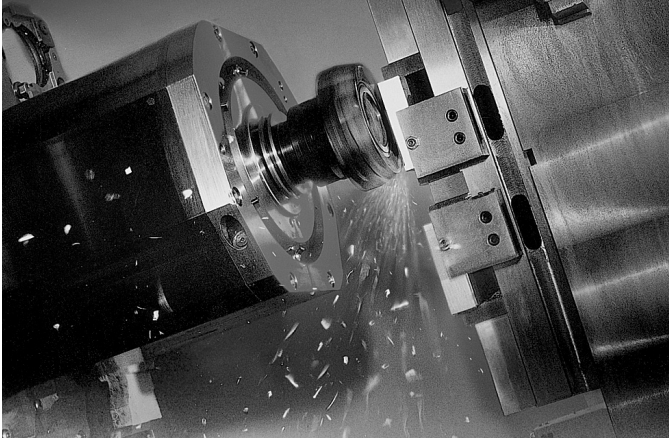


Chapter 6

Hand Tools



LEARNING OBJECTIVES

After studying this chapter, students will be able to:

- Identify the most commonly used machine shop hand tools.
- Select the proper hand tool for the job.
- Maintain hand tools properly.
- Explain how to use hand tools safely.

INSTRUCTIONAL MATERIALS

Text: pages 91–126

Test Your Knowledge Questions,
pages 123–125

Workbook: pages 33–38

Instructor's Resource: pages 101–120

Guide for Lesson Planning

Research and Development Ideas

Reproducible Masters:

- 6-1 Torque Measurement
 - 6-2 Mounting Work for Hand Sawing
 - 6-3 Starting a Hand Reamer
 - 6-4 Using a Hand Reamer
 - 6-5 Specifications for Thread Sizes
 - 6-6 Inch-Based and Metric-Based Threads
 - 6-7 Thread Nomenclature
 - 6-8 Starting a Die
 - 6-9 Cutting Threads to a Shoulder
 - 6-10 Test Your Knowledge Questions
- Color Transparencies (Binder/CD only)

GUIDE FOR LESSON PLANNING

This chapter serves to present the numerous hand tools that a machinist will use as well as their proper handling and care. Since this

chapter is extensive, it is recommended that it be divided into several parts. It can be taught as a series of short lessons in which students can become actively involved.

Student Presentations

Assign pairs of students or request volunteers to demonstrate and explain the proper care and use for the family of tools on which they are providing instructions. The following preparations should be made before each presentation:

- All tools in safe working condition.
- Additional tools in reserve.
- Demonstration clearly visible to all.
- All safety precautions taken.
- Have students read and study the assignment.

Students should furnish a written outline for the lesson they are to present. Aid them in preparing their topic for discussion and questions. In addition to becoming more involved in the class, students will gain experience in preparing and giving presentations.

An outline for hand threading, for example, would include the following:

I. Objectives

- A. After studying this topic, students should be able to:
1. Understand how threads are specified on drawings.
 2. Explain thread nomenclature.
 3. Select the proper tap(s) and tap wrench for each job.
 4. Determine the correct tap drill size for specified thread to be tapped.
 5. Adjust a die for different classes of fits.
 6. Use, clean, and store threading tools properly.
 7. Observe hand threading safety.

II. Instructional Aids

- A. Text pages 114–122
- B. Reproducible Masters:
- 3-3 How Threads are Depicted on Drawings
 - 6-5 Specifications for Thread Sizes
 - 6-6 Inch-Based and Metric-Based Threads
 - 6-7 Thread Nomenclature
 - 6-8 Starting a Die
 - 6-9 Cutting Threads to a Shoulder

A list of necessary equipment should also be prepared. For example, the list below includes equipment necessary to demonstrate hand threading.

- Examples of UNC, UNF, and metric threaded sections (bolts, nuts, threaded rods, etc.)
- Different tap sets
- Different size tap wrenches
- Material drilled for tapping
- A selection of dies
- Different size die holders
- Stock for threading with a die
- Cutting fluid

The demonstration area should be clearly visible to all students.

Have students read and study the material prior to the presentation, paying special attention to the illustrations. Allow students to use the Reproducible Masters as overhead transparencies or handouts, as they discuss and demonstrate their topic. The following list includes some areas that should be covered.

- How threads are depicted on drawings
- How UNC and UNF threads of the same size differ
- Thread nomenclature
- Why there are taper, plug, and bottom taps
- Tap drills and their importance
- Proper way to tap a hole
- Why cutting fluids are necessary
- Removing broken taps
- The proper way to cut threads with a die
- Advantages of using adjustable dies
- Precautions to be taken when hand threading
- How to clean and store hand threading tools
- Importance of washing hands thoroughly after hand threading

A review of the demonstrations will provide students the opportunity to ask questions.

Technical Terms

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

abrasive
American National Thread System
blind hole
classes of fits
foot-pounds
newton meters
number sizes
safe edges
torque
Unified System

Review Questions

Assign *Test Your Knowledge* questions. Copy and distribute Reproducible Master 6-10 or have students use the questions on pages 123–125 and write their answers on a separate sheet of paper.

Workbook Assignment

Assign Chapter 6 of the *Machining Fundamentals Workbook*.

Research and Development

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

1. Industry makes considerable use of the

- pneumatic chisel. Secure information on this tool for a bulletin board display and, if possible, borrow the tool for examination from a local industry.
2. Design a safety poster that shows the correct way to use a chisel.
 3. Secure samples of the various types of hack-saw blades used for hand sawing. Prepare them as a bulletin board display.
 4. Design and produce a series of safety posters on the file that illustrate the following unsafe practices:
 - Using a file as a pry.
 - File used without a handle.
 - File used as a hammer.
 5. Design a panel that shows the file in various stages of manufacturer. Secure samples.
 6. Inspect the files in your shop. Clean and repair or replace damaged file handles. Make a new file rack if the present rack is badly worn.
 7. Examine the screwdrivers in your shop. Repair or regrind the tools as needed.
 8. There are many other types of wrenches not covered in this unit. Prepare a paper featuring these wrenches. Include drawings. Reproduce the report for distribution to the class.
 9. Give a demonstration on the proper way to use a torque-limiting wrench.
 10. Contact various tool manufacturers for information on how wrenches are manufactured. Prepare a bulletin board display with the material.
 11. Repair and lubricate all adjustable wrenches in the shop.
 12. Make a safety poster illustrating the proper way to use a wrench.
 13. Prepare a sample block of metal that can be used to show the difference between a drilled hole and a reamed hole.
 14. Develop and construct displays that show:
 - Samples of various abrasive materials.
 - A flow chart showing how synthetic abrasives are manufactured. If possible, secure samples of the raw materials.
 - Metal samples in various stages of polishing. Spray them with lacquer or acrylic plastic to prevent rust.
 15. Set up an experiment to determine what abrasive materials are best for aluminum, brass, cast iron, and tool steel. The experiment should include the quantity of material removed within a specified period of time; surface finish of the completed piece; degree of clogging, if any, of the abrasive cloth; and the effect lubricating oil has on the surface finish. Abrasives of similar grade value must be used if tests are to be valid.
 16. Give a demonstration on the different methods for removing broken taps. Industry often uses a technique that erodes the tap electrically, permitting the parts to be removed easily. Secure information on this process for a bulletin board display.
 17. Prepare a study on the accuracy of hand reamers. Make sample holes and measure them to determine whether they are within acceptable limits. Does the application of cutting fluid affect the size of a reamed hole?
 18. Demonstrate the proper way to tap a blind hole.
 19. Demonstrate the correct way to run a thread down to a shoulder.

TEST YOUR KNOWLEDGE ANSWERS, Pages 123–125

1. Solid base and swivel base.
2. By the width of the jaws.
3. soft metal caps (copper, brass or aluminum)
4. Avoid letting the vise handle or work project into aisle beside bench.
5. C-clamp, parallel clamp
6. They can be opened wider at the hinge pin to grip larger size work.
7. Permits them to cut flush with the work surface.
8. Student answers will vary but may include any three of the following: *never* using as a substitute for a wrench; not trying to cut metal sizes that are too large, or work that has been heat-treated; not applying additional leverage to the handles; cleaning and oiling them; storing in a clean, dry place; not throwing them in a drawer or tool box with other tools; using pliers that are large enough for the job.
9. Pliers that can be adjusted to various size work and can clamp tightly on the work. They have a quick release.

10. They permit tightening a threaded fastener or part for maximum holding power without danger of fastener or part failing, or causing work to warp or spring out of shape.
11. Work equally well in either direction but for safety, they should be pulled.
12. Pipe wrench, monkey wrench, and regular adjustable wrench.
13. Any three of the following: the movable jaw should face the direction the fastener is to be rotated; the thumbscrew should be adjusted so the jaws fit the bolt head or nut snugly; an extension should not be used for additional leverage; should never hammer on the handle to loosen a stubborn fastener; the smallest wrench that will fit the fastener should be used.
14. pipe, damage
15. Socket wrenches are box-like and are made with a tool head-socket (opening) that fits many types of handles (either solid bar or ratchet type).
16. Pin, hook, and end spanner wrenches.
17. larger
18. Any five of the following: always pull on a wrench; never push; select a wrench that fits properly; never hammer on a wrench to loosen a stubborn fastener; rather than lengthening a wrench handle for additional leverage, use a larger wrench; clean any grease or oil off the handle and the floor in the work area before using a wrench; and never try to use a wrench on moving machinery.
19. Standard has a wedge-shaped tip. Phillips has an X-shaped tip.
20. e. Tip is similar to that of a Phillips head screwdriver.
21. a. Has a flattened wedge-shaped tip.
22. f. Has an insulated handle.
23. c. Has a square shank to permit additional force to be applied with a wrench.
24. g. Is short and is used when space is limited.
25. b. Moves the fastener on the power stroke, but not on the return stroke.
26. Student answers will vary but may include any three of the following: screwdrivers should not be used as a substitute for a chisel, hammered on, or used as a pry bar; should always wear safety goggles when grinding screwdriver tips; burred heads (on screws) should be replaced or the burrs removed with a file or abrasive cloth; the screwdriver should have an insulated handle and the power should always be turned off before working on electrical equipment; screwdrivers should not be carried in pockets.
27. By the weight of the head.
28. Used to strike heavy blows where steel faced hammers would damage or mar the work.
29. Student answers will vary but may include any three of the following: never strike two hammers together; do not use a hammer unless the head is on tightly and the handle is in good condition; do not "choke up" too far on the handle when striking a blow, or you may injure your knuckles; strike each blow squarely, or the hammer may glance off of the work and injure you or someone working nearby; place a hammer on the bench carefully so that it doesn't fall and cause a painful foot injury, or damage precision tools on the bench.
30. mushroomed, grinding
31. removing rivets
32. Flat, cape, round nose, and diamond point chisels.
33. different length blades
34. 40, 50
35. Vibration and chatter are eliminated. They cause blade to dull rapidly.
36. As a blade dulls the slot made by it becomes narrower. To continue in this slot will cause a new blade to bind and be ruined in a few strokes.
37. three or more, teeth will straddle work and be broken off
38. Mount it between two sections of wood.
39. Place soft wood blocks between the vise jaws and the work to prevent marring the exterior surface of the tubing and insert a snug-fitting wooden dowel into the tubing.
40. file card/brush, your hand
41. Single-cut, double-cut, rasp, and curved tooth.
42. Flat, pillar, square, 3-square, knife, half-round, crossing, round.
43. Student answers will vary but may include any three of the following: never use a file without a handle; files should be cleaned with a file card, not your hand; files should not be cleaned by slapping it on the bench, since it may shatter; files are very brittle and

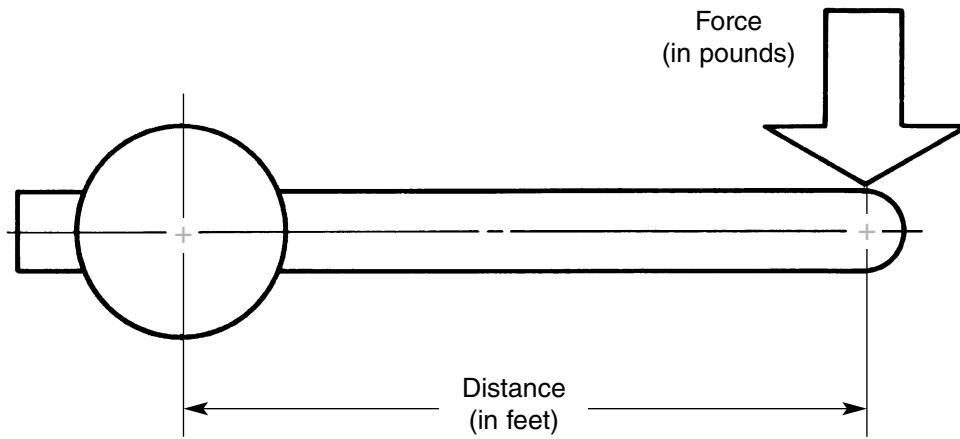
should never be used for prying tasks; a piece of cloth should be used to clean the surface being filed, not your bare hand; you should never hammer on or with a file because it could shatter.

44. When a hole must be finished accurately to size and with a very smooth surface finish.
45. 0.005" to 0.010" (0.15 mm to 0.25 mm)
46. tap, die
47. e. None of the above.
48. tap drill
49. UNC has fewer threads per inch for a given diameter than the UNF of the same diameter.
50. In order: taper, plug, and bottom.
51. Neither. It must be the same size as the desired threads.
52. tap wrench, die stock
53. An abrasive is any hard, sharp material that is used to cut or grind away another material.
54. Machined

WORKBOOK ANSWERS, Pages 39–46

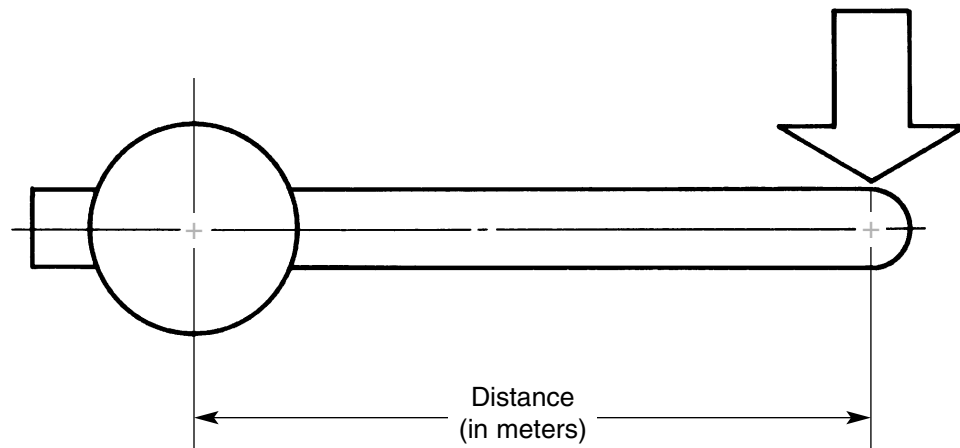
1. d. All of the above.
2. a. using the handle to turn the heavy screw
3. paper
4. b. overall length of the tool
5. e. Both b and c.
6. Under no condition should the handle be lengthened for additional leverage.
7. Pulled. Pushing any wrench is considered dangerous.
8. a. the movable jaw should face the direction the fastener is to be rotated
9. c. box wrench
10. Torque is the amount of turning or twisting force applied to a threaded fastener or part.
11. d. All of the above.
12. Hook, pin, and end.
13. Any four of the following: always pull on a wrench; never push; select a wrench that fits properly; never hammer on a wrench to loosen a stubborn fastener; rather than lengthening a wrench handle for additional leverage, use a larger wrench; clean any grease or oil off the handle and the floor in the work area before using a wrench; never try to use a wrench on moving machinery.
14. A. Standard
B. Phillips
C. Clutch
D. Square
E. Torx
F. Hex
15. A. For general cutting.
B. To cut grooves.
C. To cut radii and round grooves.
D. For squaring corners.
16. entire length
17. b. chatter and vibration will dull the teeth
18. a. cut will be too narrow for the new blade
19. a. the teeth will straddle the section being cut and snap off
20. c. general outline and cross section
21. A. Single cut
B. Double cut
C. Rasp
D. Curved tooth
22. draw
23. surface finish
24. c. expansion hand
25. b. spiral-fluted
26. Student answers will vary but may include any three of the following: to prevent injury, remove all burrs from holes; never use your hands to remove chips and cutting fluid from the reamer (use a piece of cotton waste); store reamers carefully so they do not touch one another, they should never be stored loose or thrown into a drawer with other tools; clamp work solidly before starting to ream; do not use compressed air to remove chips and cutting fluid or to clean a reamed hole.
27. e. None of the above.
28. In order: taper, plug, and bottom.
29. Diameter must be same size as threads.
30. Any of the following: too little or lack of cutting oil, dull die cutters; stock too large for threads being cut; die not started square; one set of cutters could be upside down when using a two part die.
31. b. used to wear away another material
32. Emery
33. Silicon carbide
34. A–F, evaluate individually.
35. Evaluate individually.

Torque Measurement



$$\begin{aligned}\text{Torque} &= \text{Force (in pounds)} \times \text{distance (in feet)} \\ &= \text{foot-pounds} \\ &= \text{ft.-lbs.}\end{aligned}$$

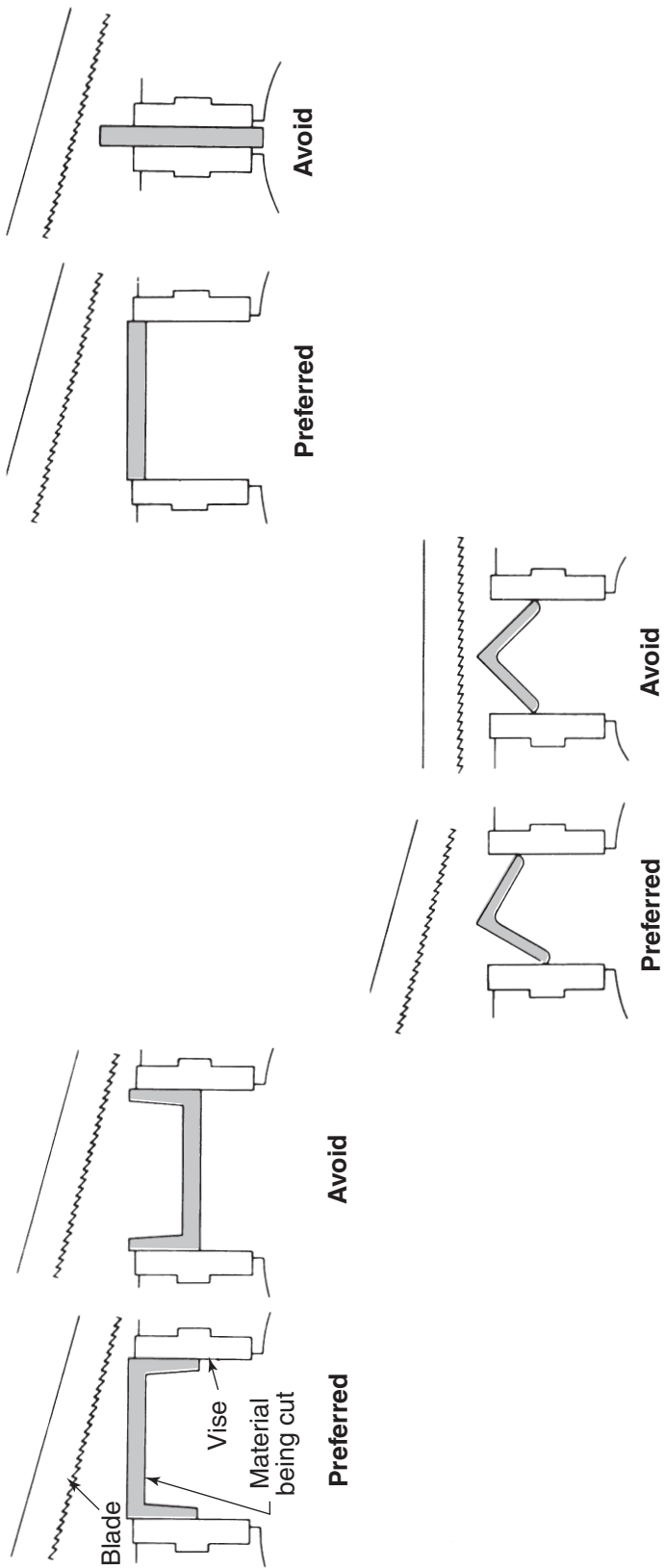
US Conventional



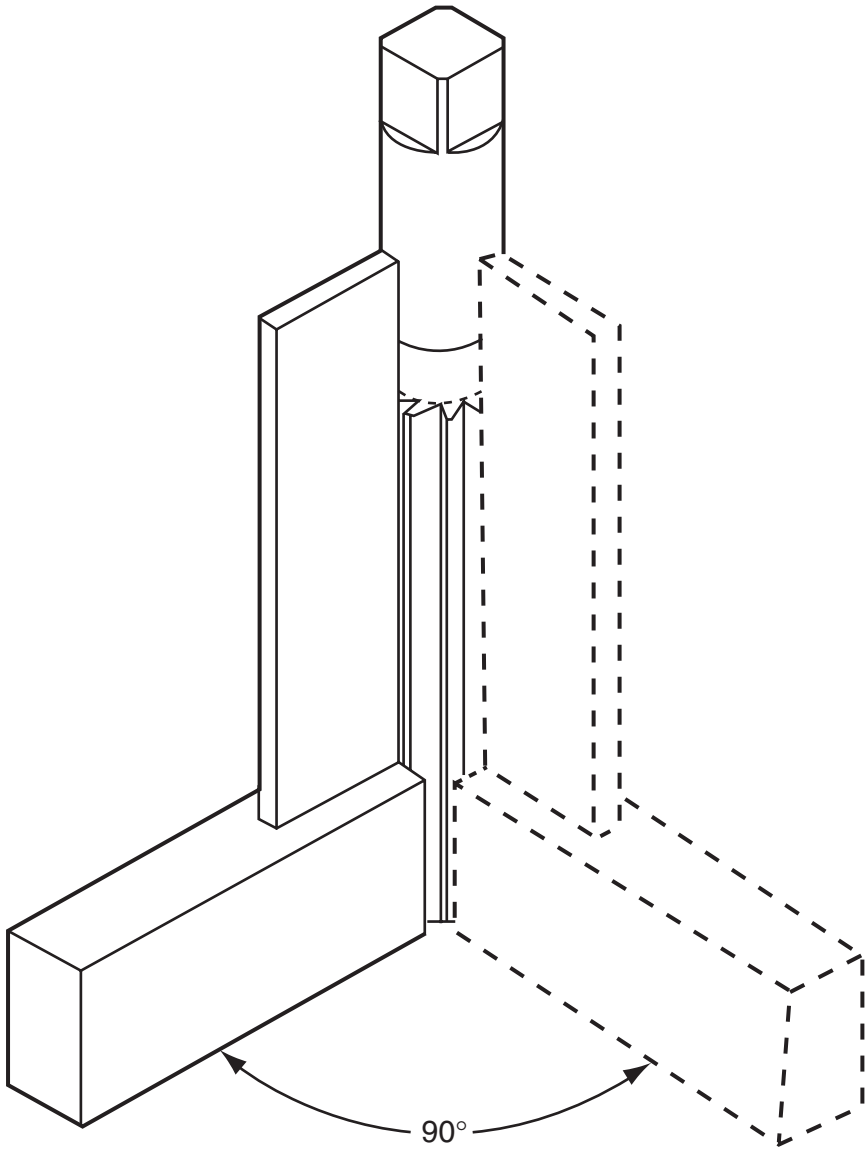
$$\begin{aligned}\text{Torque} &= \text{Force (in newtonss)} \times \text{distance (in meters)} \\ &= \text{newton-meters} \\ &= \text{N m}\end{aligned}$$

SI Metric

Mounting Work for Hand Sawing

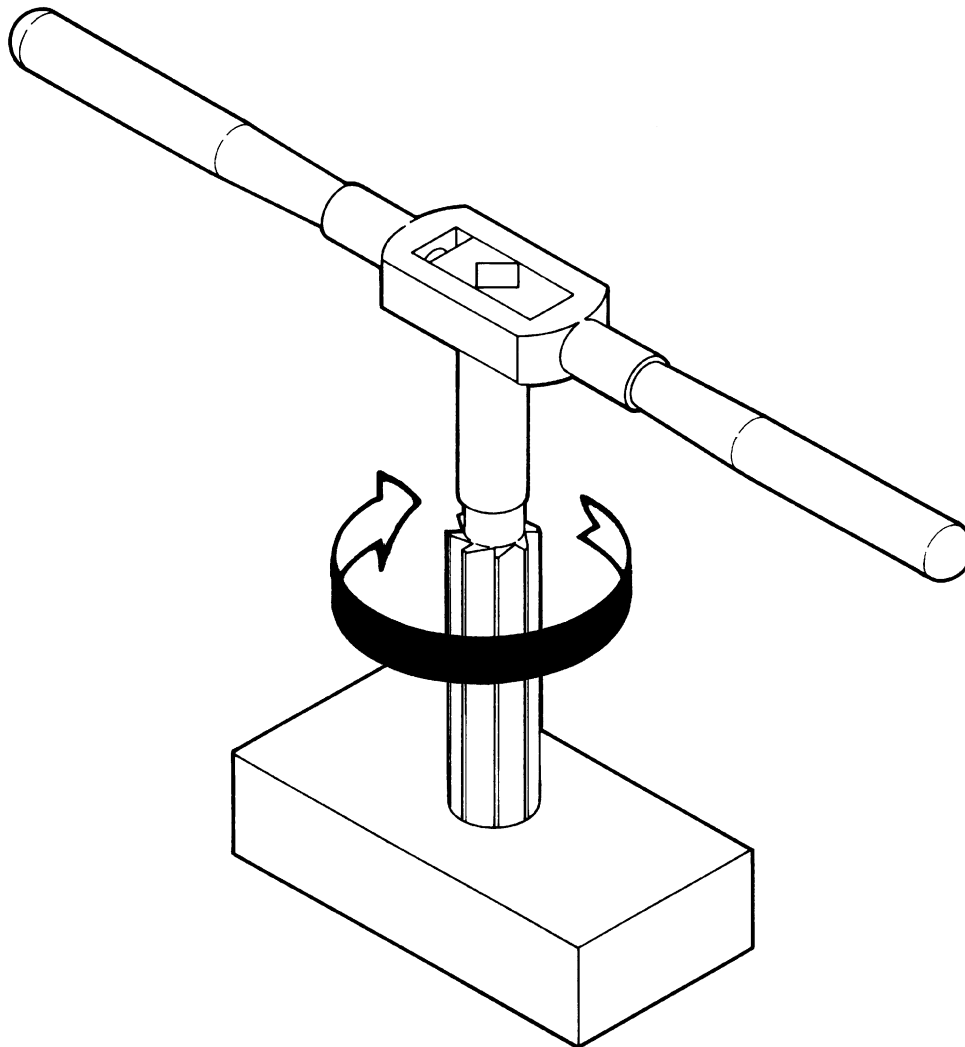


Starting a Hand Reamer



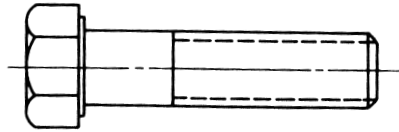
Always make sure that the reamer is square with the work.

Using a Hand Reamer

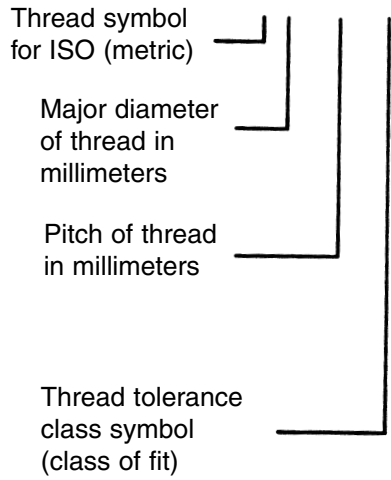


Always turn a hand reamer in a clockwise direction.

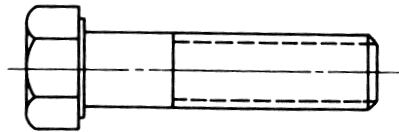
Specifications for Thread Sizes



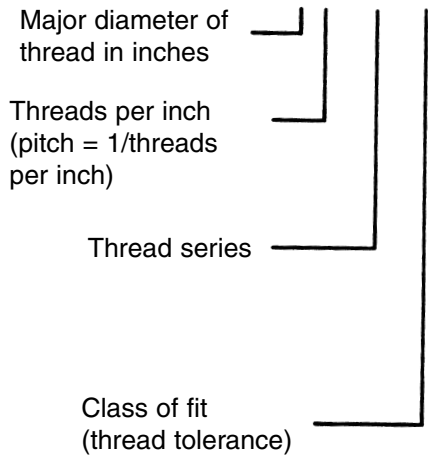
M10 × 1.5–6g



ISO Metric thread series



3/8–16 UNC–2A



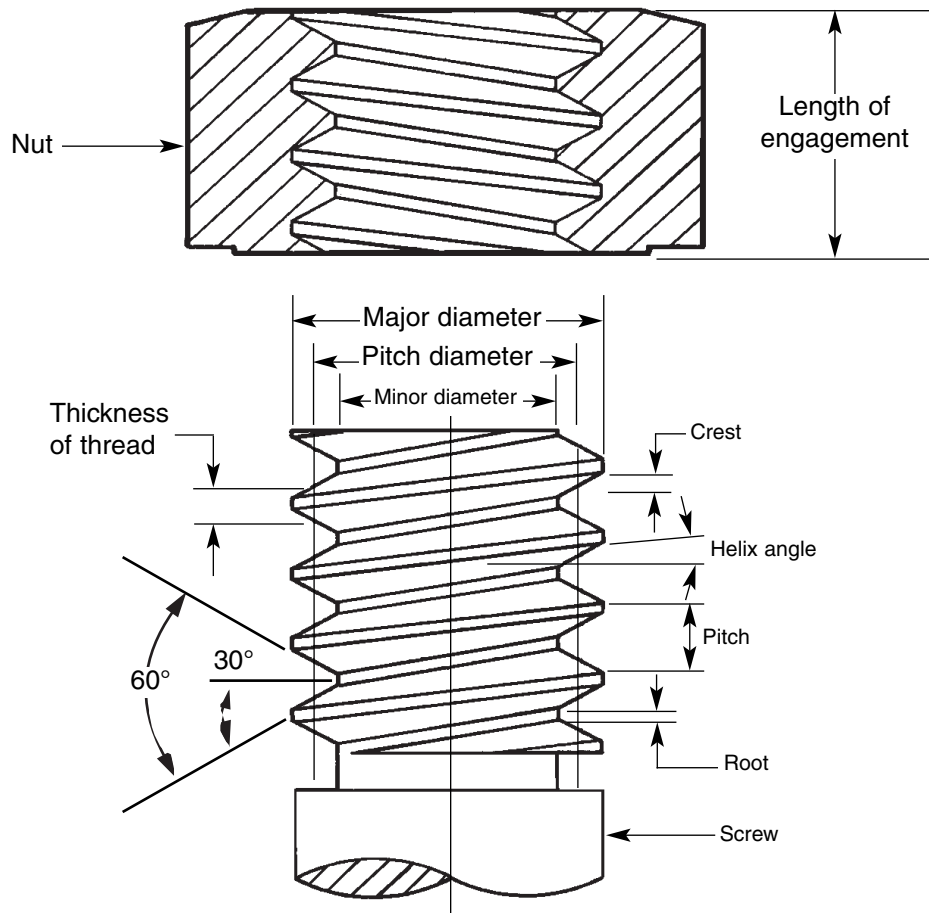
Unified National coarse thread series

Inch-Based and Metric-Based Threads

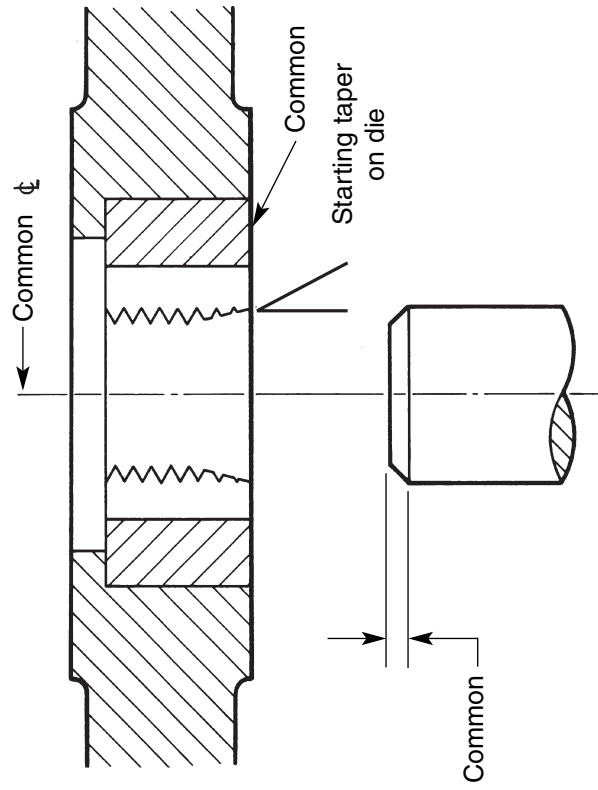
ISO Metric Thread Series	Unified National Coarse Thread Series
M24 x 3	1-8UNC
	7/8-9UNC
M20 x 2.5	3/4-10UNC
M16 x 2	5/8-11UNC
M14 x 2	9/16-12UNC
	1/2-13UNC
M12 x 1.75	7/16-14UNC
M10 x 1.5	3/8-16UNC
M8 x 1.25	5/16-18UNC
M6.3 x 1	1/4-20UNC
	12-24UNC
M5 x 0.8	10-24UNC
M4 x 0.7	8-32UNC
M3.5 x 0.6	6-32UNC
	5-40UNC
M3 x 0.5	4-40UNC
	3-48UNC
M2.5 x 0.45	
	2-56UNC
M2 x 0.4	

A comparison of ISO metric coarse and Unified Coarse (UNC) inch-based thread sizes. Even though several of them seem to be the same size, they are not interchangeable (one cannot be substituted for the other).

Thread Nomenclature

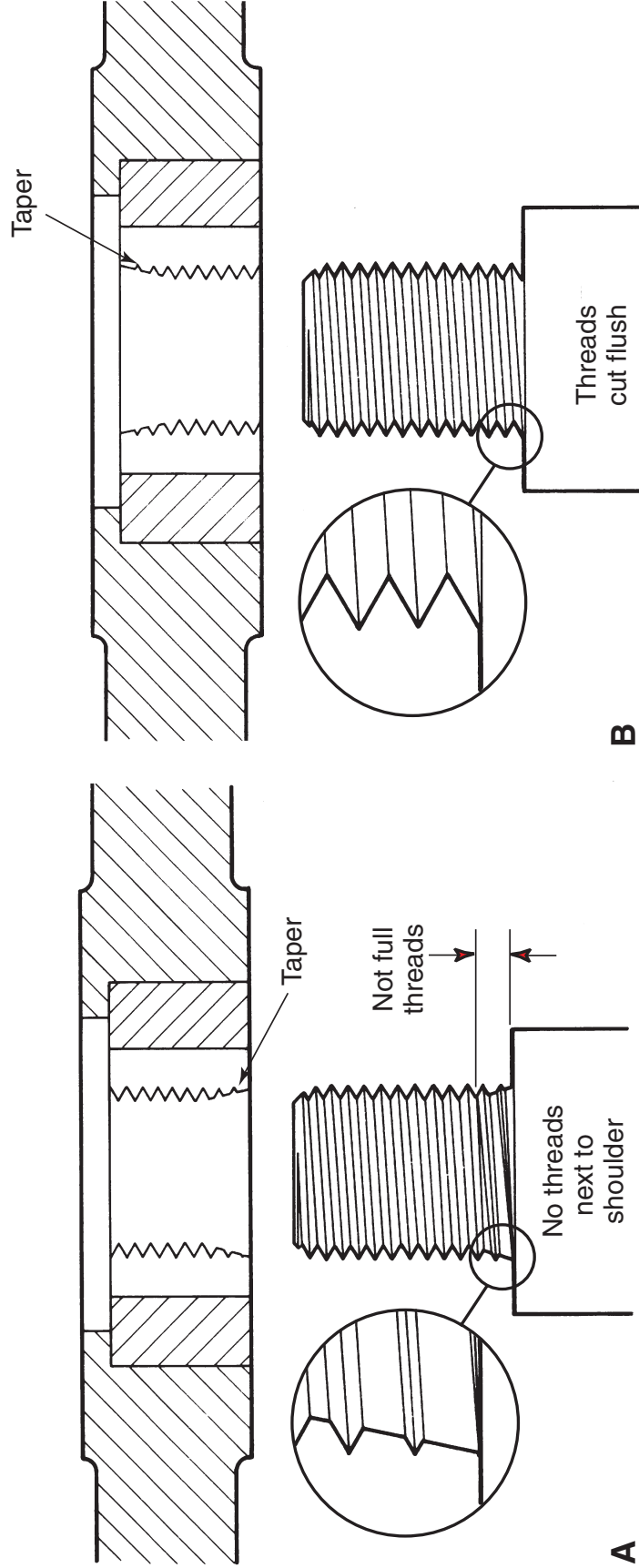


Starting a Die



A die will start more easily if a small chamfer is cut or ground on the end of the shaft to be threaded.
Section through die and die stock shows proper way to start threads.

Cutting Threads to a Shoulder



After die has been run down as far as possible, the die is reversed. When rotated down the shaft, it will cut threads almost flush with shoulder.
A—Running die down normally. B—Reversing die to cut flush.

Hand Tools

Name: _____ Date: _____ Score: _____

1. List two variations of the machinist's vise. _____

2. How is vise size determined? _____

3. Work held in a vise can be protected from damage by the jaw serrations if _____ are placed over the jaws.
3. _____
4. To prevent injuries, what should be avoided when mounting work in a vise? _____

5. Work is often held together with a _____ and/or _____ while being machined or worked on.
5. _____
6. How do combination pliers have an advantage over many other types of pliers? _____

7. Why are the cutting edges on diagonal pliers set at an angle? _____

8. List three ways of extending the working life of pliers.

9. What are adjustable clamping pliers? _____

10. Of what use are torque-limiting wrenches? _____

11. Do torque-limiting wrenches give a more accurate reading when they are pushed or when they are pulled? _____

12. Several different wrenches can be classified as adjustable wrenches. Name three. _____

Name: _____

13. List three points that should be observed when using an adjustable wrench. _____

14. Round work can be gripped with a _____ wrench. Its main disadvantage is that the jaws will probably _____ the work. 14. _____

15. Describe socket wrenches. _____

16. What wrenches are employed to turn flush and recessed types of threaded fasteners? The fasteners have slots or holes to receive the wrench lugs. _____

17. Rather than lengthen the wrench handle for additional leverage, it is better to use a _____ wrench. 17. _____

18. List five safety precautions that should be observed when using a wrench.

19. What is the difference between a standard screwdriver tip and a Phillips screwdriver tip?

- Match each phrase in the right column with the correct screwdriver name in the left column.

_____ 20. Pozidriv[®]

_____ 21. Standard

_____ 22. Electrician

_____ 23. Heavy-duty

_____ 24. Stubby

_____ 25. Ratchet

a. Has a flattened wedge-shaped tip.

b. Moves the fastener on the power stroke, but not on the return stroke.

c. Has a square shank to permit additional force to be applied with a wrench.

d. Useful when handling small screws.

e. Tip is similar to that of a Phillips head screwdriver.

f. Has an insulated handle.

g. Is short and is used when space is limited.

Name: _____

26. List three safety precautions that should be observed when using a screwdriver.

27. How is the size of a ball-peen hammer determined?

28. Why are soft-face hammers and mallets used in place of a ball-peen hammer? _____

29. List three safety precautions that should be observed when using striking tools.

30. There are few things more dangerous than a chisel with a head that has become _____ from use. This danger can be removed by _____.

30. _____

31. The chisel is an ideal tool for _____.

31. _____

32. List the four general types of cold chisels. _____

33. The standard hacksaw is designed to accommodate _____.

33. _____

34. A hacksaw cuts best at about _____ to _____ strokes per minute.

34. _____

35. Why should work be mounted solidly and close to the vise before cutting with a hacksaw?

36. Should a blade break or dull before completing a cut, you should *not* continue in the same cut with a new blade. Why? _____

37. The number of teeth per inch on a hacksaw blade has an important bearing on the shape and kind of metal being cut. At least _____ or _____ should be cutting at all times, otherwise _____.

Name: _____

38. What is the best way to hold thin metal for hacksawing? _____

39. What is the best way to hold thin wall tubing for hacksawing?

40. Files are cleaned with a _____, never with _____. 40. _____

41. Files are classified according to the cut of their teeth. List the four cuts. _____

42. What are the most commonly used file shapes? _____

43. List three safety precautions that should be observed when files are used. _____

44. When is reaming done? _____

45. How much stock should be left in a hole for hand reaming? 45. _____

46. A _____ is used to cut internal threads. External threads are cut with a _____. 46. _____

47. The hole to be tapped must be: 47. _____
a. The same diameter as the desired thread.
b. A few thousandths larger than the desired thread.
c. A few thousandths (0.003"–0.004") smaller than the threads.
d. All of the above.
e. None of the above.

48. The drill used to make the hole prior to threading, is called a _____. 48. _____

49. How does the UNC thread series differ from the UNF thread series? _____

Name: _____

50. List the correct sequence taps should be used to form threads the full depth of a blind hole.

51. Should a shaft be larger or smaller than the finished size if external threads are to be cut on it?

52. Taps are turned in with a _____. A _____ is used with dies. 52. _____

53. What is an abrasive? _____

54. _____ surfaces are never polished with an abrasive. 54. _____