Rivets - types & uses

Objectives : At the end of this lesson you shall be able to
- **state what is riveting**
- **state the uses of a rivet**
- **name the features of a rivet**
- **name the different types of rivets.**

Riveting (Fig. 1)

Riveting is a method of making permanent joints. For riveting, the plates to be joined are drilled or punched The head on the other end is formed after assembling the parts.

The main features of rivets used in self-piercing riveting are:

Shank diameter and rivet length

Shape of rivet head and tail design

Rivet material and hardness

Type of crating/plating

Types of rivets

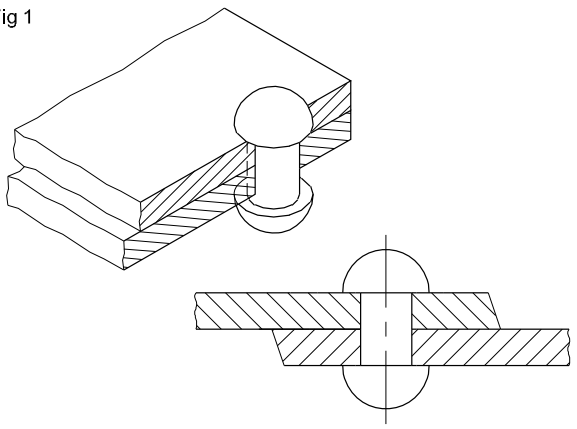
1 solid/round rivets

2 Semi tubular rivets

3 Blind rivets

4 Oscar rivets

Fig 1



5 Drive rivets

6 Flesh rivets

7 Friction-lock rivets

8 Rivet alloys shear strength and driving conditions

9 Self-piercing rivets

Rivet proportions

Objectives : At the end of this lesson you shall be able to
- **determine the hole sizes for different diameters of rivets**
- **choose the rivet diameters according to the thickness of the plates/sheets**
- **calculate the length for different diameter rivets and plate sizes.**

In order to produce efficient and good quality riveted joints the following aspects are important.

The size of the hold drilled for inserting the rivets.

The diameter of the rivet in proportion to the thickness of the plates/sheets to be joined.

The length of the rivet according to the type of the rivet and the thickness of the plates/sheets.

The size of the rivet and hole

The size of the hole to be drilled is according to the diameter of the rivet used.

A formula generally used for determining the diameter of a solid rivet is

D.Min = T

to D.Max = 2T

The actual value used will depend upon the actual joint features and service conditions.

The size of the hole has to be slightly larger than the nominal diameter of the rivet (Table 1)

For hot working, rivets will have holes with more clearance than for cold working.

TABLE 1

Hole diameter for rivets

Rivet nomial dia	2	3	4	5	6	8	10	12	15	15-40
Hole dia	2.2	3.2	4.2	5.3	6.3	8.5	11	13	16.5	Holes largethan the nominal dia by 1.5. to 2.0mm

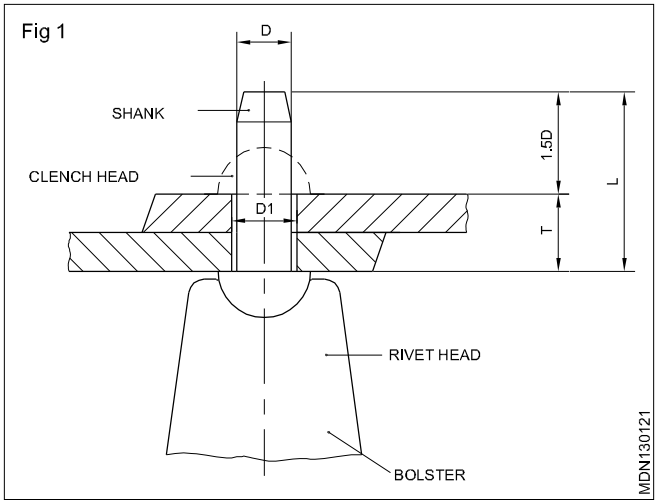
Length of rivets

The length of a rivet is the shank length. This will vary according to the thickness of the plates to be riveted and the type of the rivet head.

A formula generally used in the shop floor is

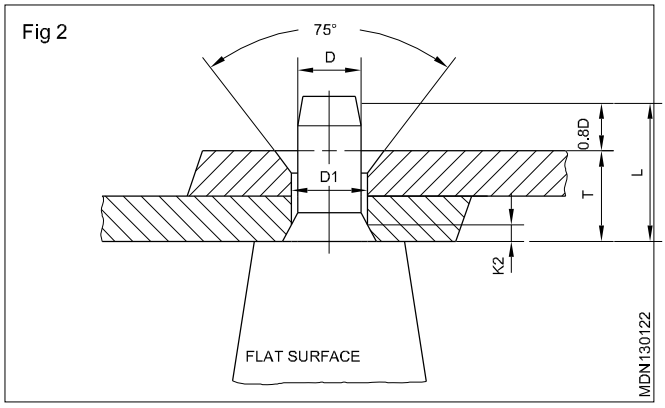
length of snap-head rivets (Fig 1)

L = T + 1.5 D



Length of countersunk head rivets (Fig 2)

L	=	T + 0.6 D
L	=	shank length
T	=	total thickness of the number of plates used
D	=	rivet diameter
D1	=	hole diameter



The rivets are then inserted and closed by force so that they completely fill the hole and form a rigid joint.

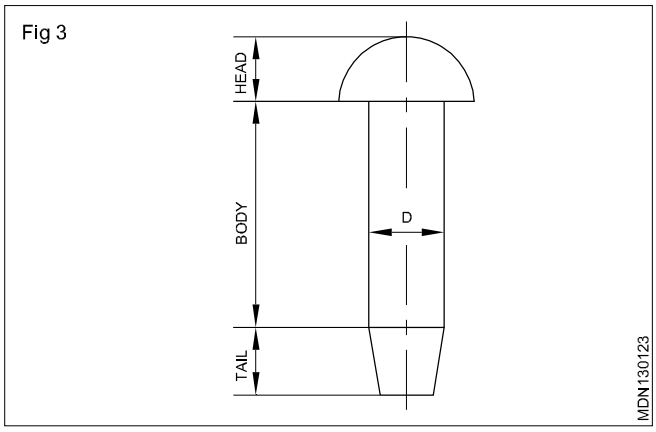
Uses

Rivets are fasteners used for joining metal sheets and plates in fabrication work such as bridges, ships. cranes. structural steel work, boilers, aircraft etc.

Parts (Fig 3)

The following are the parts of a rivet.

Head



Body

Tail

Materials

In riveting, the rivets are secured by deforming the shank to form the head. These are made of ductile materials.

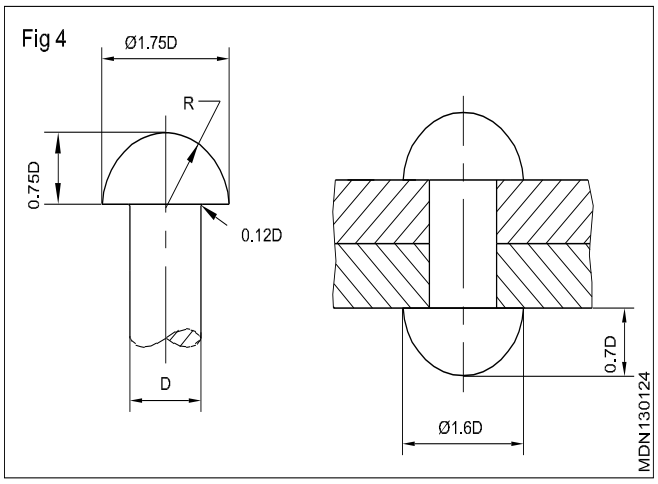
Examples

Low carbon steel, brass, copper and aluminium.

Rivet head-shapes

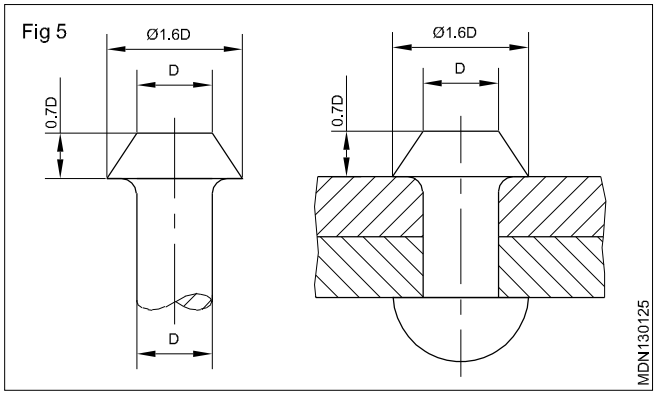
Snap-head (Fig 4)

This rivet is most commonly used for structural works. The opposite end of the rivet is shaped similar to the head.



Pan head (Fig 5)

It is a very strong rivet. The opposite end is usually finished to the snap-head shape. Pan head rivets are used in heavy construction.



Riveted joints

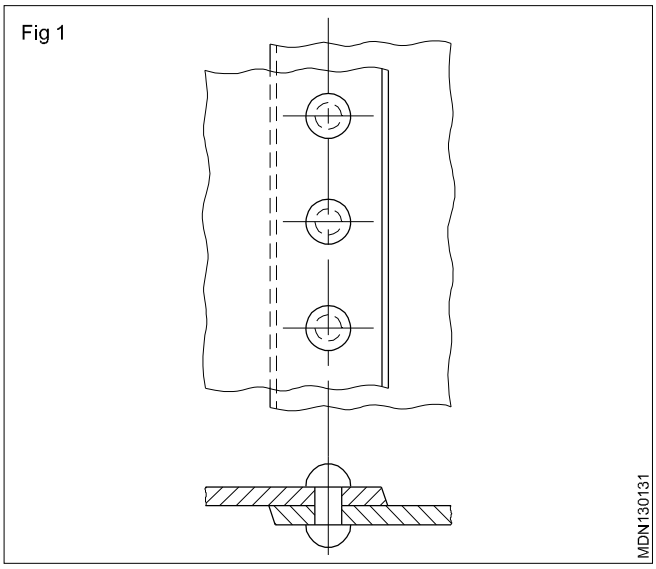
Objectives : At the end of this lesson you shall be able to
- **name the different types of riveted joints**
- **state the features of different types of riveted joints**
- **distinguish between chain riveting and zigzag riveting.**

In construction and fabrication work different types of riveted joints are made.

The commonly used joints are:

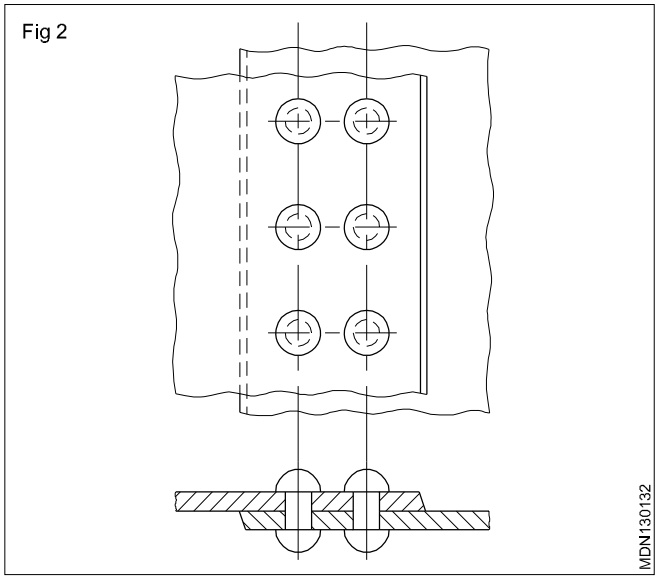
- single riveted lap joint
- double riveted lap joint
- double riveted (zigzag) lap joint
- single strap butt joint
- double strap butt joint

Single riveted lap joint (Fig 1)



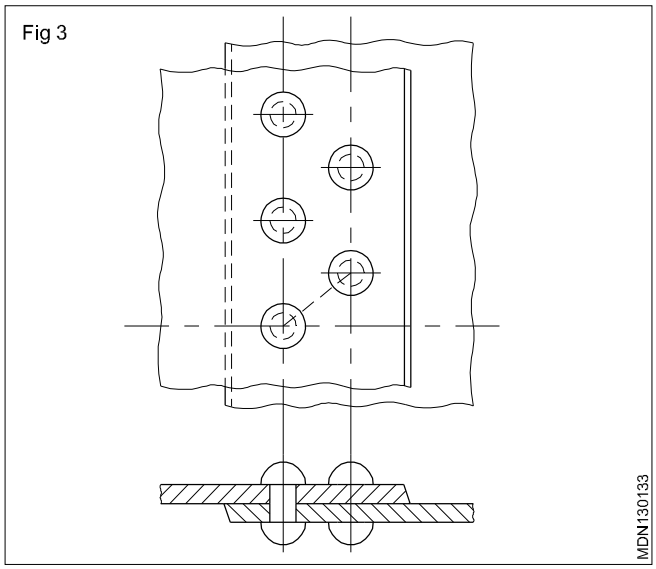
This is the simplest and most commonly used type of joint. This joint is useful for joining both thick and thin plates. In this, the plates to be joined are overlapped at the ends and single row of rivets is placed in the middle of the lap.

Double riveted lap joint (Fig 2)



This type of joint will have two rows of rivets. The overlap is large enough to accommodate two rows of rivets.

Double riveted (Zigzag) lap joint (Fig 3)

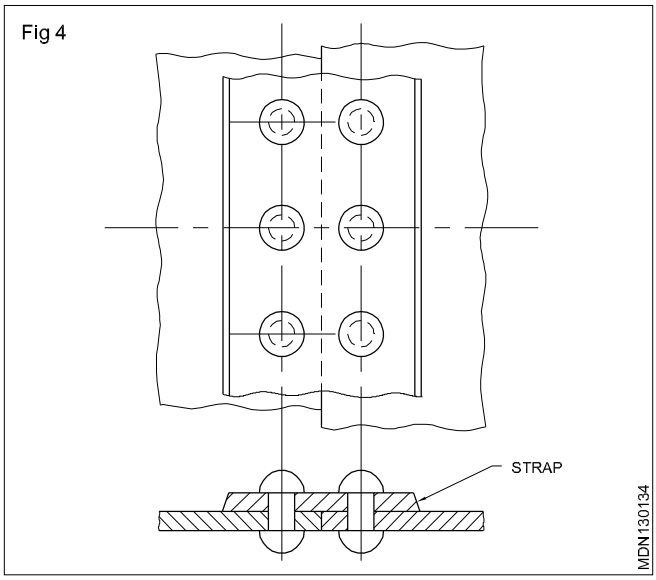


This provides a stronger joint than a single lap joint. The rivets are placed either in a square formation or in a triangular formation. The square formation of rivet placement is called CHAIN riveting. The triangular formation of rivet placement is called zigzag riveting.

Single strap butt joint (Fig 4)

This method is used in situations where the edges of the components are to be joined by riveting.

A separate piece of metal called STRAP is used to hold the edges of the components together.



Double strap butt joint (Figs 5 & 6)

This joint is also used for joining the edges of components together. This is stronger than the single strap butt joint. This joint has two cover plates placed on either side of the components to be assembled.

When a single or double straps are used for riveted butt joints, the arrangement of rivets may be:

- Single riveted, i.e. one row on either side of the butt

double or triple riveted with chain or zigzag formation.

Fig 5

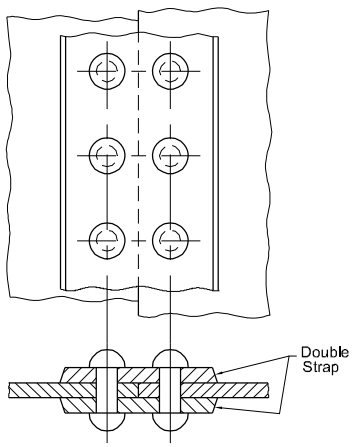
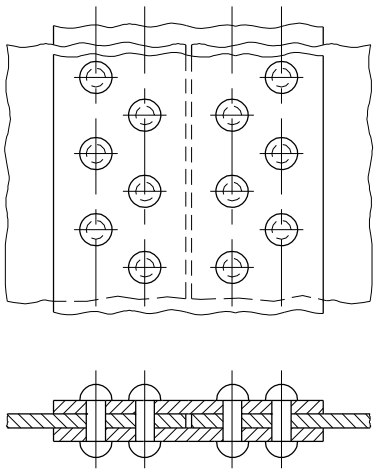


Fig 6



Tools for hand riveting

Objectives : At the end of this lesson you shall be able to
- **name the different tools used for hand riveting**
- **state the uses of different hand riveting tools.**

The following tools are used for making efficient riveted joints.

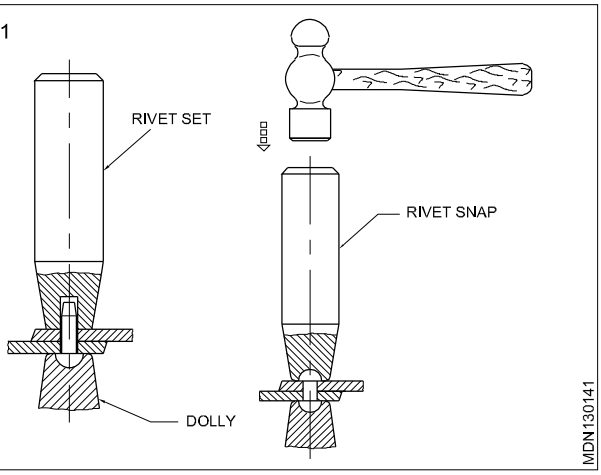
Rivet set (Fig 1)

A rivet set is used for bringing the plates closely together after inserting the rivet in the hole. This is required while riveting thin plates or sheets with small rivets.

Dolly

This is used to support the head of the rivet which is already formed and also to prevent damage to the shape of the rivet head.

Fig 1

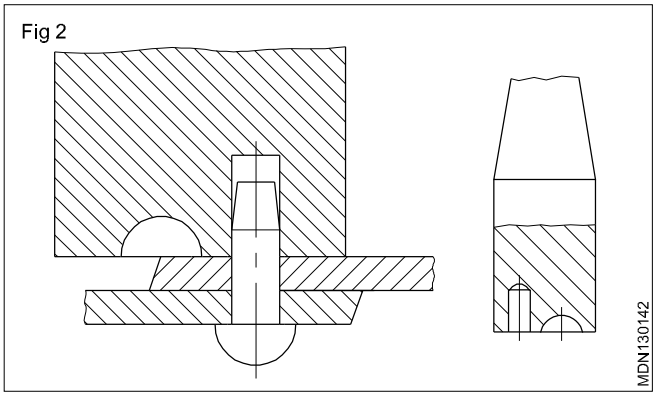


Snap

The rivet snap is used to form the final shape of the rivet during riveting. Snaps are available to match the different shapes of rivet heads.

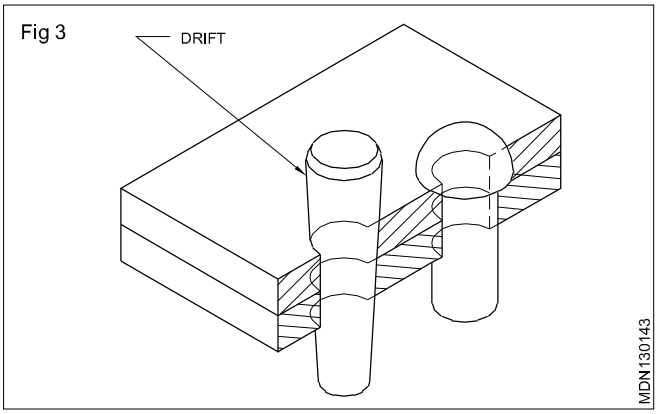
Combined rivet set (Fig 2)

Fig 2



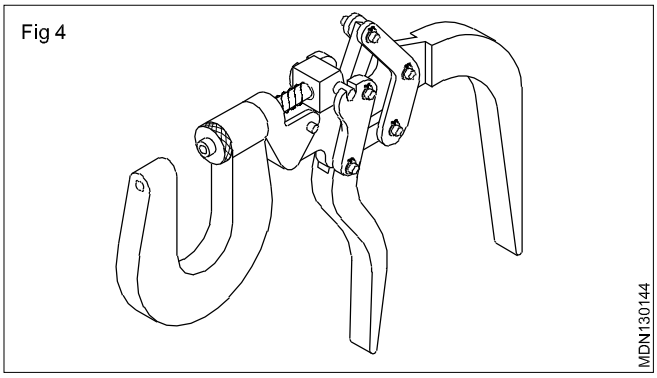
This is a tool which can be used for setting and forming the head.

Drift (Fig 3)



This is used to align the holes to be riveted.

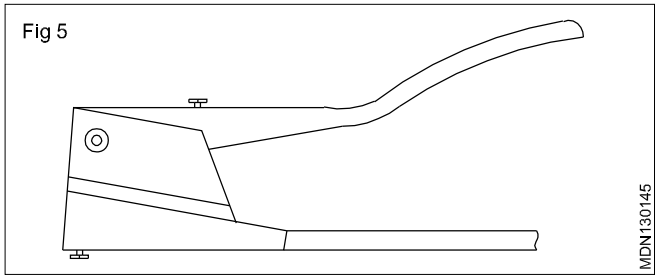
Hand riveter (Fig 4)



This has a lever mechanism which exerts pressure between the jaws when the handle is pressed.

This is useful for riveting copper or aluminium rivets, interchangeable anvils can be provided.

Pop riveter (Fig 5)



This is used for riveting pop rivets by hand. The trigger mechanism squeezes the rivet and separates the mandrel of the rivet. In this method, as the mandrel is being separated from the rivet, the head is formed on the other end.

Spacing of rivets in joints

Objectives : At the end of this lesson you shall be able to
- **determine the distance between the rivet and the edge of the joint.**
- **state the effect on the joints when the rivets are too close or too far from the edge**
- **determine the pitch of rivets in joints**
- **state the effect of too close and too far a pitch of rivets in joints**.

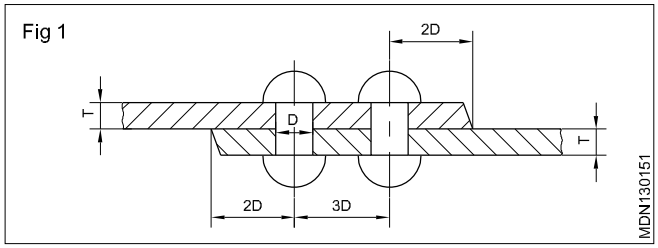
The spacing of the rivet holes depends upon the job. Given below is a general approach in determining this.

Distance from the edge to the centre of the rivet (Fig1)

The space or distance from the edge of the metal to the centre of any rivet should be at least twice the diameter of the rivet.

The purpose of this is to prevent the splitting of the edges. The maximum distance from the edge should not be more than ten times the thickness of the plate.

Too much distance from the edge will lead to GAPING.



Pitch of rivet

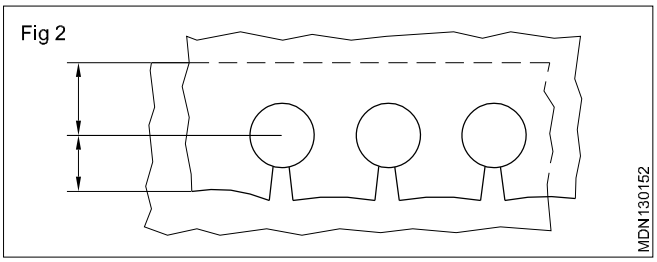
The minimum distance between rivets should be three times the diameter of the rivet (3D)

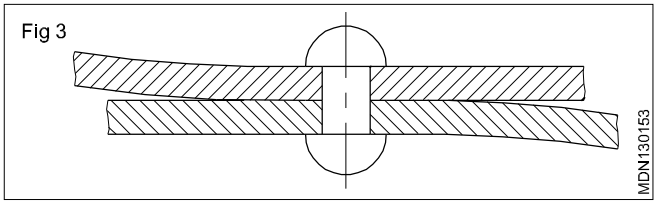
This distance will help to drive the rivets without interference.

Too closely spaced rivets will tear the metal along the centre line of the rivets.(Fig 2)

The maximum distance between the rivets should not exceed twenty four times the thickness of the metal.

Too far a pitch will allow the sheet/plate to bukcle between the rivets. (Fig 3)



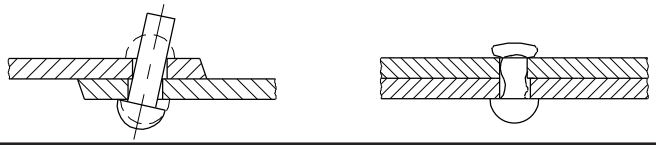
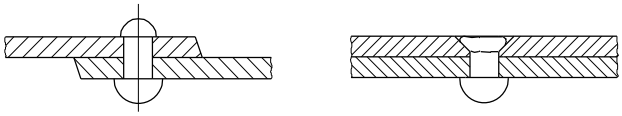
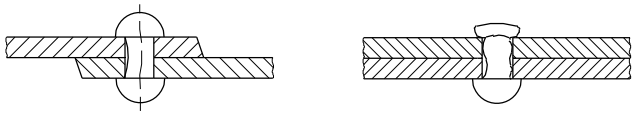
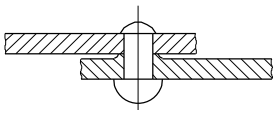
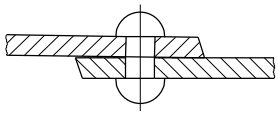
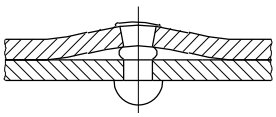
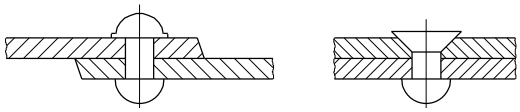
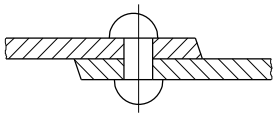


Defects in riveted joints

Objectives : At the end of this lesson you shall be able to
- **relate riveting defects with their causes.**

While making riveted points certain precautions are to be exercised to avoid defects in the joints.

A few common causes and defects and resistant effects in riveting are given below:

Causes of riveting defects	Resultant effect
Holes wrongly aligned	
Rivet too short	
Hole too large	
Burrs in drilling	
Burrs between plates	
Rivet not set correctly	
Rivet length too long	
Head formed out of centre	

Caulking and fullering

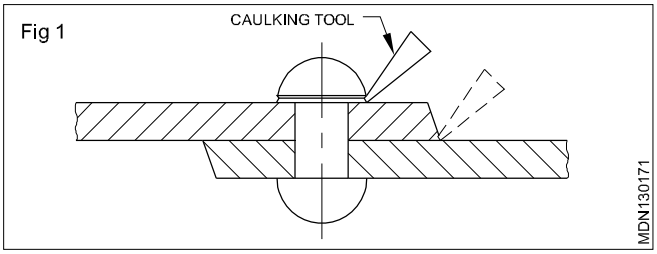
Objectives : At the end of this lesson you shall be able to
- **state the purpose of caulking and fullering**
- **distinguish between caulking and fullering processes.**

In order to provide a leak-proof joint in the construction of fluid containers, caulking and fullering are carried out after riveting.

Caulking (Fig. 1)

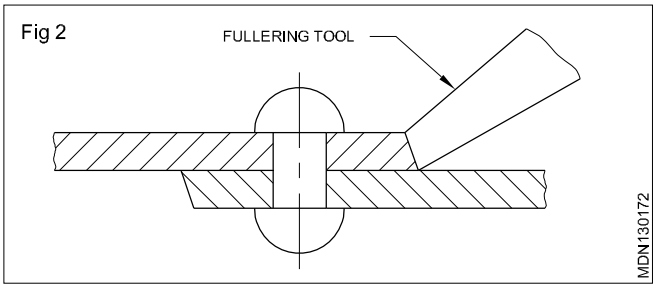
Caulking is an operation of closing down the edges of the plates and heads of the rivets to form a metal-to-metal joint.

Fig 1



The edge of the rivet head is tightly pressed and expanded on the plate by a caulking tool which looks like a flattened cold chisel.

Fullering (Fig. 2)



Fullering is an operation of pressing the whole surface of the edge of the plate. It is done by a fullering tool.

When the caulking tool is about as thick as the plate, it is called a fullering tool.

The whole surface of the edge of the first plate is tightly pressed on the second plate.

A better fluid-tight joint is achived by fullering.

Caulking is done on the edges of the plates as well as on the edges of the rivet heads. But fullering is done on the edges of the plate only. To facilitate caulking and fullering on the plates, the edges of the plates are bevelled about 80° to 85°.

The strength of riveted joints

A riveted joint is only as strong as its weakest part and it must be borne in mind that it may fail in one of the following four ways.

Shearing of the rivet

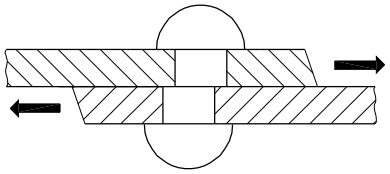
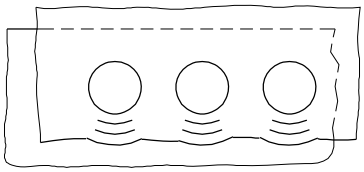
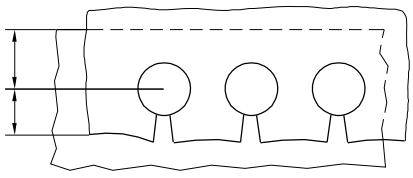
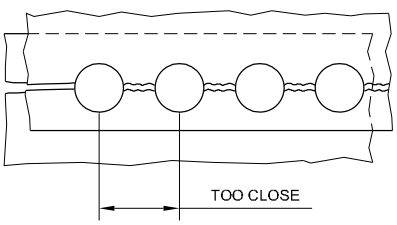
Crushing of the metal

splitting of the metal

Rupture or tearing of the plate

These four undesirable effects are illustrated in the table below:

Table

Riveted Joint	Effects	Causes	Prevention
	Shearing of the rivet	Diameter of the rivet too small compared with the thickness of the plate. The diameter of the rivet must be greater than the thickness of the plate in which it is to be inserted.	Select the correct diameter rivet to suit thickness of the plate.
	Crushing of the metal	Diameter of the rivet too large compared with the thickness of the plate. The rivets when driven tend to bulge and crush the metal in front of them.	Select the correct diameter rivet for the thickness of the metal plate.
	Splitting of the metal	Rivet holes punched or drilled too near the edge of plate. Metal is likely to fail by splitting in front of the rivets.	Drill or punch the rivet at the correct distance from the edge and use the correct lap allowance for the diameter of the rivet.
	Tearing of the plate	Plates weakened by rivete holes being too close together. Plate tend to rupture along the centre line of the rivets	Punch or drill rivet holes at the correct spacing or ‘pitch. In addition remove all burrs from the holes before final assembly.

Special sheet metal rivets and their applications

Objectives : At the end of this lesson you shall be able to
- **state the types and uses of tubular rivets**
- **state the use of `hank' rivet bushes**
- **state the use of speed nuts.**

Tubular rivet (Figs 1, 2 & 3)

The use of the tubular rivet removes much of the skill necessary, and there is no need for the support as with a solid rivet.

Fig 1

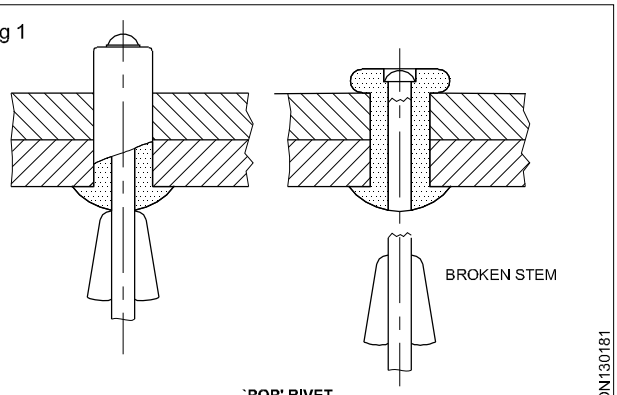


Fig 2

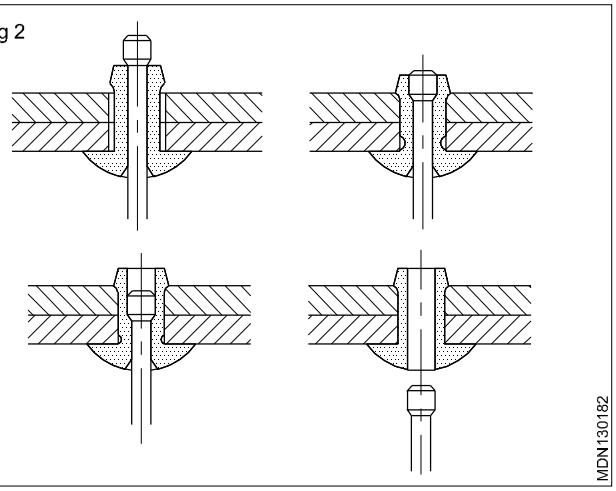
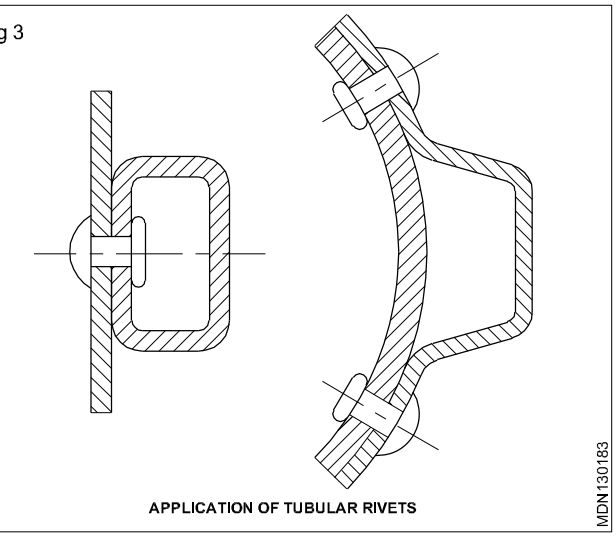


Fig 3



One type of tubular rivet is the `pop rivet'. While it is held by its stem in the riveting `gun', the rivet is pushed into the rivet hole and the gun causes the stem to be pulled back into the gun, while the gun nozzle remains pushed against the flanged head. The stem-head causes the rivet tube to be swaged out thus forming a new head on the far side of the joint, and consequently pulling the plates tightly together. Finally the pulling force on the stem is sufficient to fracture the stem below its head on the stem diameter.

Another type of tubular rivet has a stem-head which breaks off outside the rivet tube after the swaging stage, thus leaving the central hole clear. This is essential where drainage from cavities and hollow sections is necessary.

`Hank' rivet bushes (Figs 4, 5 & 6)

These bushes are a means of providing a thin sheet metal with a deep tapped hole, and diameters and thread form, and they are used in conjuction with the standard set screws where access cannot be gained to fit the standard nuts.

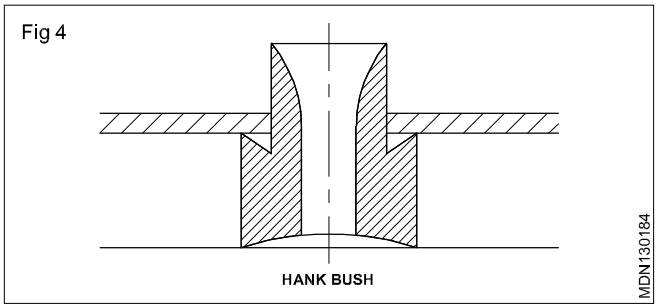
The following steps are required to fit shank bushes.

Position the previously drilled hole in the panel.

Mark the centre punch hole position

Drill a hole of the required size. The hole should be the clearance size of the bush shank.

Fig 4

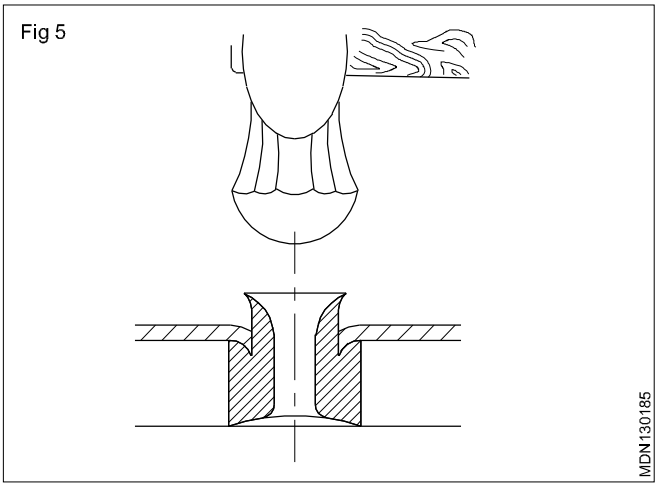


Remove the burrs.

Fit the shank bush from the under the side.

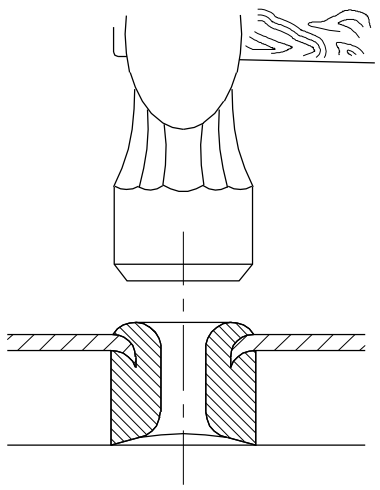
Support for riveting operation.

Fig 5



Using a ball pein hammer, spread the shank of the bush. Strike squarely to ensure the even spread of the shank.

Fig 6



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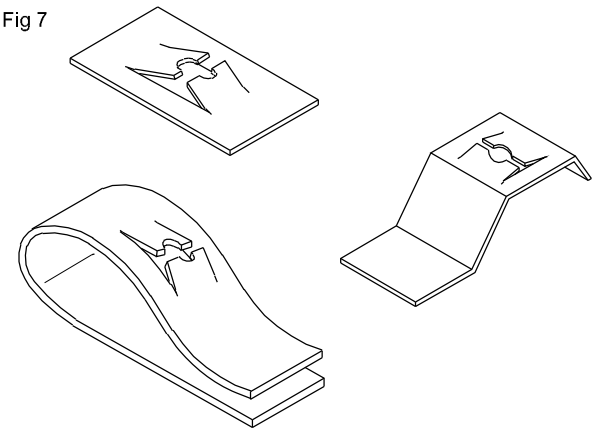
Change to the flat face of the hammer. Strike squarely, flatten the shank.

Speed nut (Fig. 7)

Speed nuts are available in a variety of forms and are made form different materials such as spring steel, stainless steel etc. The speed nut consists of a strip of metal stamped in such a manner that one or more thread engaging portions are pressed upwards from the base to form part of a screw thread.

Fig 7



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Speed nuts are generally used in conjunction with coarse thread or sell-tapping screws. As the screw is tightened, the pressure exerted on the tongues gives a self-locking action.

This is used for lacking and soldering of joining points.

Bolts, studs and nuts

Objectives : At the end of this lesson you shall be able to

- **state the situations in which bolts and nuts are used**
- **state the advantages of using bolts and nuts**
- **name the different types of bolts**
- **state the applications of the different types of bolts**
- **state the situations in which studs are used**
- **state the reason for having different pitches of threads on stud ends.**

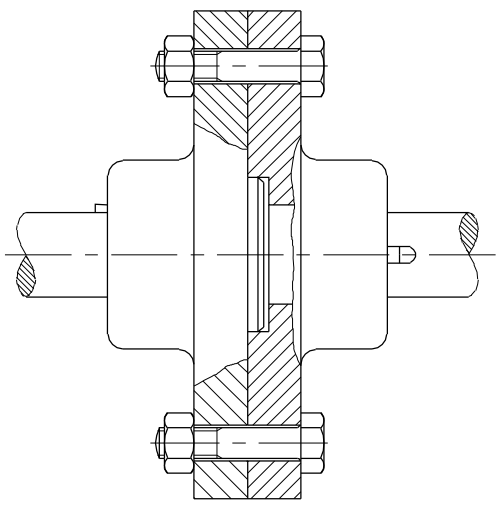
Bolts and nuts (Fig.1)

These are generally used to clamp two parts together.

When bolts and nuts are used, if the thread is stripped, a new bolt and nut can be used. But in the case of a screw directly fitted in the component. When threads are damaged, the component may need extensive repair or replacement.

Depending on the type of application, different types of bolts are used.

Fig 1



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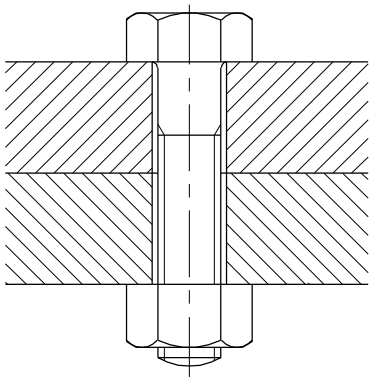
Bolts with clearance hole (Fig.2)

This is the most common type of fastening arrangement using bolts. The size of the hole is slightly larger than the bolt (clearance hole)

Slight misalignment in the matching hole will not affect the assembly.

Fig 2



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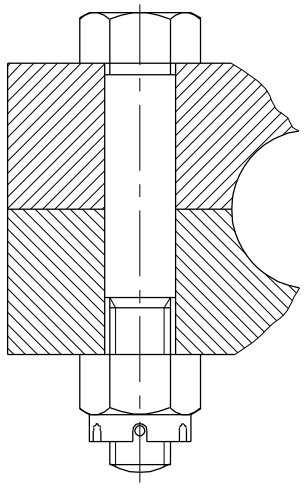
Body fit bolt (Fig.3)

This type of bolt assembly is used when the relative movement between the workpieces has to be prevented. The diameter of the threaded portion is slightly smaller than the shank diameter of the bolt.

Fig 3



BODY FIT BOLT

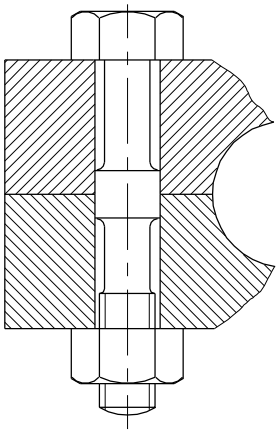
MDN121523

The bolt shank and the hole are accurately machined for achieving perfect mating.

Anti-fatigue bolt (Fig.4)

This type of bolt is used when the assembly is subjected to alternating load conditions continuously. Connection rod big ends in engine assembly are examples of this application.

Fig 4



ANTI-FATIGUE BOLT

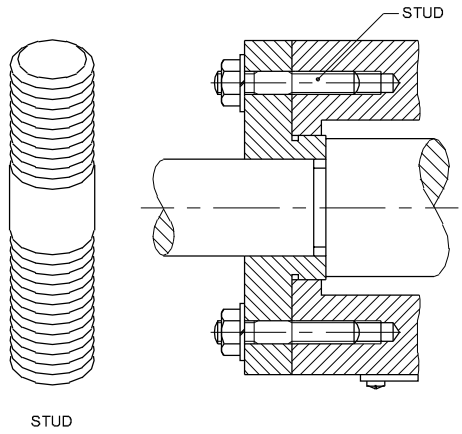
MDN121524

The shank diameter is in contact with the hole in a few places and other portions are relieved to give clearances.

Studs (Fig.5)

Studs are used in assemblies which are to be separated frequently.

Fig 5



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When excesssively tightened, the variation in the thread pitch allows the fine thread or nut end to slip. This prevents damage to the casting.

Designation of bolts as per B.I.S. specifications

Hexagon head bolts shall be designated by name, thread size, nominal length, property class and number of the Indian Standard.

Example

A hexagon head bolt of size M10, nominal length 60mm and property class 4.8 shall be designated as:

Hexagon head bolt M10x60 - 4.8-IS: 1363 (Part 1)

Explanation about property class

The Part of the specification 4.8 indicates the property class (mechanical properties). In this case it is made of steel with minimum tensile strength = 40kgf/mm2 and having a ratio of minimum yield stress to minimum tensile strength = 0.8.

NOTE

Indian standard bolts and screws are made of three product grades - A,B, & C, `A' being precision and the others of lesser grades of accuracy and finish.

While there are many parameters given in the B.I.S. specification, the designation need not cover all the aspects and it actually depends on the functional requirement of the bolt or other threaded fasteners.

For more details on the designation system, refer to IS: 1367, Part XVI 1979.

Locking Devices

Objectives : At the end of this lesson you shall be able to

- **state what is a locking device**
- **name the effect, if proper locking devices are not employed**
- **name the various types of locking devices**
- **state the uses of the commonly used locking devices.**

Locking devices

A locking device is a device used to lock the threaded fasteners to prevent them from loosening. Due to vibration in the moving part, there is a tendency for the threaded fastener to get slack and to slip off. Then the assembled part will get loose and cause damages. Some examples are given below to illustrate the importance of the locking device.

In the case of a micrometer, the lock-nut avoids the Movement of the spindle after taking the reading. In the case of boilers and gas cylinders, locking of the nut avoids the leakage of steam or gas.

In automobiles the lock-nut avoids the loosening of the assembled part.

Classification of lock-nuts

Lock-nuts are classified into two categories.

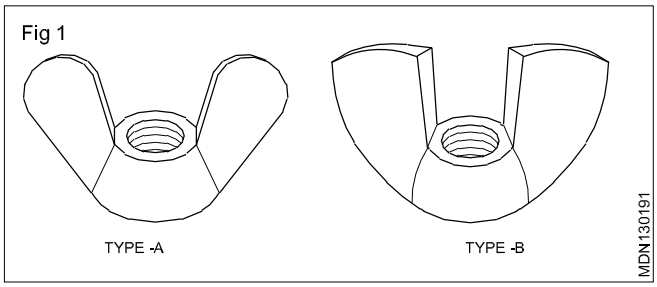
- Positive locking device
- Frictional locking device

These nuts have special provision in the form of slots for fixing split pins for locking the nuts.

Slotted nuts are hexagonal shaped throughout. In the case of castle nuts, the top part of the nut is cylindrical in shape.

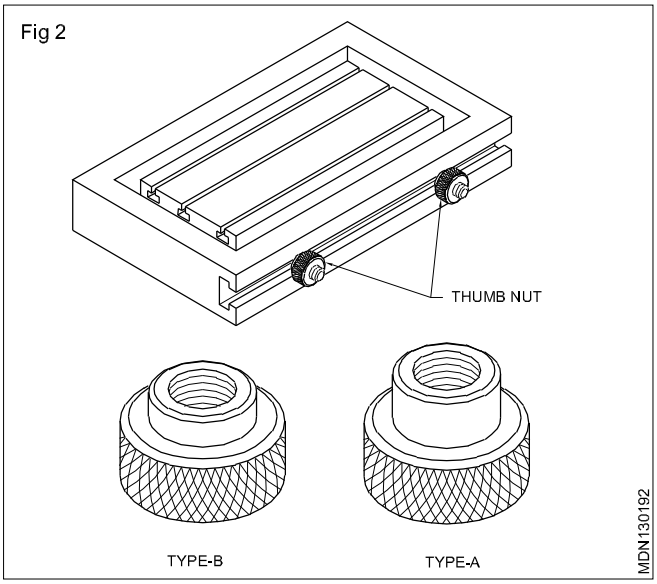
Wing-nuts (Fig. 1)

Wing-nuts are used in light duty assembly which require frequent removal and fixing. These are available as hot forged/cast (Type A) and cold forged (Type B).



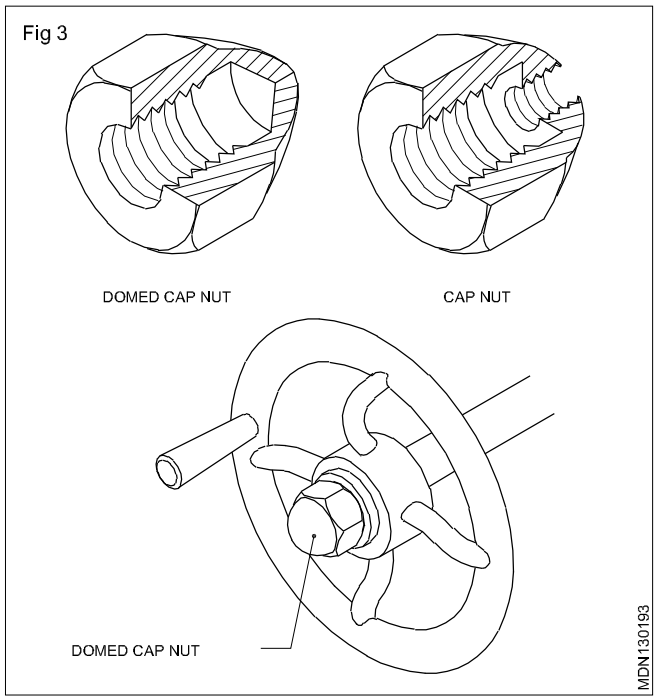
Thumb-nut (Fig. 2)

These are used in places where frequent adjustments are required and mere finger tightening enought. They are available in two types - Types A & Type B.



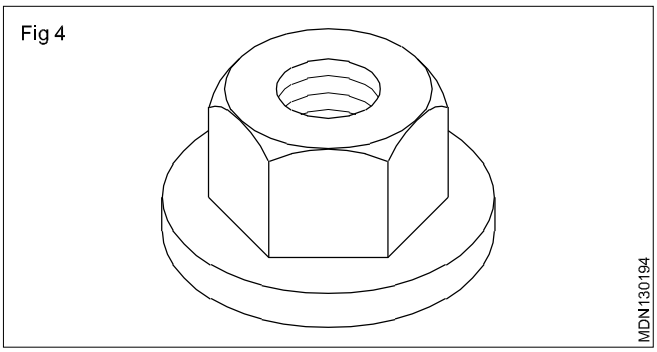
Cap nut (Fig. 3)

These are used to protect the bolt end threads from damages and also as a protector for safe working. They serve to provide a decorative appearance.



Hexagonal nuts with collar (Fig. 4)

These nuts have a machined collar on one end. This provides additional bearing surface in assembly. The collar acts like a washer and is useful where frequent tightening



and loosening is necessary.

Hexagonal weld nuts (Fig. 5)

These are nuts used for welding on the plate work. These nuts have:

- a spigot ring which fits in the hole of the plate
- three projections to provide a uniform contact on the surface, that is to be welded
- a countersunk hole on one end to protect the thread during welding.

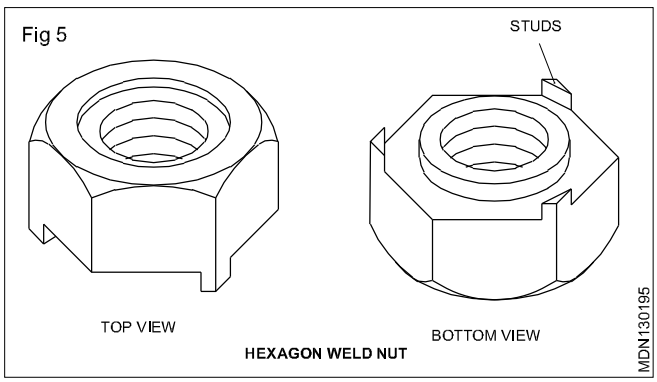
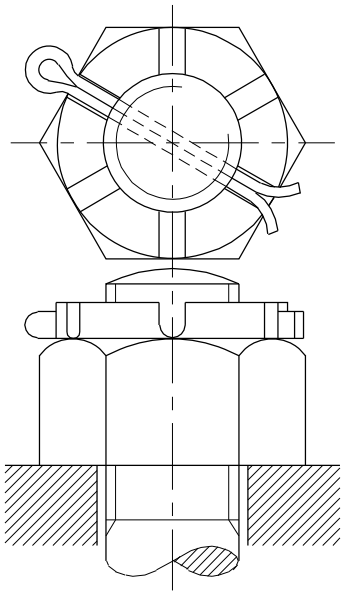


Fig 6



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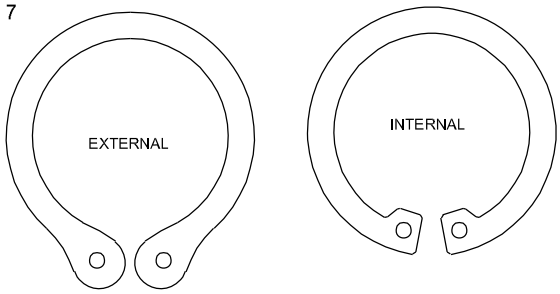
Out. Castle nuts (Fig. 6) are widely used in automobiles and locomotive engines to avoid sudden shock and vibration.

Circlip (Fig. 7)

These are widely used to retain the component on a shaft or in a bore. Seating of these circlips in a slot by using a special type of pliers facilitates rapid assembly and disassembly.

Fig 7



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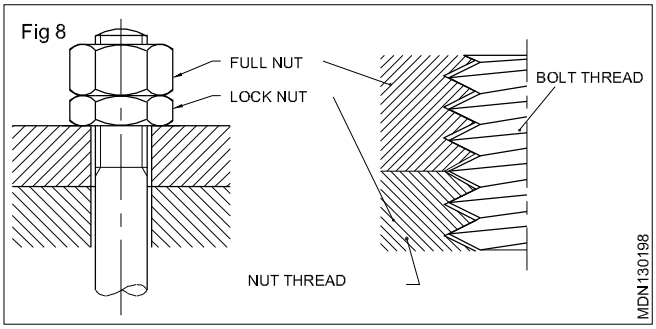
Chuck nut (Fig. 8)

This nut is used along with one ordinary nut as shown in the figure.

Fig 8



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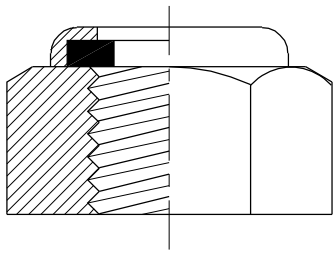
A chuck nut is also called a lock-nut. The two nuts are thus locked or wedged tightly against each other and against the bolt. This will prevent slackening.

Self-locking nut (Fig. 9)

Self-locking nut will have a nylon insert to prevent the loosening of the nut from shock, vibration and temperature.

Fig 9



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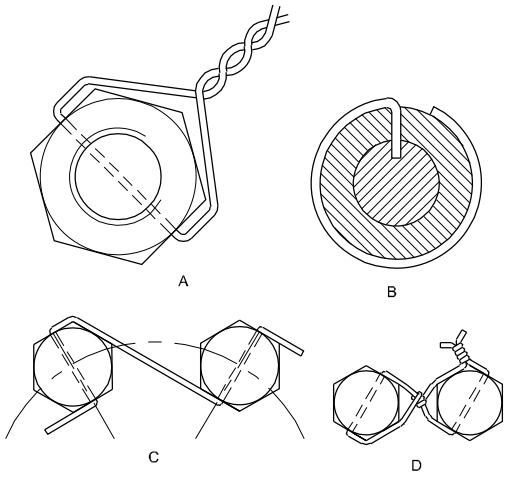
Wire lock (Fig. 10)

Wire locks are used for light engineering works. The wire is passed through the groove.

Nut applied with a sealant

These locking devices are for permanent locking in light works.

Fig 10



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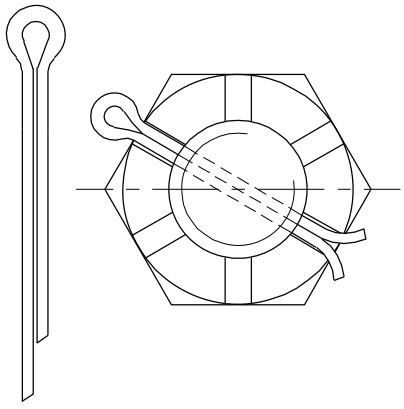
Split pin (Fig. 11)

A split pin is made from a steel wire of semicircular crosssection, bent as shown in the figure. It is inserted in a hole drilled in the bolt so that it exerts pressure on the top face of the nut to prevent it from turning.

Fig 11



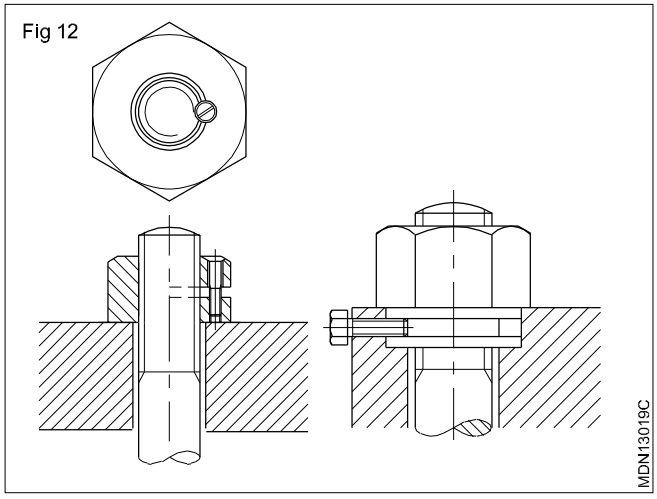
MDN13019B

Sawn nut (Wiles nut)

In this locking device, a slot is cut half way across the nut. A screw is fitted with a clearance hole on the top part and a matching thread on the lower part of the nut. Tightening of the nut provides positive locking for the nut.

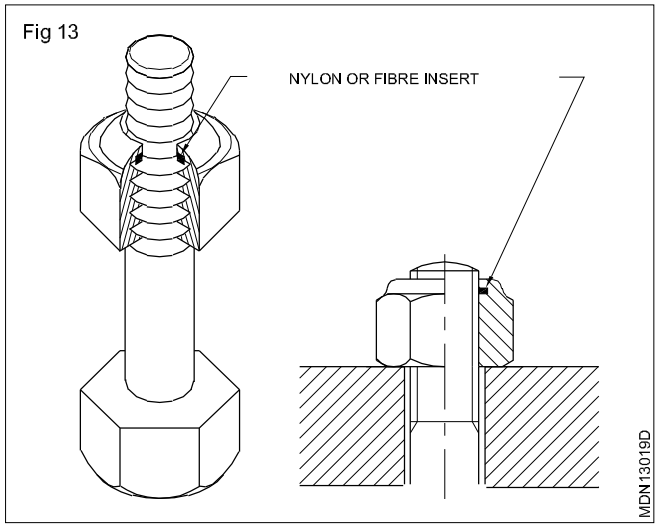
Positive locking device (Fig. 12)

Frictional locking device



Positive locking device(Fig. 13)

In the positive locking device, the locking action is positive. This locking device is difficult to fit and may take more time. But it is very essential to use this type of locking device in critical joints where failure could cause serious accidents.



Eg. Clutches, brakes, controls etc.

The positive locking devices are:

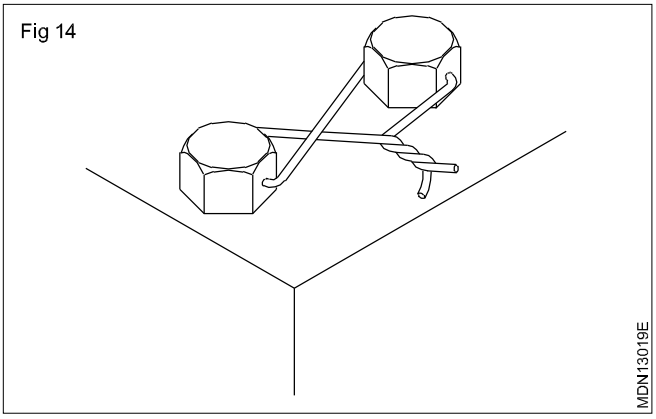
- standard hexagonal nut, cross-drilled and pinned
- standard slotted nut
- standard castle nut
- hexagonal nut and locking plate
- wiring bolt heads.

Frictional locking devices (Fig 14)

These lock nuts are easy to fit and less time consuming.

The frictional locking devices are:

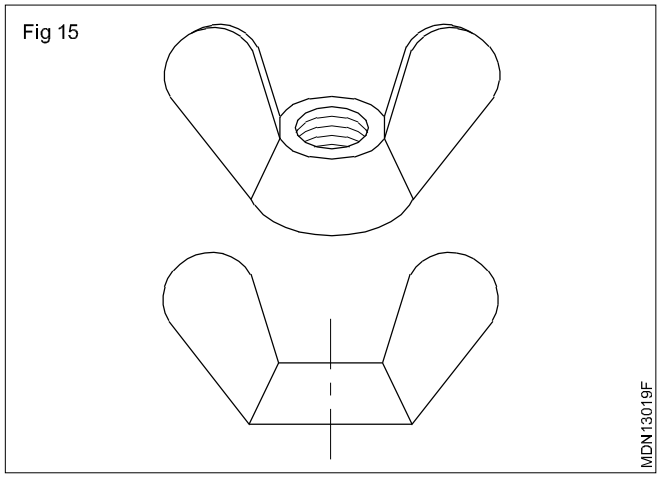
- lock-nut (chuck nut)
- spring washer
- wedge lock bolt
- simmonds lock-nut.



Commonly used locking devices

Wing-nut (Fig. 15)

A wing-nut is used where frequent adjustment or removal is necessary. It can be loosened or tightened rapidly without the need of a wrench. These nuts are manufactured with the same material as is used for the bolts.



Thumb-nut

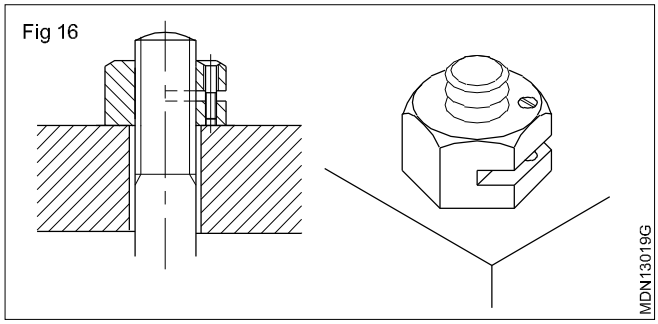
A thumb-nut is used where the movement of the spindle is to be locked, as in a micrometer. Stopping the movement of the spindle is necessary for taking a correct reading.

Locking ring

A locking ring is used in taper nose spindles of lathes to lock the chuck.

Castle nut (Fig. 16)

Slots are cut in a cylindrical collar provided on the top of the nut, thus overcoming the disadvantage of the slotted



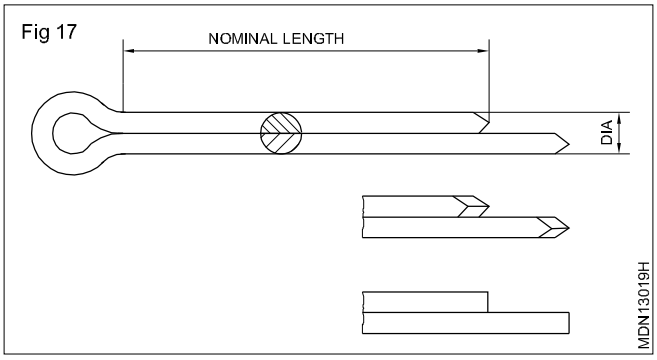
Slotted and castle nut with a split pin

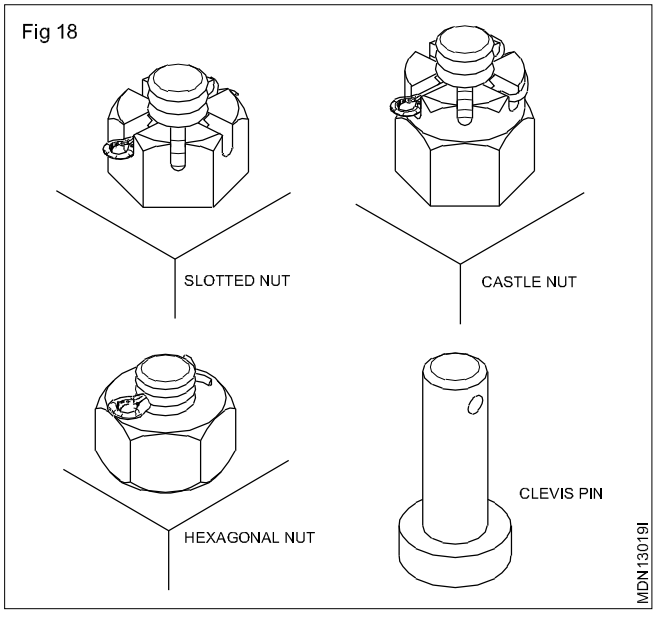
The position of the nut can be locked using the split pin.

Split pins are designated by the nominal size, nominal length, the number of the Indian Standard and the material. (Fig. 17 & 18)

The nominal length is the distance from the underside of the eye to the end of the short leg.

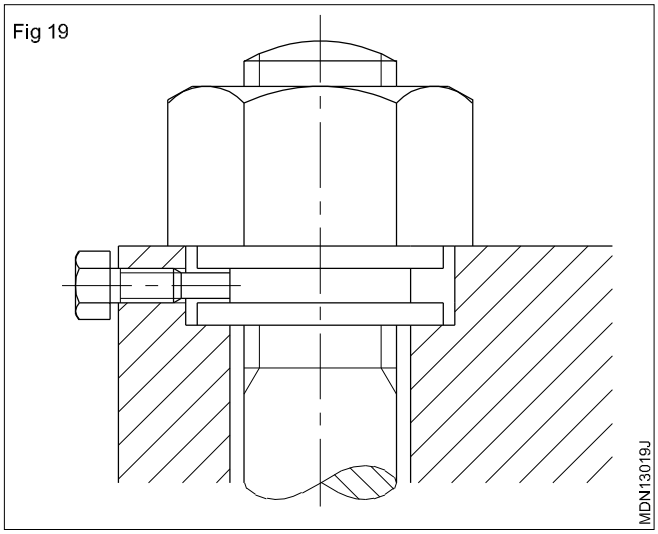
Split pins are used for locking slotted nuts, castle nuts, hexagonal nuts, clevis pins etc. and are used in different ways.





Grooved nut (Penning nut) (Fig. 19)

This is a hexagonal nut with the lower part made cylindrical. On the cylindrical surface there is a recessed groove in which a set screw is used to lock the nut.

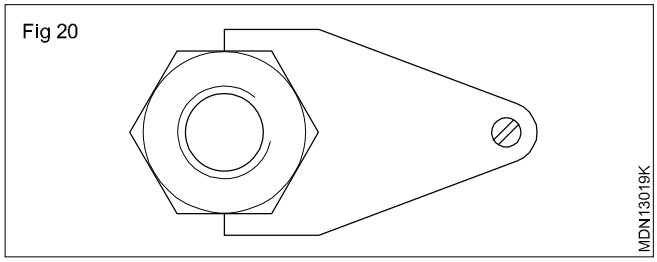


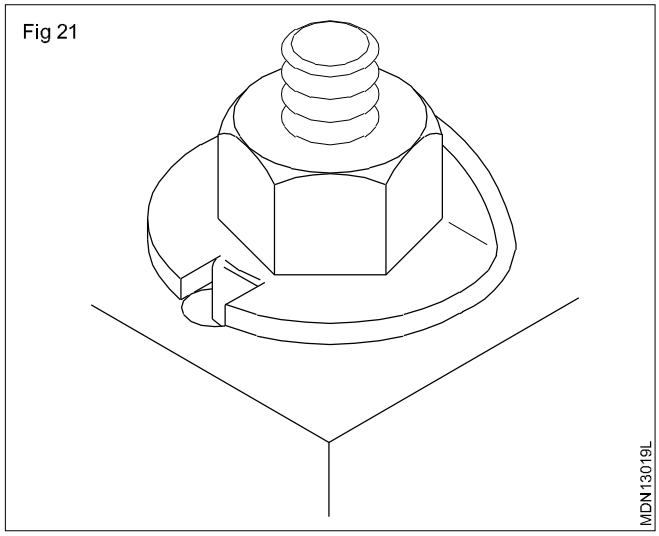
Locking plate (Fig. 20)

For preventing the nut from loosening, locking plates are fixed on the outside of the hexagonal nut.

Lock washers with lug (Fig. 21)

In this arrangement of locking, a hole is drilled for accommodating the lug.





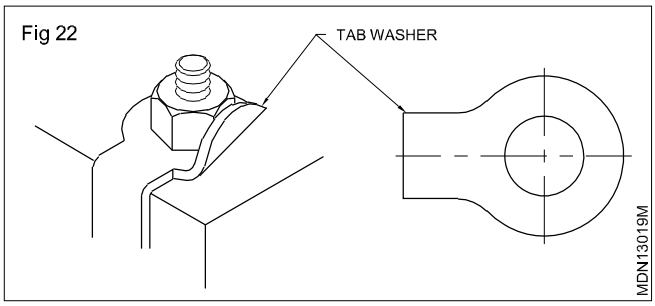
The movement of the nut is prevented by folding the washer against the nut.

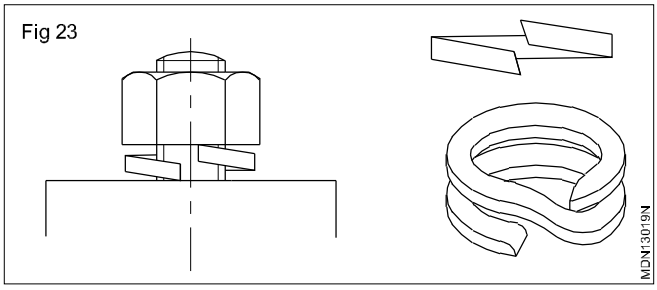
Tab washers (Fig. 22)

Tab washers can be used for locking the nuts which are located near an edge or corner.

Spring washer (Fig. 23)

Spring washers are available with single or double coils. These are placed under a nut in the assembly as washers. The stiff resistance offered by the washer against the surface of the nuts serves to prevent loosening.



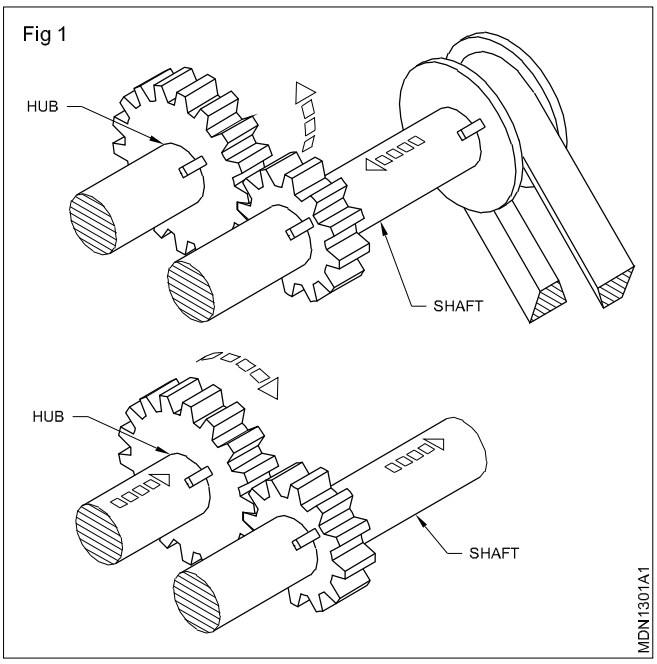


Keys and Splines

Objectives : At the end of this lesson you shall be able to
- **name the different types of keys used in transmission**
- **state the features of each type of keys.**

Keys and splines

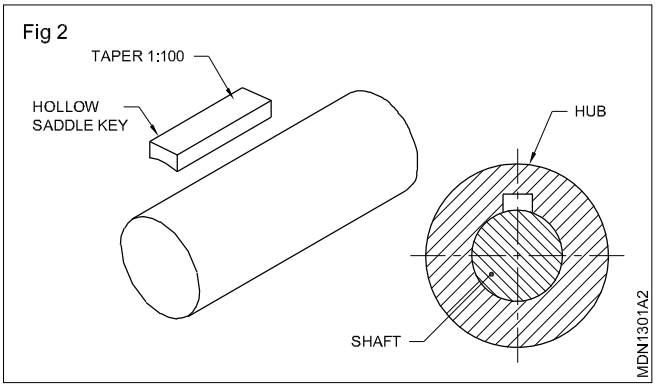
Keys are used for transmitting torque from a rotating shaft to a hub/wheel or from a hub/wheel to the shaft. (Fig.1)



Keys of different types are used depending on the requirements of transmission.

Hollow saddle key

One face of this key has a curvature to match with that of the shaft surface. It has a taper of 1 in 100 and is driven in through the keyway. (Fig.2)

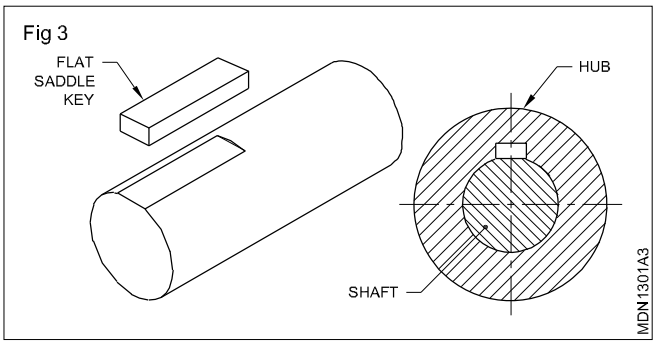


The hub is held on the shaft due to friction. This key is useful only for light duty transmission.

Flat saddle key

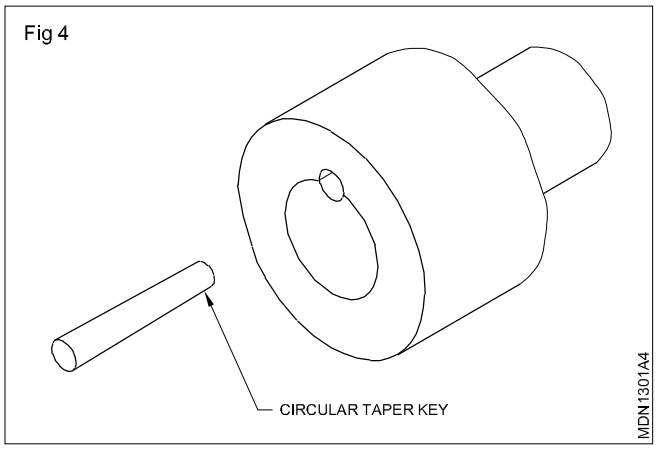
This key has a rectangular cross-section.

For fitting this key in the assembly a flat surface is machined on the shaft. (Fig. 3). The key is placed between the flat surface of the shaft and the keyway on the hub. This is considered to be stronger than the hollow saddle key. This is not suitable for heavy duty transmission.



Circular taper key (Fig 4)

In this case both the shaft and the hub have semicircular keyways cut on them. (Fig.4) The taper key is driven in while assembling. This key is suitable only for light transmission.



Sunk key (Fig 5 & Fig 6)

This key has a rectangular cross-section and its fits into the keyway cut on both the shaft and the hub. Sunk keys are either parallel or tapered. (Figs.5 and 6)

Fig 5

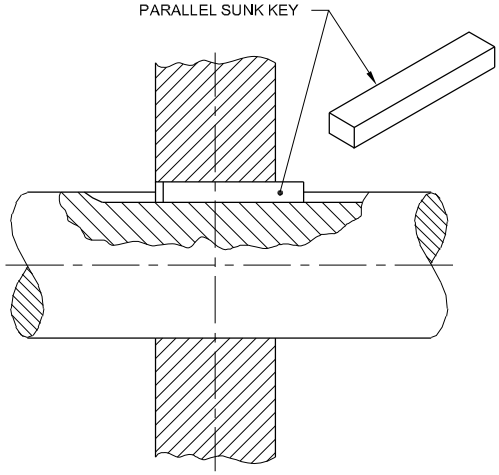
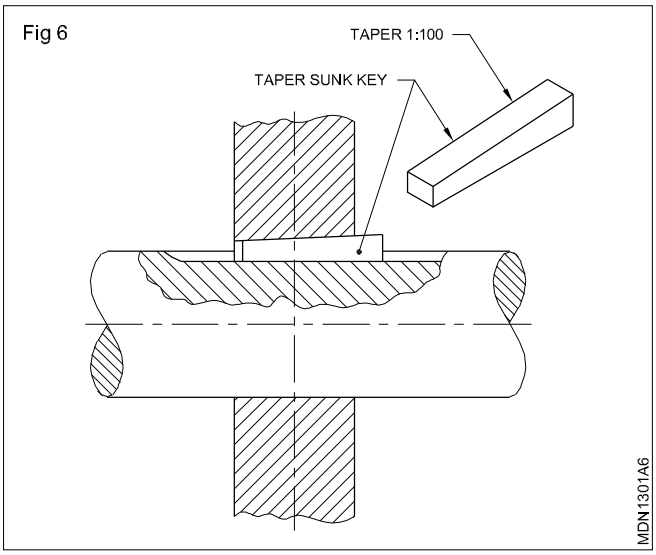


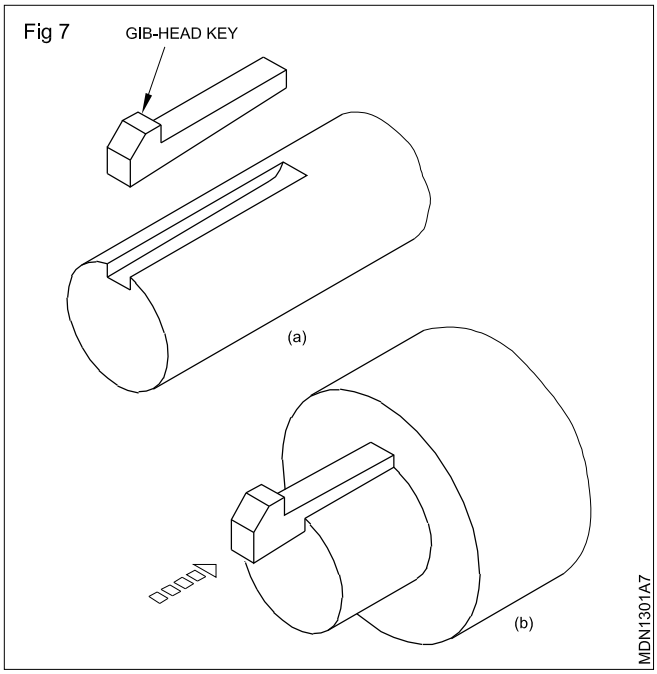
Fig 6



Gib-head key (Fig 7)

This is another type of sunk key. This has a gib-head to assist in fixing and removing the keys. (Figs 7a and b)

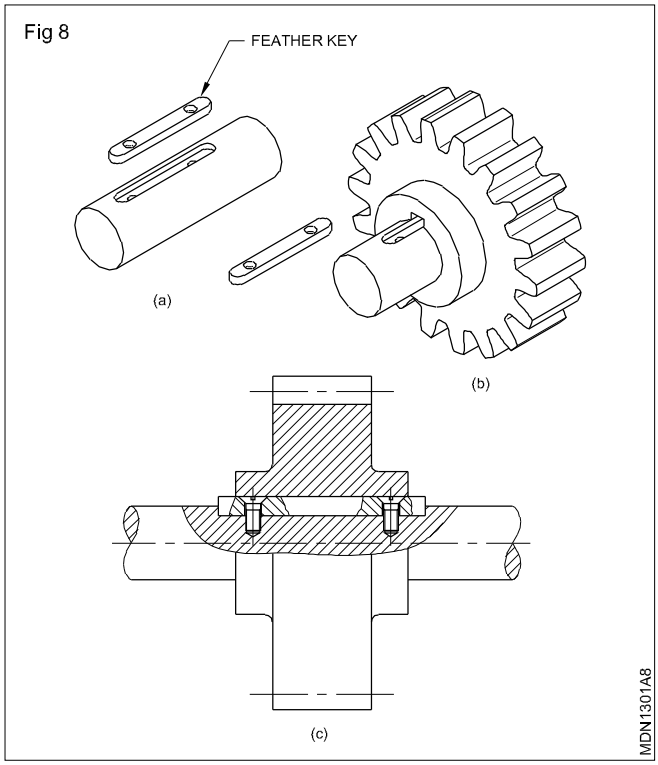
Fig 7



Feather key (Fig 8)

This is a parallel key with rounded ends. This is useful when the hub/pulley has to slide axially on the shaft to some distance. (Figs 8a,b and c) This key may be either tightly fitted in the keyway or screwed in.

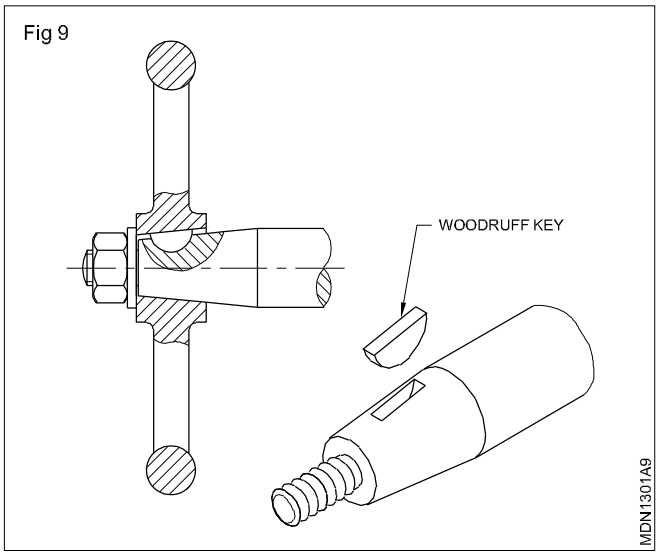
Fig 8



Woodruff key (Fig 9)

This is semicircular key and it fits on to the shaft on which matching recesses are cut. The top portion of the key projects out and fits in the keyway cut on the hub. (Fig.9)

Fig 9



This key is particularly useful on tapered fittings of shafts.

Splined shaft & serrated shaft

Splinded shafts along with splined hubs are used particularly in the motor industry. The splined hub can also slide along the shaft, wherever necessary. (Figs 10a and b)

In certain assemblies, serrated shafts are also used for transmission. (Figs 11a and b)

Fig 10

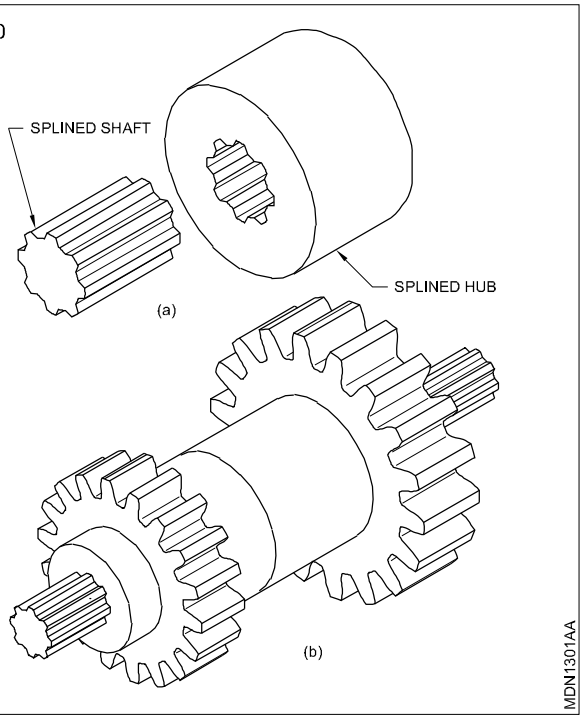
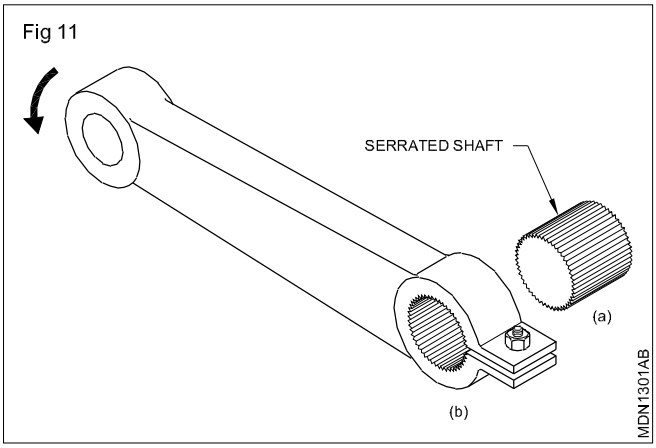


Fig 11



Circlips

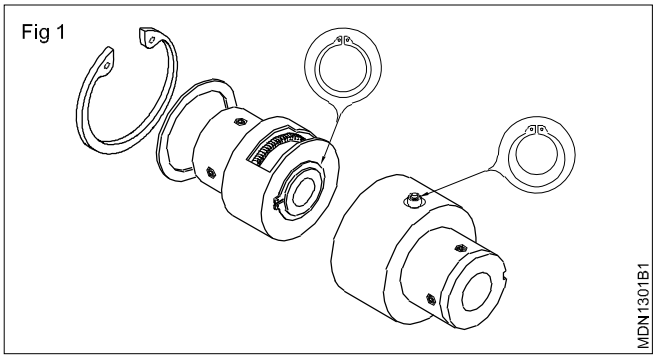
Objectives : At the end of this lesson you shall be able to

- **state the functions of circlips**
- **state the different types of circlips**
- **state the advantages of circlips over other fastening devices**
- **state the material used for circlips.**

Circlips are fastening devices used to provide shoulders for positioning or limiting the movement of parts in an assembly (Fig.1) Circlips are also called `Retaining rings.

The rings are generally made of meterials having good spring properties so that the fastener may be deformed elastically to a considerable degree and still spring back to its original shape. This permits the circlips to spring back into a groove or other recess in a part or they may be seated on a part in a deformed conditiona so that they grip the part by functional means. Circlips are manufactured from spring steel with high tensile and yield strength.

Fig 1



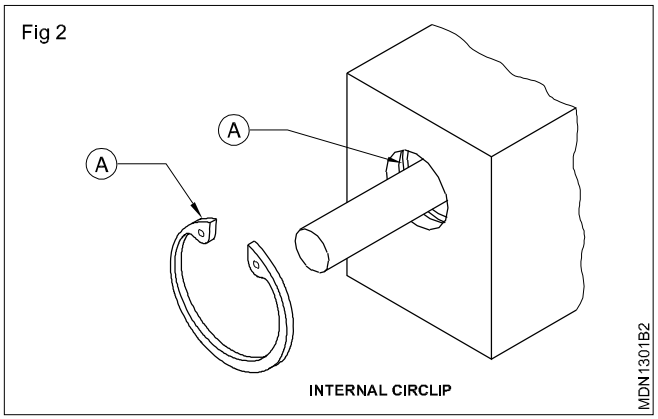
TYPES

There are two types.

Internal circlips (Fig.2)

This type of rings are assembled in holes, bores or housing.

Fig 2



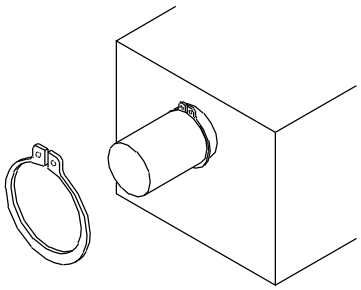
External circlip (Fig.3)

This type of rings are installed on shafts, pins, studs and similar parts.

Both types offer a number of advantages over other types of fasteners.

- Their cost is relatively low when compared with other types of fasteners.
- Their use often results in savings in raw material and simplified machining operations for other parts in the assembly.
- One circlip often can replace two or more parts.
- Assembly toolings developed for circlips usually permit very rapid assembly of the fasteners, even by unskilled workers.

Fig 3



EXTERNAL CIRCLIP

MDN1301B3

Material

Because retaining rings depend for their function largely on their ability to be deformed elastically during assembly and disassembly, the materials must have good spring properties. Circlips are manufactured from spring steel with high tensile and yield strength.

Washers - Types and Uses

Objectives : At the end of this lesson you shall be able to

- **state the purpose of washers**
- **name the types of washers**
- **state the uses of each type of washers**
- **specify the washers as per B.I.S.**

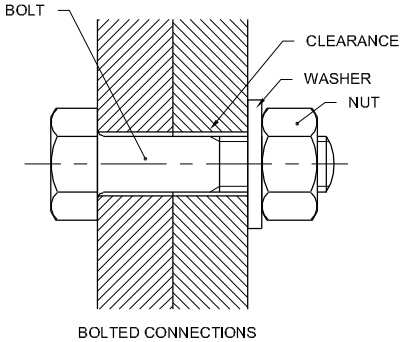
Purpose

It is a common practice to provide washers under the nuts in bolted joints.

Washers help to (Fig 1)

- increse the frictional grip
- prevent loosening of nuts due to vibration
- prevent damage to the work piece and
- distribute force orver a larger area.

Fig 1



BOLTED CONNECTIONS

MDN1301C1

Types of washers

There are different types of washers available. They are

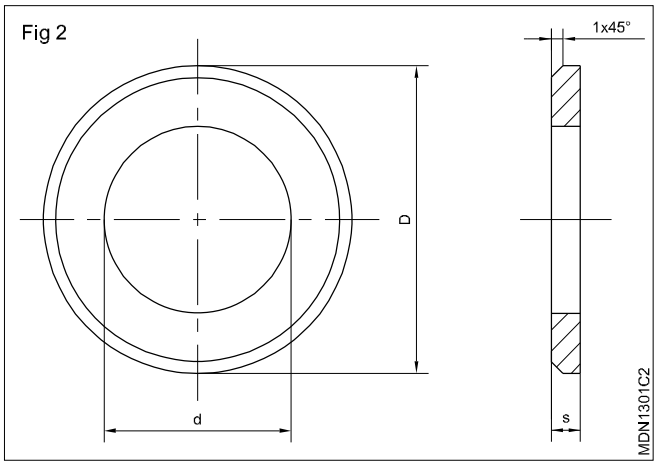
- plain or flat washers
- taper washers
- spring washers
- tab washers
- toothed lock washers.

Plain or flat washers (Fig 2)

These washers are used for bolting assemblies with flat surfaces. The diameter thickness and the bore diameter are proportional to the diameter of the bolt. (I.S. 2016)

Plain washers are available as machined or punched washers.

Fig 2

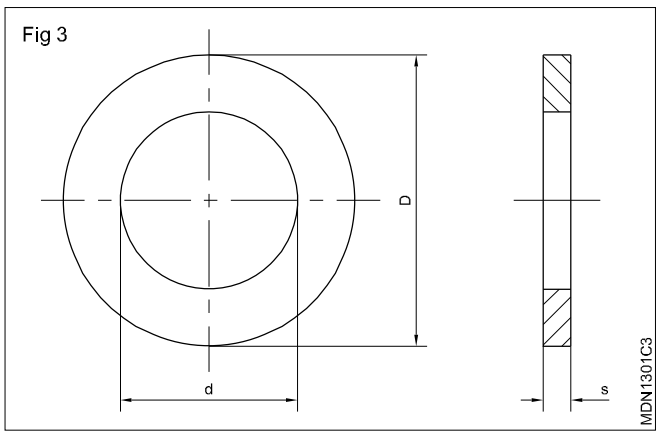


MDN1301C2

Machined washers (Fig 3)

These washers are used for assemblies using machined components. These washers are available with chamber on one side or on both sides. They are heat treated and ground.

Fig 3



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Punched washers

These do not have chamfers and are commonly used in structural fabrication work.

Tapered washers (Figs 4 & 5)

These are used in structural assemblies with tapered surfaces like the inside of beams, channels etc. These washers help bolt head or nut to seat square to the hole.

Fig 4

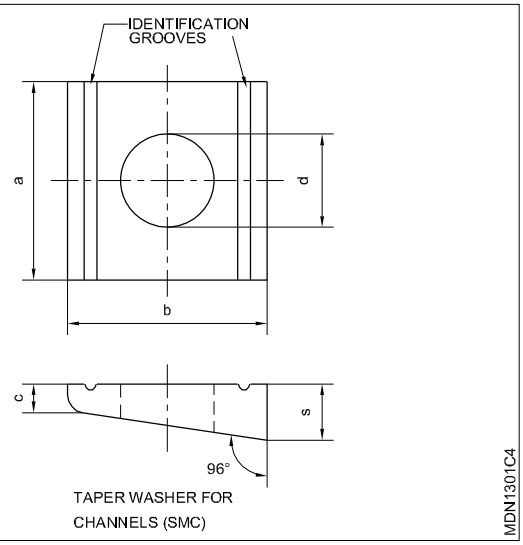
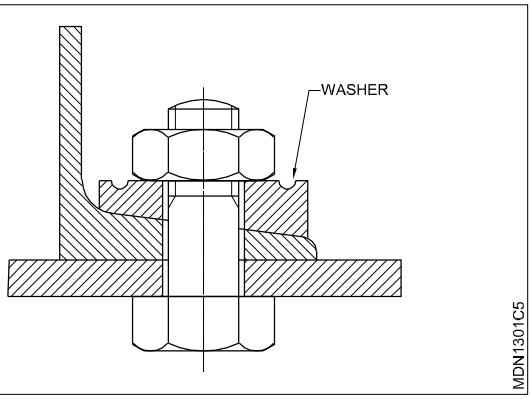


Fig 5



Spring washers (Figs 6 & 7)

Spring washers are used under the nuts to prevent slackening of the nuts due to vibrations. They are made of spring steel, and when compressed they create tension between the bolt and the nut.

Fig 6

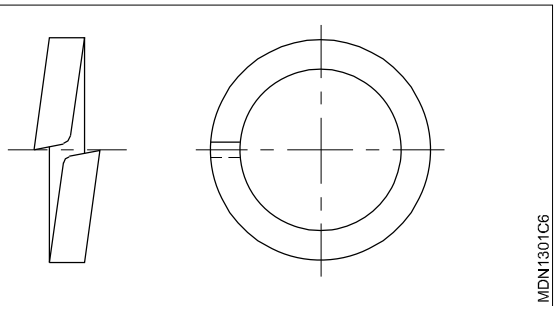
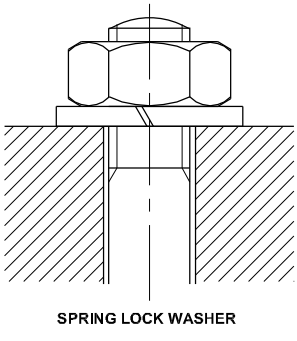


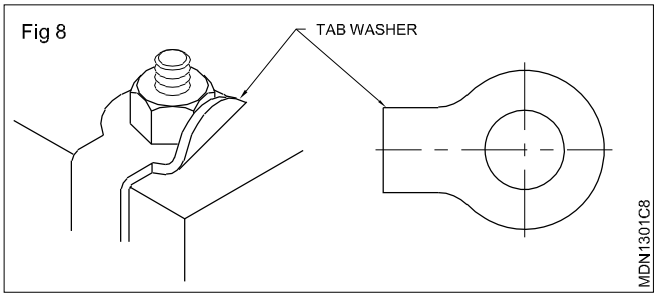
Fig 7



Tab washers (Fig. 8)

These washers are used for locking the nuts.

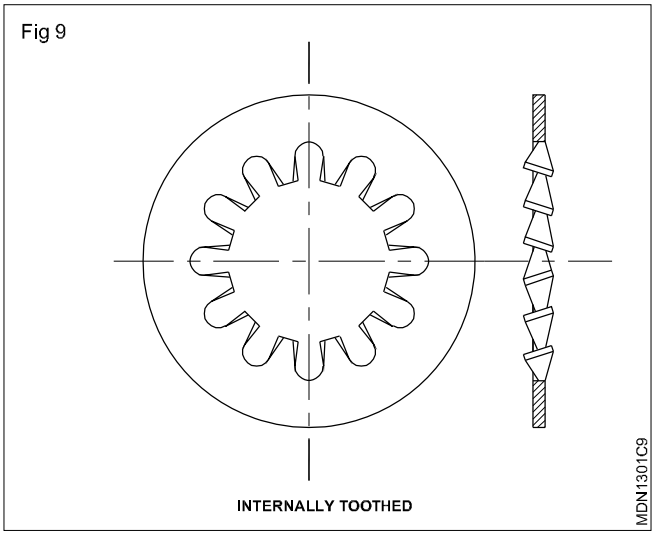
Fig 8



Toothed lock washers (Fig. 9)

These washers have serrations, cut and twisted. When placed between the nut and the assembly, this washer exerts friction on both the contacting surfaces. This prevents the nuts from slackening.

Fig 9



Specifications

The Indian standard Is:2016-1967 designates a washer by name, type size and number of the standard and material.

Example

A machined washer of size 10.5 mm made of brass shall be designated as machined washer 10.5 IS:2016 Brass.

Note

For detailed specification of different types of washers refer to the following IS specifications.

Taper washer	- IS: 5374 and IS: 5372
Tab washer	- IS: 8068
Toothed lock washer	- IS: 5371
Plain washer	- IS: 2016

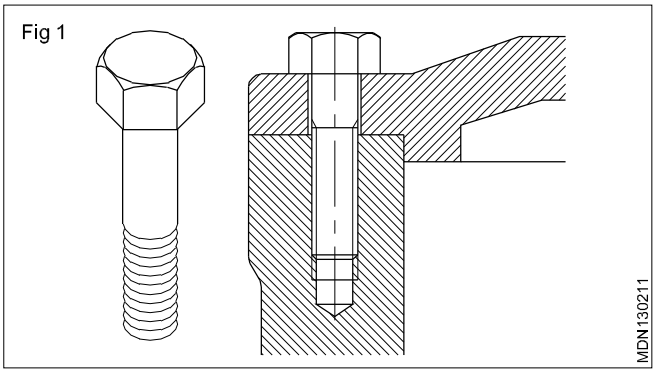
Different types of screws, nuts, studs and bolts.

Objectives : At the end of this lesson you shall be able to

- **name the different types of machine screws used in heavy duty assembly**
- **name the different types of machine screws used in light assembly work**
- **state the uses of different types of machine screws**
- **name the different types of set screws.**

Machine screws are used when a nut cannot be used in the assembly and the component in the assembly has a threaded hole to receive the screws (Fig.1)

Fig 1



Types of machine screws (Heavy duty)

Hexagon head screws

Hexagon socket head cap screws

Square head countersink head screws

These are heavy duty screws.

Hexagon head screws

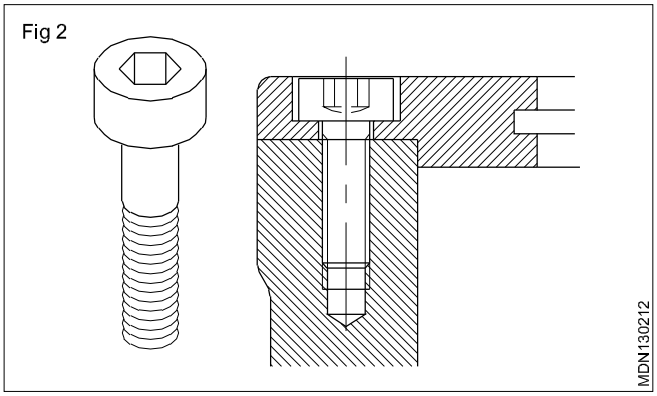
These are used when the projection of the screw head will not be an obstruction in the assembly (Fig.1)

Hexagon socket head cap screws

These are used when the projection of the screw head above the surface is to be avoided. (Fig.2) The Indian Standard specification head socket cap screws cover the range from 1.6 mm to 36mm.

Hexagon head screws and hexagon socket head screws are made of steel. Hexagon head screws used in electrical work are made of brass.

Fig 2



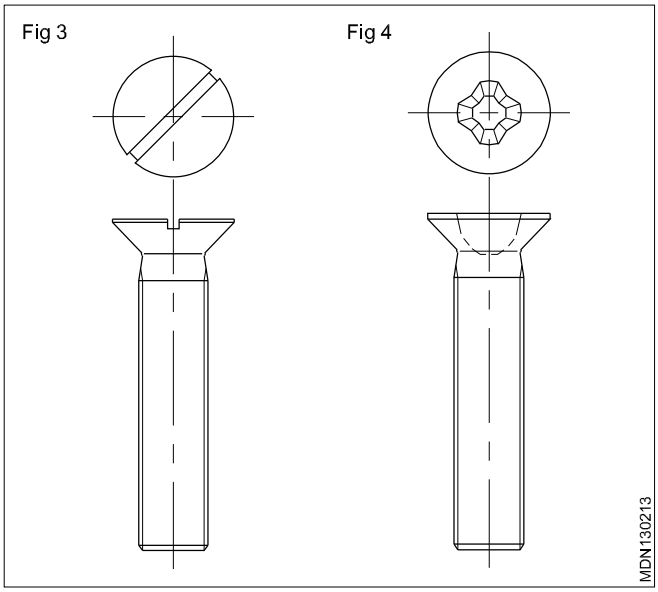
Countersink head screws

There are four types of countersink head screws in common use.

They are:

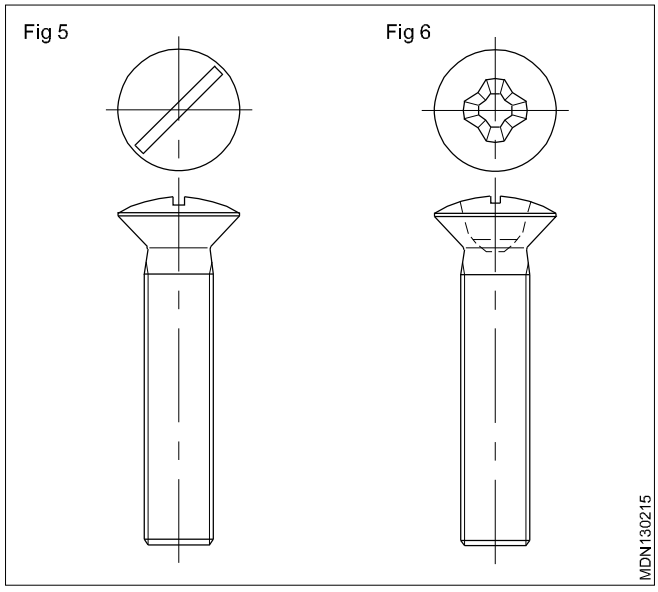
- slotted countersink head screws (Fig.3)
- cross-recessed countersink head screws (Fig 4)

Fig 3 Fig 4



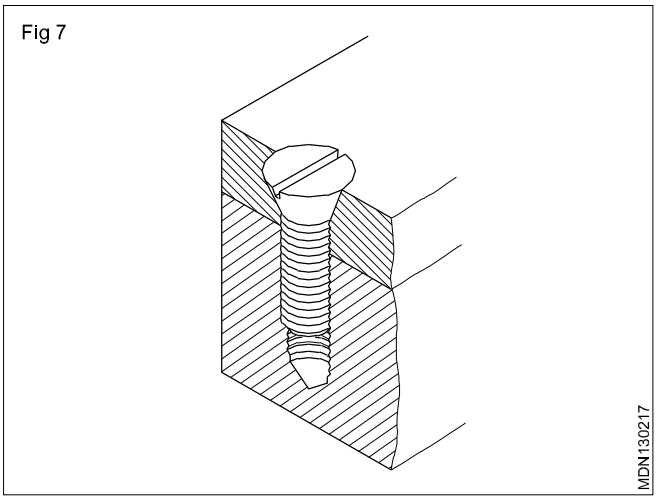
- slotted raised countersink head screws (Fig.5)
- cross recessed, raised countersink head screws. (Fig.6)

Fig 5 Fig 6



Countersink screws are capable of aligning the matching component correctly with the threaded hole. (Fig.7)

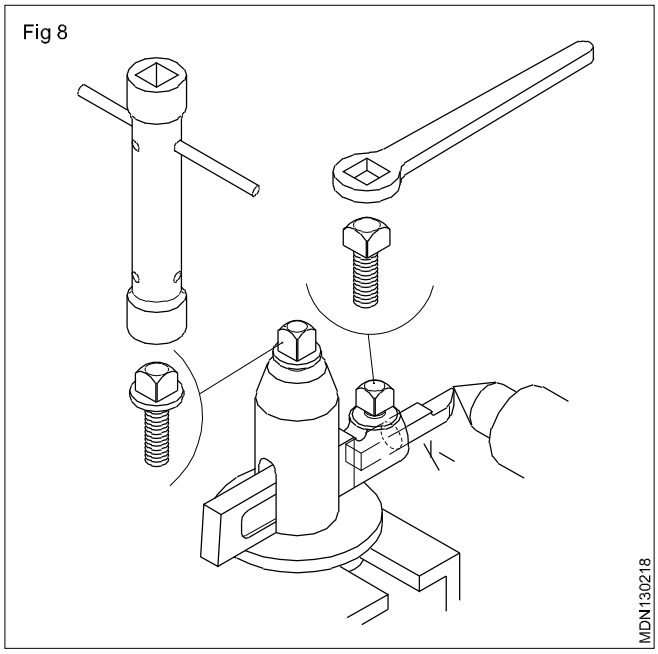
The projection of the screw head above the assembly is also avoided. B.I.S. specification covers the following ranges of countersink head screw sizes in different types.



- Slotted countersink head screws M1 - M20
- Cross-recessed countersink head screws M1.6 to M10.
- Slotted raised countersink head screws M1 to M20.
- Cross-recessed raised countersink head screws M1.6 to M10.

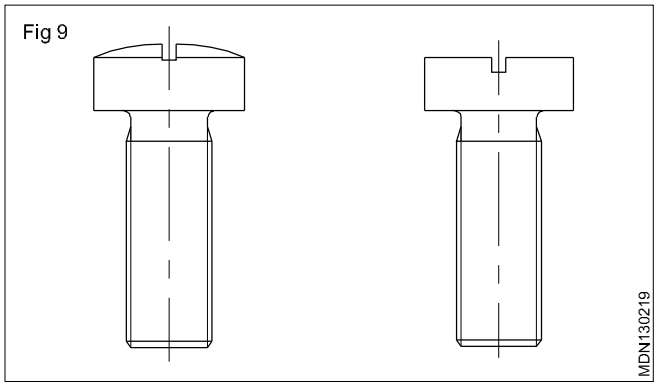
Square head screws. (Fig. 8)

Square head screws are used in places where there is frequent removal and refitting of the assembly. These screws are tightened to a higher torque using a wrench. (Fig.8) Square head screws are also available with a collar. In this there is a washer at the base which is an integral part of the head. The purpose of this collar is to protect the work-surface from damages due to constant use of wrenches.

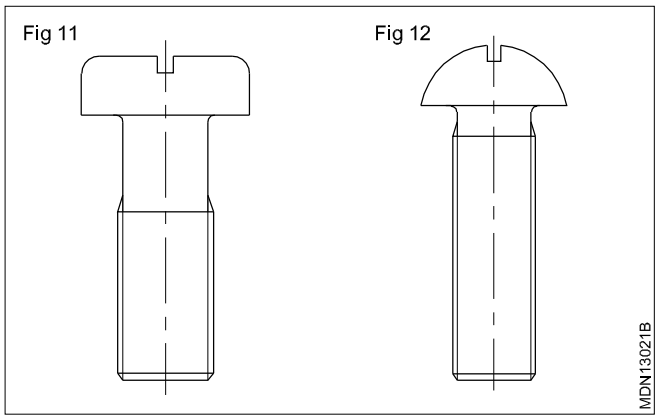


Other types of machine screws used in light assembly work are:

Pan head (Fig 9) ; Cheese head (Fig 10)



Raised cheese head (Fig 11) ; Round head (Fig 12)



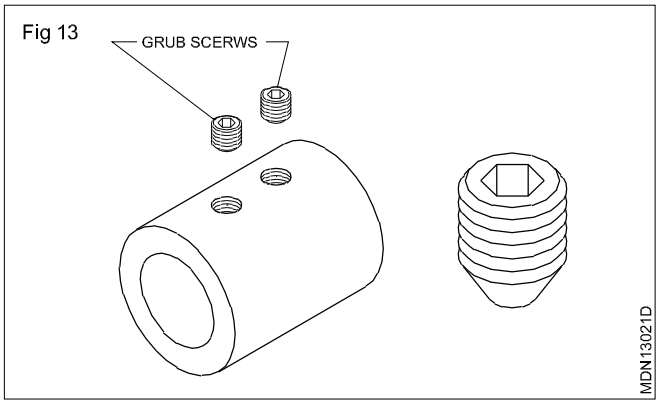
These screws are also available with slotted head or as cross-recessed.

The screws used for light duty are normally available up to 10mm thread diameter.

These screws are made of steel, stainless steel or brass. These screws are either plain finished, zinc-coated or chrome-plated.

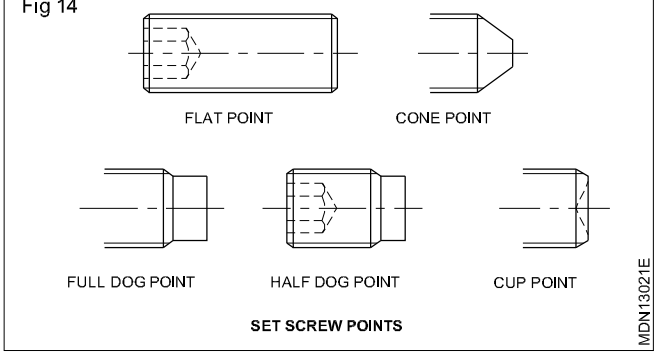
Set screws and grub screws

Hexagonal socket set screws (Fig.13)



These are headless socket screws available with different points for various functional requirements. (Fig.14)

Fig 14

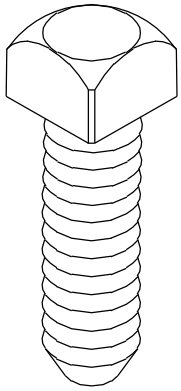


These points either allow to bite into the metal or tighten without damage to the work-surface. They are used to fasten pulleys, collars etc. to the shafts. They are used for higher strength applications where space is limited.

Square set screws (Fig.15)

These set screws have similar applications as hexagon socket set screws but have square heads projecting above the work-surface.

Fig 15

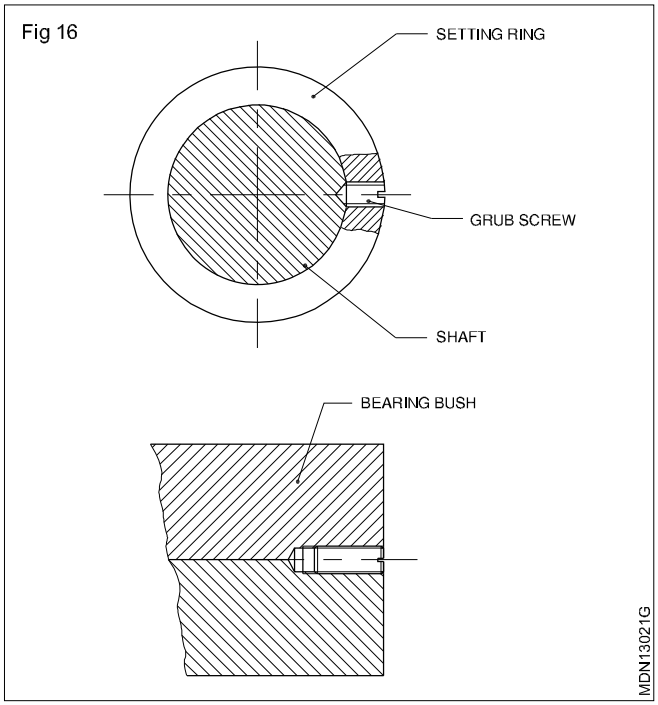


These are useful when the assembly needs frequent disassembly and setting.

Grub screws

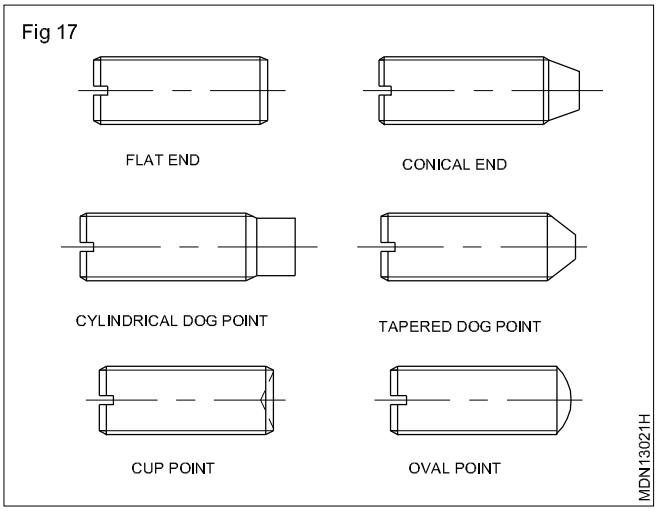
Grubs have similar application as hexagon socket set screws but are used for light holding. (Fig. 16)

Fig 16



Grub screws are also available with different types of points (Fig.17)

Fig 17



Thumb Screws

Objectives : At the end of this lesson you shall be able to
- **state the types of thumb screws**
- **state the uses of thumb screws**
- **designate thumb screws as per B.I.S. specification**.

Thumb screws are used in places where fixing and removal of components are frequent. Tightening and loosening of the assembly is finger tight only.

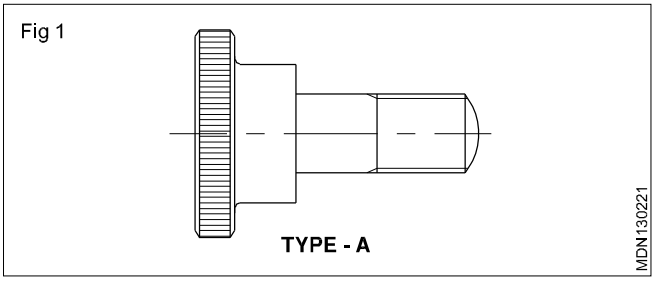
Types

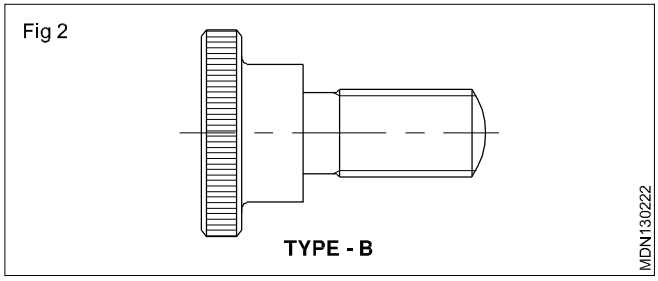
As per the Indian standard specification IS:3726-1972 there are five types of thumb screws.

Type-A Thumb screws partially threaded (Fig 1)

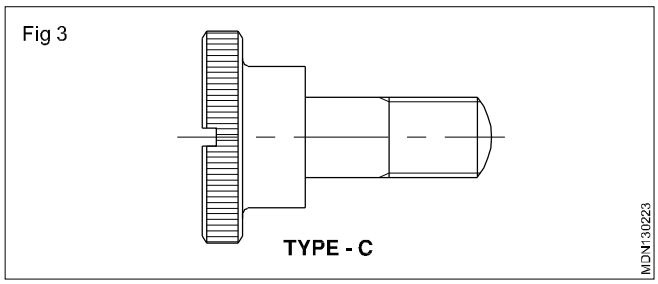
Type-B Thumb screws fully threaded (Fig 2)

Fig 1

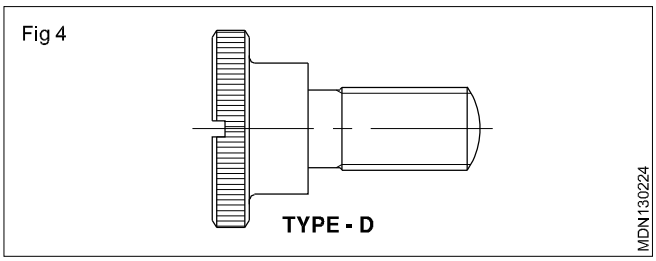




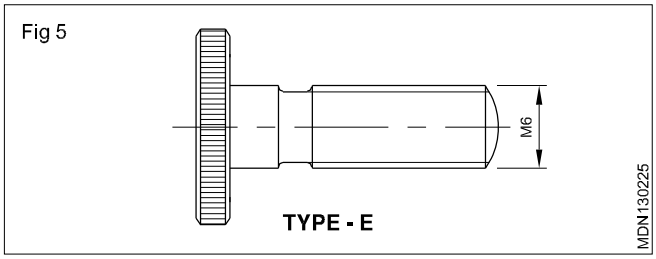
Type-C Slotted thumb screw partially threaded (Fig 3)



Type-D Slotted thumb screw fully threaded (Fig 4)



Type-E Flat thumb screws (Fig 5)



The type of thumb screw selected depends on the actual requirement in the assembly.

Sizes

Thumbs screws are available in the following sizes as per B.I.S.

M1.6, M2, M2.5, M3, M4, M5, M6, M8 and M10.

Designation of thumb screws

Thumb screws shall be designated by the nomenclature, type, thread size, nominal length, the number of Indian Standard and the symbol for mechanical properties.

Example

A thumb screw of Type `A', size M6, nominal length 12mm and of property class 4.6 shall be designated as:
Thumb screws A M6 x 12 IS: 3726-4.6
When brass or any other non-ferrous metal is used for the manufacture of thumb screws, the word Brass or the name of the non-ferrous metal used will replace the property class number in the designation.

Types of Nuts

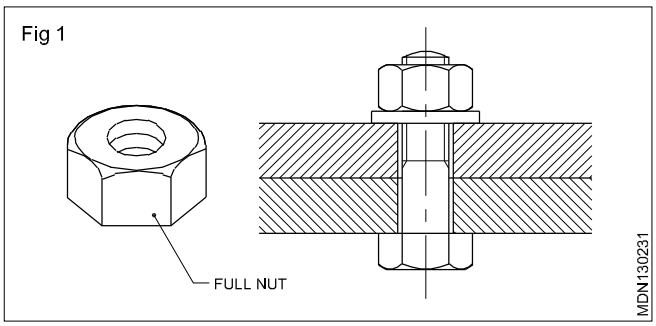
Objectives : At the end of this lesson you shall be able to
- **name the common types of nuts**
- **state the features and uses of the common types of nuts.**

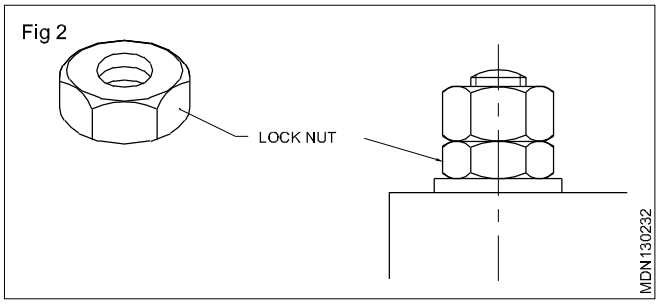
Different types of nuts are used depending on the requirement of the assembly.

Hexagonal nuts (Figs 1 & 2)

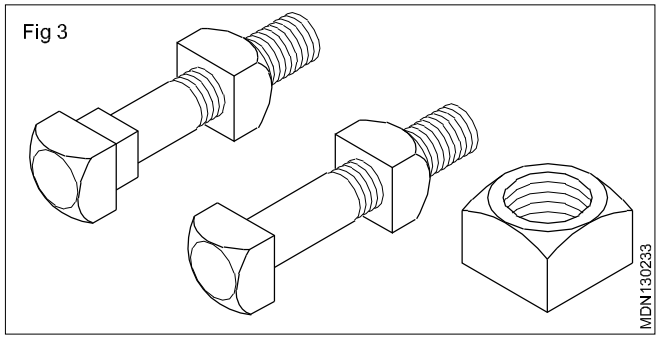
This is the most commonly used type of nut in structural and machine tool construction.

Hexagonal nuts are available in different thicknesses. Thin nuts are used as lock-nuts.





Square nut (Fig. 3)



Square bolts are provided with square nuts. In bolts for coaches mostly square nuts are used.

Self-locking nuts (Simmonds lock-nut)

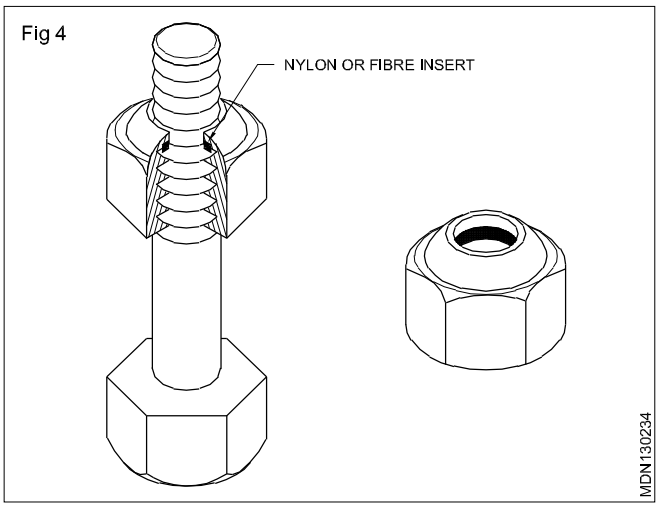
This nut has an internal groove cut in which a fibre or nylon ring is inserted. This ring holds the nut tightly on the bolt and serves as a locking device.

Self-locking nuts are not used with studs.

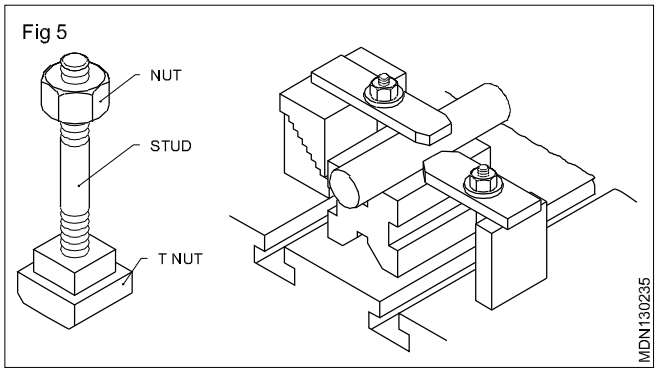
T-nuts.

T-nuts are used along with studs on machine tools for fixing/holding devices or workpieces.

Slotted and castle nuts (Fig. 4)



Round nuts (Fig. 5)



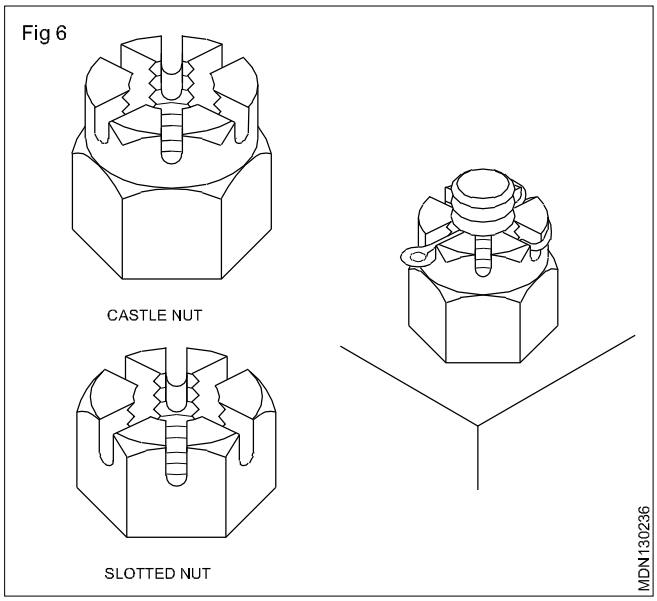
Round nuts of different types are available for special applications.

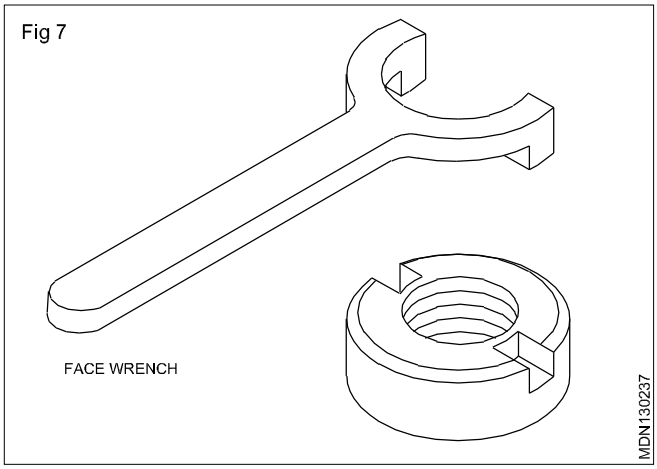
Slotted round nut (Figs 6, 7, 8, 9 & 10)

Slotted round nut for hook wrench.

Round nut with set pin holes on sides

Round nut with holes in the face.





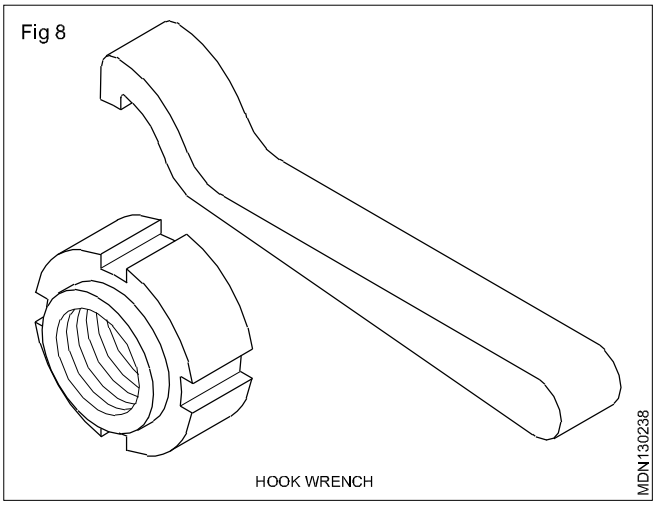
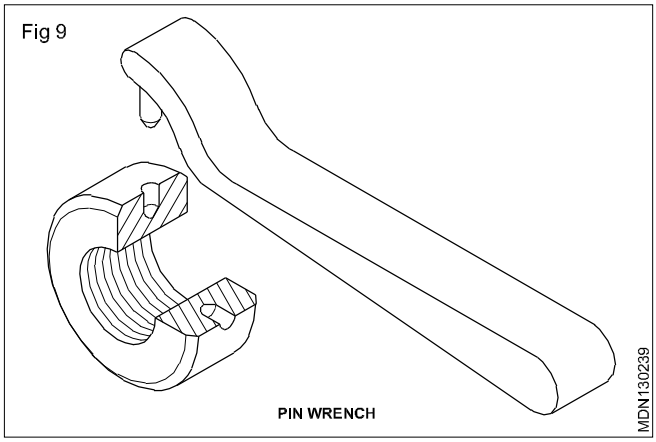


Fig 9



PIN WRENCH

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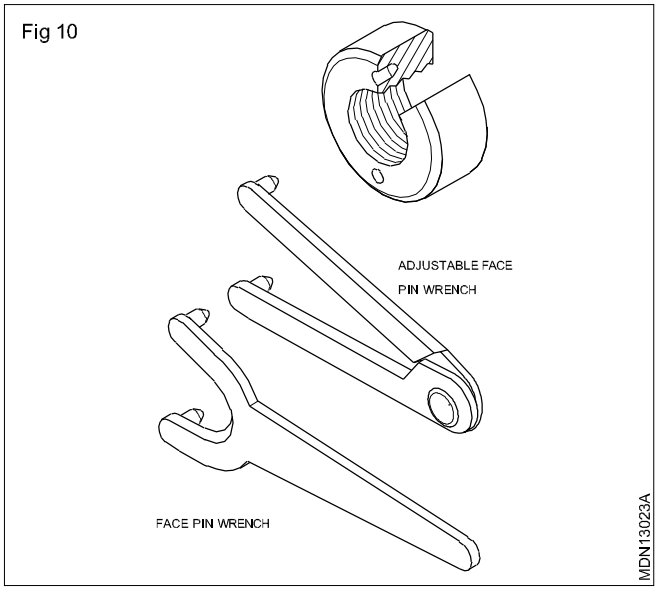
Fig 10



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Methods of removing broken studs

Objectives : At the end of this lesson you shall be able to
- **state the reasons for breakage of studs**
- **state the different methods for removing broken studs.**

The stud is used in the place of a bolt. Where hole cannot be had for the bolt to pass through or to avoid the use of an unnecessarily long bolt. Studs are generally used to fix up cover plates or to connect cylinder covers to engine cylinders.

Reasons for breakage of stud/bolt

Excessive torque is applied while screwing the stud into the hole/tightening the nut.

Threads are corroded excessively.

Matching threads are not of proper formation.

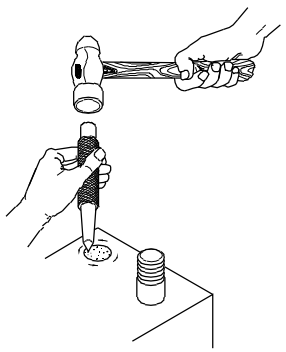
Threads are seized.

Methods of removing broken studs

Prick punch method (Fig 1)

If the stud is broken very near to the surface, drive it in an anticlockwise direction, using a prick punch and hammer to remove it.

Fig 1



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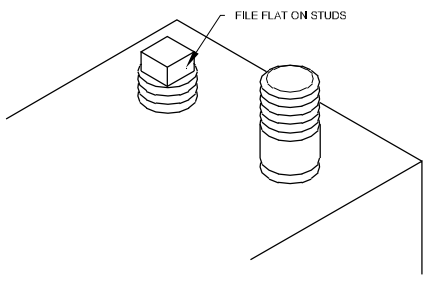
Filling square form (Fig 2)

When the stud is broken a little above the surface, form a square on the projecting portion to suit a standard spanner. Then turn it anticlockwise using a spanner to remove stud.

Fig 2



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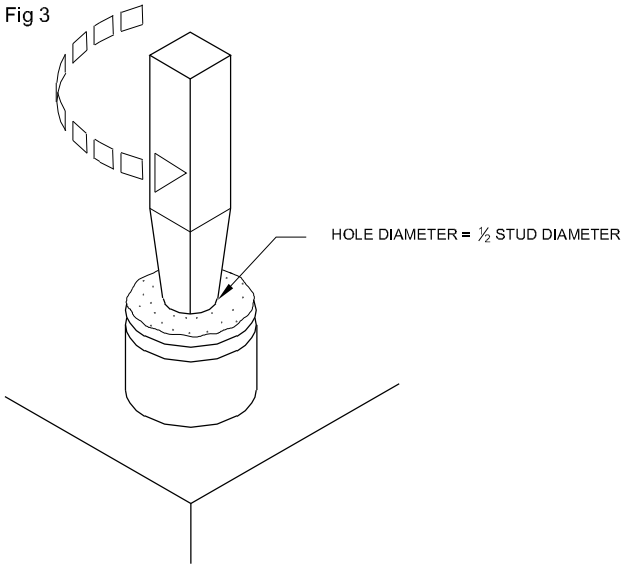
Using square taper punch (Fig 3)

Broken studs can also be removed by drilling a blind hole (hole diameter equal to half of stud diameter) and driving a square taper punch into the hole as shown Fig 3. Turn the punch using a suitable spanner in an anticlockwise direction to unscrew the stud.

Fig 3



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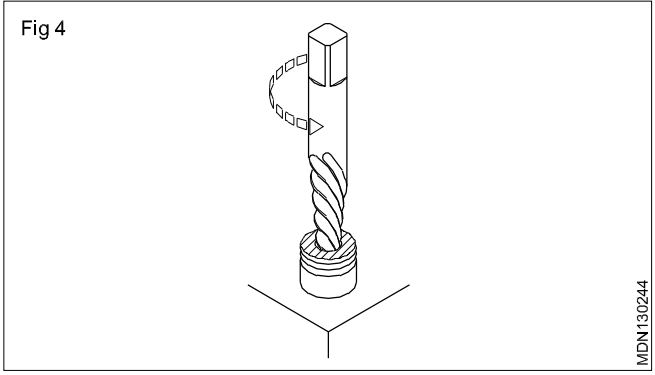
Ezy-out method (Fig 4)

Ezy-out or a stud extractor is a hand tool, some what similar to the form of a taper reamer but it has left hand spiral. It is available in a set of 5 pieces. The recommended drill size is punched on each ezy-out.

Drilling the hole, the recommended ezy-out is set on and turned in an anticlockwise direction by a tap wrench. As it is rotated it penetrates into the hole increasing its grip and in the process the broken stud gets unscrewed.

Fig 4



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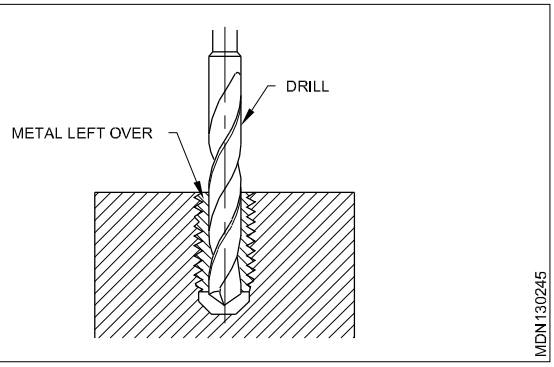
Making drill hole (Fig 5)

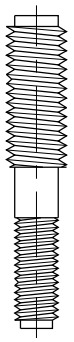
Fig 5



Correctly find out the centre of the broken stud and drill a hole nearly equal to the core diameter of the stud down the centre so that the threads only remain (Fig 5). Remove the thread portion by the point of a scriber in the form of broken chips. Re-tap the drill hole to clear the threads.

If all other methods fail drill a hole equal to the size of the stud size or a little over and tap the hole with an oversize tap. Now a special oversize stud as shown in figure 6 is to be made and fitted in position. (Fig. 6)

Fig 6



Screw pitch gauge

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a screw pitch gauge**
- **state the features of a screw pitch gauge.**

Purpose

A screw pitch gauge is used to determine the pitch of a thread.

It is also used to compare the profile of threads.

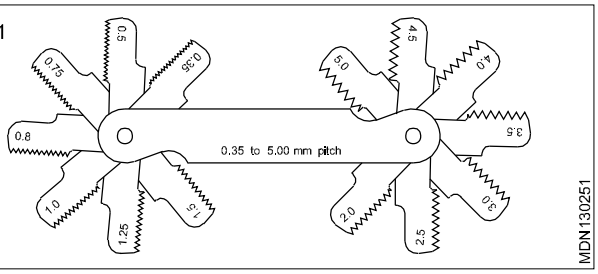
Constructional features

Pitch gauges are available with a number of blades assembled as a set. Each blade is meant for checking a particular standard thread pitch. The blades are made of thin spring steel sheets, and are hardened.

Some screw pitch gauge sets will have blades provided for checking British Standards threats (BSW, BSF etc.) at one end and the Metric Standard at the other end.

The thread profile on each blade is cut for about 25 mm or 30 m.. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 1)

Fig 1



For obtaining accurate results while using the screw pitch gauge, the full length of the blade should be placed on the threads. (Fig 2)

Fig 2