MEM09208A

Detail fasteners and locking devices in mechanical drawings

First Published April 2013

Edition 1 – April 2013

Conditions of Use:

Unit Resource Manual

Manufacturing Skills Australia Courses

This Student's Manual has been developed by BlackLine Design for use in the Manufacturing Skills Australia Courses. It is supplied free of charge for use in approved courses only.

Feedback:

Your feedback is essential for improving the quality of these manuals.

Please advise the appropriate industry specialist of any changes, additions, deletions or anything else you believe would improve the quality of this Student Workbook. Don't assume that someone else will do it. Your comments can be made by photocopying the relevant pages and including your comments or suggestions.

Forward your comments to:

BlackLine Design

blakline@bigpond.net.au

Sydney, NSW 2000

Aims of the Competency Unit:

This unit of competency covers the skills and knowledge required to produce detailed engineering drawings containing fastening and locking devices.

Unit Hours:

36 Hours

Prerequisites:

MEM09002B	Interpret technical drawing
MEM09204A	Produce basic engineering detail drawings

Elements and Performance Criteria

1.	Determine drawing requirements	1.1	Check purpose, scope and information requirements for drawing
		1.2	Interpret available information relevant to project and work requirements, and identify and address further information needs
		1.3	Identify and prepare equipment required to complete work
		1.4	Identify and access organisational files, templates and symbols as required for work
2.	Identify system requirements	2.1	Access catalogues, tables, standards and specifications to determine required components
		2.2	Identify types of fasteners, their features, uses and thread types
		2.3	Identify mechanical location and locking devices, their features, uses and thread types
		2.4	Identify and apply relevant codes, standards and symbols used for components and methods used to locate on drawings
3.	Prepare detail drawing	3.1	Lay out drawing in accordance with the sketches and specifications
		3.2	Apply line work using a range of different line types and media in accordance with standard industry drawing practice
		3.3	Produce detail and assembly drawings containing engineering fasteners and location devices
		3.4	Ensure drawing accurately reflects specifications, is presented according to organisational requirements and contains all relevant information, including full notation and dimensioning
		3.5	Apply workplace occupational health and safety (OHS) and environmental procedures
4.	Document and store drawings	4.1	Document drawings and associated technical information in accordance with project requirements and organisational procedures
		4.2	Store drawings according to organisational procedures

Required Skills and Knowledge

Required skills include:

- literacy skills sufficient to read and interpret instructions, relevant codes of practice and specifications for drawing work
- using computer technologies and navigating software
- numeracy skills sufficient to interpret technical information and conduct mathematical problem solving as required in the scope of this unit
- using and maintaining drawing equipment
- applying spatial principles to achieve scale and proportion
- interpersonal skills to consult with other disciplines
- drafting skills
- applying symbols, schedules and legends to the drawing
- arranging the views in a logical manner and in accordance with AS 1100.101–1992 Technical drawing – General principles
- correctly using line thickness and construction to identify parts
- using correct method for identifying thread forms on detail and assembly drawings
- using engineering and manufacturer catalogues, tables, standards and specifications
- filing drawings according to workplace procedures

Required knowledge includes:

- general knowledge of different approaches to drawing
- awareness of copyright and intellectual property issues and legislation in relation to drawing
- environmental and OHS issues associated with the tools and materials used for drawing
- quality assurance procedures
- company standards for CAD
- order of drawing process
- company checking procedures for drawings
- layout and presentation
- the standards applicable to the work to be undertaken
- the process of checking the completed drawing
- the process of storing paper drawings and electronic drawing files
- the International System of Units (SI)
- the different types of fasteners used in the manufacture of an engineering project
- lubrication components and systems and lubricants
- terminology associated with the preparation of mechanical drawings
- different types of thread forms, types and sizes
- types of nuts and uses for locking purposes
- manufacturing processes required to create a drilled and tapped hole and a threaded feature
- grades of bolts and their applications

Lesson Program:

Unit hour unit and is divided into the following program.

Topic	Skill Practice Exercise
Topic 1 – Fastening Methods:	MEM09208-SP-0101 to MEM09208-SP-0103
Topic 2 – Bolts & Machine Screws:	MEM09208-SP-0201 & MEM09208-SP-0202
Topic 3 – Locking Devices:	MEM09208-SP-0301 & MEM09208-SP-0302
Topic 4 – Miscellaneous Fastening Devices	MEM09208-SP-0401 & MEM09208-SP-0402
Topic 5 – Washers:	MEM09208-SP-0501 & MEM09208-SP-0502
Topic 6 – Location Devices	MEM09208-SP-0601
Topic 7 - Circlips	MEM09208-SP-0701 & MEM09208-SP-0702
Practice Competency Test	MEM09208–PT-01

Contents:

Terminology:

Black Bolts And Nuts	The word black refers to the comparatively wider tolerances employed and not necessarily to the colour of the surface finish of the fastener.
Bolt	A fastening containing a head and a partly threaded shank that secures two or more components by a nut being tightened over the threaded shank.
Crest	The top surface joining two adjacent sides of the thread.
Depth of Thread	The distance between root and crest measured normal to the axis
External Thread	A screw thread which is formed on an external cylinder, such as on bolts, screws, studs etc.
Grip Length	Total distance between the underside of the nut to the bearing face of the bolt head; includes washer, gasket thickness etc.
HSFG Bolts (High Strength Friction Grip)	Sometimes abbreviated to HSFG bolts. Bolts which are of high tensile strength used in conjunction with high strength nuts and hardened steel washers in structural steelwork. The bolts are tightened to a specified minimum shank tension so that transverse loads are transferred across the joint by friction between the plates rather than by shear across the bolt shank.
Internal Thread	A screw thread which is formed in holes, such as in nuts.
Knurling	Knurling is a manufacturing process, typically conducted on a lathe, whereby a visually-attractive diamond-shaped (criss-cross) pattern is cut or rolled into metal to form a series of regular ridges or rectangles on a metal surface to help prevent slipping.
Lead	The distance parallel to the axis that the screw advances in one complete revolution.
Lefthand Thread	A screw thread that is screwed in by rotating counter clockwise.
Lock Nut	A nut which provides extra resistance to vibration loosening by either providing some form of prevailing torque, or, in free spinning nuts, by deforming and/or biting into mating parts when fully tightened.
Lock Washer	A washer with tongue and prongs to hold a lock nut in place.
Machine Screw	A fastening containing a head and a threaded shank, and secures two or more components by screwing into a tapped hole.
Major Diameter	The largest or outside diameter of a screw thread.
Minor Diameter	The smallest or root diameter of a screw thread.
Pitch	The distance between corresponding points on consecutive threads measured parallel to the axis.
Pitch Diameter	The diameter of the circle on a gear determined by dividing the number of teeth in the gear by the diametral pitch.
Preload	The tension created in a fastener when first tightened. Reduces after a period of time due to embedding and other factors.

Topic 1 – Fastening Methods:

Required Skills:

On completion of the session, the participants will be able to:

- List, draw and sketch thread forms noting features.
- List, draw and sketch thread types.
- Write the designation of thread forms.

Required Knowledge:

- Reason for joining components.
- Types of methods used for assembling and disassembling assemblies.
- Types of joints.
- Terminology applicable to mechanical fasteners and locking devices.
- Reading charts and manufacturer's specifications and catalogues

Lesson Purpose:

The section is designed to give the students an understanding of **WHY** it is often necessary to join components in such a way that it is possible to assemble and disassemble them later without damage. The section includes threads and teaches the student how to represent threaded holes and fittings.

Joining of Components:

The cost of assembly labour and equipment, as well as space requirements for assembly operations and equipment depends on the ease and speed with which it can be made.

Ease of manufacture

Several factors contribute to the ease of manufacture:

The complexity of the shape may mean that the object must be manufactured in several parts and then joined either temporarily or permanently. The casing of a carburettor from a motor vehicle could not be manufactured from a solid block as the valves and needles could not be accurately positioned; the top of the casing is held in place by several screws.

a) The size or weight of an object determines whether it can be manufactured as a single element, or if it requires fabrication in two or more pieces. Most equipment used on ships must be able to be removed from the ship through a hole measuring approximately 3m x 2m,

b) The availability of equipment determines if an object is to be constructed in one piece or whether fabrication is required. Special equipment may be required for the manufacturing process and therefore the job may become financially unenviable. To overcome the problem, the object could be manufactured in smaller sections using the equipment available and fabricated or assembled on completion.

Use of a number of different materials

Many components are manufactured using different materials; very few objects in the manufacturing industry are made from a solid block. Resilient mounts remove vibrations on finely tuned instruments and consist of metal pads separated by a rubber block, the two pads can be glued to the rubber. An aluminium fitting may need to be secured to a steel structure, welding of these two metals is impossible with the current techniques available therefore other joining methods must be used.

Size limitations on individual components

a) Most objects are required to be transported after manufacture, the larger the object the greater the transport costs. To reduce the transportation costs of large jobs, the components are broken into smaller sub-assemblies then reassembled on site.
b) Large components require special handling equipment; therefore, being able to assemble the object on site in smaller sections could eliminate the special equipment.
c) Machine capacity
d) Erection problems can be overcome by joining smaller sections. Large sections could be hard to handle on a work site due the effects of wind or gravity; smaller sections can be easily handled.
e) Weight of objects is a problem on many construction sites. Heavy components require special lifting apparatus and increase the cost of the project. By using smaller sections, smaller lifting equipment such as winches could be used instead of heavy mobile cranes.
f) Volume

Servicing

Most machinery requires servicing therefore, the components require jointing allowing the service technician access for maintenance and repairs.

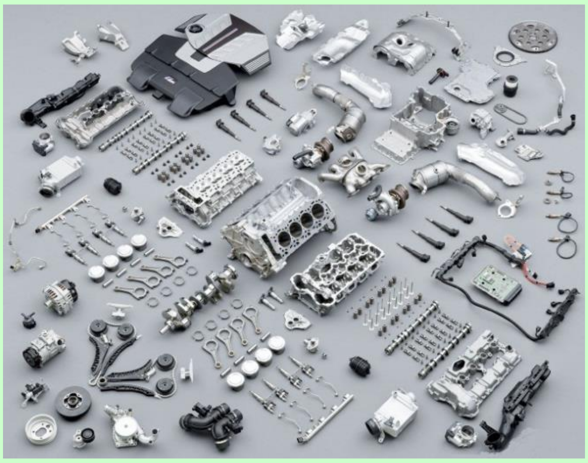


Figure 1.1

Figure 1.2

In Figure 1.1 the various components required to be assembled are logically laid out prior to assembly. Figure 1.2 shows the assembled engine ready for fitting into the engine bay of a vehicle.

Replacement of worn or broken parts

Machinery often requires the replacement of broken or worn parts; by having a joint, the machinery can be easily stripped to replace the effected parts. Motor vehicle engines require the rings on the pistons to be replaced when worn. The engine can be removed from the vehicle and access gained to the internal areas of the engine by removing the engine head and sump cover.

Figure 1.3

Figure 1.4

Figure 1.5

Figure 1.3 shows a spur gear where some teeth have been broken off. Figure 1.4 is a piston where the bottom casing has been corroded or broken away. Figure 1.5 is a shaft which has shattered due to excessive stresses.

Disassembly for transport

Components can be assembled in the workshop to ensure they work correctly then disassembled and transported prior to their reassembly on site. By being able to assemble a project in the workshop, many problems of assembly can be discovered and overcome without the need of transporting one or more components between the workplace and final assembly site.

Figure 1.6

Figure 1.7

Figure 1.6 shows a truck moving a house which results in roads or lanes being closed, traffic chaos, electricity lines raised and forward planning to avoid low bridges. Figure 1.7 however shows a truck moving the wall and roof trusses a similar sized building without the accompanying headaches of the former method.

Methods of Joining Components:

The different methods for joining components include Bolts, Screws, Keys, Rivets, Taper Locks and Adhesive Bonding.

Bolted:

The bolt is widely used in all industry to fasten components together in conjunction with a nut to form a non-permanent connection between 2 or more parts. The bolt has a head, and shank that is threaded for a short length.

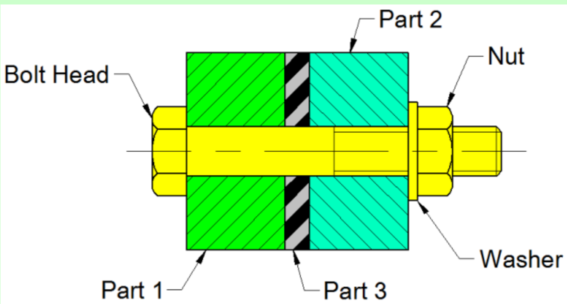


Figure 1.8

Figure 1.9

In bolted joints, the bolt passes through all components and is tightened with a washer and nut.

Screwed:

Screws are similar to bolts but are generally used in lighter situations. Two types of screw are available for use in either timber or metal; metal screws are called machine screws and have shanks that are threaded for the entire length. Wood screws have tapered shanks with a coarser thread.

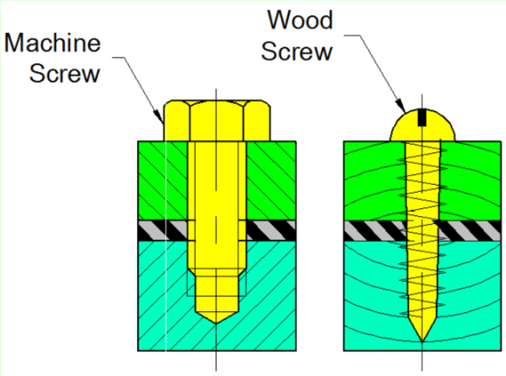


Figure 1.10

Figure 1.11

Figure 1.12

Fasteners in screwed joints do not protrude through the last component and are embedded in "*blind*" holes. Figure 1.11 shows an assembly where metal components have been joined while Figure 1.12 displays a metal bracket being screwed to a timber or plywood/particle board base.

The origin of the screw is unknown. It does not appear in any of the artefacts or paintings from ancient Babylon, Crete, Troy or the Egyptian tombs and is not mentioned in the writing of Homer or other Greek writers. The earliest records of the screw are found in the writings of Archimedes (278-212BC), although specimens of ancient Greek and Roman screws are so rare as to indicate that they were seldom used. By the Middle Ages, the screw was in common use and it is known both dyes and lathes were used to cut threads however most threads were cut by hand, forging the head and cutting the slot with a saw and fashioning the thread with a file. In colonial times, wood screws were blunt on the end, the gimlet point not appearing until 1846. Iron screws were individually made for each tapped hole and as there was no interchangeability of parts, the nuts had to be tied to their own bolts. Sir Joseph Whitworth made the first attempt at a uniform standard in 1841 and although adopted by the United Kingdom, was disregarded by the United States.

The initial attempt to standardise screw threads in the United States came in 1864 with the adoption of a report prepared by a committee appointed by the Franklin Institute. The system that came into use was called the "United States Thread" and although fulfilling the need of the period was inadequate for use with automobiles and aircraft. In 1919 Congress authorised the National Screw Thread Commission and inaugurated the American series of thread.

Keyed:

A key is a piece of metal lying partly in the groove of a shaft and extending into another groove in the hub are used to transmit motion from the shaft through to the hub, or vice versa, without slippage. Keys can also be used to prevent machine parts from moving relative to another part in a given direction. Keys are normally manufactured from metal and have square or rectangular cross sections or circular in shape.

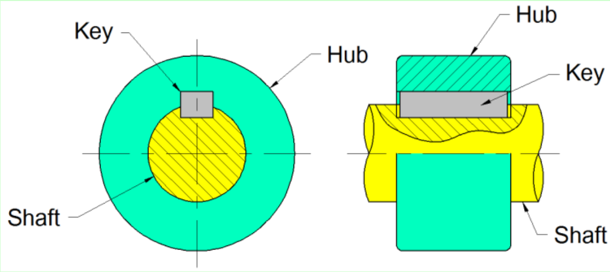


Figure 1.13

Figure 1.14

Riveting:

A rivet is a permanent mechanical fastener consisting of various types requiring different methods for installation. Traditionally, before being installed a basic rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite the head is *clinched*. On installation the rivet is placed in a punched or drilled hole, and the tail is *clinched* (i.e., deformed), using a ball-peen hammer or rivet gun so that it expands to about 1.5 times the original shaft diameter and holding the rivet in place. To distinguish between the two ends of the rivet, the original head is called the *factory head* and the deformed end is called the *clinched* end.

Figure 1.15

Figure 1.16

Figure 1.17

Different styles of rivets are shown in Figure 1.15 – Pop Rivet, Figure 1.16 Solid Rivet & Figure 1.17 Huck Bolt.

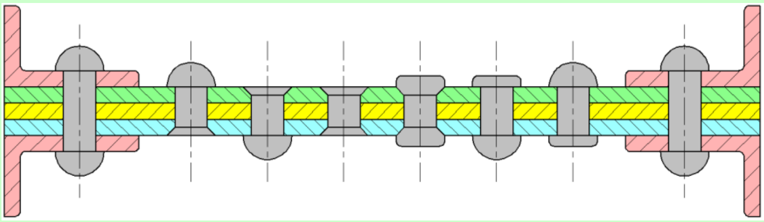


Figure 1.18

Figure 1.18 indicates the various rivet head shapes.

Taper Locking:

Taper Locks are tapered split bushings fit into a matching tapered bore in a sheave, sprocket, pulley, etc., they are used to securely mount the product onto a shaft. Taper locks allow a product to be securely mounted to any shaft size within the range of the bushing series with no need for remachining. Tapered bushing compensates for normal variations in shaft and component dimensional tolerances and allows an Easy-on/Easy-off, no fretting corrosion between bore and shaft. Taper-Lock bushings are flangeless for clean, compact application.

Figure 1.19

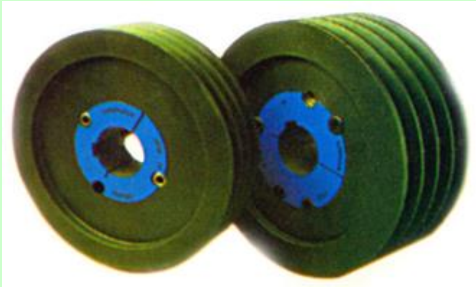


Figure 1.20

Figure 1.21

Adhesive Bonding (Gluing):

When two or more parts are to be joined into an assembly, adhesives permit a strong, durable fastening between similar materials and often are the only fastening method available for joining dissimilar materials. Structural adhesives are made from the same basic resins as many plastics and thus react to their operating environment in a similar manner. In order to provide maximum strength, adhesives must be applied as a liquid to thoroughly wet the surface of the part. The bonding surface must be chemically clean to permit complete wetting. Basic plastics vary in physical properties, so adhesives made from these materials also vary.

Figure 1.22

Figure 1.23

Figure 1.22 shows adhesively bonded PVC piping; the faint ring where the pipes fit into the fittings is the expulsion of excess adhesive on assembly Figure 1.23 is a branded can of PVC cement.

Thread Forms:

Standards for machine screw threads have existed since the mid nineteenth century, to facilitate compatibility between different manufacturers and users. Many of these standards also specified corresponding bolt head and nut sizes, to facilitate compatibility between spanners and other driving tools. Nearly all threads are oriented so that a bolt or nut, seen from above, is tightened (the item turned moves away from the viewer) by turning it in a clockwise direction, and loosened (the item moves towards the viewer) by turning anticlockwise; this is known as a right-handed thread. Threads oriented in the opposite direction are known as left-handed. There are also self-tapping screw threads where no nut is required. Left-handed threads are used:

- Where the rotation of a shaft would cause a conventional right-handed nut to loosen rather than to tighten, e.g. on a left-hand bicycle pedal.
- In combination with right-handed threads in turnbuckles.
- In some gas supply connections to prevent dangerous misconnections.
- In antenna connectors on some Wireless LAN access points, to prevent the connection of a non-FCC approved antenna.
- In some instances, for example early "Biro" pens, to provide a "secret" method of disassembly.

Screw threads are normally manufactured by one of three methods:

- Cutting: The excess material is removed, with taps and dies for smaller diameters, or with a thread-cutting lathe for larger ones.
- Rolling: The material is extruded into a thread through mechanical pressure. Common for high-production threads of diameters typically smaller than one inch. A rolled thread is instantly recognizable because the thread has a larger diameter than the blank rod from which it has been made. The threads of bicycle spokes provide a perfect example. Rolled threads tend to be slightly stronger than cut threads.
- Casting: Material is either heated to a liquid (or rarely a gas), or dissolved in a liquid that will evaporate and allow the material to solidify (such as plaster or cement). Alternately, the material may be forced into a mould as a powder and compressed into a solid, as with graphite.

Acme:

Acme threads have a trapezoidal section, are easier to cut and have greater root strength than a square thread. Acme threads are used for power transmission and sometimes used for the lead screw in lathes. Machining on a lathe forms the threads.

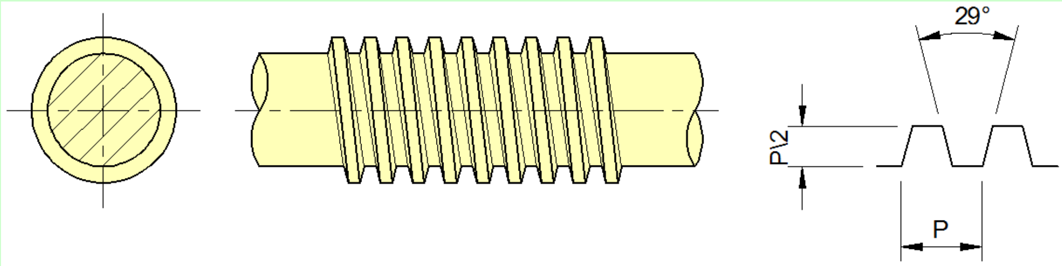


Figure 1.24

Buttress:

Buttress threads are used for power transmission and combine the advantage of both square and acme threads. The thread takes pressure in one direction only – against the surface perpendicular to the axis. Machining on a lathe forms the threads.

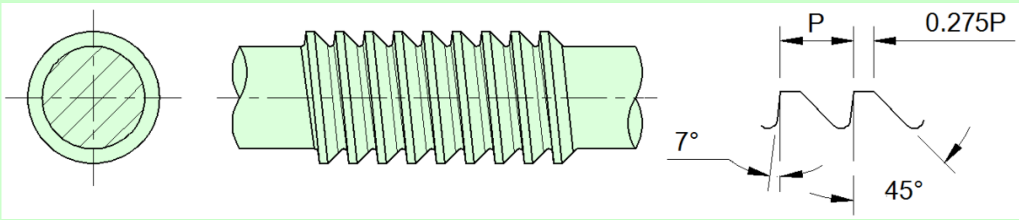


Figure 1.25

Round:

The Round or Knuckle Thread is usually manufactured by rolling or casting. The thread form is only used where an object is to be secured where little if any loads are sustained.

A typical example of the thread form is seen on electric light bulbs and sockets.

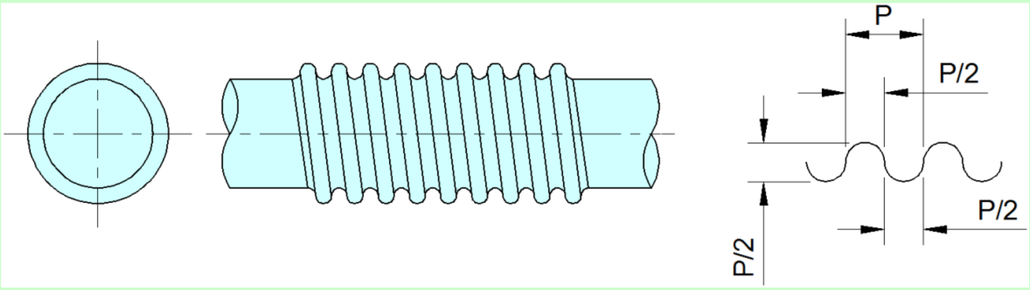


Figure 1.26

Square:

The Square Thread is mechanically strong and is used for mainly power transmission. Machining on a lathe forms the thread. There is no radial forces acting on the nut and friction is low.

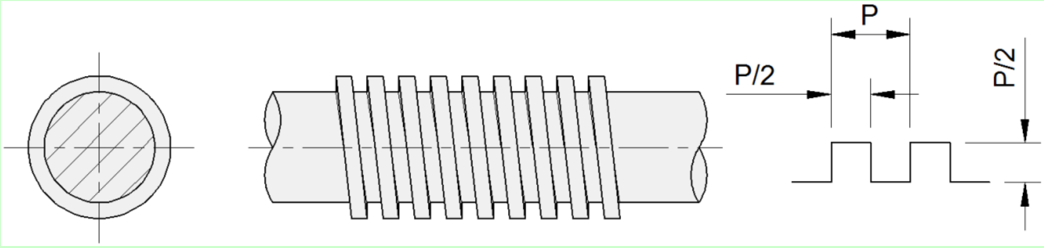


Figure 1.27

Vee:

There are several types of Vee Thread forms used throughout industry and are primarily used for fasteners. The original Vee type thread had sharp threads but was replaced due the difficulty in maintaining sharp roots during quantity production. Vee shape threads are not desirable for transmitting power as the thrust tends to burst the nut

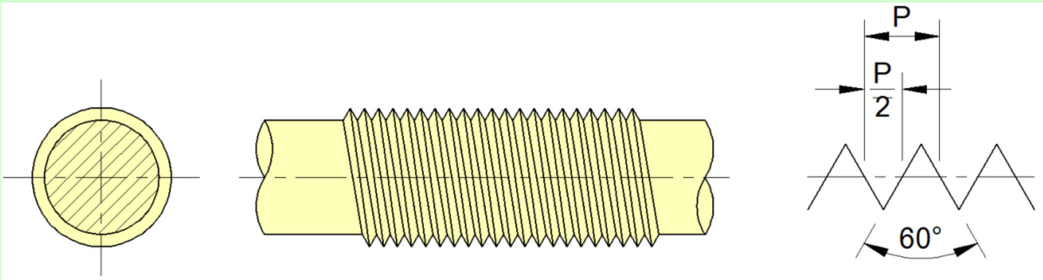


Figure 1.28

Modern Vee thread forms may contain flat or rounded crests and a rounded root. The angle of the thread can alter, depending on the particular type of thread being used i.e., British Standard Whitworth, British Standard Fine, Metric Coarse, Metric Fine, Unified National Coarse and Unified National Fine.

Thread Types:

It might be thought that after centuries of use, a seemingly simple a thing as a thread could have been brought to perfection, but unfortunately, many countries differ with the type of thread forms used and specific engineering problems require different thread forms due to forces or manufacturing costs. The main thread forms used throughout the world are based on American, French or British Standards.

The main features of all threads are the Major Diameter, Effective or Pitch Diameter, Minor Diameter and the Pitch of the thread.

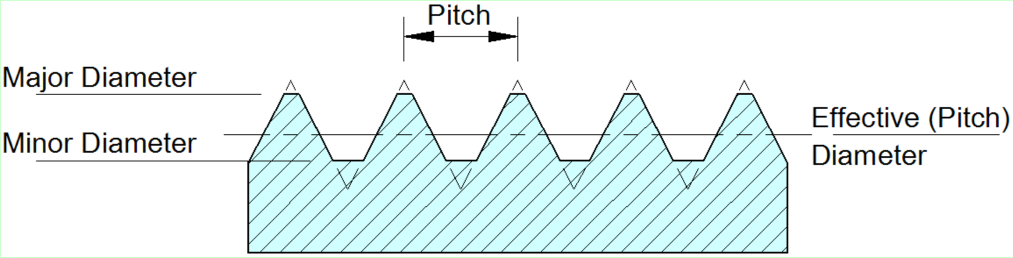


Figure 1.29

Metric Coarse and Metric Fine (M)

The Metric Series of threads has been agreed upon for all international screw thread fasteners. The crest and root are flat (but can be rounded) while the thread form is similar in shape to the Unified Thread but with less depth of thread. The thread is represented on drawings by the abbreviation M.

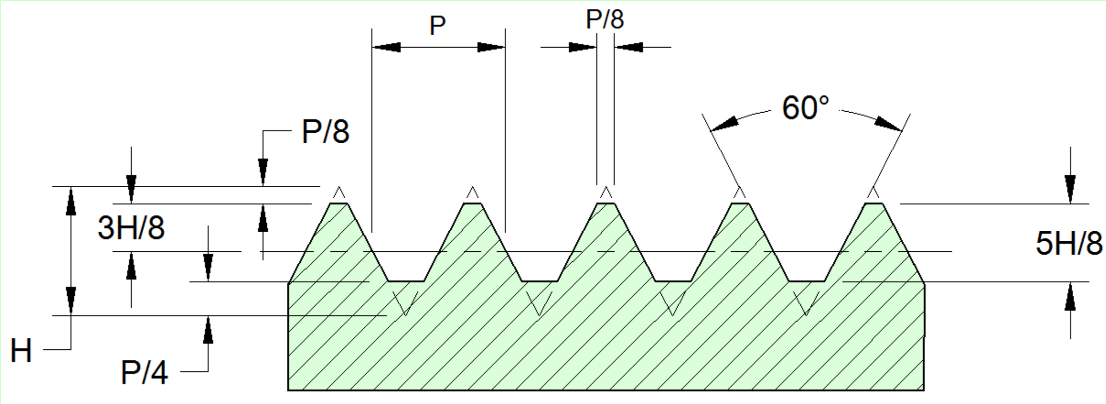


Figure 1.30

Example: M6 x 1 – 6H/6g B LH

M = Metric thread designation
6 = Major diameter of thread size
1 = Pitch of thread
6H/6g = Class of fit
B = Internal thread (A = External thread)
LH = Left hand thread (RH= Right hand thread)

British Standard Whitworth (BSW)

The Whitworth thread has been the British Standard thread but is being replaced by the Unified Thread. The shape of the thread is based on an included angle of 55° with radius roots. The thread is represented on drawings by the abbreviation BSW.

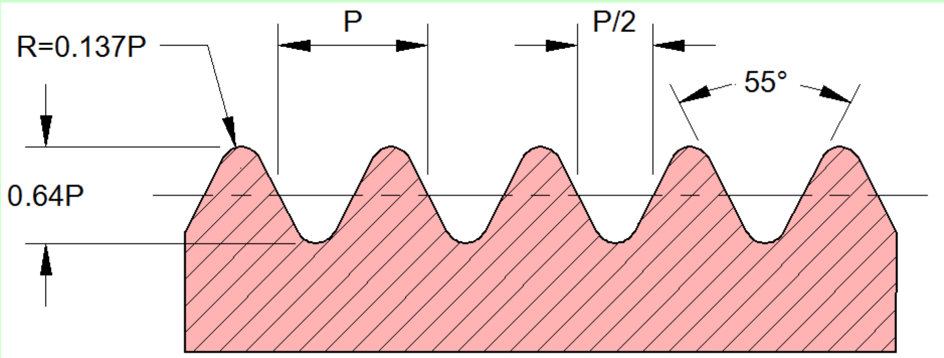


Figure 1.31

British Standard Fine (BSF)

The British Standard Fine is used for small threads that have a thread shape of 47½° included angle. The thread is represented on drawings by the abbreviation BSF.

Unified National Coarse and Unified National Fine (NC & NF)

Canada, the United Kingdom and the United States of America agreed to use the Unified Thread. The thread form has a rounded root while the crest may be flat or round and is represented on a drawing by the abbreviations NC & NF.

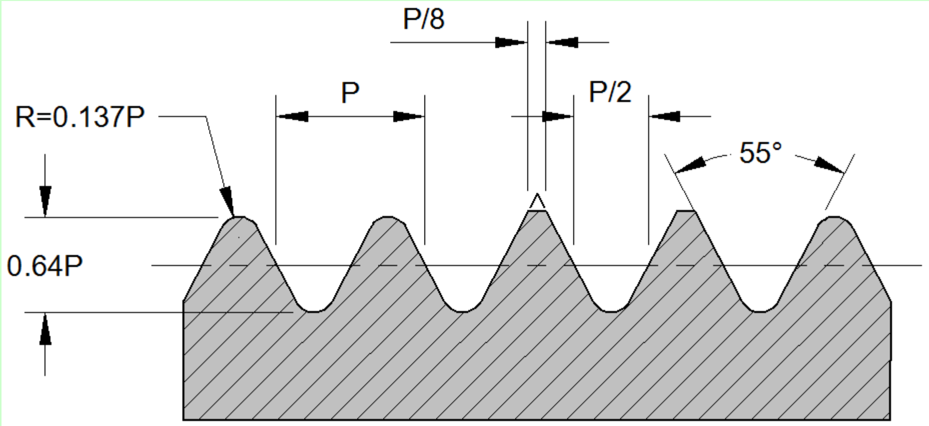


Figure 1.32

Example: ¼-20 UNC-2B LH
¼ = Major diameter of thread
20 = Number of threads per inch
Series UNC = Unified Form - Coarse Series
UNF = Unified Form - Fine
N = National form with special pitch
2 = Class of fit
B = Internal thread (A = External thread)
LH = Left hand thread (RH= Right hand thread)

Form Thread Class:

The different thread classes have differing amounts of tolerance and allowance. Classes 1A, 2A, 3A apply t external threads; Classes 1B, 2B, 3B apply to internal threads.

Classes 2A and 2B - The maximum diameter of uncoated (unplated) class 2A, (external) thread are less than the basic by the amount of allowance. When a coating is intended, the max diameter of class 2A may be exceeded by the amount of allowance. For an internal thread, the minimum diameters are basic whether or not coated (plated)--no allowance is available at the maximum metal limits.

Classes 3A and 3B - are used for closer tolerances than those available from classes 2A and 2B. The maximum diameters of Class 3A (external) threads and the minimum diameters of Class 3B (internal) threads are basic, whether coated (plated) or not--thus no allowance or clearance is available for assembly of components at maximum material condition.

Classes 1A and 1B - are the replacement threads for American National Class 1. They are intended for special applications involving replacement parts, for quick and easy assembly even when the threads are slightly damaged or dirty.

General Thread Representation:

The methods shown in Figure 1.33 are recommended for the representation of left, or right hand screw threads. The diameter of a thread is the nominal size of the thread, for example, for a 10mm thread (M10), D=10mm. Note that when the threads are shown in cross section, the hatching is taken through the tapped hole to the edge of the drilled hole.

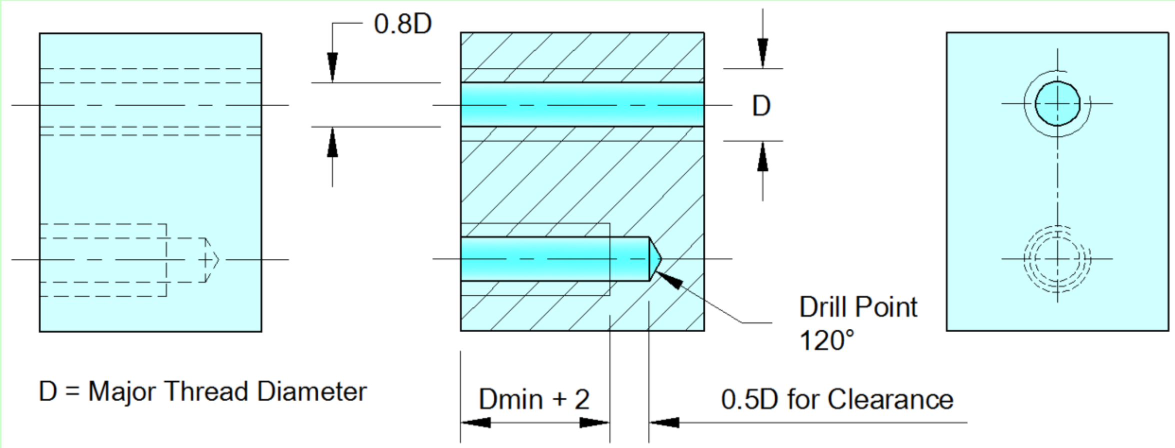


Figure 1.33

The diameter of the drill hole is determined by the pitch of the thread; the depth of the hole depends on the length of the fastening and the thickness of the other components that the fastening is passing through. Generally, the depth of the tapping hole has a minimum depth equal to the diameter of the fastening however must be sufficient to take the full length of the fastening plus 2mm for tightening. The depth of the drill hole is equal to the depth of the tapping hole plus ½ the diameter of the tapping hole.

Tapped Holes:

A tapped hole is made by first drilling a hole to the required depth and then using a series of taps to form the thread inside the hole. Depending on the thread diameter, material and thread pitch, a number of different taps may be required to form the thread. Bottom taps have a chamfer (lead) of 1–2 threads, the angle of the lead being around 18 degrees per side and are used to produce threads close to the bottom of blind holes. Second taps have a lead of 3-5 threads at 8 degrees per side and are the most popular as they can also be used for through holes, or blind holes where the thread does not need to go right to the bottom. Taper taps have a lead of 7-10 threads at 5 degrees per side. The taper lead distributes the cutting force over a large area, and the taper shape helps the thread to start; they can therefore be used to start a thread prior to use of second or bottom leads, or for through holes.

Some taps are combined with the drill so only one operation is required.

Figure 1.34 – Bottom Tap

Figure 1.35 – Second Tap

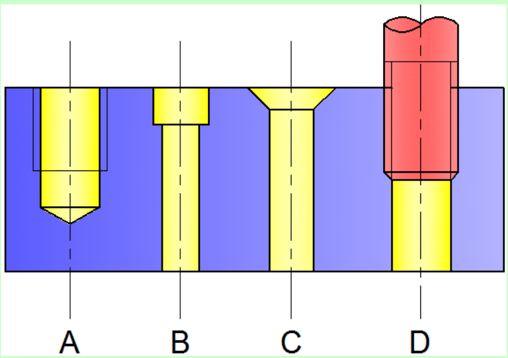
Figure 1.36 - Taper Tap

Figure 1.37 - Combined Drill & Tap

The diameter of the drilled hole can be established by referring to **Error! Reference source not found.**

Skill Practice Exercises:

Skill Practice Exercise MEM09208-SP-0101.
Create a new drawing using the template file called DRILLED PLATE provided in the template and complete the partially drawn detail as shown below:



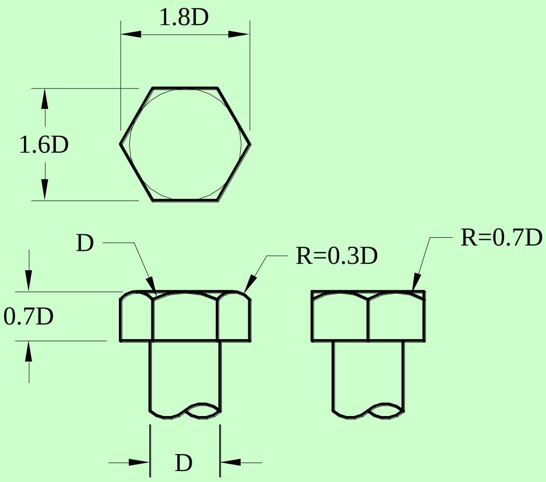
Holes:

A: Drill Ø33x2x65 deep and then tap to M40x 45 deep.
B: Drill Ø20 through and counterbored Ø30x20 deep.
C: Drill Ø24 through with Ø48x90° countersink.
D: Drill Ø32 through and tap through to suit M39x3 thread. Show a threaded object protruding 50mm into the hole.

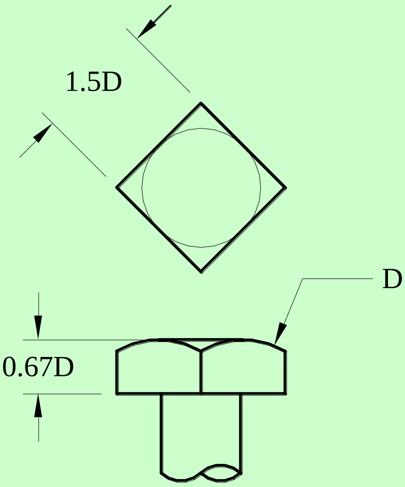
Save the drawing in your work folder as MEM09208-SP-0101 and plot the final drawing on an A4 sheet to an appropriate scale complete with a standard title block and border.

Tables

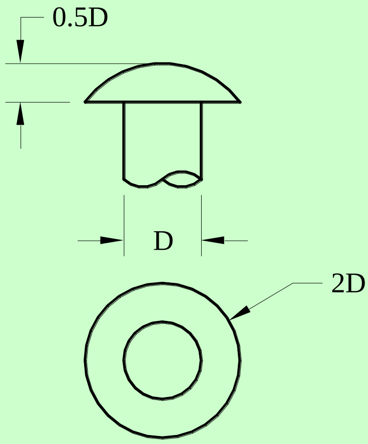
Table 1 – Proportions of Standard Bolts



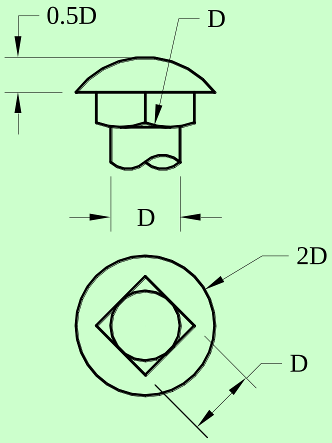
Hexagonal Head



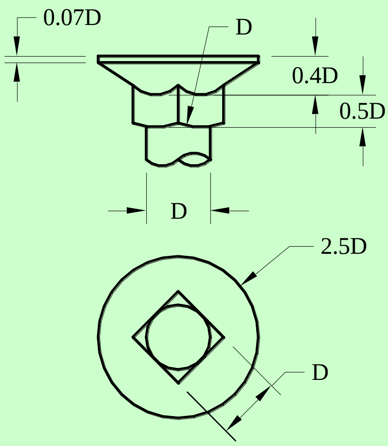
Square Head Bolt

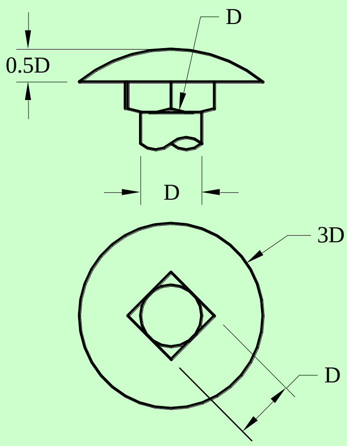


Round Head Bolt



Carriage or Square Neck Head Bolt

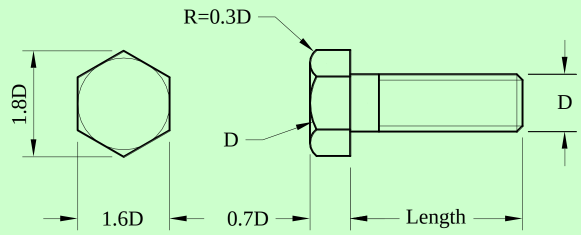




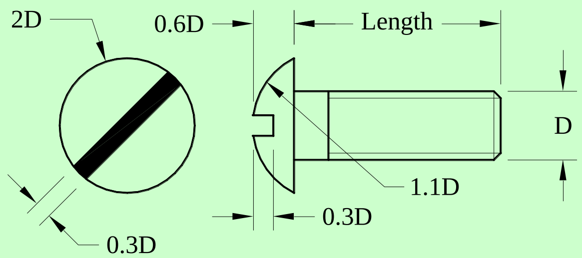
Countersunk Head Bolt

D = Nominal Diameter of Thread

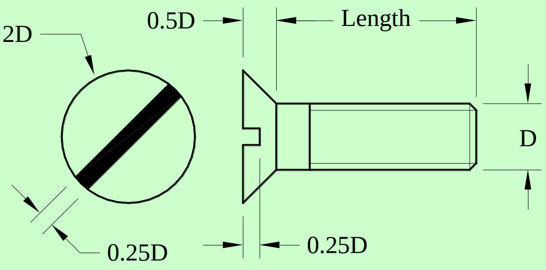
Table 2 - Proportions of Standard Machine Screws



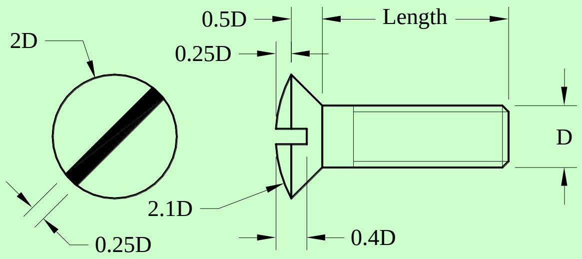
Hexagonal Head Machine Screw



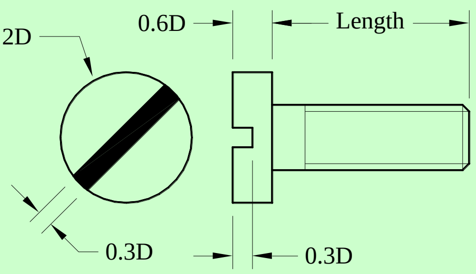
Round Head



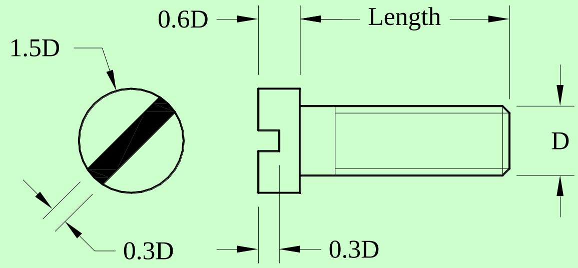
Countersunk Head



Raised Head Countersunk

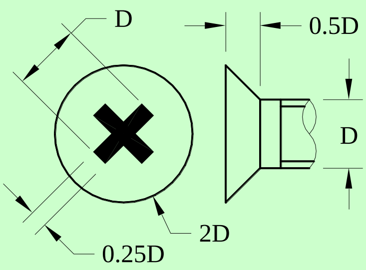


Pan Head

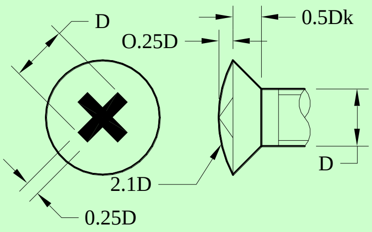


Cheese Head

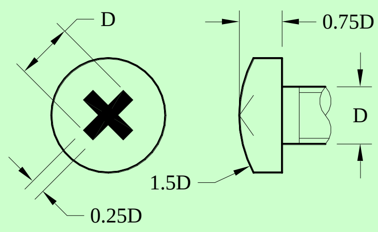
Phillips Head Fastenings



Countersunk



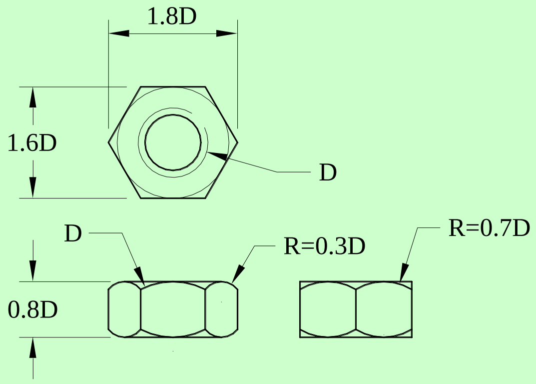
Raised Countersunk



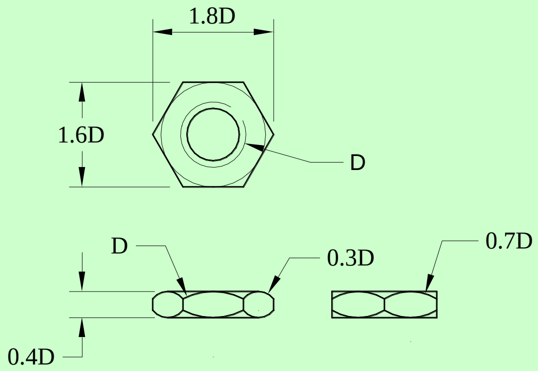
Pan

D = Nominal Diameter of Thread

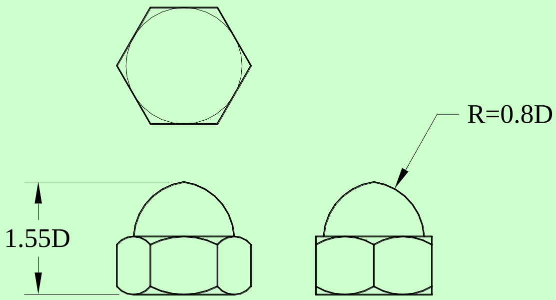
Table 3 – Proportions of Standard Nuts & Washers



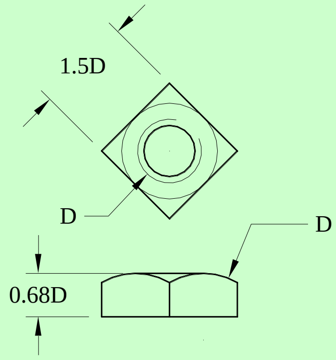
Hexagonal Nut



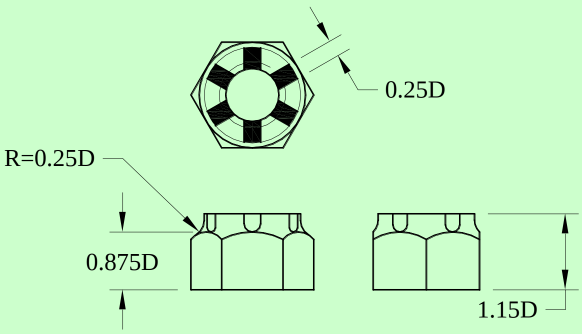
Hexagonal Lock Nut



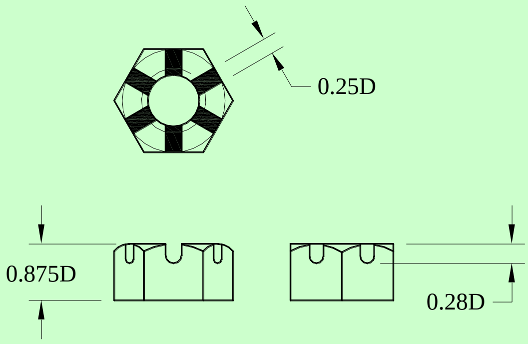
Acorn Nut



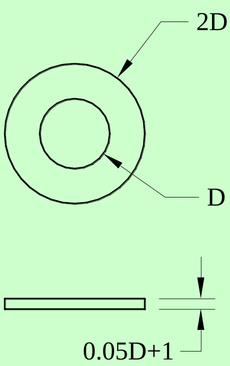
Square Nut



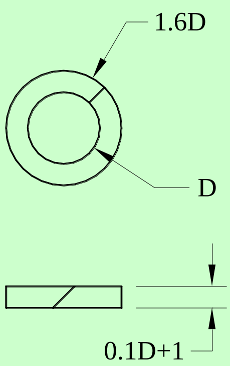
Castle Nut



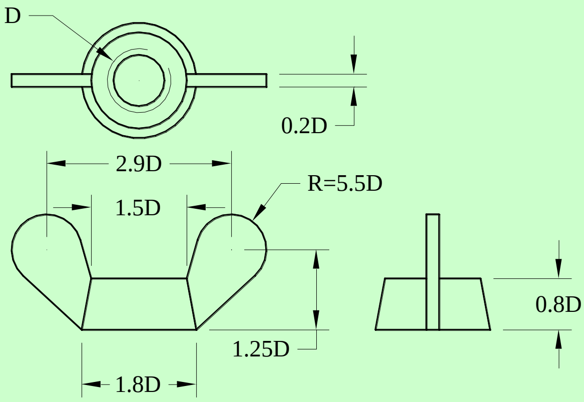
Slotted Nut



Plain Washer



Split Washer

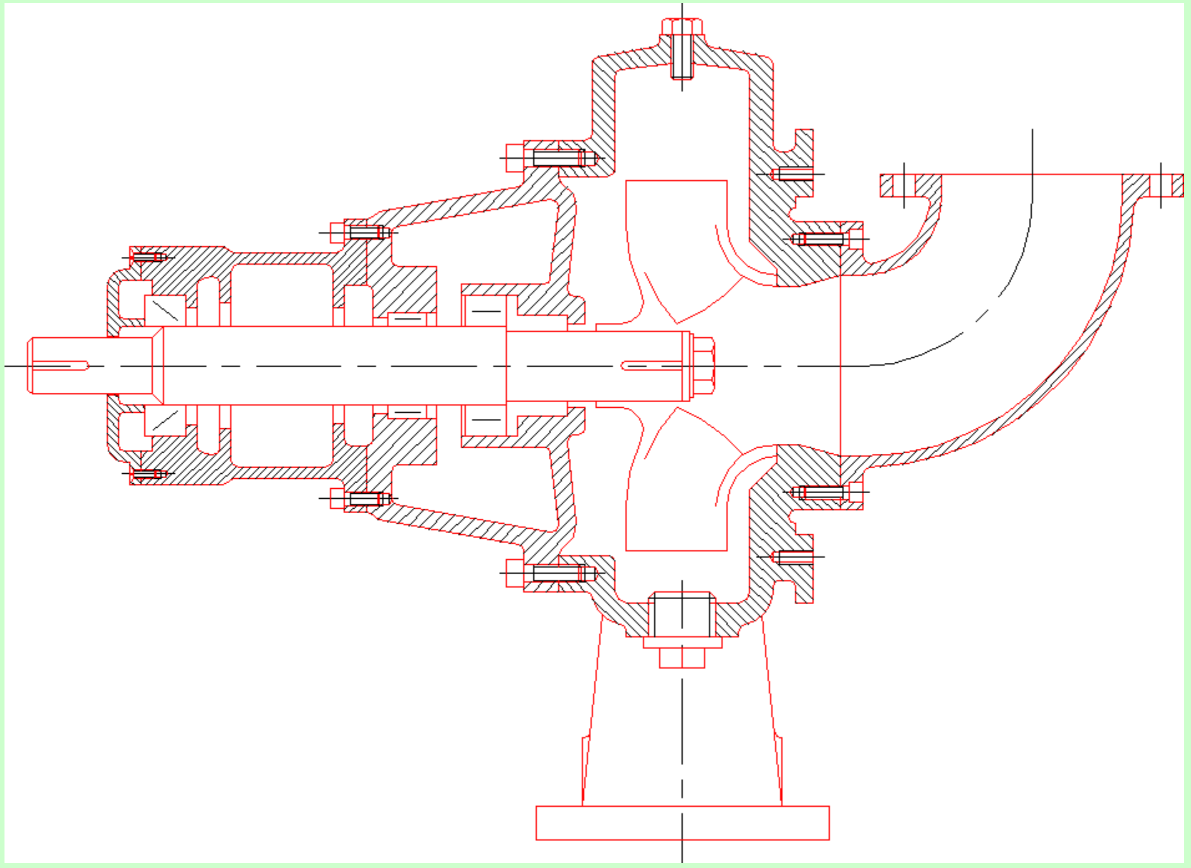


Wing Nut

D = Nominal Diameter of Thread

Sample Completed Exercise:

Unless a specific Assembly drawing is required with completed sheet, Title Block, Parts List and cross-referencing, the assembly drawing shows the draftsperson's skills in placing holes and fastenings on the drawing.



The detail drawing must show all views, dimensions and notation to manufacture the component. Specific skills targeted are the indication of sizing and drawing holes; fastenings will not be indicated. All completed drawings must include a border and Title Block.