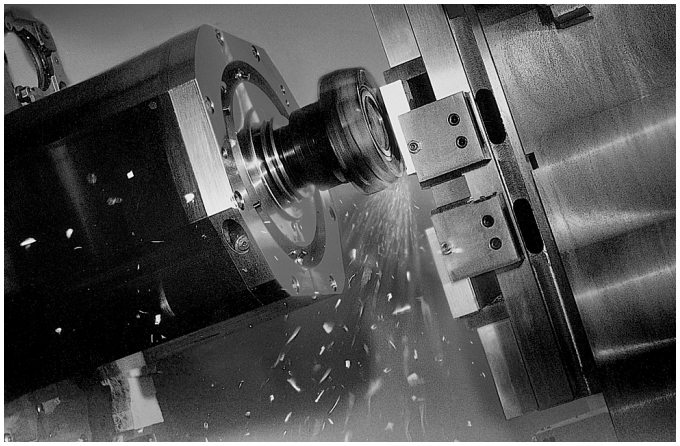


Chapter 10

Drills and Drilling Machines

LEARNING OBJECTIVES

After studying this chapter, students will be able to:

- Select and safely use the correct drills and drilling machine for a given job.
- Make safe setups on a drill press.
- Explain the safety rules that pertain to drilling operations.
- List various drill series.
- Sharpen a twist drill.

INSTRUCTIONAL MATERIALS

Text: pages 153–182
Test Your Knowledge Questions, page 182
Workbook: pages 55–60
Instructor's Resource: pages 139–152
Guide for Lesson Planning
Research and Development Ideas
Reproducible Masters:
10-1 How a Drill Cuts
10-2 Parts of a Twist Drill
10-3 Clamping Work for Drilling
10-4 Sharpening a Drill
10-5 Centering Round Stock
10-6 Counterbored Hole
10-7 Spotfaced Hole
10-8 Test Your Knowledge Questions
Color Transparency (Binder/CD only)

GUIDE FOR LESSON PLANNING

This chapter introduces various types of drills and drilling machines and explains basic drilling practices. An assortment of drilling equipment (drills, drill gage, center finder, center drill, sleeve, socket, drift, vises, parallels), should be available for student examination.

Have students/trainees read and study the chapter. Review the assignment and discuss and demonstrate the following:

- Definition of a machine tool.
- Types of drilling machines.
- Variety of drill press machining operations.
- How drill press size is determined.
- How a twist drill cuts.
- Why tool is called a twist drill.
- Types of drills and drill sizes.
- Ways to determine drill size.
- Parts of a drill.
- How drills can be mounted in a drill press.
- Work-holding devices and setups.
- Cutting speeds and feeds and their importance.
- Using a center finder to position drill.
- Proper sequence for drilling a hole.
- Cutting fluids and when they should or should not be used.

- Reason for pilot hole and determining its size.
- Holding and centering round stock for drilling.
- Reamers and reaming.
- Countersinking, counterboring, and spotfacing.
- Safety procedures to be observed when using drilling machines.

Emphasize drilling safety, especially the importance of mounting work solidly to the work table to prevent the dangerous "merry-go-round."

Before demonstrating drill press operations, be sure the tools and equipment are in safe operating condition with all guards and safety devices in place. Students must wear approved eye protection while observing the demonstrations.

Briefly review the demonstrations and encourage students to ask questions.

Technical Terms

Review the terms introduced in the chapter. New terms can be assigned as a quiz, homework, or extra credit. The following terms are also listed at the beginning of the chapter.

blind hole
center finder
countersinking
drill point gage
flutes
lip clearance
machine reamer
multiple spindle drilling machines
spotfacing
twist drills

Review Questions

Assign *Test Your Knowledge* questions. Copy and distribute Reproducible Master 10-8 or have students use the questions on page 182 and write their answers on a separate sheet of paper.

Workbook Assignment

Assign Chapter 10 of the ***Machining Fundamentals Workbook.***

Research and Development

Discuss the following topics in class or have students complete projects on their own.

1. Drills are expensive. Each semester, keep a record of drills broken in the shop and the cause of breakage. Make recommendations for reducing drill breakage and damage.
2. Make a series of safety posters on the use of a drill press.
3. Prepare a research paper on early drilling devices. Include sketches. You may want to reproduce this report or make a series of transparencies for the overhead projector.
4. Develop a research project investigating the effects of cutting fluids and compounds on drilling (quality of finished hole, etc.). Include samples of holes drilled in the same material with and without coolant/cutting fluid.
5. Prepare a teaching aid that will show examples of a drilled hole, reamed hole, countersinking, spotfacing, and counterboring.
6. Borrow drill jigs from a local industry. Explain how they are used.
7. Demonstrate one of the following:
   - Centering round stock in a V-block.
   - The proper way to use a wiggler.
   - Sharpening a twist drill.
   - Several methods of safely clamping work on a drill press table.

TEST YOUR KNOWLEDGE ANSWERS, Page 182

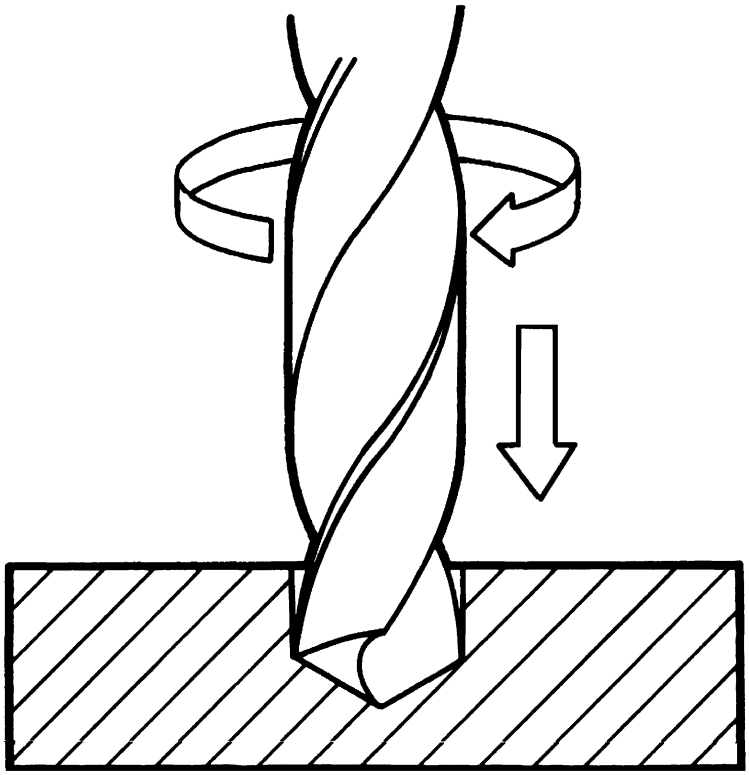
1. c. Rotating against material with sufficient pressure to cause penetration.
2. It is determined by the largest diameter of a circular piece that can be drilled on center.
3. c. Both of the above.
4. Fractional, Number, Letter, and Metric.
5. By micrometer and drill gage.
6. Straight shank and taper shank.
7. Straight
8. Taper
9. flutes
10. d. All of the above.
11. Sleeve
12. socket
13. Drift
14. d. All of the above.
15. Lip clearance, length and angle of lips, and proper location of dead center.
16. One lip will cut and hole will be oversized and out-of-round.
17. drill point gage

18. 118
19. Compressed air
20. pilot or lead, dead center
21. A hole that does not go all of the way through the work.
22. The distance the full diameter goes into the work.
23. jobber's reamer (machine reamer)
24. solid
25. It should be removed before stopping the machine.
26. two-thirds
27. Countersinking
28. counterboring
29. Spotfacing

WORKBOOK ANSWERS, Pages 55–60

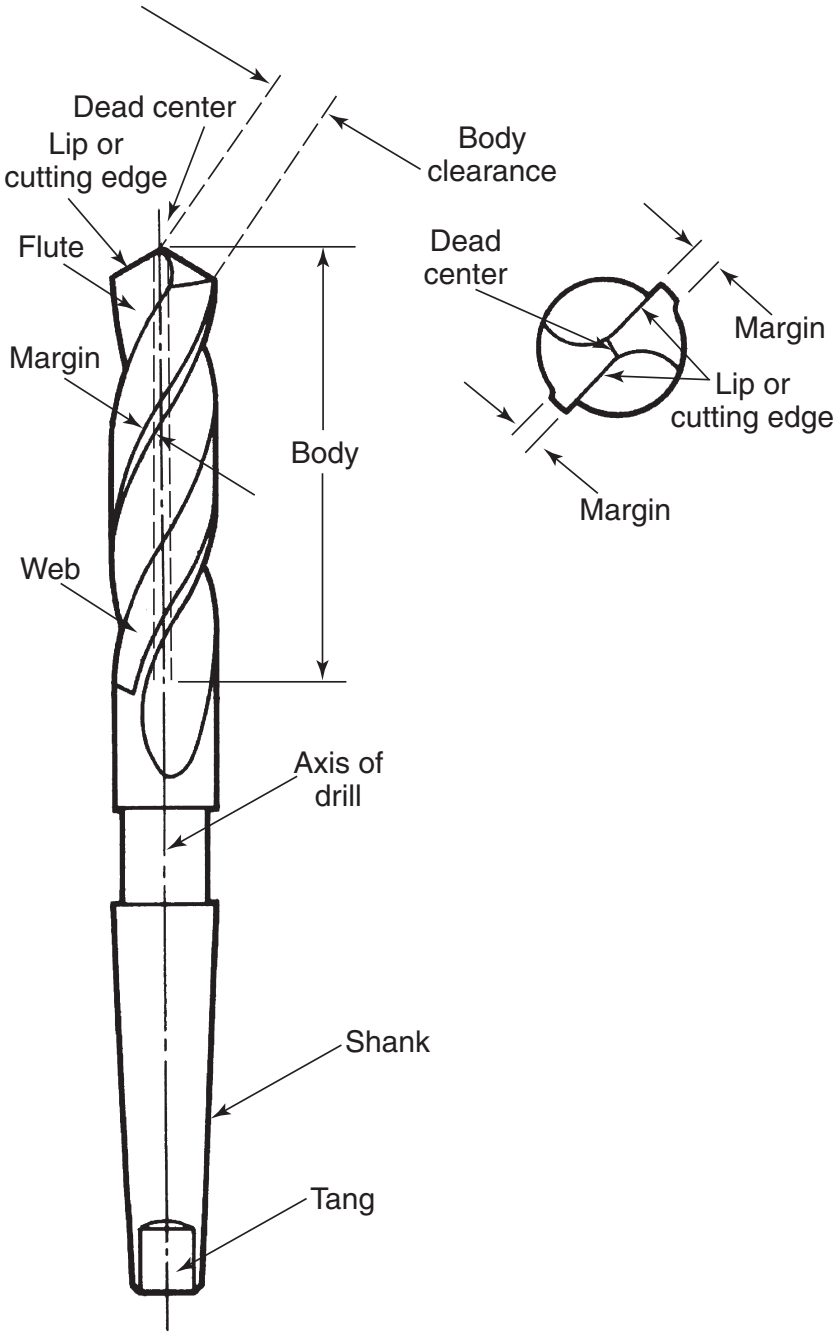
1. drill press
2. b. the largest diameter circular piece that can be drilled on center
3. c. Bench drill presses
4. a. Radial drill presses
5. d. All of the above.
6. d. All of the above.
7. high-speed (HSS), carbon
8. titanium nitride
9. b. oil-hole drill
10. e. None of the above.
11. drill margins
12. b. Dead center
13. a. provides a means of separating the taper from the holding device
14. d. All of the above.
15. d. Either a or b.
16. Parallels
17. angular
18. d. All of the above.
19. U-strap
20. A. Sleeve
    B. Socket
    C. Drift
21. enlarge smaller taper shank to fit drill press spindle
22. reduce taper shank so it will fit drill press spindle
23. separate taper shank from sleeve, socket, or drill from drill press spindle
24. Check with drill point gage.
25. a. distance that the drill cutting edge circumference travels per minute
26. does not cause
27. 2400 rpm
28. 4000 rpm
29. 480 rpm
30. 680 rpm
31. drilling a hole in soft metal and observing chip formation; When properly sharpened, chips will come out of the flutes in curled spirals of equal size and length.
32. d. All of the above.
33. V-blocks
34. To receive flat-headed fasteners.
35. The operation machines a flat circular area on a rough surface to provide a bearing surface for the head of a bolt, washer, or nut.
36. d. All of the above.
37. mounts on a special arbor that can be used with several reamer sizes
38. b. rose chucking
39. Evaluate individually.
40. Evaluate individually.

How a Drill Cuts



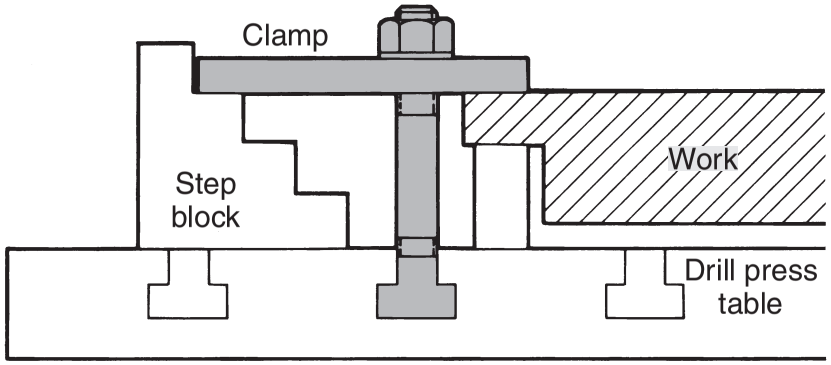
Drilling is the operation most often performed on a drill press. Both rotating force and a downward pushing force are needed for drilling.

Parts of a Twist Drill

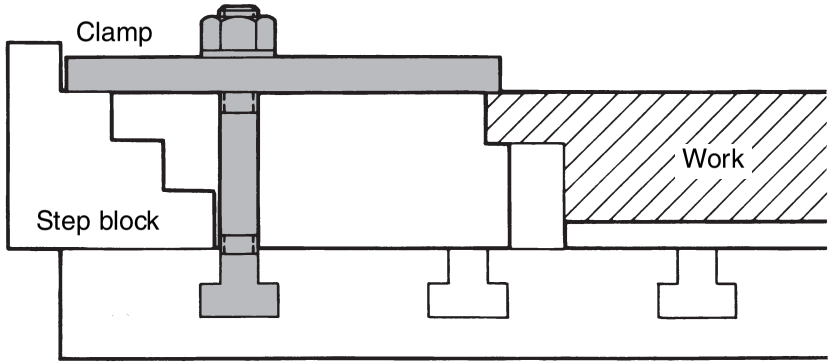


Clamping Work for Drilling

Correct clamping technique. Note that clamp is parallel to work. Clamp slippage can be reduced by placing a piece of paper between the work and the clamp.

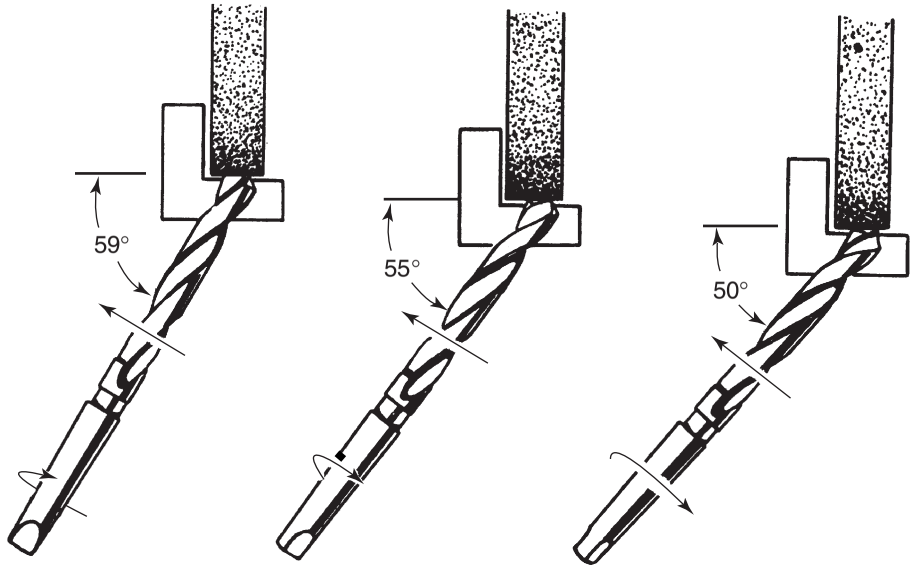


Incorrect clamping technique. T-bolt is too far from work. This allows the clamp to spring under pressure.



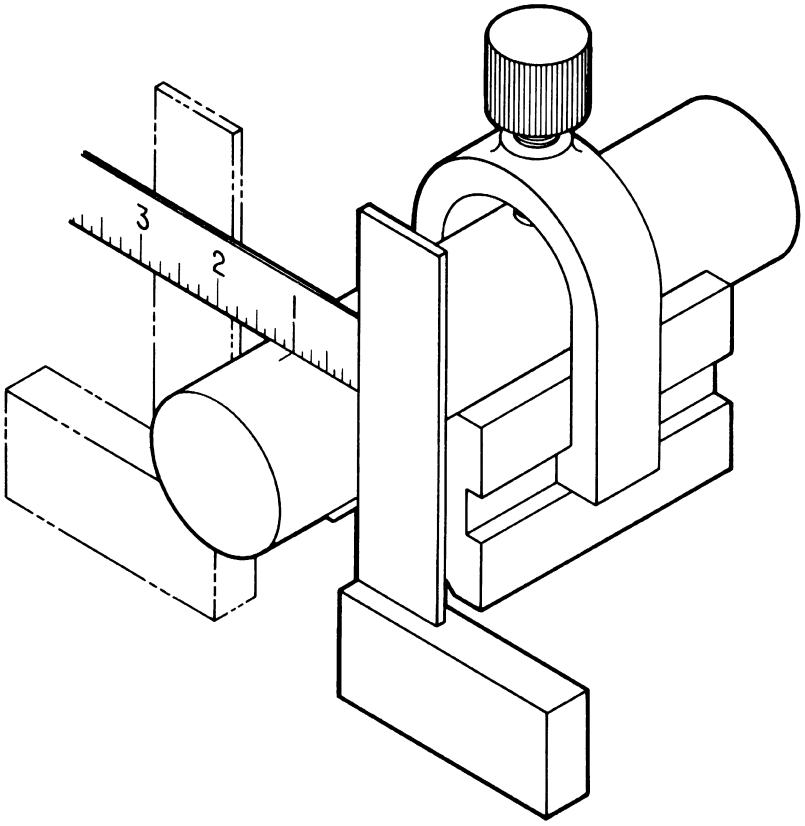
Sharpening a Drill

Hold the point lightly against the rotating wheel and use three motions of the shank: to the left, clockwise rotation, and downward.



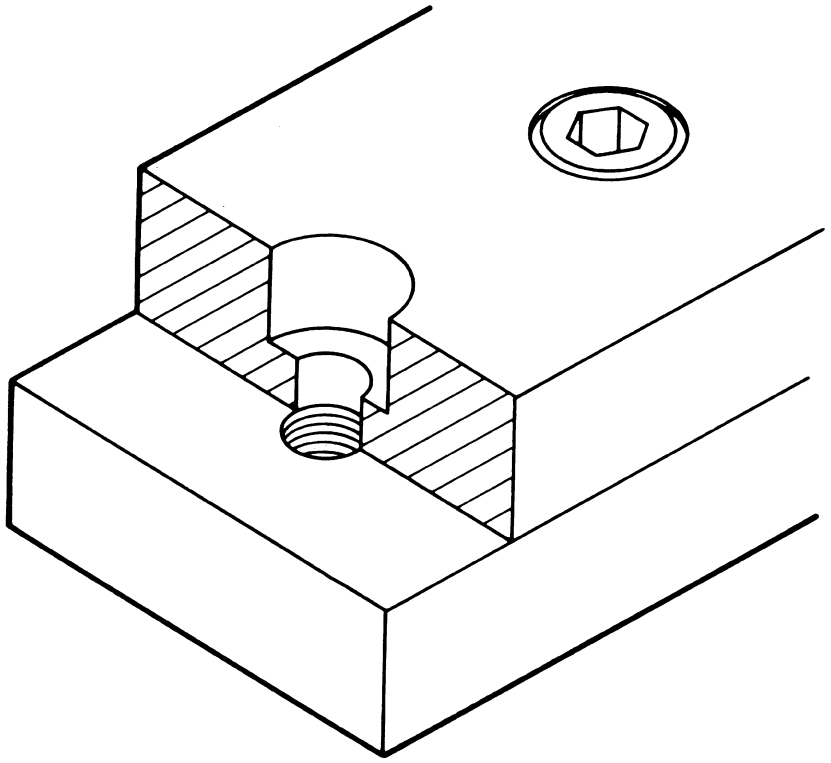
Left Clockwise Downward

Centering Round Stock



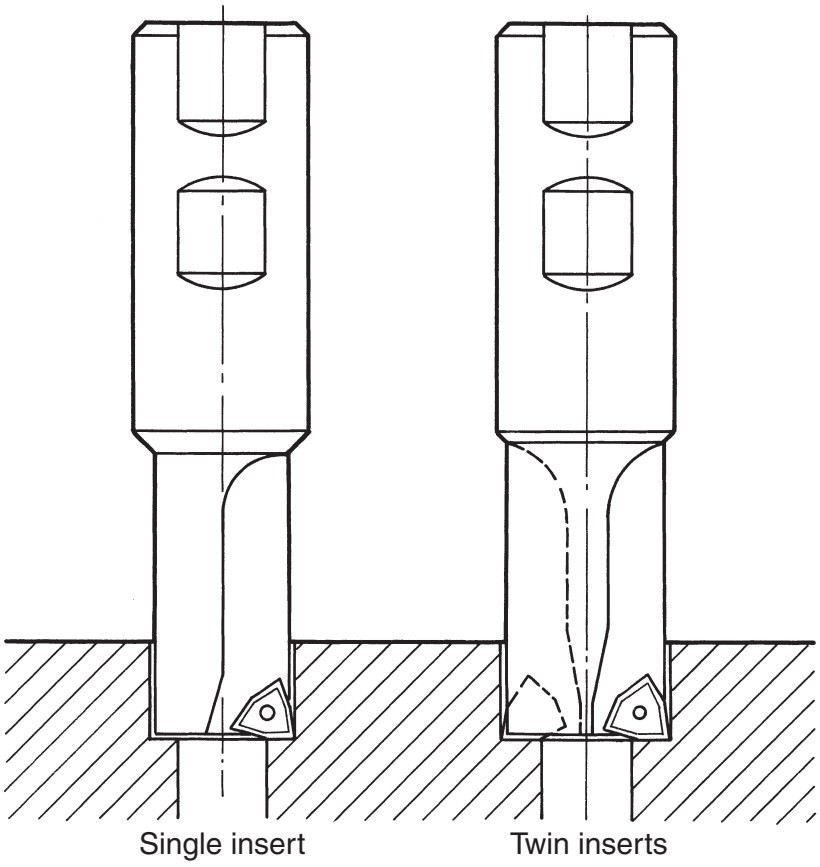
To align the hole for drilling through exact center, place the work and V-block on the drill press table or on a surface plate. Rotate the punch mark until it is upright. Place a steel square on the flat surface with the blade against the round stock as shown above. Measure from the square blade to the punch mark, and rotate the stock until the measurement is the same when taken from both sides of the stock.

Counterbored Hole



A sectional view of a hole that has been drilled and counterbored to receive a socket-head screw.

Spotfaced Hole



Counterbores with carbide indexable inserts. The inserts are rotated when a cutting edge becomes dull.

Drills and Drilling Machines

Name: _____ Date: _____ Score: _____

1. A twist drill works by: 1. _____
   a. being forced into material.
   b. rotating against material and being pulled through by the spiral flutes.
   c. Rotating against material with sufficient pressure to cause penetration.
   d. All of the above.
   e. None of the above.
2. How is drill press size determined? _____
   _____
3. Drills are made from: 3. _____
   a. high-speed steel.
   b. carbon steel.
   c. Both of the above.
   d. Neither of the above.
4. Drill sizes are expressed by what four series? _____
   _____
5. What are two techniques used to determine a drill's size? _____
   _____
6. List the two types of drill shanks. _____
   _____
7. _____ shank drills are used with a chuck. 7. _____
8. _____ shank drills fit directly into the drill press spindle. 8. _____
9. The spiral grooves that run the length of the drill body are called _____. 9. _____
10. The spiral grooves in a drill body are used to: 10. _____
    a. help form the cutting edge of the drill point.
    b. curl chips for easier removal.
    c. form channels through which the chips can escape from the hole.
    d. All of the above.
    e. None of the above.
11. Name the device employed to enlarge a taper shank drill so it will fit the spindle opening. 11. _____
12. The device used to permit a drill with a taper shank too large to fit the spindle opening is called a _____. 12. _____
13. What is the name of the tool used to separate a taper shank drill from the above devices in question # 12? 13. _____

(continued)

Name: _____

14. Cutting fluids or compounds are used to: 14. _____
    a. cool the drill.
    b. improve the finish of a drilled hole.
    c. Aid in the removal of chips.
    d. All of the above.
    e. None of the above.
15. List the three factors that must be considered when repointing a drill. _____

    _____

16. What occurs when the cutting lips of a drill are not sharpened to the same lengths? _____

    _____

17. The _____ should be used frequently when sharpening to ensure a correctly sharpened drill. 17. _____
18. The included angle of a drill point sharpened for general drilling is _____ degrees. 18. _____
19. What coolant should be used when drilling cast iron? 19. _____
20. Large drills require a considerable amount of power and pressure to get started. They also have a tendency to drift off center. These conditions can be minimized by first drilling a _____ hole. This hole should be as large as, or slightly larger than, the width of the _____ of the drill point. 20. _____ _____
21. What is a blind hole? _____

    _____

22. How is the depth of a drilled hole measured? _____

    _____

23. The _____ is almost identical to the hand reamer except that the shank has been designed for machine use. 23. _____
24. A _____ expansion reamer provides rigidity and accuracy not possible with conventional expansion reamers. 24. _____
25. How should a reamer be removed from a finished hole? _____

    _____

26. The cutting speed for a high-speed reamer is approximately _____ that for a similar-sized drill. 26. _____
27. What is the name of the operation employed to cut a chamfer in a hole to receive a flat-head screw? 27. _____
28. The operation used to prepare a hole for a fillister or socket-head screw is called _____. 28. _____
29. _____ is the operation that machines a circular spot on a rough surface for the head of a bolt or nut. 29. _____