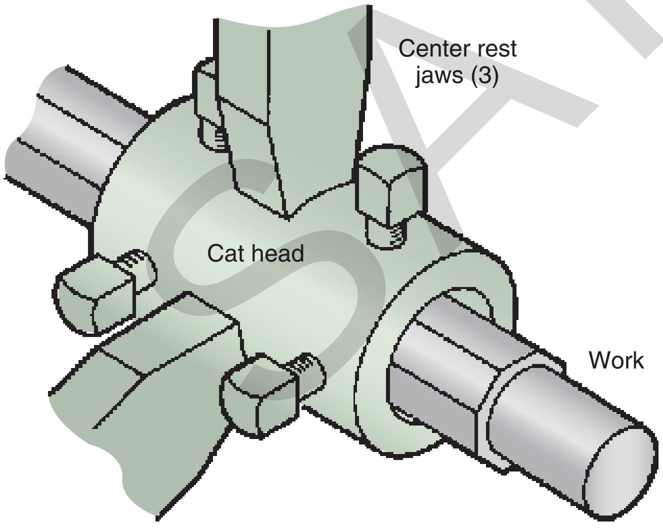

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Figure 15-26. A cat head provides a bearing surface when needed.

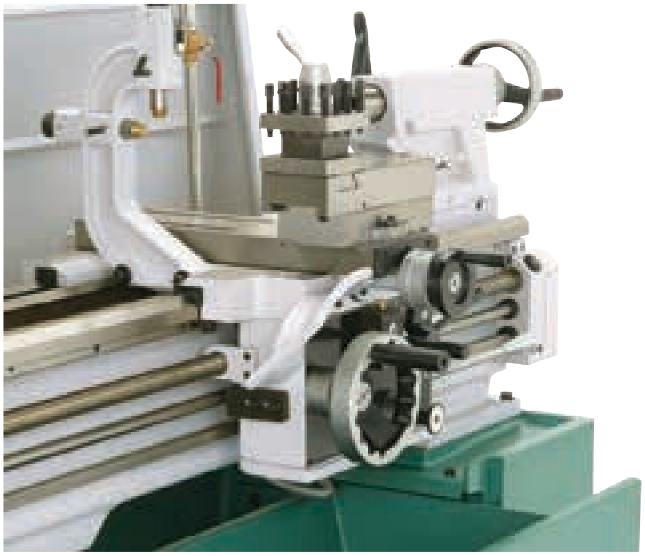

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Figure 15-27. A follower rest is used to support long slender workpieces during machining operations.

from hardened steel. The sleeve is slotted so it can expand when forced onto the tapered shaft.

A gang mandrel, **Figure 15-29C**, is helpful when many pieces of the same configuration must be turned. Several pieces are mounted on the mandrel and separated with spacing collars. They are locked in place by tightening a nut.

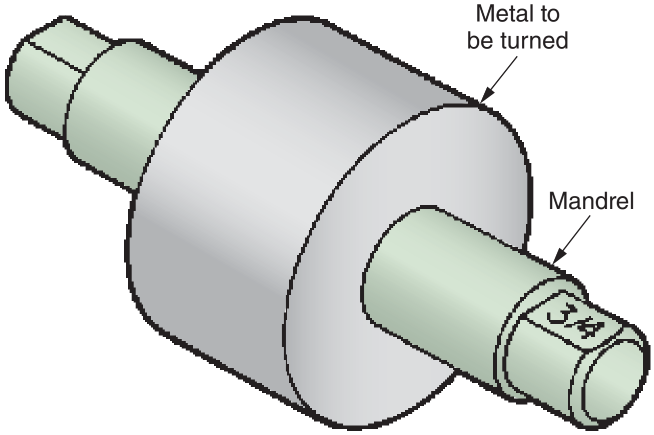

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Figure 15-28. Work mounted on a lathe mandrel.

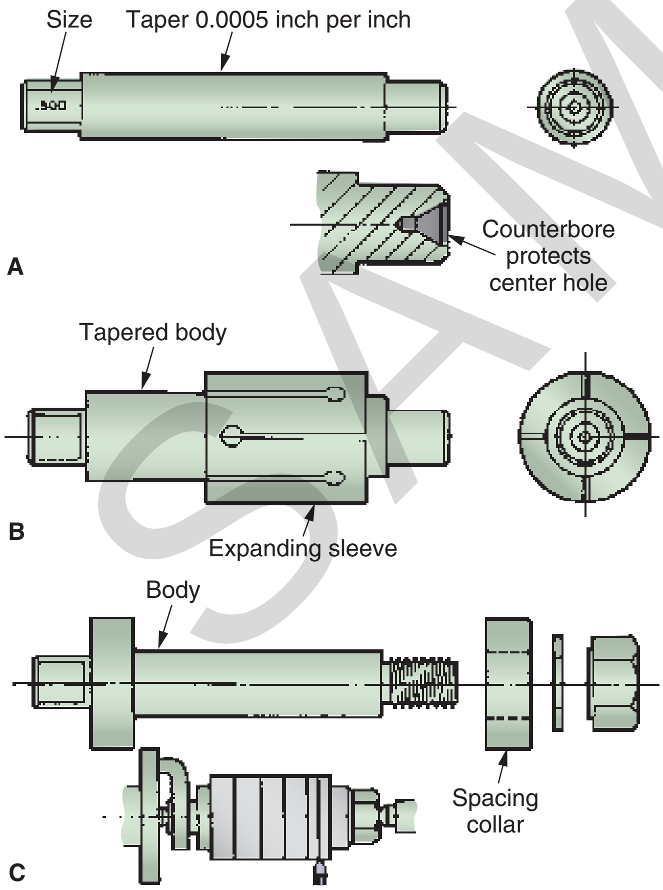

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Figure 15-29. Different kinds of mandrels. A—Solid mandrel. B—Expansion mandrel. C—Gang mandrel.

Work is pressed on a mandrel with a mechanical arbor press. The work must first be checked for burrs and cleaned. Lubricate the work with a light oil to prevent it from "freezing" on the mandrel.

The mandrel is mounted between centers and driven by a lathe dog. Use care so the tool does not come into contact with the mandrel during the machining operation. In an emergency, a mandrel can be machined from a section of mild steel.

15.8 Grinding on the Lathe

The tool post grinder permits the lathe to be used for internal and external grinding, **Figure 15-30**. With a few simple attachments, it is possible to sharpen reamers and milling cutters on the lathe. You can also grind shafts and true lathe centers.

Since steel parts sometimes warp during heat treatment, it is common to machine the piece to within 0.010″ to 0.015″ (0.2 mm to 0.3 mm) of finished size. After heat treatment, the metal is mounted on the lathe and ground to finished size. A light grinding cut is made on each pass. When done properly, grinding produces a very smooth finish.

15.8.1 Preparing a Lathe for Grinding

Particles of the grinding wheel wear away during the grinding operation. Abrasive particles can cause excessive wear if they get into moving parts, so it is important to protect the lathe from them. When preparing to grind, cover the lathe bed, cross-slide, and other parts with canvas or heavy kraft paper to protect them from abrasive dust and grit. It is also good practice to place a small tray of water or oil just below the grinding wheel to collect as much grit and dust as possible.

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Figure 15-30. A tool post grinder used for internal grinding on a lathe.

SAFETY NOTE

When placing the protective covering on the lathe, be sure the covering material cannot become entangled in the lead screw or other moving parts.

15.8.2 Preparing the Grinder

Select the grinding wheel best suited for the job. It must be balanced and run true in order to obtain a smooth, accurately sized job.

Use a diamond wheel dresser, consisting of an industrial diamond tip mounted on a steel shank, for the truing operation, **Figure 15-31**. Mount it solidly to the lathe, on center or slightly below the center of the grinding wheel. Move the rotating wheel back and forth across the diamond, removing about 0.001″ (0.02 mm) on each pass. Remove only enough material to true the wheel.

15.8.3 External Grinding

External grinding, **Figure 15-32**, is done to finish the exterior surface of the piece. The following steps are recommended to complete the job with the least amount of difficulty:

1. Mount the work solidly in the lathe. Provide adequate clearance.
2. Adjust lathe spindle speed to 80–100 rpm, and set a feed of 0.005″–0.007″ (0.12 mm–0.17 mm).
3. Turn on power for lathe and grinder. The work turns into the grinding wheel, **Figure 15-33**.
4. Feed the grinding wheel into the work until it just begins to "spark."
5. Engage the automatic longitudinal feed.
6. Check work diameter frequently with a micrometer. Use light cuts to avoid overheating and warping the workpiece.
7. Dress the grinding wheel again before making the final pass over the work. Allow the work to "spark out" (reach the point where the grinding wheel no longer cuts).

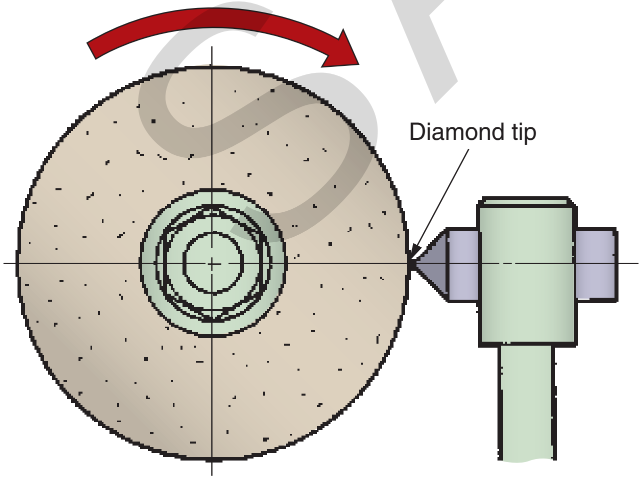

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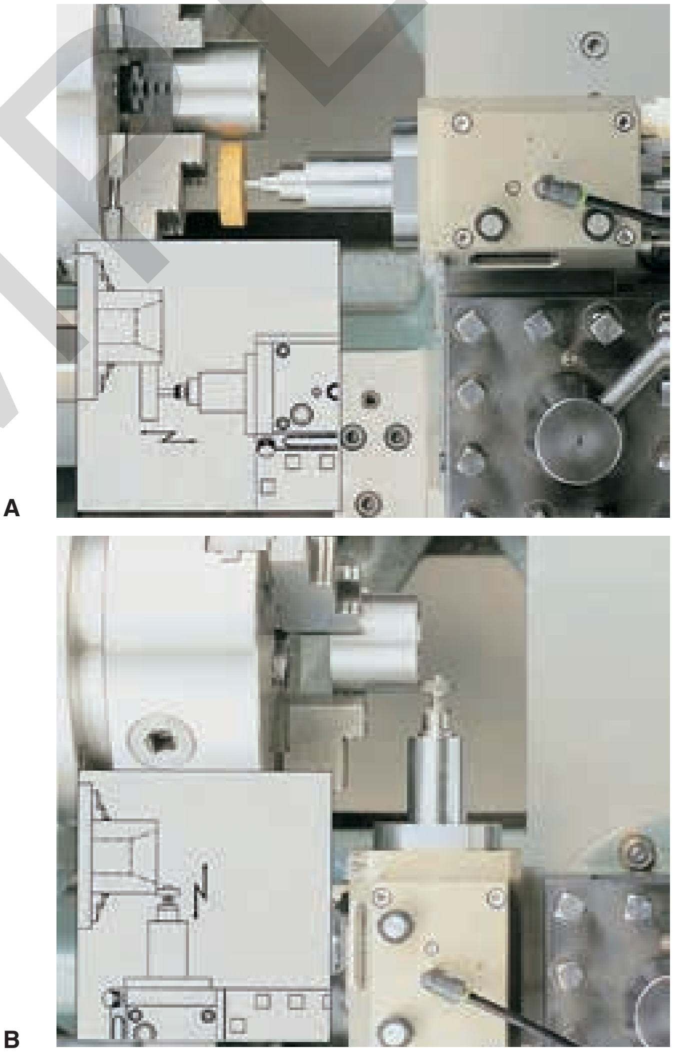
Figure 15-31. Using a diamond wheel dresser to true the wheel on a tool post grinder before grinding on a lathe.

15.8.4 Internal Grinding

Internal grinding is done in much the same manner as external grinding but on the inside of the work, **Figure 15-34**. The work and grinding wheel must rotate in opposite directions, **Figure 15-35**. Because the quill (shaft for mounting the grinding wheel for internal work) is slender, use very light cuts and slow feeds to prevent the hole from "bell-mouthing," as shown in **Figure 15-36**. For the same reason, it is suggested that the grinding wheel be allowed to "spark out" on the last cut.



NSK America

Figure 15-32. External grinding on a lathe. A—Grinding the circumference of a workpiece. B—Grinding the end of a workpiece.

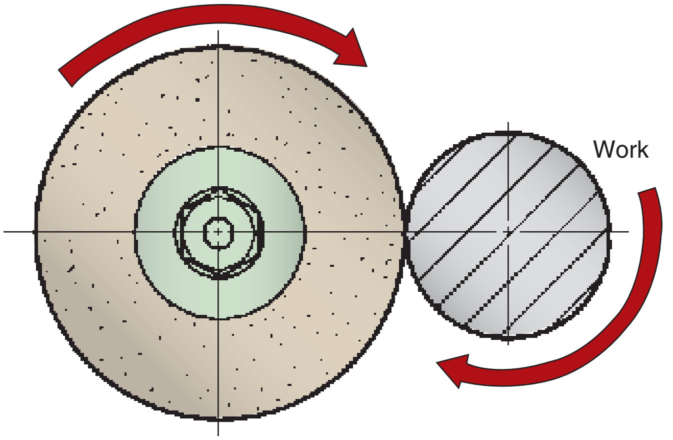


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Figure 15-33. For external grinding, the work turns into the grinding wheel.

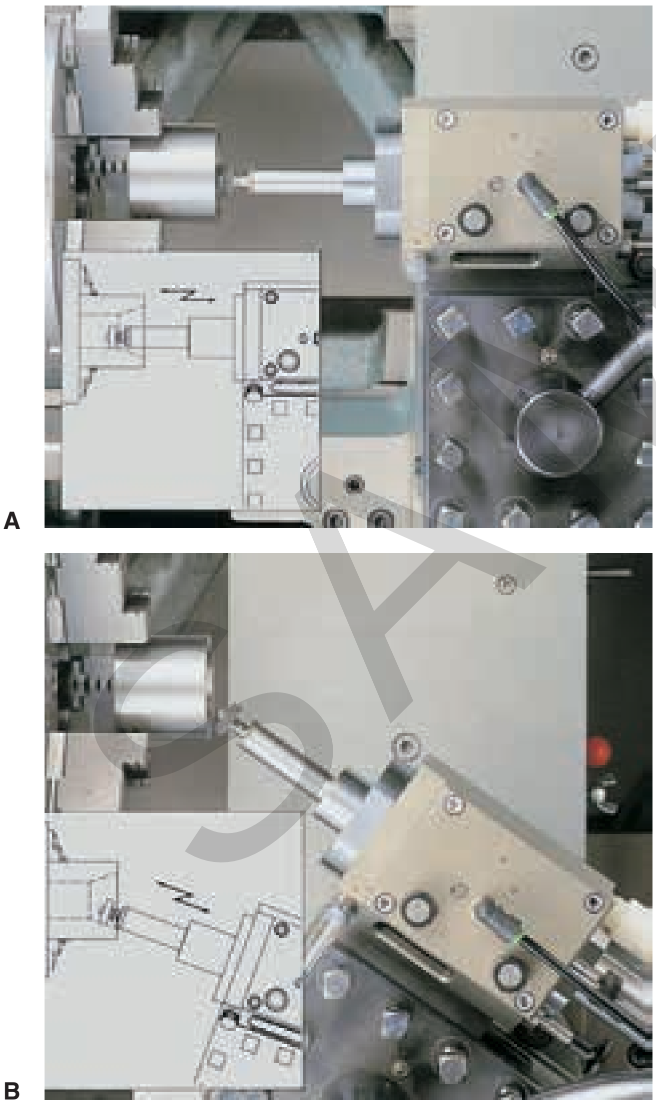

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Figure 15-34. Internal grinding operations on the lathe. A—Internal grinding. B—Taper grinding.

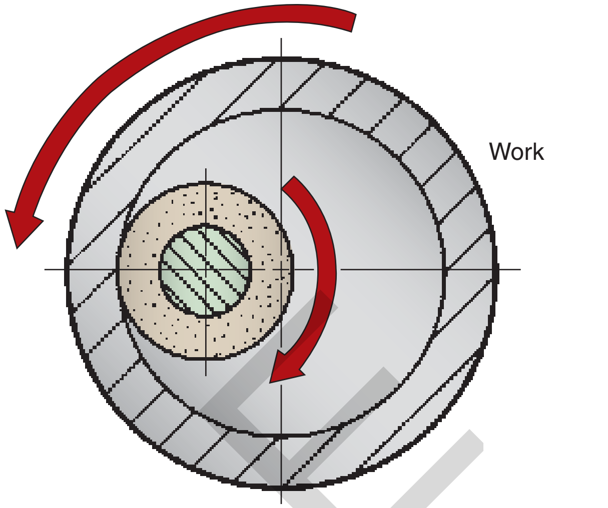

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Figure 15-35. For internal grinding, the work and grinding wheel turn in opposite directions.

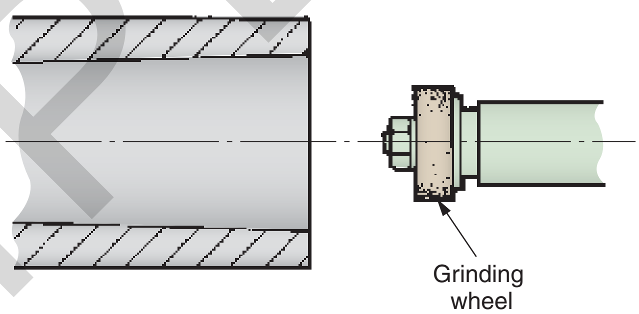

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Figure 15-36. Bell-mouthing (grinding a hole larger at its mouth) is caused by taking too deep a cut with the grinder or by grinding with a feed that is too rapid.

SAFETY NOTE

When cleaning the lathe after grinding, use a brush to sweep particles off the lathe. Never use your hand or compressed air. Using compressed air can force particles into the joints of the machine and cause premature wear.

15.9 Other Lathe Attachments

Other attachments for the lathe further extend its capabilities. Among these are milling attachments and duplicating or tracing units.

15.9.1 Milling on a Lathe

Some lathes can be fitted with a vertical milling attachment, **Figure 15-37**. Such machines are designed primarily

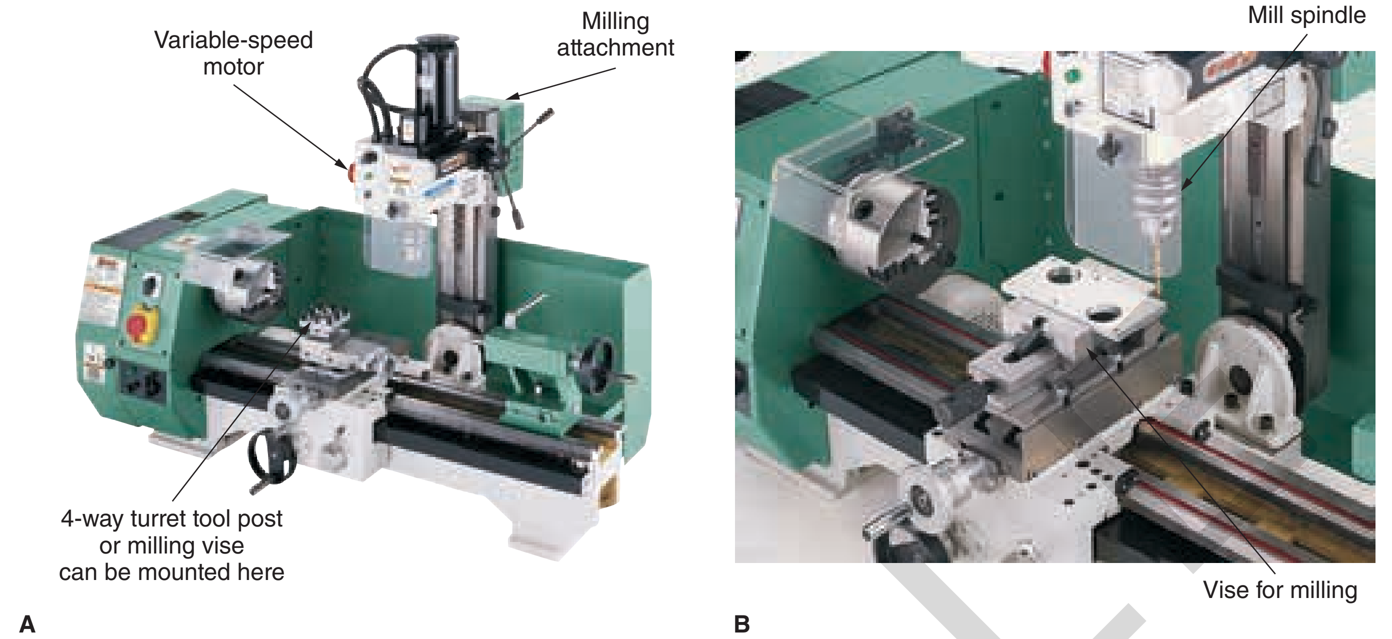

Photo courtesy of Grizzly Industrial, Inc. www.grizzly.com

Figure 15-37. Milling attachments on a lathe. A—A lathe with a milling attachment mounted on the back of the bed. B—Workholding devices are fitted on the cross-slide.

for home workshops, but they are often used in model and experimental shops as well. A vise is mounted to the cross-slide, which also provides traverse (in-and-out) movement. Longitudinal (back-and-forth) feed is furnished by the carriage.

A horizontal milling attachment is available for some lathes that permits limited milling operations to be performed. The cutter is mounted on an arbor or fitted into the headstock. Cutter depth is controlled by the adjusting screw on the device. Cutter movement is controlled by carriage and cross-slide movements.

15.9.2 Duplicating and Tracing

A tracing or duplicating unit can be used when several identical pieces must be produced. Several types are available. One type uses flat templates. Another type uses a three-dimensional template or pattern. Most units are hydraulically operated.

The duplicating unit improves quality because each part is an exact duplicate of the master template. However, computer-controlled lathes now do the work formerly done by these units.

15.10 Industrial Applications of the Lathe

Industry makes wide use of variations of the basic lathe. Conventional metalworking lathes are manufactured in a large range of sizes from the tiny jeweler's lathe to large machines that turn forming rolls for the steel industry.

Heavy-duty engine lathes are used to machine very large workpieces, **Figure 15-38**. A highly accurate toolroom lathe is required to meet the close tolerances and fine surface finish specifications of toolrooms, model shops, and research and development laboratories. See **Figure 15-39**.

Limited production runs (usually less than 250 pieces) are sometimes produced on a manually operated ***turret lathe***. This is a conventional lathe equipped with a four- to six-sided toolholder called a *turret*. **Figure 15-40** illustrates a number of different cutting tools fitted to the turret. Stops control the length of tool travel and rotate the turret to bring the next cutting tool into position automatically.

ID1974/Shutterstock.com

Figure 15-38. A heavy-duty engine lathe on display at a military technologies exposition.

Hardinge Super Precision HLV-DR is a registered trademark of Hardinge, Inc.

Figure 15-39. The Hardinge Super Precision HLV-DR toolroom lathe.

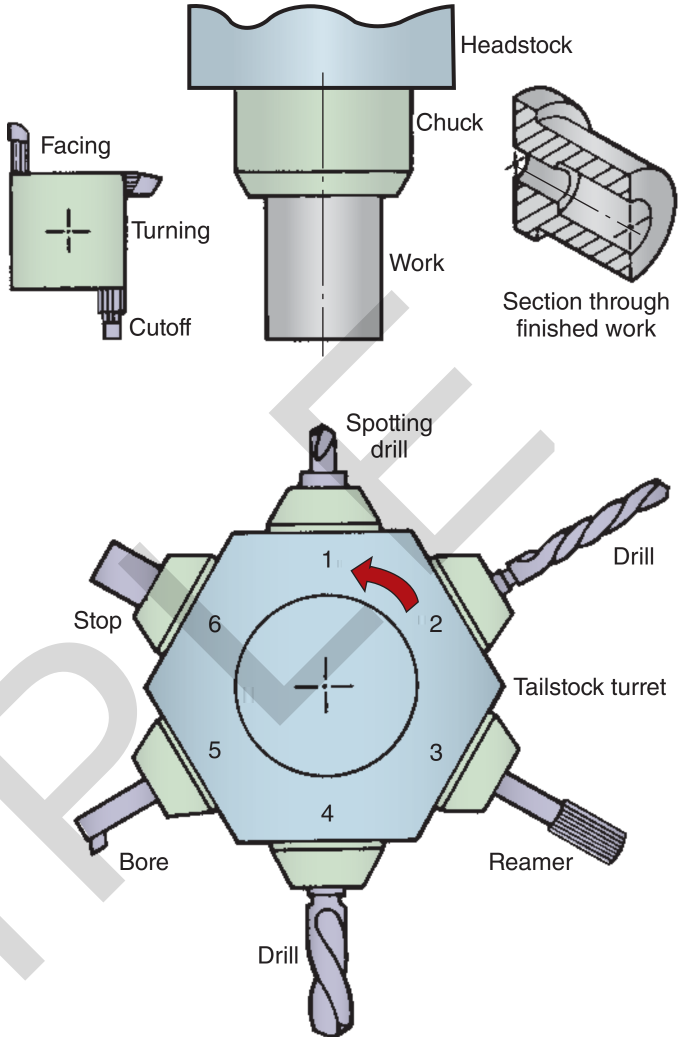

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Figure 15-40. The turret in relation to other parts of a lathe. The turret rotates to bring each cutting tool into position. Stops control the depth of tool cuts.

A cross-slide unit is fitted for turning, facing, forming, and cutoff operations, **Figure 15-41**.

The ***automatic screw machine*** is a variation of the lathe that was developed for high-speed production of large numbers of small parts. The machine performs a large number of operations either simultaneously or in a very rapid sequence.

Increasingly, industry is relying on automatic turning centers to produce tiny precision parts in quantity. These centers, referred to as "Swiss-type" machines because they were originally used in the Swiss watchmaking industry, use computer control to perform a number of operations in sequence, producing a finished part. See **Figure 15-42**.

WORKPLACE SKILLS

Creativity and Brainstorming

The ability to "think outside the box" to come up with workable design solutions is an important skill for machinists, machine designers, and most other professionals involved in machining. Creativity is therefore an important employability skill.

Some people are creative by nature. Even if you are not one of these people, you can learn to be more creative. One method is to practice *brainstorming*. Choose an issue that interests you—machining related or not—and write down as many solutions as you can think of. Do not worry at first about whether your solutions are probable or even possible. There are no right or wrong answers when brainstorming. Just list everything that comes into your head. Give yourself about 10 or 15 minutes to create the list. Then go back over your list and evaluate all of your ideas. By practicing brainstorming, you will become a more creative thinker.

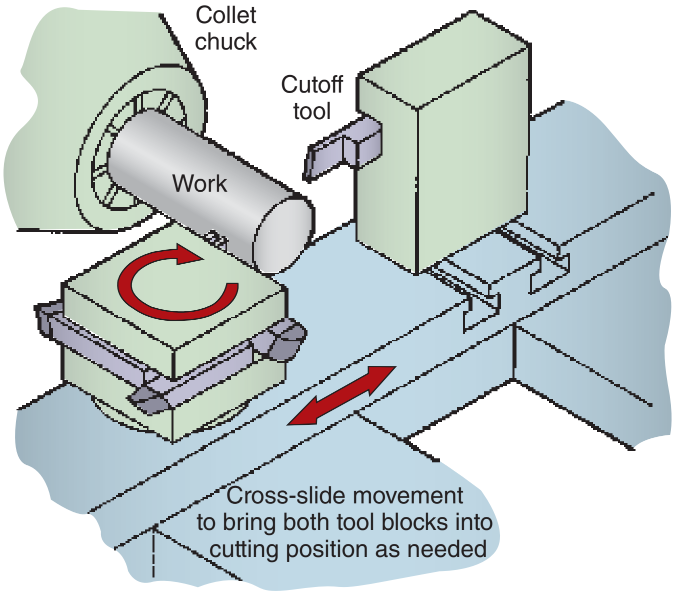

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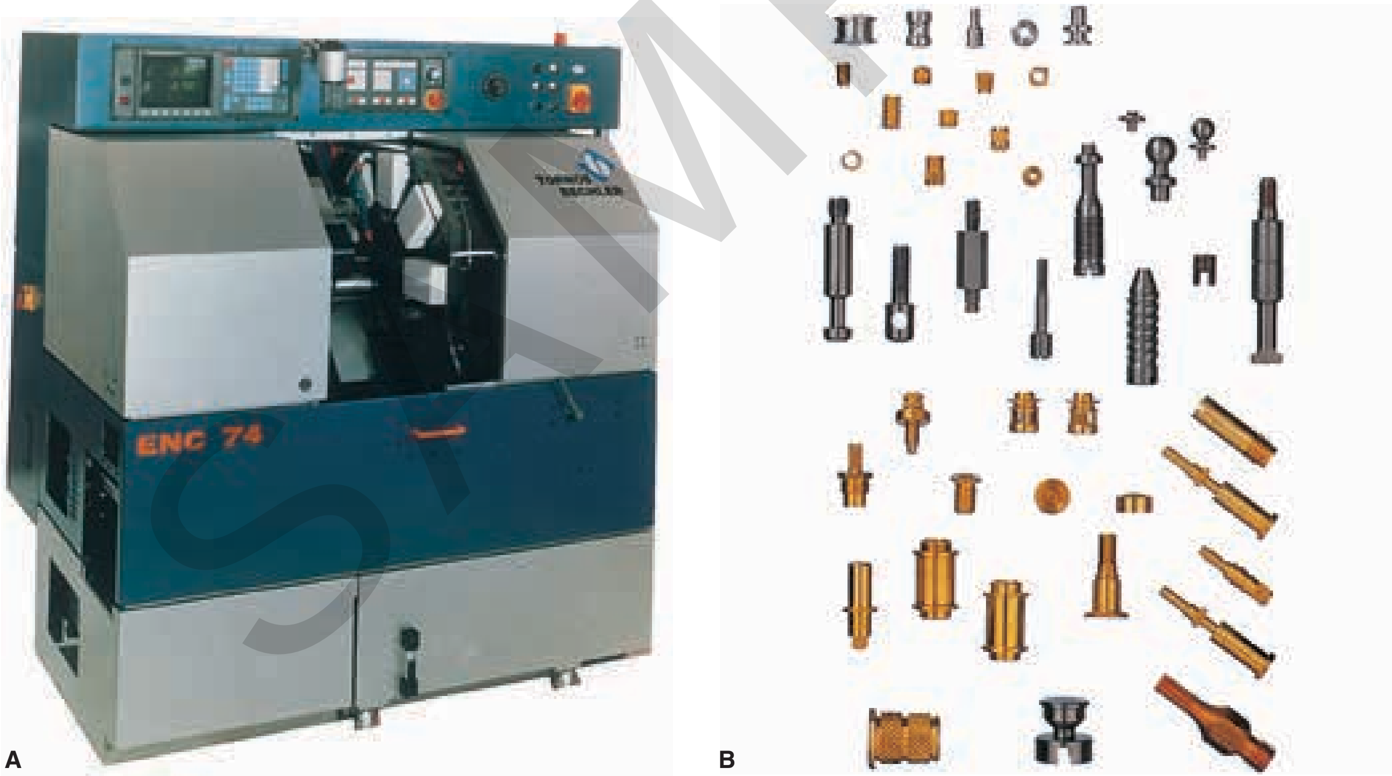
Figure 15-41. The cross-slide on a turret lathe is similar to the cross-slide on a conventional lathe. However, it is fitted with several cutting tools that can be brought into position as needed.

Work that is too large or too heavy to be turned in a horizontal position is machined on a vertical lathe, **Figure 15-43**. These huge machines, also known as ***boring mills***, are capable of turning and boring work with diameters up to 40′ (12 m).

Portable turning equipment is available for work in the field. For example, portable equipment is often used to chamfer the ends of large pipe prior to welding. See **Figure 15-44**.

Computer numerically controlled (CNC) lathes and turning machines are widely used for industrial production. See **Figure 15-45**. With proper programming, these machine tools are capable of producing complex work with great accuracy and repeatability. A more detailed description of CNC machine tools and automated manufacturing operations is provided later in this book.



Tornos-Bechler S.A.

Figure 15-42. Swiss-type automatic turning center. A—This high-precision turning center machines small parts from bar stock ranging from 1 mm to 10 mm in diameter at high production rates. B—These tiny components, produced by a Swiss-type automatic turning center, are used in precision instruments.

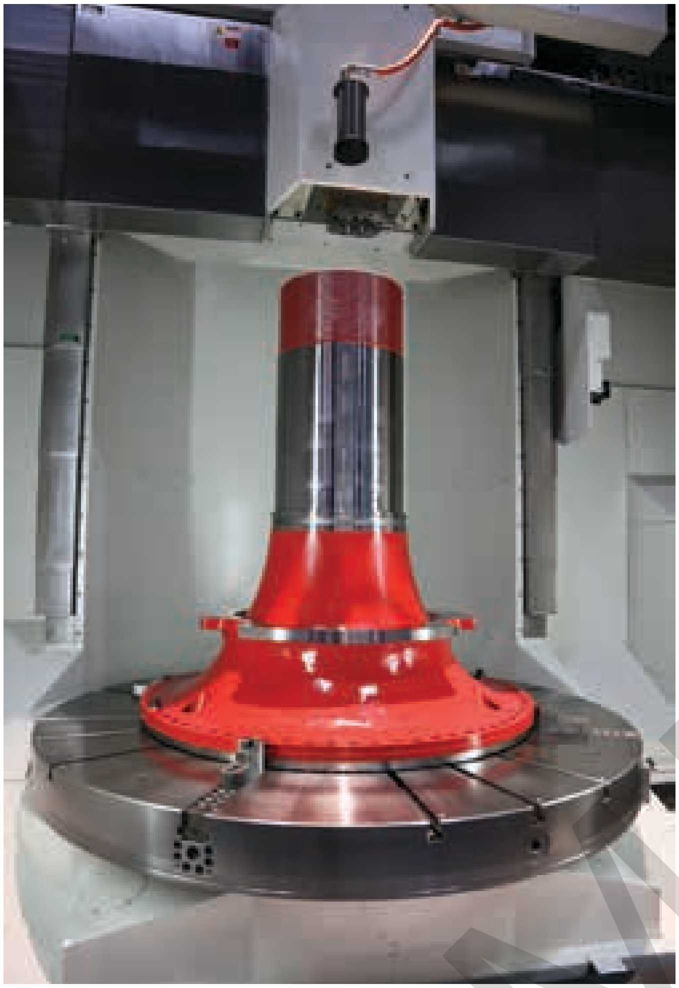


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Figure 15-43. A large boring mill. Workpieces are mounted on the large turntable and rotated into position for machining.

Tri-Tool, Inc.

Figure 15-44. A portable lathe that can be taken into the field. This worker is shown turning the end of a high-pressure gas pipeline to prepare it for being welded.

Clausing Industrial, Inc.

Figure 15-45. A large industrial CNC lathe that can remove a large amount of stock quickly.

Chapter Review

Summary

- Boring is a machining operation performed on a lathe to enlarge a hole.
- Drilling can be accomplished on a lathe by feeding a stationary drill into the revolving workpiece.
- Reaming is used to make a hole accurate in diameter and finish.
- Knurling forms horizontal or diamond-shaped serrations on the circumference of the work.
- Filing and polishing can be performed on a lathe to remove burrs, round off sharp edges, and blend in form-cut lines.
- Steady rests and follower rests are work-holding devices that offer additional support to securely hold long, thin work during lathe operations.
- Mandrels allow an outside diameter to be machined concentric with an inside diameter; some mandrels also allow multiple workpieces to be machined at once.
- A tool post grinder allows the lathe to be used for both internal and external grinding.
- Vertical milling attachments and tracing or duplicating units are also available to extend the capability of the lathe.
- Industrial applications of the lathe make use of several lathe attachments and variations of the basic lathe machine.

Review Questions

Answer the following questions using the information provided in this chapter.

Know and Understand

1. Boring is a(n) _____.
   A. drilling operation
   B. internal machining operation in which a single-point cutting tool is used to enlarge a hole
   C. external machining operation in which a single-point cutting tool is used to reduce the diameter of a hole
   D. None of the above.
2. Drills that are used on the lathe are fitted with _____ shanks.
   A. straight
   B. taper
   C. fluted
   D. Both A and B.
3. The process of forming horizontal or diamond-shaped serrations on the circumference of the work is called _____.
   A. checking
   B. rolling
   C. knurling
   D. forming
4. Knurling is commonly done to _____.
   A. provide a gripping surface
   B. change the appearance of the work
   C. increase the work's diameter
   D. All of the above.
5. What should be done to protect the lathe from the abrasive dust and grit created during grinding operations?
   A. Use a nonabrasive grinding wheel.
   B. Cover the bed and moving parts with a heavy cloth.
   C. Use a soft abrasive grinding wheel.
   D. None of the above.
6. *True or False?* Reaming is an operation used to make a hole accurate in diameter and finish.
7. Polishing can be performed on the lathe using a(n) _____.
   A. fine-toothed file
   B. pad with polishing compound
   C. abrasive cloth
   D. whetstone
8. When a shaft is unsuitable as a bearing surface and cannot be used with a steady rest, a _____ can be used so the shaft can be supported with the steady rest.
   A. center rest
   B. chuck
   C. cat head
   D. file
9. Internal and external grinding can be done on a lathe with a(n) _____.
   A. boring bar
   B. twist drill
   C. knurling tool
   D. tool post grinder
10. *True or False?* Automatic turning centers, also known as automatic screw machines, can produce tiny precision parts in quantity.

11. Work that is too large or too heavy to be turned in the horizontal position is turned on huge machines called _____.
    A. vertical lathes
    B. boring mills
    C. gun mills
    D. A and B only.
12. *True or False?* A follower rest is sometimes called a center rest.

Apply and Analyze

1. What is a mandrel and when is it used?
2. Name two types of tracing or duplicating units available for the lathe.
3. What is the difference between a steady rest and a follower rest?
4. For what three purposes is filing usually done on the lathe?
5. Why should right-hand filing be avoided?

Critical Thinking

1. Explain why automatic screw machines are sometimes referred to as turret lathes.
2. Suppose a fellow manual machinist is experiencing chatter while boring holes with long, slender boring bars. What are four things you could suggest be tried to eliminate the chatter?