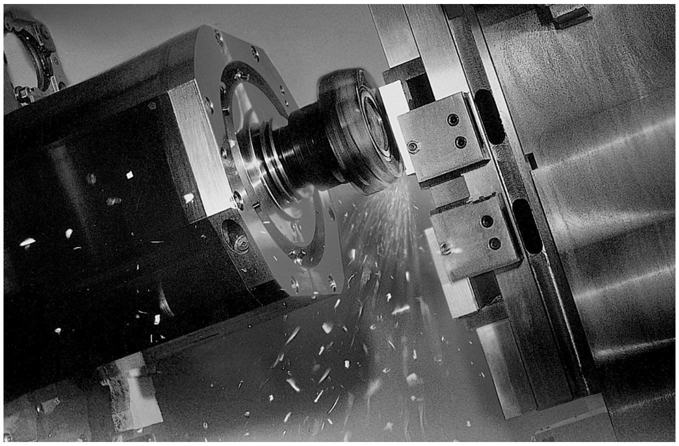


Chapter 14

Cutting Tapers and Screw Threads on the Lathe

LEARNING OBJECTIVES

After studying this chapter, students will be able to:
- ❍ Describe how a taper is turned on a lathe.
- ❍ Calculate tailstock setover for turning a taper.
- ❍ Safely set up and operate a lathe for taper turning.
- ❍ Describe the various forms of screw threads.
- ❍ Cut screw threads on a lathe.

INSTRUCTIONAL MATERIALS

Text: pages 241–260
  Test Your Knowledge Questions, pages 259–260
Workbook: pages 77–84
Instructor's Resource: pages 191–206
  Guide for Lesson Planning
  Research and Development Ideas
  Reproducible Masters:
    14-1 Angle Measurement and Conversion
    14-2 Tapers (*basic information*)
    14-3 Calculating Tailstock Setover (*taper per inch given*)
    14-4 Calculating Tailstock Setover (*taper per foot given*)
    14-5 Calculating Tailstock Setover (*all taper dimensions given*)
    14-6 Screw Thread Forms (*formulas included*)
    14-7 Screw Thread Lead and Pitch
    14-8 Cutting Action of Threading Tools
    14-9 Three-Wire Method of Measuring Threads
    14-10 Test Your Knowledge Questions
  Color Transparencies (Binder/CD only)

GUIDE FOR LESSON PLANNING

This chapter can be divided into two segments. Part I should cover cutting tapers on the lathe and Part II should cover cutting screw threads on the lathe. Copy and distribute Reproducible Masters 14-1 and 14-2.

Part I—Cutting Tapers on the Lathe

Set up lathes for demonstration purposes. Demonstrate the various ways tapers can be cut on a lathe.

Have students read and study pages 241–250. Review the assignment using Reproducible Masters 14-3, 14-4, and 14-5 as overhead transparencies and/or handouts. (Answers are located on page 193 of this Instructor's Resource.) Discuss the following:

- The advantages and disadvantages of the various methods used to cut tapers on a lathe.
- How to calculate tailstock setover.
- Methods used to setover the tailstock.
- Types of taper attachments and how to set them.
- How to measure tapers.

Emphasize the safety precautions that must be observed when cutting tapers.

Part II—Cutting Screw Threads on the Lathe

Prepare a lathe to cut threads. Explain and demonstrate procedures for cutting threads.

Have students read and study pages 250–259. Review the assignment after demonstrating how to set up a lathe and cut threads. Discuss the following:

- Major uses of the screw thread.
- Screw thread forms. Use Reproducible Masters 14-6 and 14-7.
- Review thread nomenclature. Use Reproducible Master 6-7.
- Setting up a lathe to cut 60° threads.
- Threading tool cutting action. Use Reproducible Master 14-8.
- How to use the thread dial.
- The three-wire method for measuring threads. Use Reproducible Master 14-9.
- How to cut Acme threads.
- How to cut internal threads.
- Why cutting fluid should be used.

Emphasize safety precautions to be observed when cutting threads on a lathe. Briefly review the demonstrations. Provide students with 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. The following list is also given at the beginning of the chapter.

external threads
internal threads
major diameter
minor diameter
offset tailstock method
pitch diameter
setover
taper attachment
thread cutting stop
three-wire method of measuring threads

Review Questions

Assign *Test Your Knowledge* questions. Copy and distribute Reproducible Master 14-10 or have students use the questions on pages 259–260 in the text and write their answers on a separate sheet of paper.

Workbook Assignment

Assign Chapter 14 of the ***Machining Fundamentals Workbook.***

Research and Development

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

1. Make a display board showing large scale models of Sharp V, square, and Acme screw threads.
2. Write a paper on how the first screw threads were made. If possible, include illustrations.
3. Demonstrate to the class the proper technique of machining screw threads. Illustrate how the tool can be repositioned after being resharpened and how to use the 3-wire method of measuring threads.

TEST YOUR KNOWLEDGE ANSWERS, Pages 259–260

1. Compound, offset tailstock, taper attachment, tool bit, and reamer. Evaluate list of advantages and disadvantages individually. Refer to Figure 14-3.
2. When it increases or decreases in diameter at a uniform rate.
3. A. 0.250″
   B. 0.563″
   C. 15.7 mm
4. Making adjustments, assembling parts, transmitting motion, applying pressure, and making measurements.
5. d. Cut on outside surface of piece.
6. f. Cut on inside surface of piece.
7. b. Largest diameter of thread.
8. a. Smallest diameter of thread.
9. e. Diameter of imaginary cylinder that would pass through threads at such points as to make width of thread and width of space at these points equal.
10. c. Distance from one point on a thread to a corresponding point on next thread.
11. g. Distance a nut will travel in one complete revolution of screw.
12. d. All of the above.
13. center gage, fish tail
14. thread dial
15. 29°
16. a. M = 0.520″

b. M = 0.270″
c. M = 0.415″
d. M = 0.509″

WORKBOOK ANSWERS, Pages 77–84

1. e. All of the above.
2. offset tailstock or tailstock setover
3. c. Both a and b.
4. micrometer dial
5. Lessens pressure on the tail center.
6. *Plain taper attachment.* Requires the cross-slide screw to be disengaged from the cross-slide feed nut. The cutting tool must be advanced by the compound rest feed screw.
   Telescopic taper attachment. It is not necessary to disengage the cross-slide feed nut.
7. Can only cut short tapers.
8. Measuring tapers by comparison plug and ring gages, etc.
   Direct measurement of tapers, gage blocks, and sine bar, etc.
9. c. thread cutting stop
10. Evaluate individually. Refer to Section 14.6.4.
11. d. All of the above.
12. 1/N (N = Number of threads per inch.)
13. b. the reverse of those used
14. sharpening the cutting tool and positioning it to cut the threads
15. start the next cut in the same direction
16. A device on the lathe that indicates when to engage the half-nuts to permit the tool to follow exactly in the original cut.
17. the half-nuts are not engaged
18. d. Both b and c.
19. b. in relation to the centerline of the taper
20. 0.025″
21. 0.044″
22. 1.50″
23. 0.876 mm
24. 175.0 mm
25. 57.14 mm
26. 0.324″
27. 0.384″
28. 0.457″
29. 0.515″
30. 0.763″
31. 0.899″
32. 1.154″
33. 0.257″
34. 0.225″
35. 0.153″
36. 0.580″
37. 0.645″
38. 0.771″
39. 1.281″
40. 1.411″

ANSWERS FOR REPRODUCIBLE MASTERS

14-3 Calculating Tailstock Setover (TPI given)

1. 0.149″
2. 0.380″
3. 0.034″
4. 0.278″
5. 0.066″

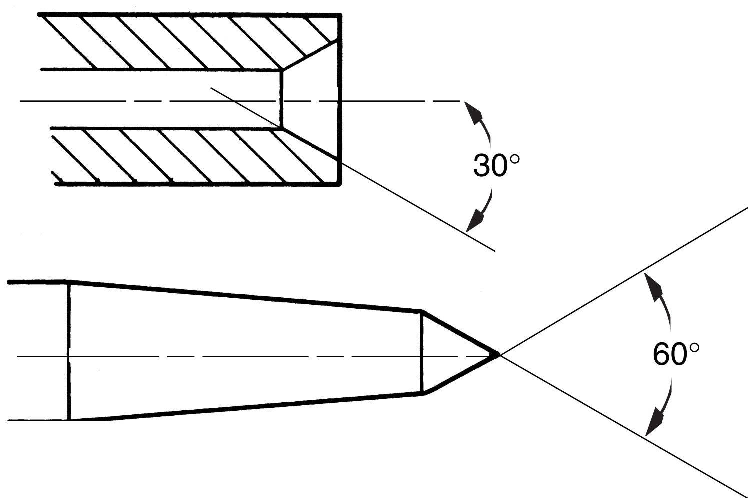
14-4 Calculating Tailstock Setover (TPF given)

1. 0.032″
2. 0.102″
3. 0.158″
4. 0.166″
5. 0.061″

14-5 Calculating Tailstock Setover (all dimensions given)

1. 0.417″
2. 0.563″
3. 0.563″
4. 0.560″
5. 0.556″

Angle Measurement and Conversion

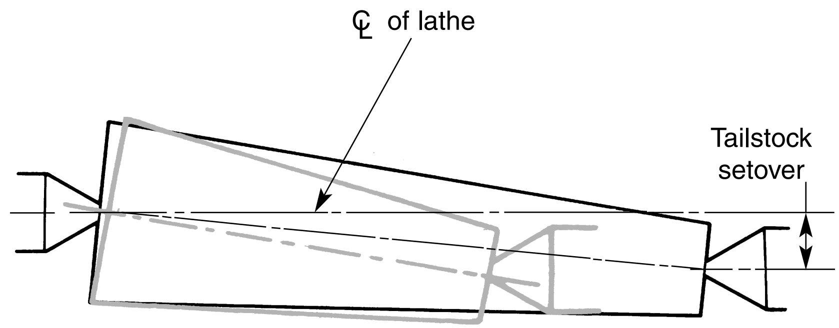


Taper per Foot with Corresponding Angles		
Taper per foot	Included angle	Angle with centerline
1/16	0° 17′ 53″	0° 8′ 57″
1/8	0° 35′ 47″	0° 17′ 54″
3/16	0° 53′ 44″	0° 26′ 52″
1/4	1° 11′ 38″	0° 35′ 49″
5/16	1° 29′ 31″	0° 44′ 46″
3/8	1° 47′ 25″	0° 53′ 42″
7/16	2° 5′ 18″	1° 2′ 39″
1/2	2° 23′ 12″	1° 11′ 36″
9/16	2° 41′ 7″	1° 20′ 34″
5/8	2° 58′ 3″	1° 29′ 31″
11/16	3° 16′ 56″	1° 38′ 28″
3/4	3° 34′ 48″	1° 47′ 24″
13/16	3° 52′ 42″	1° 56′ 21″
7/8	4° 10′ 32″	2° 5′ 16″
15/16	4° 28′ 26″	2° 14′ 13″
1	4° 46′ 19″	2° 23′ 10″

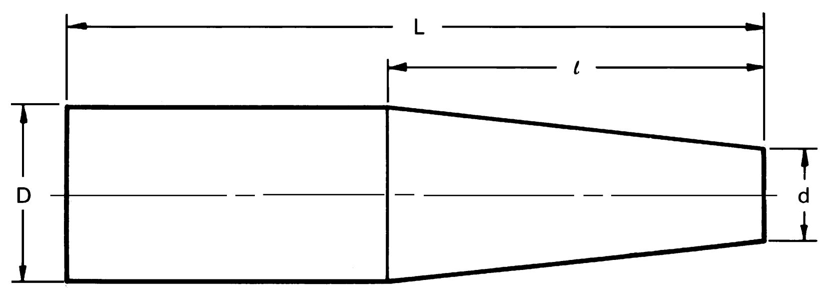
Table can be used to convert taper per foot into corresponding angles for adjustment of the compound rest.

14-2

Tapers



Length of work causes taper to vary even though tailstock offset remains the same.



D = diameter at large end of taper; d = diameter at small end of taper; ℓ = length of taper; L = total length of piece.

Calculating Tailstock Setover

The tailstock offset must be calculated for each job because the work length plays an important role in the calculation. Information needed: TPI = Taper per inch, L = Total length of work.

Formula: When taper per inch is known, Offset = $\frac{L \times TPI}{2}$

1. What will be the setover for the following job? Show your work.

   TPI = 0.035″ L = 8.500″

2. What will be the setover for the following job? Show your work.

   TPI = 0.062″ L = 12.25″

3. What will be the setover for the following job? Show your work.

   TPI = 0.009″ L = 7.625″

4. What will be the setover for the following job? Show your work.

   TPI = 0.055″ L = 10.125″

5. What will be the setover for the following job? Show your work.

   TPI = 0.025″ L = 5.250″

Calculating Tailstock Setover

The tailstock offset must be calculated for each job because the work length plays an important role in the calculation. When the taper per foot (TPF) is known, it must first be converted to taper per inch (TPI). The following formula takes this into account.

Formula: When taper per foot is known, Offset = $\frac{L \times TPF}{24}$

1. What will be the setover for the following job? Show your work.

   TPF = 0.123″ L = 6.330″

2. What will be the setover for the following job? Show your work.

   TPF = 0.250″ L = 9.750″

3. What will be the setover for the following job? Show your work.

   TPF = 0.375″ L = 10.125″

4. What will be the setover for the following job? Show your work.

   TPF = 0.312″ L = 12.75″

5. What will be the setover for the following job? Show your work.

   TPF = 0.126″ L = 6.750″

Calculating Tailstock Setover

The tailstock setover must be calculated for each job because the work length plays an important role in the calculation. Often plans do not specify TPI, TPF, or T/mm, but do provide pertinent information. If inch dimensions are given in fractions, they must be converted to decimals.

Formula: Offset = $\frac{L \times (D - d)}{2 \times \ell}$

1. What will be the setover for the following job? Show your work.

   D = 2.000″ d = 1.500″ ℓ = 6.000″ L = 10.000″

2. What will be the setover for the following job? Show your work.

   D = 1.125″ d = 0.750″ ℓ = 3.000″ L = 9.000″

3. What will be the setover for the following job? Show your work.

   D = .875″ d = 0.500″ ℓ = 4.000″ L = 12.000″

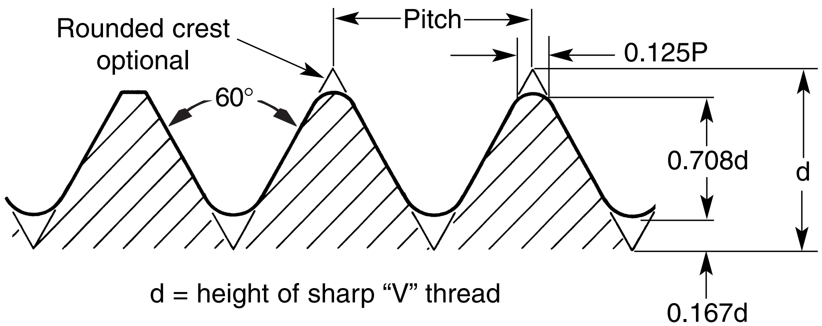
4. What will be the setover for the following job? Show your work.

   D = 1.375″ d = 0.937″ ℓ = 6.000″ L = 15.00″

5. What will be the setover for the following job? Show your work.

   D = 2 1/2″ d = 1 15/16″ ℓ = 6 1/8″ L = 12 1/8″

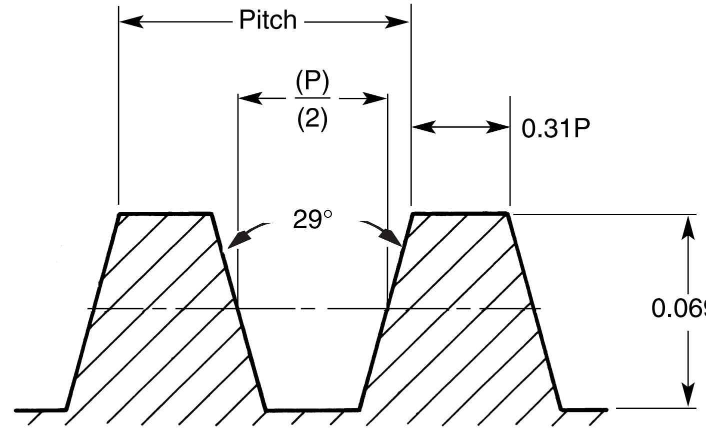
Screw Thread Forms



d = height of sharp "V" thread

AMERICAN NATIONAL UNIFIED
(Interchangeable with Unified Thread)

Pitch = $\frac{1}{N}$ d = $\frac{0.866}{N}$

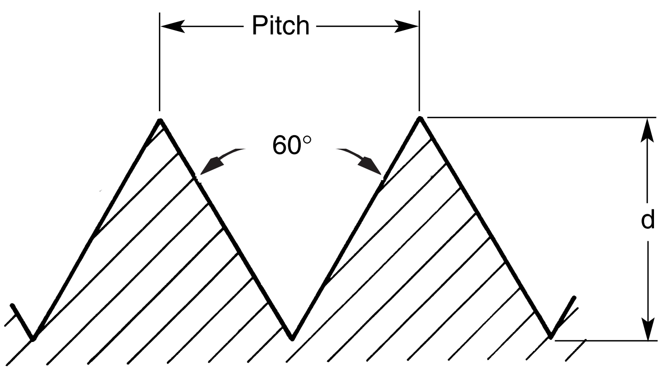


ACME THREAD

Pitch = $\frac{1}{N}$ d = $\frac{P}{2 + 0.010}$

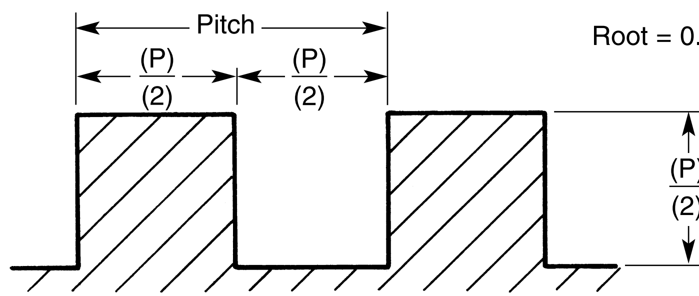
Flat = 0.371P

Root = 0.71P–0.0052



SHARP "V" THREAD

Pitch = $\frac{1}{N}$ d = $\frac{0.866}{N}$



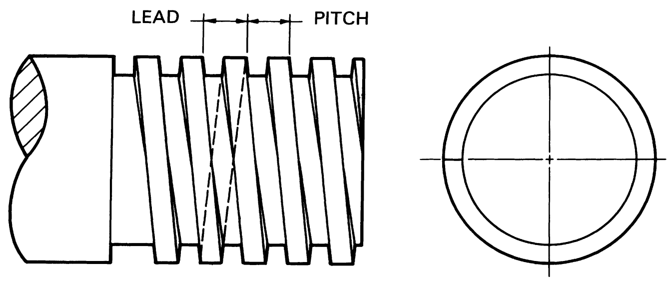
SQUARE THREAD

Pitch = $\frac{1}{N}$ d = $\frac{P}{2}$

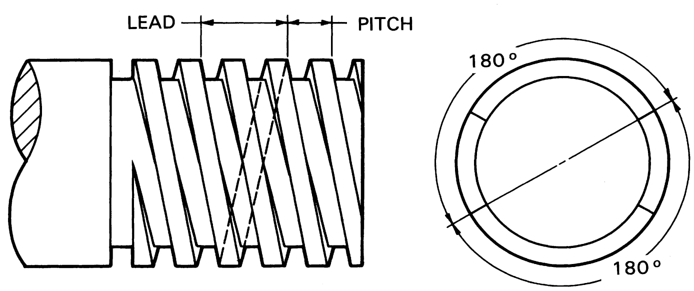
Flat or space = $\frac{P}{2}$

KEY:
N = Number of threads per inch
P = Pitch
d = Depth of thread

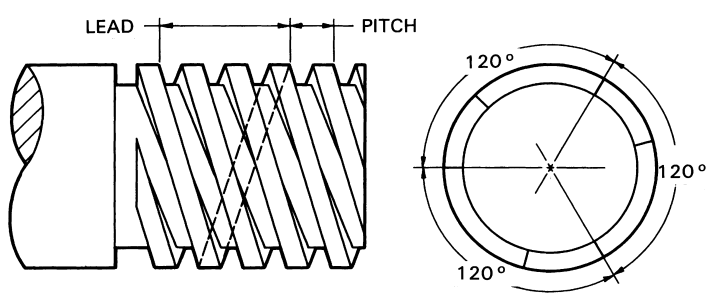
Screw Thread Lead and Pitch



Single Thread Screw
(Pitch and thread are equal)

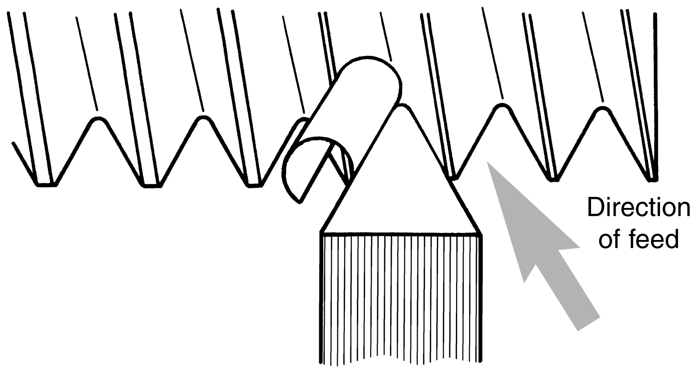


Double Thread Screw
(The lead is twice the pitch)

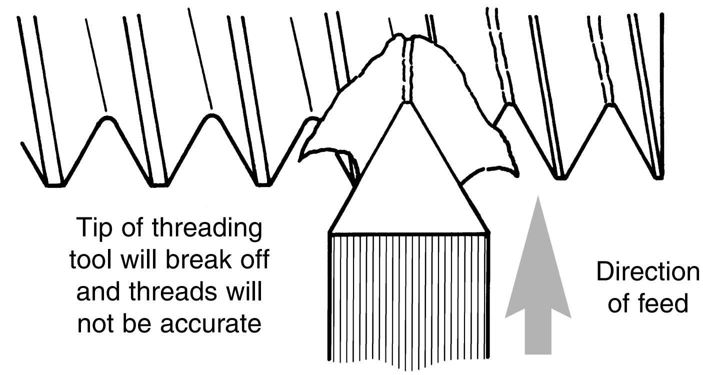


Triple Thread Screw
(The lead is three times the pitch)

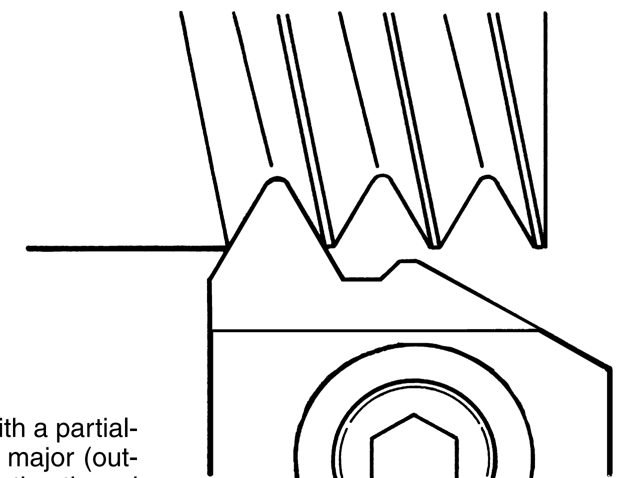
Cutting Action of Threading Tools



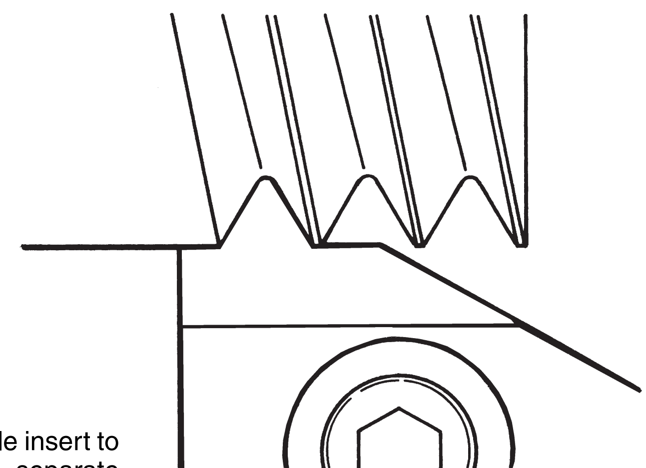
When the tool is fed in at a 29° angle, note that only one edge is cutting and that the cutting load is distributed evenly across the edge.



When fed straight in, note that both edges are cutting and the weakest part of the tool, the point, is doing the hardest work.



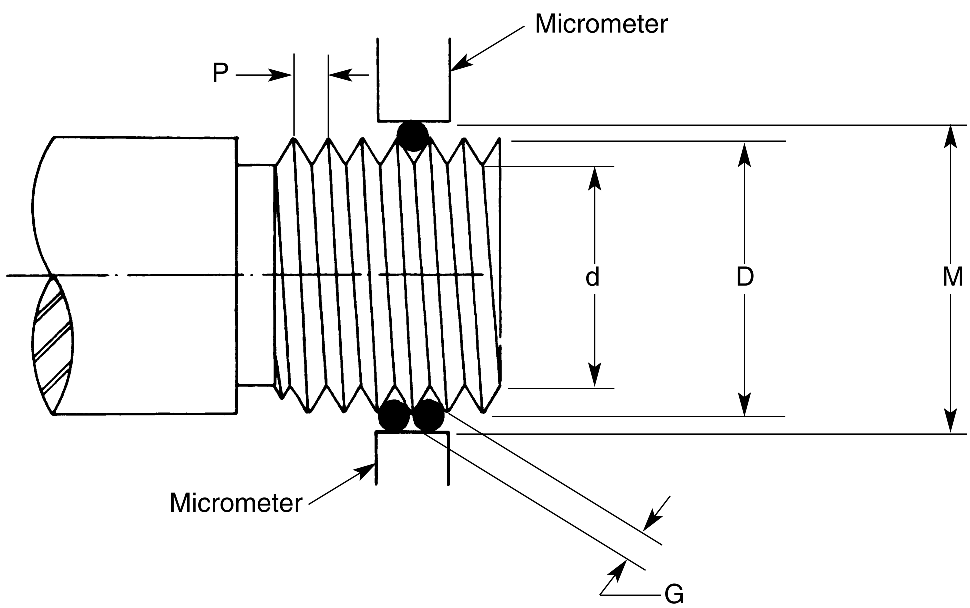
Cutting threads with a partial-profile insert. The major (outside) diameter of the thread must be cut to size before using this type insert.



Using a full-profile insert to cut a thread. A separate insert is required for each thread pitch.

14-8

Three-Wire Method of Measuring Threads



$$M = D + 3G - \frac{1.5155}{N}$$

Where: M = Measurement over the wires
D = Major diameter of thread
d = Minor diameter of thread
G = Diameter of wires
P = Pitch = $\frac{1}{N}$
N = Number of threads per inch

The smallest wire size that may be used for a given thread.

$$G = \frac{0.560}{N}$$

The largest wire size that can be used for a given thread.

$$G = \frac{0.900}{N}$$

The three-wire formula will work only if ''G'' is no larger or smaller than the sizes determined above. Any wire diameter between the two extremes may be used. All wires must be the same diameter.

Cutting Tapers and Screw Threads on the Lathe

Name: ______________________________ Date: ____________ Score: ______

1. There are five ways of machining tapers on a lathe. List them, with their advantages and disadvantages.

   ____
   ____
   ____
   ____

2. When is a section of material considered tapered? ______________________
   ____

3. Machine adjustments must be calculated for each tapering job. The information given below will enable you to calculate the necessary tailstock setover for the problems given. *Show your work in the space provided.*

Formulas: When taper per inch is known, Offset = $\frac{L \times TPI}{2}$

When taper per foot is known, Offset = $\frac{L \times TPF}{2}$

When dimensions of tapered section are known but TPI or TPF is not given,

$$\text{Offset} = \frac{L \times (D - d)}{2 \times \ell}$$

Where: TPI = Taper Per Inch TPF = Taper Per Foot

D = Diameter at large end of taper d = Diameter at small end of taper

ℓ = Length of taper L = Total length of piece

Note: These formulas, except for the TPF formula, can be used when dimensions are in mm.

Problem A: What will the tailstock setover be for the following job?

Taper Per Inch = 0.125″ Total length of piece = 4.000″

Name: ____

Problem B: What will the tailstock setover be for the following job?

D = 2.50″ d = 1.75″ ℓ = 6.00″ L = 9.00″

Problem C: What will the tailstock setover be for the following job?

D = 45.0 mm d = 25.0 mm ℓ = 175.0 mm L = 275.0 mm

4. Screw threads are used for many reasons. List five or more important uses.

____

____

____

____

____

- The following questions are of the matching type. Place the letter of the correct explanation in the space provided.

______ 5. External thread.

______ 6. Internal thread.

______ 7. Major diameter.

______ 8. Minor diameter.

______ 9. Pitch diameter.

______10. Pitch.

______11. Lead.

a. Smallest diameter of thread.
b. Largest diameter of thread.
c. Distance from one point on a thread to a corresponding point on next thread.
d. Cut on outside surface of piece.
e. Diameter of imaginary cylinder that would pass through threads at such points as to make width of thread and width of space at these points equal.
f. Cut on inside surface of piece.
g. Distance a nut will travel in one complete revolution of screw.

Name: ____

12. A groove is cut at the point where a thread is to terminate. It is cut to the depth of the thread and serves to: 12. ____________________
   a. provide a place to stop the threading tool after it makes a cut.
   b. permits a nut to be run up to the end of the thread.
   c. terminate the thread.
   d. All of the above.
   e. None of the above.
13. The tip of a cutting tool to cut a Sharp V thread is sharpened using a _____ to check that it is the correct shape. This tool is frequently called a _____. 13. ____________________ ____________________
14. The _____ is fitted to many lathe carriages. It meshes with the lead screw and is used to indicate when to engage the half nuts to permit the thread cutting tool to follow exactly in the original cut. 14. ____________________
15. The compound rest is set at _____ when cutting threads to permit the cutting tool to shear the material better than if it were fed straight into the work. 15. ____________________
16. The three-wire thread measuring formula for inch-based threads is:

$$M = D + 3G - \frac{1.5155}{N}$$

Where: G = Wire diameter D = Major diameter of thread (Convert to decimal size).
M = Measurement over the wires N = Number of threads per inch.

Problems: Calculate the correct measurement over the wires for the following threads. Use the wire size given in the problem. *Show your work in the space provided.*

______ a. 1/2-20 UNF (wire size 0.032″)

______ b. 1/4-20 UNC (wire size 0.032″)

______ c. 3/8-16 UNC (wire size 0.045″)

______ d. 7/16-14 UNC (wire size 0.060″)