

UNIT D: Threads and Fasteners

Competency: D504.00

Construct various types of thread and fastener representations and their annotations.



Objective: D504.01

Specify threads and fasteners on a technical drawing.

Introduction:

This unit will provide the student with an understanding of the basic types of fasteners used in the assembly of parts and the method in which they are represented on a technical drawing. Even though most fasteners are considered as standard parts and need not be drawn, the CAD Operator should have the basic knowledge to select the best fastener for the best use.

Purpose of Fasteners: R1 (362), R2 (379-381), R3 (308)

- A. Screw threads are mainly used to hold parts together, as by a bolt or screw.
- B. Adjust parts with respect to each other, as on the adjusting screw of a drafters compass.
- C. Transmit power, as on a wood-workers vise or an automobiles tire jack.
- D. Apply pressure, such as the purpose of the setscrew, designed to hold an object in place with respect to another.

Thread Terminology: R1 (362-363), R2 (382), R3 (308-312)

- A. **Helix** – Is the spiral grooves cut into the surface of cylinders. This is the same form made by wrapping a copper wire around a cylinder to form a spring.
- B. **External** – Refers to threads found on a bolt, cap screw, wood screw, etc.
- C. **Internal** – Refers to threads found on a nut or tapped inside a part.
- D. **Major Diameter** – Is the largest diameter of a thread. Measured from crest to crest.
- E. **Minor Diameter** – Is the smallest diameter of a thread.
- F. **Crest** – Is the shallowest thread cut. It can be rounded or flat.
- G. **Root** – Is the deepest thread cut. It can be rounded or flat.
- H. **Pitch** – The pitch of a thread is the distance from one point on the thread to the corresponding point on the next form. The pitch of a thread is usually expressed in tables in terms of the number of threads per inch.
- I. **Lead** – Is the distance a thread moves in one revolution.
- J. **Single Threads** – Has a lead equal to its pitch
- K. **Multiple Threads** – Has a lead equal to more than one pitch. Multiple threads permit rapid advancement of parts. For example, a double thread will advance twice as far as a single thread in one revolution.

- L. **Class of Fit** – There is four standardized classes of fit. The term fit refers to how closely the screw fits in the threaded hole. That is the amount of play between the two parts.
1. Class 1: Loose fit, used for rough work.
 2. Class 2: Free fit, general-purpose use of most bolts and nuts.
 3. Class 3: Medium fit, used for the better grades of work, such in automobiles.
 4. Class 4: Close fit, used where a very snug fit is required, as in aircraft engines.
- M. **Thread Depth** – Refers to the distance from the top of the thread (crest), to the bottom of the thread (root).
- N. **Thread Angle** – The angle formed by the walls of the thread. The angle created by the slope of the thread is a standard 60 degrees.
- O. **Right-Handed (RH)** – Advances into a nut when turned clockwise. All threads are understood to be RH unless designated specifically LH in the thread note.
- P. **Left-Handed (LH)** – Advances into a nut when turned counterclockwise.

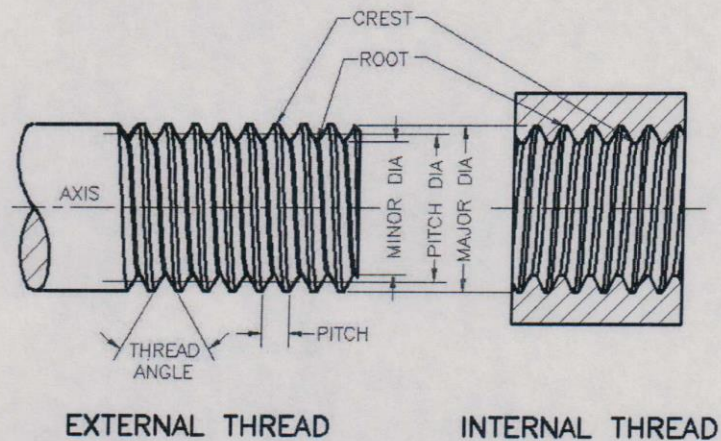


Figure 1. Screw Thread Terms.

Thread-Cutting Tools: R1 (378), R3 (309, 316-319)

Smaller threads may be cut by hand and larger threads by a lathe.

- A. **Tap** - Is a small fluted cutting tool with cutting teeth shaped to form small internal threads.
- B. **Die** – Is a machine tool used to form small external threads.

American National Standard For Unified Threads: *R1 (363), R2 (381-386), R3 (320)*

The American National Standard Institute (ANSI) established ANSI B1.1 as the American Standard for Unified Screw Threads. It is referred to as the Unified system because it has been agreed upon by the United Kingdom and Canada as well as the United States. Unified threads are the basic American standard for fastening type screw threads. Fasteners with constant pitch threads are sized by the basic major diameter and by the number of threads per inch. These two dimensions are combined to create the various thread series.

- A. **Unified National Coarse (UNC)** - Threads are the most common series.
- B. **Unified National Fine (UNF)** - Threads have a greater tensile strength than UNC threads, so they fasten securely. (Tensile strength is a measure of resistance to lengthwise stress.)
- C. **Unified National Extra Fine (UNEF)** - Threads have the highest tensile strength. They provide the greatest security in high vibration situations.
- D. **Metric Thread** – Considered as the ISO standard for international threads. Very similar in profile to the Unified series, but the two are not interchangeable.
- E. **Square Thread** – Is primarily used to transmit motion or power along the line of the screw's axis Such as the threads on a woodworking vise. However this thread is very difficult to manufacture because of its perpendicular sides.
- F. **ACME Thread** – It is a modification of the square thread, which is easier to manufacture because of its 60 degree angled form. Acme threads are popular on such designs as screw jacks, vice screws, and other machinery that requires a rapid screw action. Better known as the worm thread when used on shafts to carry power to worm gears.
- G. **Sharp-V Thread** – Type of thread that will fit and sill tightly and is used where friction holding or adjusting is important. Mainly used on brass parts.
- H. **Knuckle Thread**- Are used for items such as light bulbs and screw-type bottle tops.
- I. **Buttress Thread** – Is used to transmit great power in one direction, as on an automobile bumper jack.

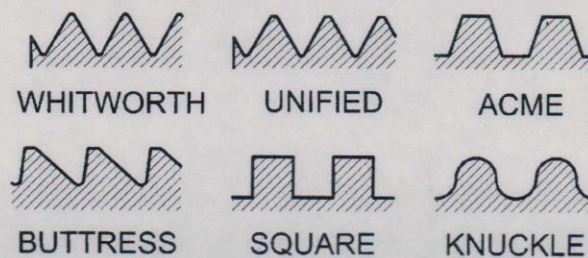


Figure 2. Screw Thread Forms.

Thread Representation: R1 (365-371), R2 (393-399), R3 (312-316)

There are three methods of thread representation in use:

- A. **Simplified Method** – is the most common method of drawing thread symbols. This method is used for all forms of threads, as Unified, square, acme, etc. Many companies have adopted the simplified method because it saves time and money in the design process. Hidden lines are drawn parallel to the axis at the approximate depth of the thread. The crest line is represented by a visible line, also parallel to the axis, in viewing the major diameter of the thread.
- B. **Schematic Method** – Is not as true to form as the detailed method but more in depth than the simplified method. The long thin lines represent the crest of the threads and the roots by the short thick lines, both at right angles to the shaft.
- C. **Detailed** – Is the nearest approximation to the true thread picture, in which straight lines replace the helical curves. This method is very complex and timely in the development of standard parts. However may be used in drawing the larger threads if show desirer.

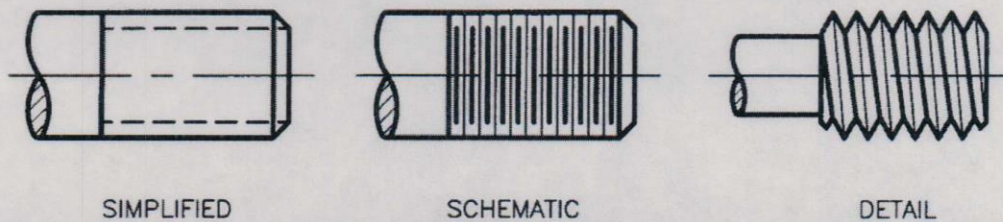


Figure 3. Thread Representation (External).

Conventional Practices: R1 (366), R2 (393-399), R3 (312-320)

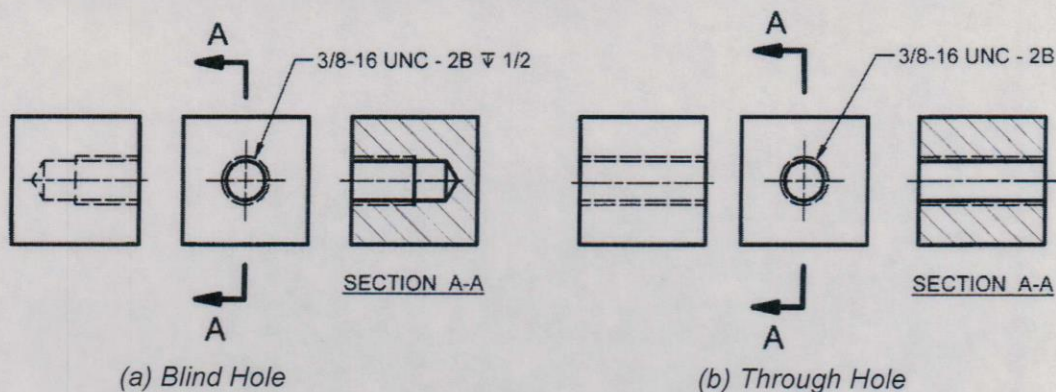


Figure 4. Simplified Method of an Internal Threaded Part.

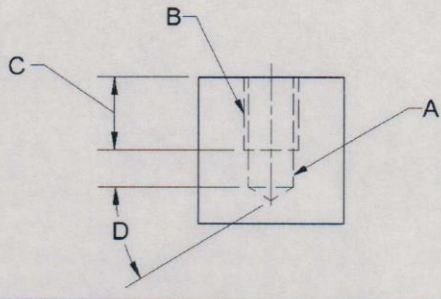


Figure 5. (a) Tap drill hole, (b) internal thread, (c) thread depth, and (d) tap representation usually drawn at 30° . The depth of the tap is taken from the horizontal hidden line at the end of the cylinder, and not the vertex of the angle.

Thread Annotations/Specifications: R1 (372-374), R2 (385-387), R3 (319-331)

Unified Annotations - The screw thread is specified by giving its nominal (major) diameter, number of threads per inch, class of fit, and external (A) or internal (B). If the thread is to be left-hand, include the letters LH after the class symbol. The size of the thread may be given on the drawing by using either fractional-inch sizes or decimal-inch sizes.

Example: **.75-10UNC-2A**

.75" = Major diameter of the thread.

10 = Threads per inch.

UN = Unified threads.

C = Coarse thread.

2 = Class 2 fit.

A = External thread.

Example: **.88-14UNF-2B**

.88 = Major diameter of the thread.

14 = Threads per inch.

UN = Unified threads.

F = Fine thread.

2 = Class 2 fit.

B = Internal thread.

Example: **.375-32UNEF-4A-LH**

.375 = Major diameter of the thread.

32 = Threads per inch.

UN = Unified threads.

EF = Extra Fine thread.

4 = Class 4 fit.

A = External thread.

LH = Left-hand thread.

Metric Annotations – ISO metric screw threads are specified by its nominal size (basic major diameter) and pitch, both expressed in millimeters. Include a (M) to denote that the thread is an

ISO metric screw thread. Place the unit of measure ("M" for metric) before the major diameter. Use "X" to separate the major diameter from the pitch.

Example: **M10 X 1.25**

M = Designates it as an ISO metric thread.
10 = Major diameter.
X = Separation between the diameter and pitch.
1.25 = Thread pitch.

Example: **M10**

M = Designates it as an ISO metric thread.
10 = Major diameter.
(This type annotation denotes a coarse metric thread).

Example: **M10 X 1.25 X 25**

M = Designates it as an ISO metric thread.
10 = Major diameter.
X = Separation between the diameter and pitch.
1.25 = Thread pitch.
X = Separation.
25 = Thread length.

Threaded Fasteners: *R1 (378-391), R2 (386402), R3 (321-331)*

- A. **Bolt** – Is an externally threaded fastener, with a hex or square type head and designed to hold two or more parts together with a nut or threaded part.
1. The bolt thread length is twice the major diameter plus .25" for bolts under 6" long and twice the major diameter plus .50" for bolts over 6" long.
 2. The thread length equals the bolt length only on short bolts.
 3. Heavy structural hex-head bolts contain a washer-like surface as an integral part of the head. Normally .016" thick.
 4. Hex and Square head bolts may be Unified coarse or fine series with a class 2 fit.
 5. Bolts and nuts are identified by a thread note, length, and head type. For example, **.625 -11UNC-2A X 1.50 LONG HEX HEAD**
- B. **Nut** – Is a bolt retainer.
1. Selected to match the bolts and the application needed.
 2. They are generally classified as flat, washer faced, plain, acorn, wing, and slotted.
 3. Designate nuts in the same matter as bolts, except the length is not required. For example: **.625-11 HEX NUT**.
- C. **Cap Screws** – Have finished heads and are used when appearance and accuracy are important.
1. Cap screws have a chamfer to the depth of the first thread.
 2. Used in the assembly of mating parts.

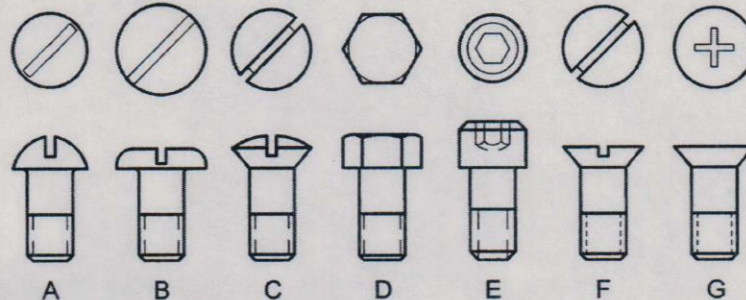
3. Typical cap screw annotation: **.437-14UNC-3 X 2.25 HEX CAP SCR**

Figure 6. Some Common Heads For Cap Screws Include: (a) Round, (b) Pan, (c) Oval, (d) Hex, (e) Socket, (f) Flat, and (g) Phillips.

D. **Machine Screws** – resemble cap screws but are smaller.

1. They are frequently used with nuts to fasten parts together.
2. Machine screws have no chamfers.
3. Machine screws are used in firearms, jigs, fixtures, and small mechanisms.
4. Common heads for Machine screws include flat, oval, round, fillister, truss, binding, and pan heads.
5. Typical cap screw annotation: **.312 X 2.25 OVAL MACH SCR**

E. **Set Screws** – are used to prevent relative motion, usually rotary, between two parts.

1. There are generally two types: square head and headless.
2. Because of safety issues the headless setscrew would be best for rotating parts.
3. Typical setscrew annotation: **.500 – 13UNC-2A X 1.50 SQ HD FLAT PT SET SCR**

F. **Wood Screws** – create their own thread when you drive them into soft woods such as pine and spruce.

1. Cone shaped shafts for easy entry into the wood.
2. Hard woods, such as maple or oak, may require drilling a pilot hole.

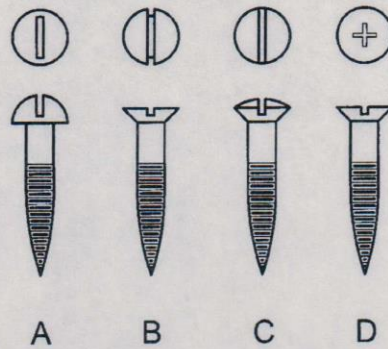


Figure 7. Some Common Heads For Wood Screws Include: (a) Round, (b) Flat Head Slotted, (c) Oval and (d) Flat Head Phillips.

Non-threaded Fasteners: R1 (386-392), R2 (391-392), R3 (330-331)

- A. **Keys** – Keys are used to prevent relative movement between, wheels, pulleys, gears, cranks, and similar parts to a shaft.
1. **Woodruff Key** – Is semicircular in shape and is often used in machine-tool work. The bottom of the key fits into a semicircular key slot cut with a Woodruff cutter and the top into a rectangular slot.
 2. **Square Key** – Design is used for heavy-duty functions. Sometimes referred to as a flat key.
 - a. The widths of keys generally used are about one-fourth the shaft size.
 - b. One half of the key is sunk into the shaft.
 - c. The depth of the keyway or the keyseat is measured on the side – not the center.
 3. **Gib Head Key** – It is exactly the same as the square key except that it has a gib head, which provides for easy removal.
 4. **Pratt & Whitney Key** – Is rectangle in shape with semi-cylindrical ends.

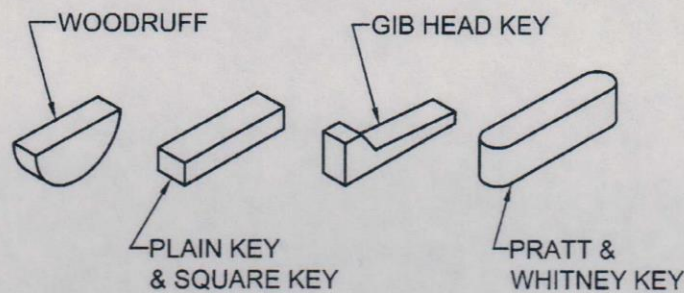


Figure 8. Key Types.

B. **Pins** – can be classified under two separate groups. One, which allows the assembly of parts that, might require the need for quick release. The other use as semi-permanent fasteners, design with an interference fit that would require the aid of tools for installation or removal. The following basic design rules should be followed:

1. The need for disassembly of parts by hand or tools.
2. Pins are usually designed for light work.
3. Use where appearance is not critical (pins need to protrude).
4. Type of machine pin to use.

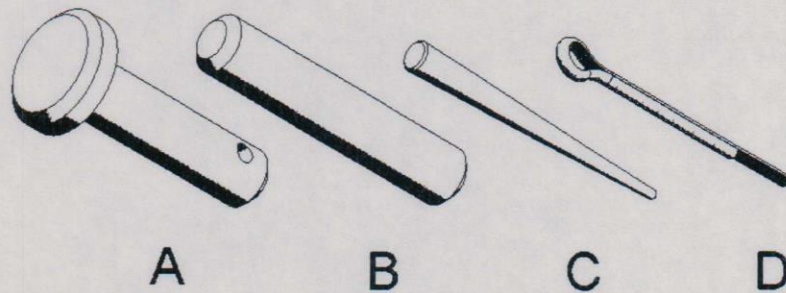


Figure 9. Most Common Types Are: (a) Clevis Pin, (b) Straight Pin, (c) Taper Pin, and (d) Cotter Pin.

C. **Rivets** – are regarded as permanent fasteners.

1. Generally used to hold sheet metal or rolled steel shapes together.
2. The shaft of the rivet is inserted into the aligned holes of the mating parts and then formed to create a head on the opposite end of the shaft, establishing a permanent assembly.

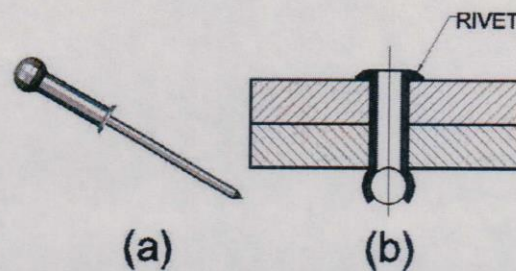


Figure 10. Rivet (a) Before Installation, (b) Installed.