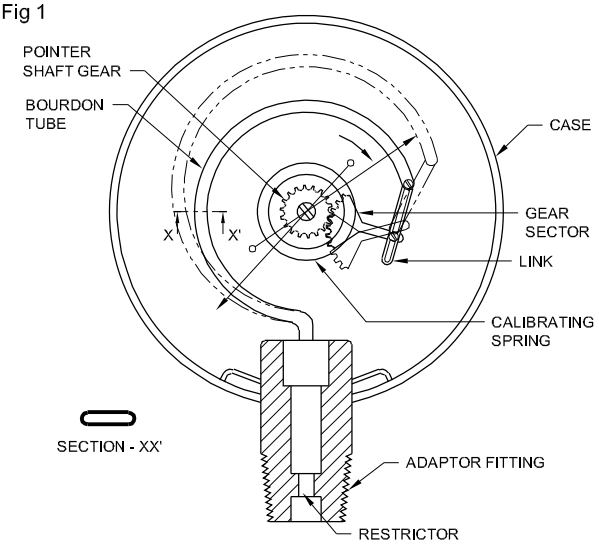
Tyre pressure gauge

Objectives: At the end of this lesson you shall be able to
- **state the construction and features of tyre pressure gauge**
- **use a tyre pressure gauge to check & set tyre pressure.**

Pressure gauge

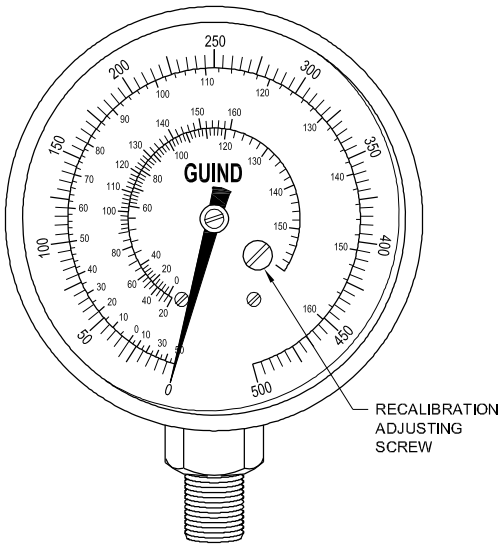
It is used to check the pressure of tyre unit. Bourdon tube pressure gauges (Fig 2) made by stainless steel. A Pressure rise in bourdon tube makes it tend to straighten. This movement will pull on the link which will turn the gear sector counter clockwise. The pointer shaft with then turn clockwise to move needle on a graduated scale to indicate pressure. (Fig 1)

Fig 1



INTERNAL CONSTRUCTION OF PRESSURE GAUGE

Fig 2



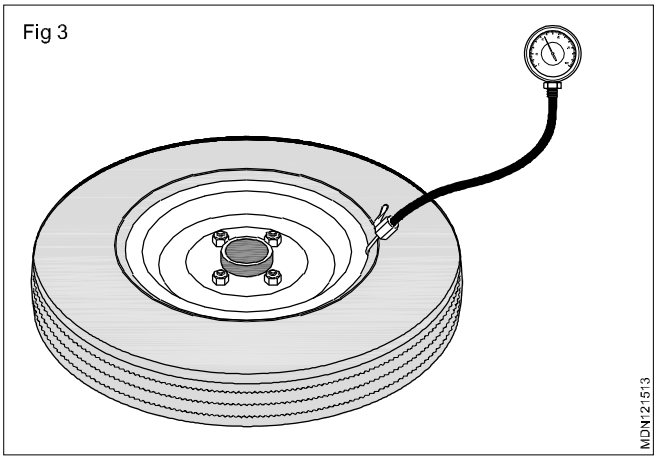
PRESSURE GAUGE

Special features

- Excellent load-cycle stability and shock resistance.
- All stainless steel construction
- Positive pressure ranges 0-200 P.S.I (Fig 3)

The pressure gauge hose has a adapter, which depresses the valve pin of tyre and compressed air get into the tube of the gauge. The pressure is indicated in the dial. Compare the pressure to the recommended pressure by the manufacturer. If it is less, refill the tyre with compressed air by operating the trigger (Fig 3). When the required pressure is shown in the gauge stop filling.

Fig 3



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

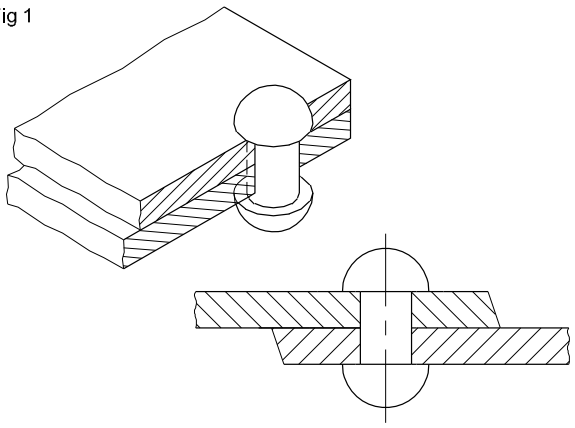
1 solid/round rivets

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

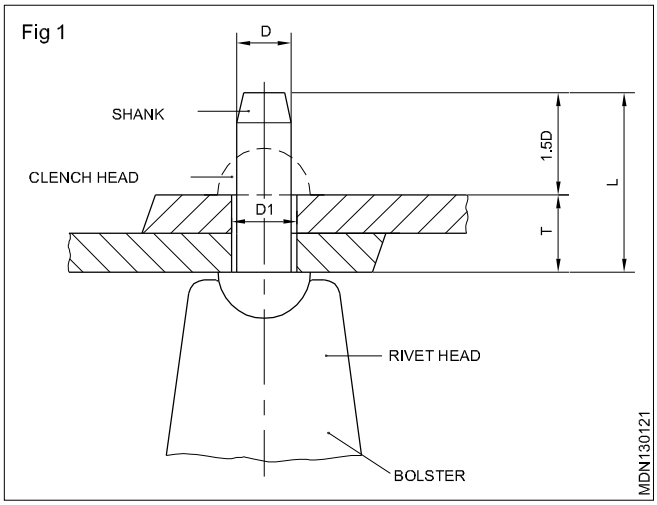
The length of a rivet is the shank length. This will vary according to the thickness of the plates to be riveted and the type of the rivet head.

A formula generally used in the shop floor is

length of snap-head rivets (Fig 1)

L = T + 1.5 D

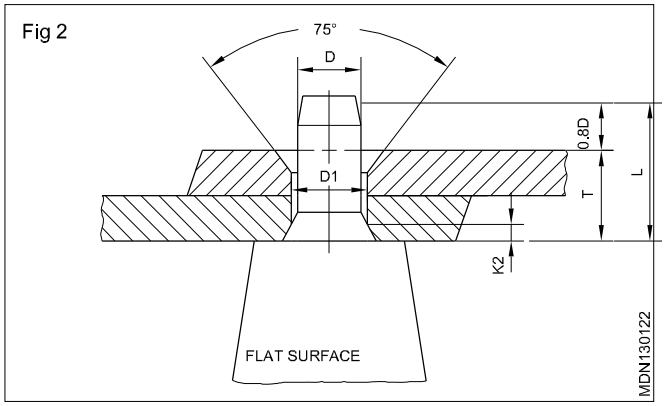
Fig 1



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

Fig 2



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

Uses

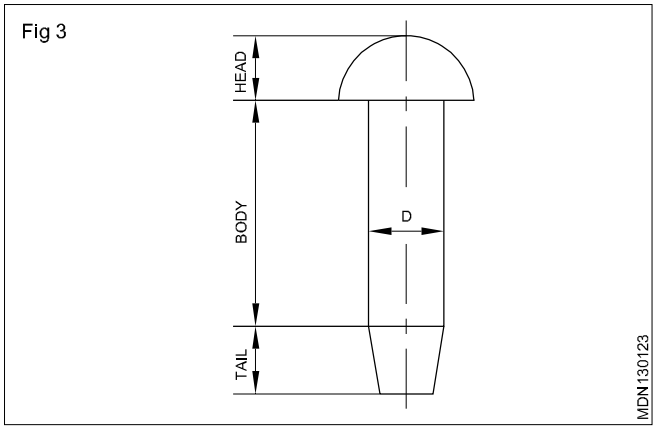
Rivets are fasteners used for joining metal sheets and plates in fabrication work such as bridges, ships. cranes. structural steel work, boilers, aircraft etc.

Parts (Fig 3)

The following are the parts of a rivet.

Head

Fig 3



Body

Tail

Materials

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

Examples

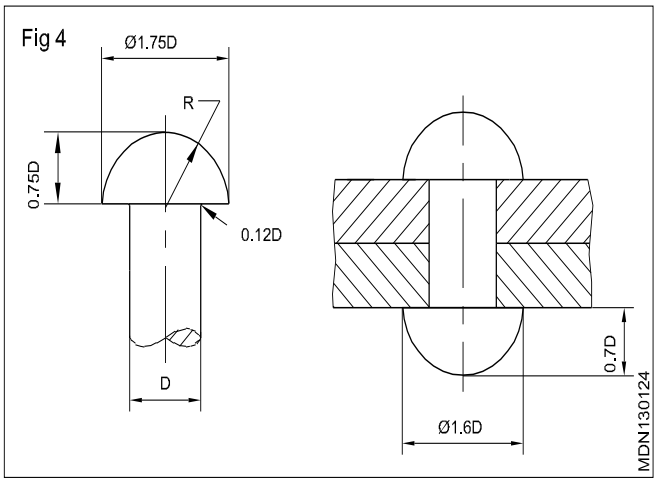
Low carbon steel, brass, copper and aluminium.

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.

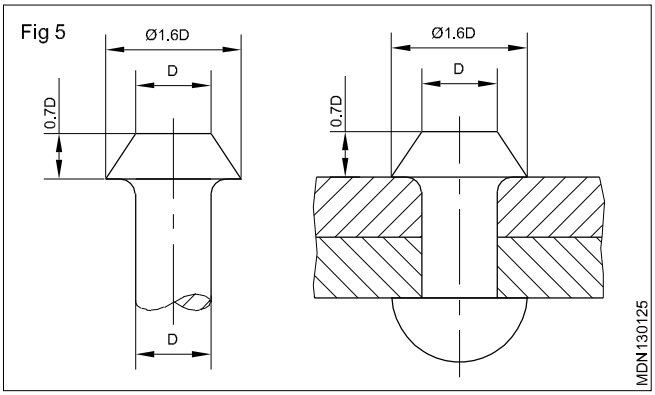
Fig 4



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.

Fig 5



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.**

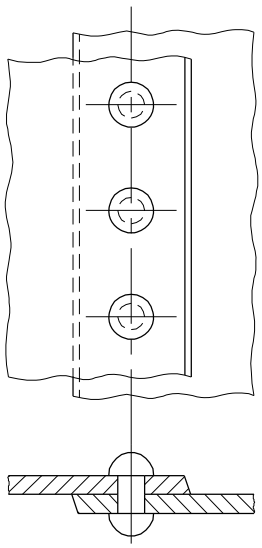
In construction and fabrication work different types of riveted joints are made.

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)

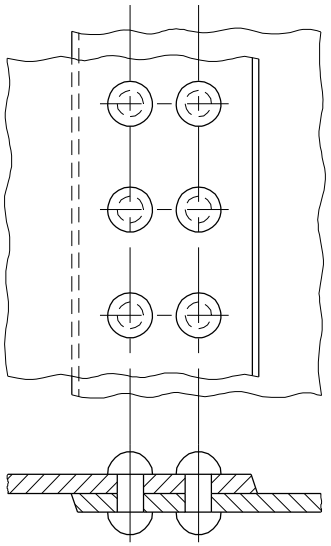
Fig 1



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)

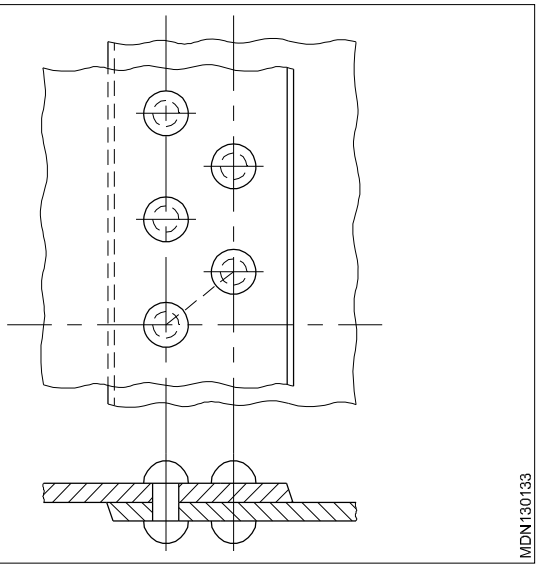
Fig 2



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)

Fig 3



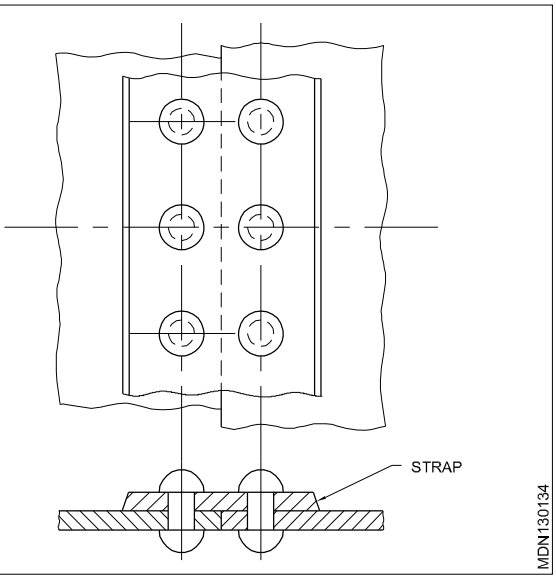
This provides a stronger joint than a single lap joint. The rivets are placed either in a square formation or in a triangular formation. The square formation of rivet placement is called CHAIN riveting. The triangular formation of rivet placement is called zigzag riveting.

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.

Fig 4



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

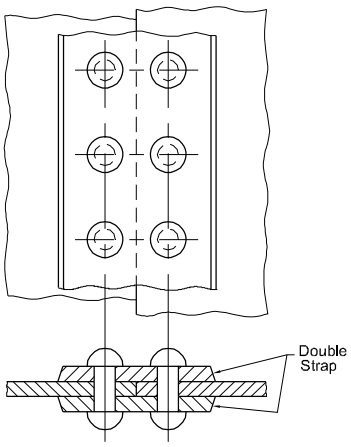
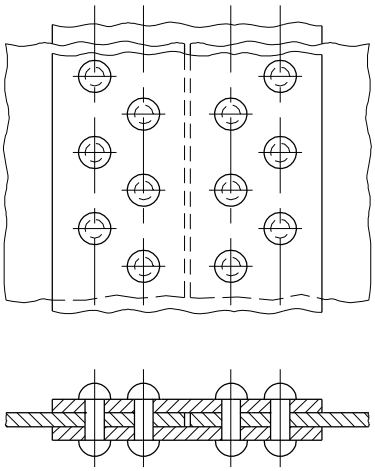


Fig 6



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.

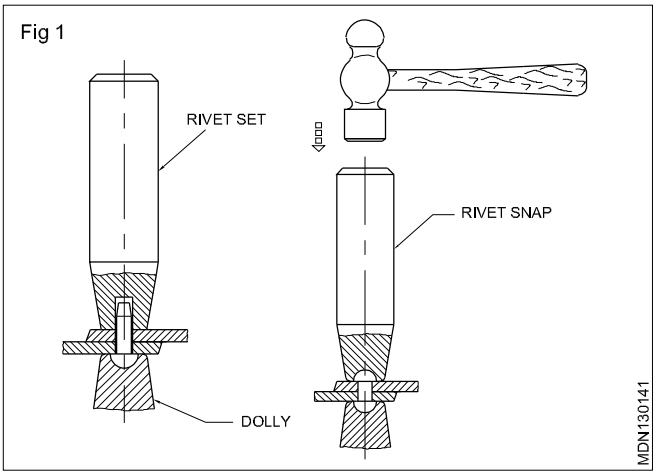
Rivet set (Fig 1)

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

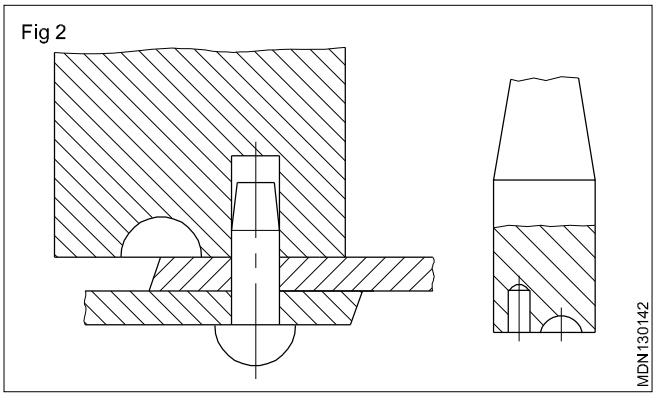


Snap

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)

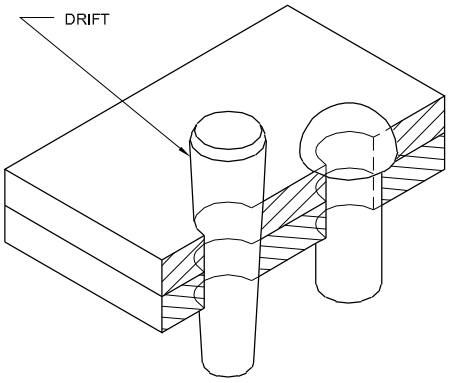
Fig 2



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

Drift (Fig 3)

Fig 3



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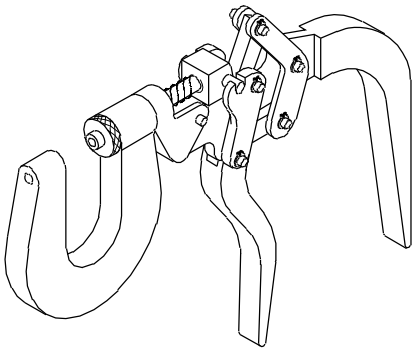
This is used to align the holes to be riveted.

Hand riveter (Fig 4)

Fig 4



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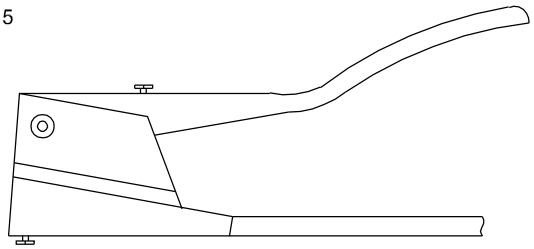
This has a lever mechanism which exerts pressure between the jaws when the handle is pressed.

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

Pop riveter (Fig 5)

Fig 5



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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.

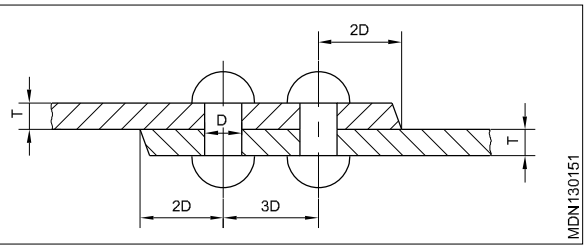
Distance from the edge to the centre of the rivet (Fig1)

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.

Fig 1



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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)

Fig 2

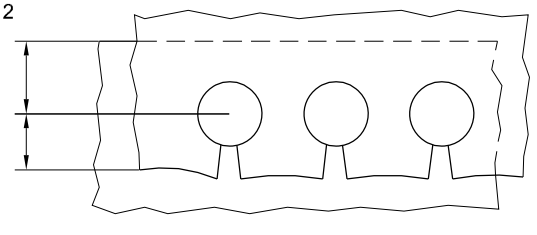

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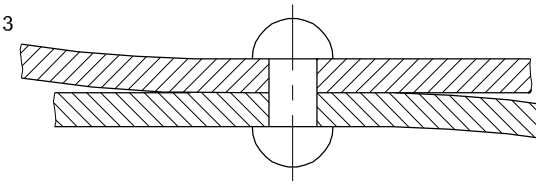
Fig 3



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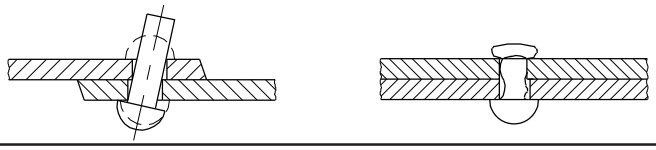
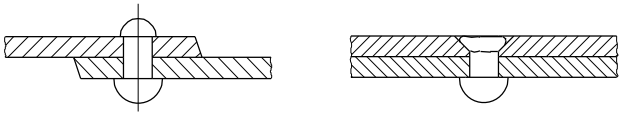
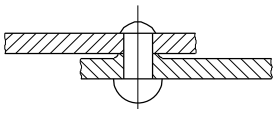
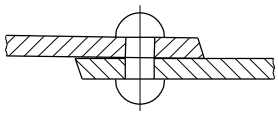
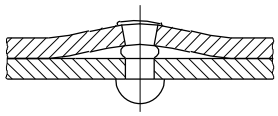
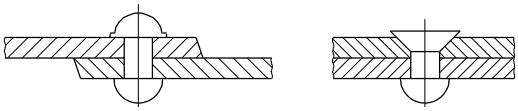
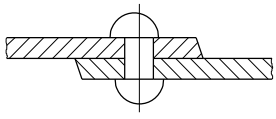
Defects in riveted joints

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

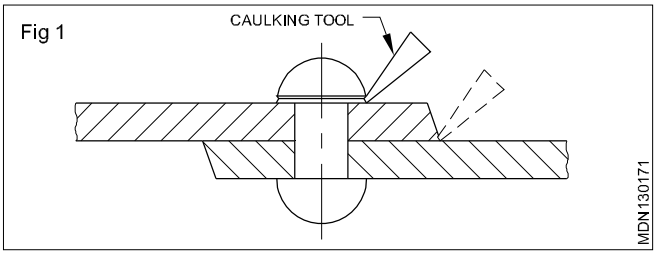
Objectives : At the end of this lesson you shall be able to
- **state the purpose of caulking and fullering**
- **distinguish between caulking and fullering processes.**

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.

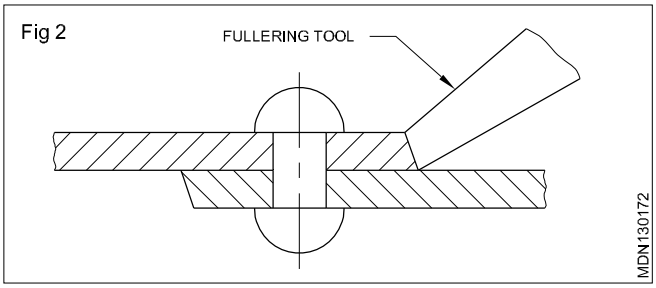
Fig 1



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)

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

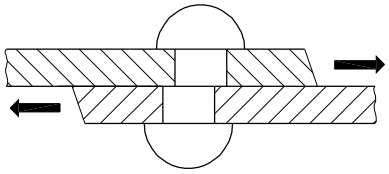
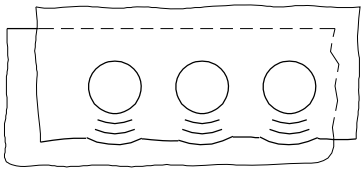
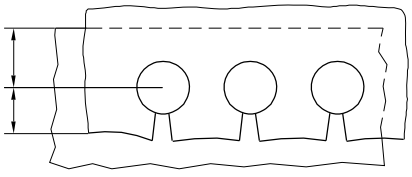
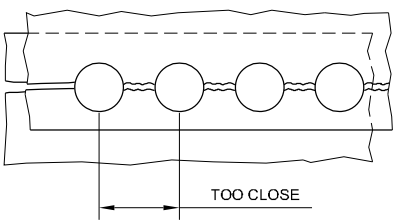
Crushing of the metal

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.

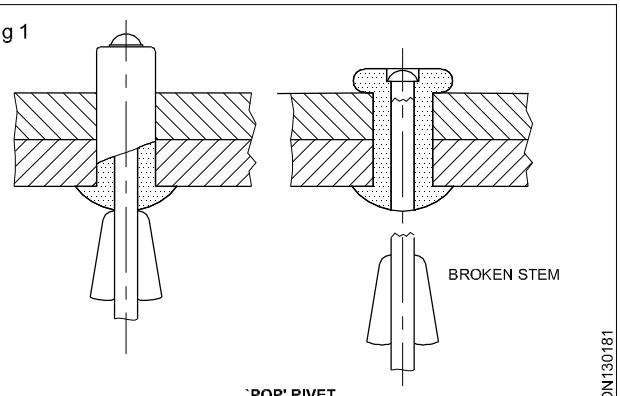
Special sheet metal rivets and their applications

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



`POP' RIVET

Fig 2

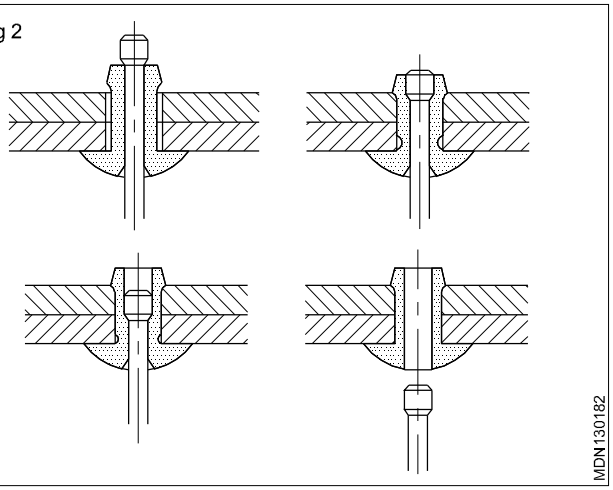
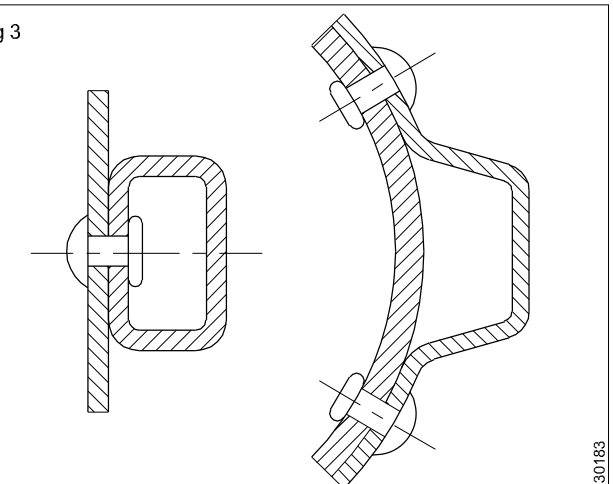


Fig 3



APPLICATION OF TUBULAR RIVETS

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.

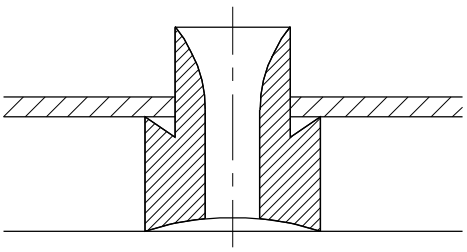
The following steps are required to fit shank bushes.

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



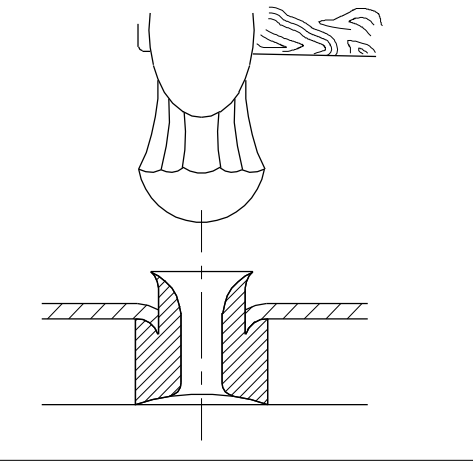
HANK BUSH

Remove the burrs.

Fit the shank bush from the under the side.

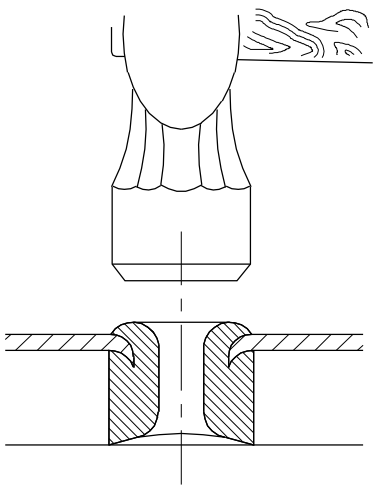
Support for riveting operation.

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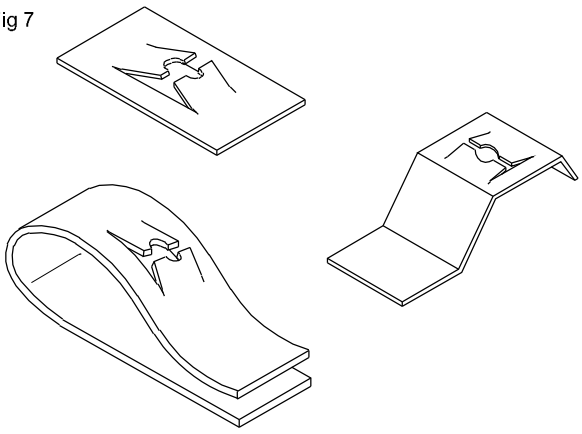
Change to the flat face of the hammer. Strike squarely, flatten the shank.

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.**

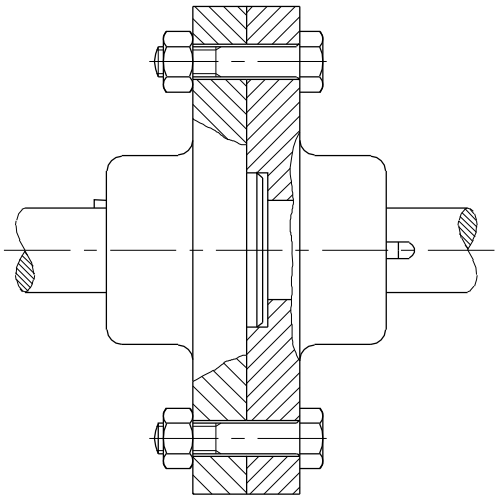
Bolts and nuts (Fig.1)

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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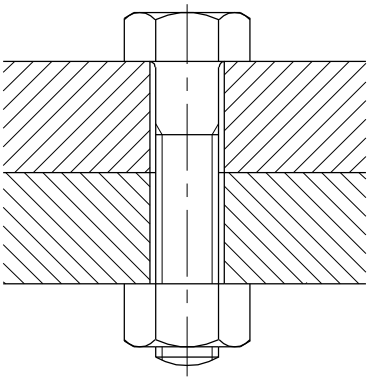
Bolts with clearance hole (Fig.2)

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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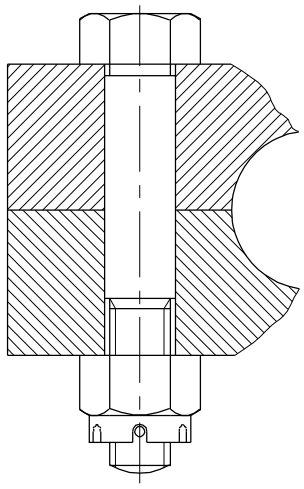
Body fit bolt (Fig.3)

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

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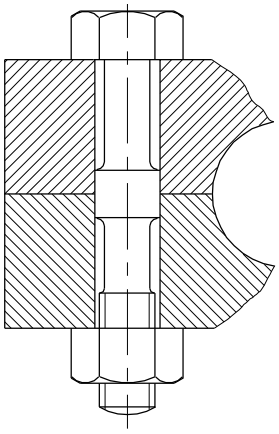
The bolt shank and the hole are accurately machined for achieving perfect mating.

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

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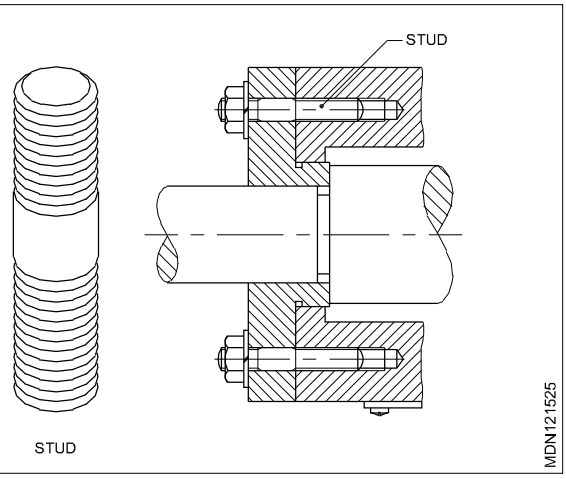
The shank diameter is in contact with the hole in a few places and other portions are relieved to give clearances.

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.

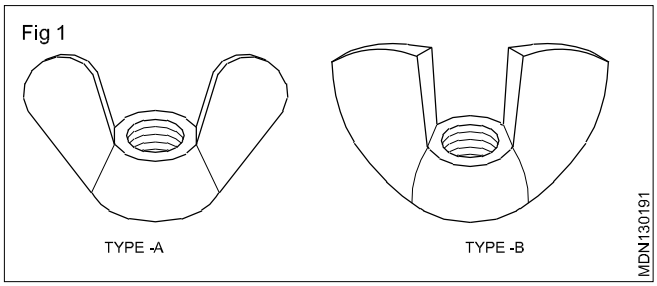
- Positive locking device
- Frictional locking device

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.

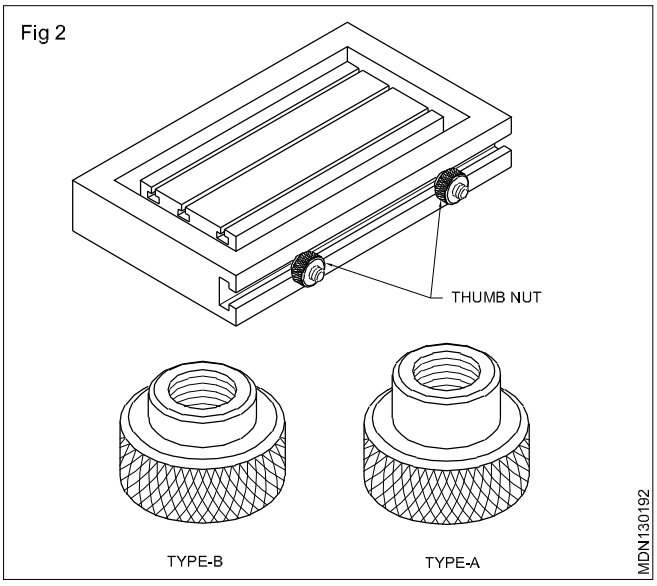
Wing-nuts (Fig. 1)

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).



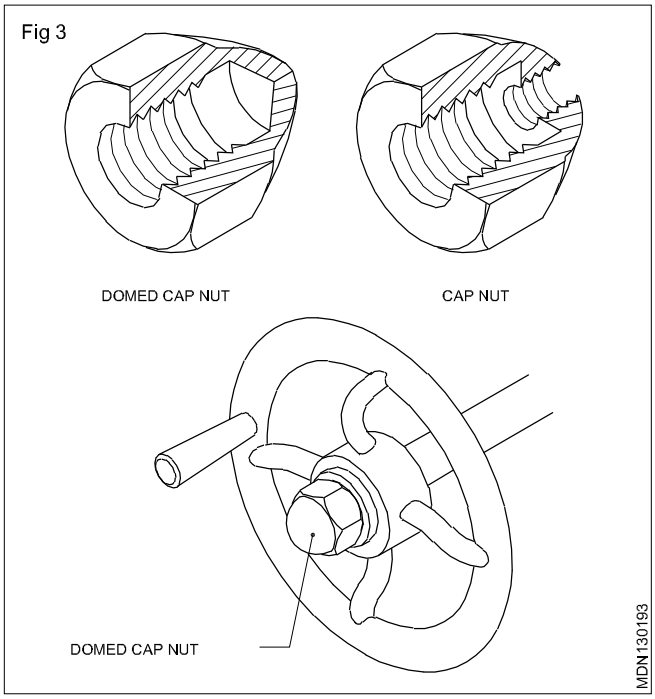
Thumb-nut (Fig. 2)

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.



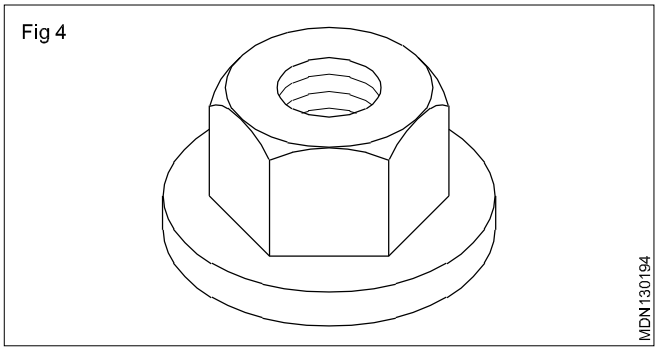
Cap nut (Fig. 3)

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.

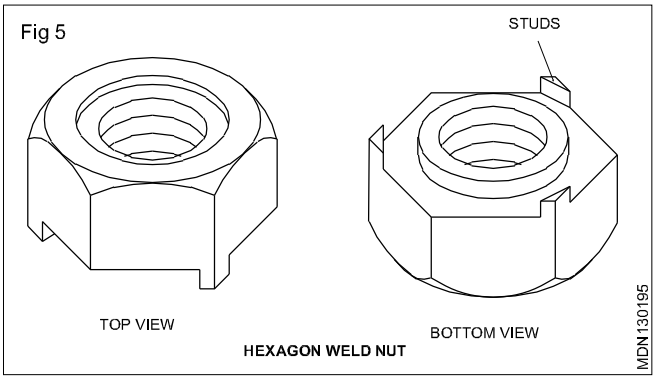
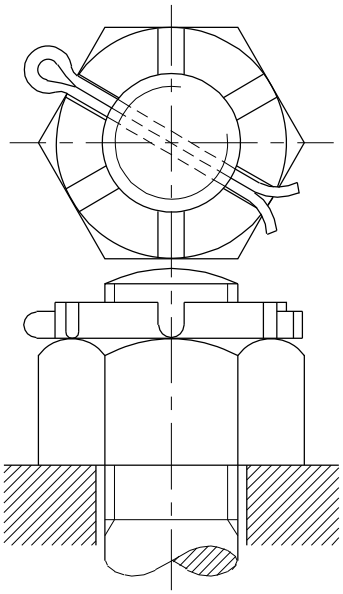


Fig 6



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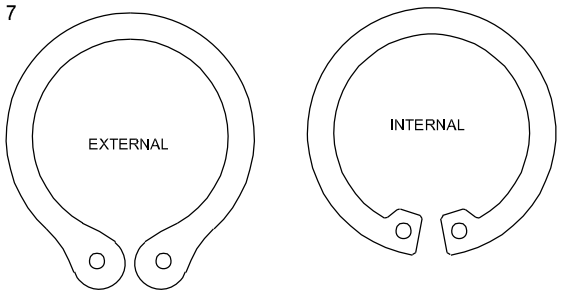
Out. Castle nuts (Fig. 6) are widely used in automobiles and locomotive engines to avoid sudden shock and vibration.

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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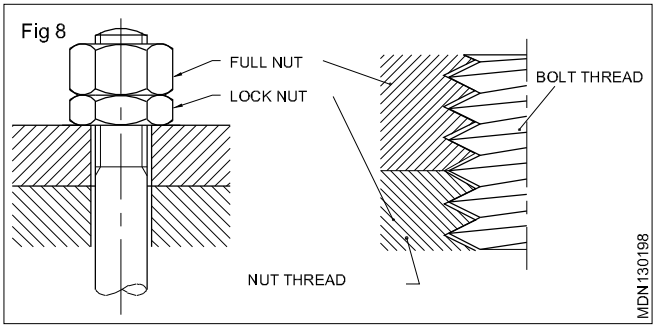
Chuck nut (Fig. 8)

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

Fig 8



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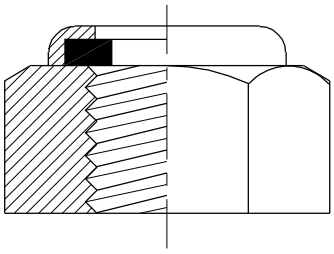
A chuck nut is also called a lock-nut. The two nuts are thus locked or wedged tightly against each other and against the bolt. This will prevent slackening.

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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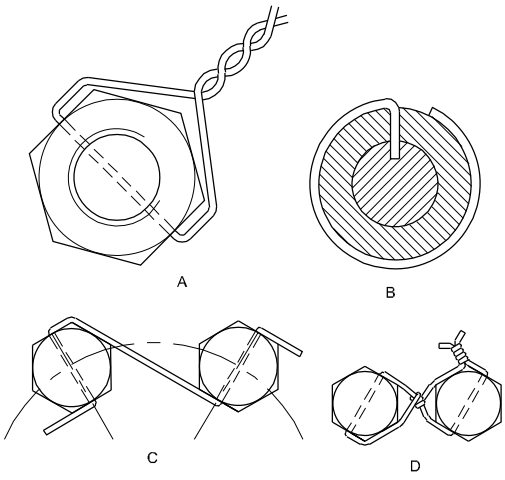
Wire lock (Fig. 10)

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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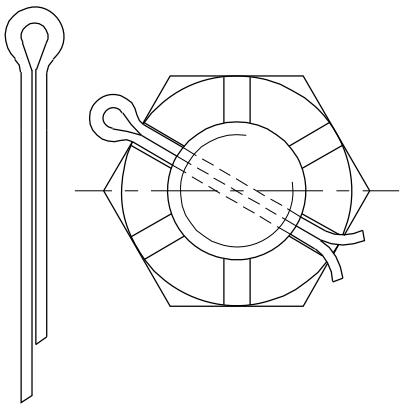
Split pin (Fig. 11)

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



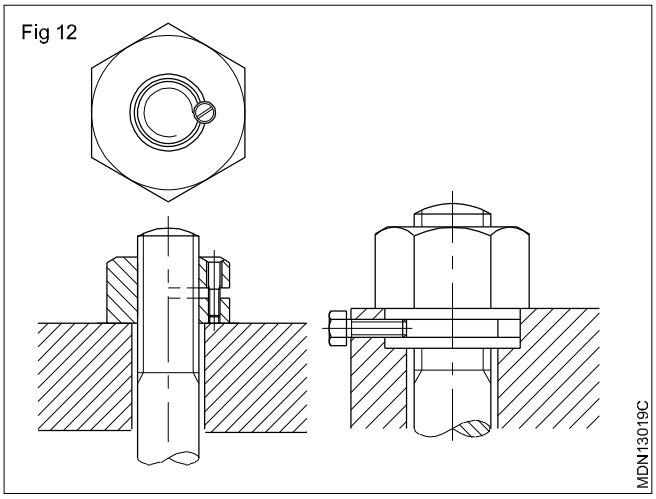
MDN13019B

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.

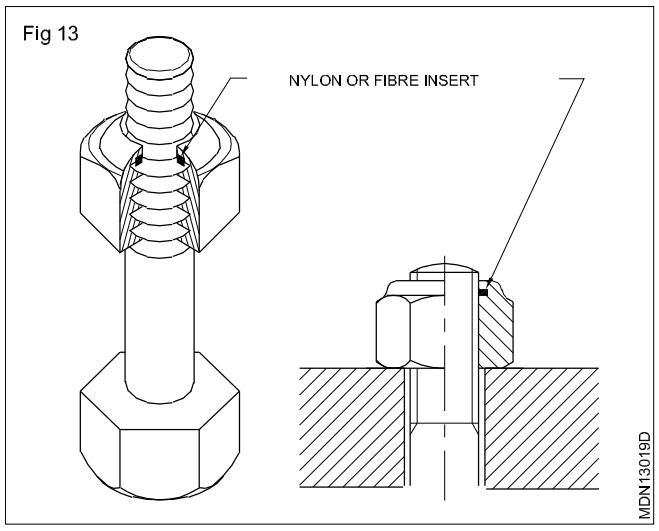
Positive locking device (Fig. 12)

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:

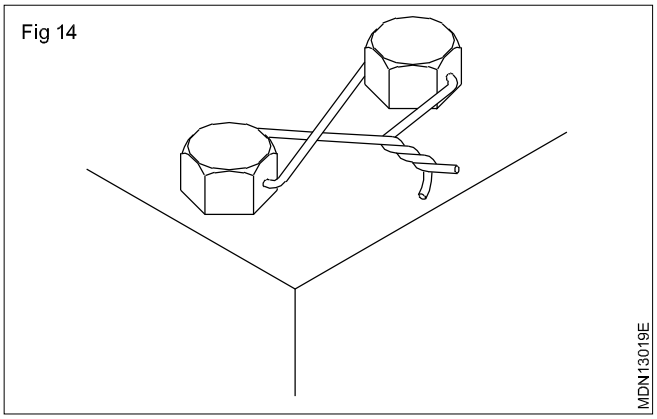
- standard hexagonal nut, cross-drilled and pinned
- standard slotted nut
- standard castle nut
- hexagonal nut and locking plate
- wiring bolt heads.

Frictional locking devices (Fig 14)

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

The frictional locking devices are:

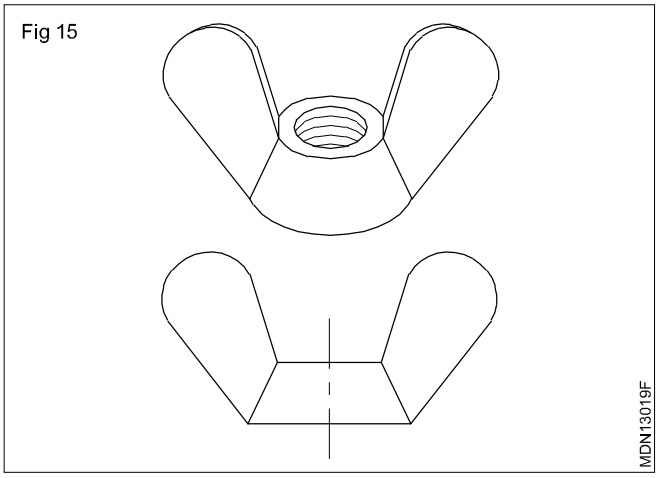
- lock-nut (chuck nut)
- spring washer
- wedge lock bolt
- simmonds lock-nut.



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.

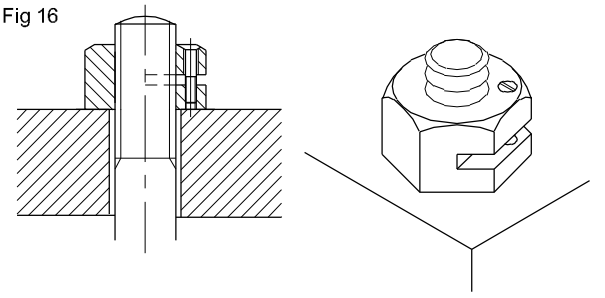
Locking ring

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

Fig 16



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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.

Fig 17

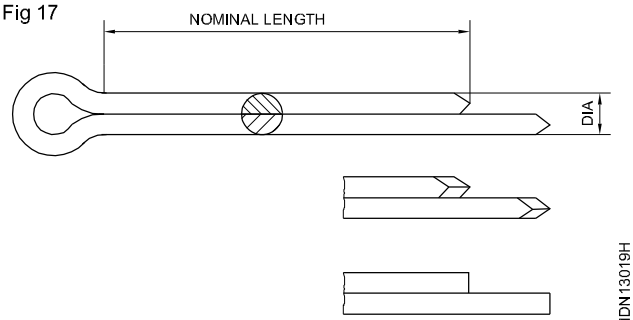

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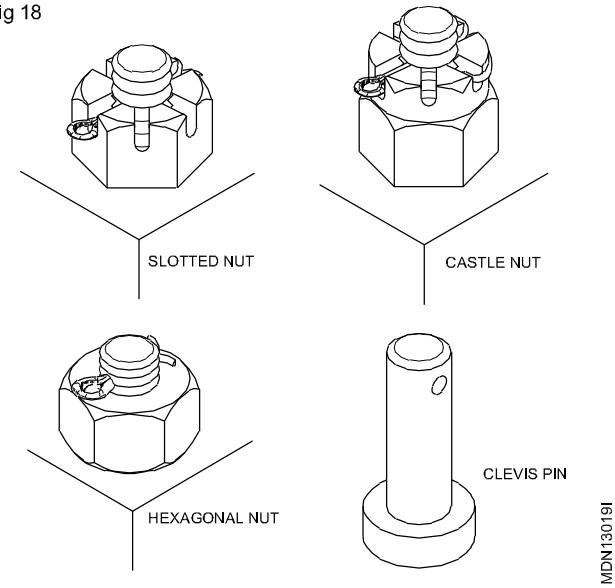
Fig 18



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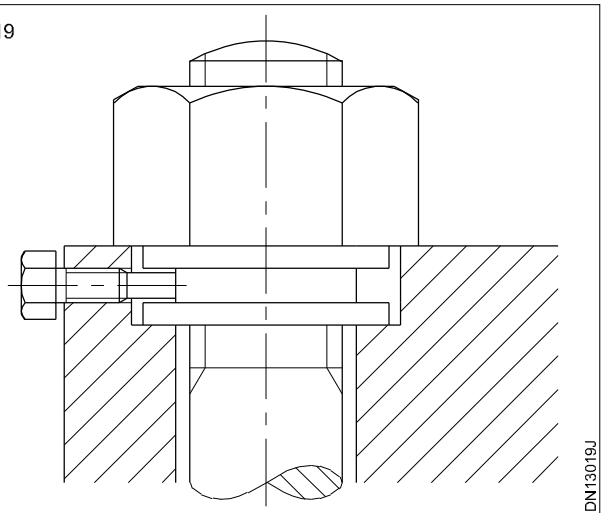
Grooved nut (Penning nut) (Fig. 19)

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.

Fig 19



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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.

Fig 20

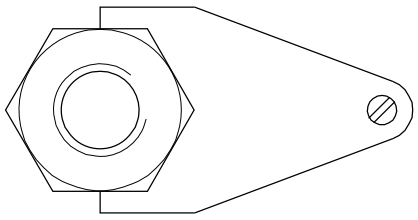

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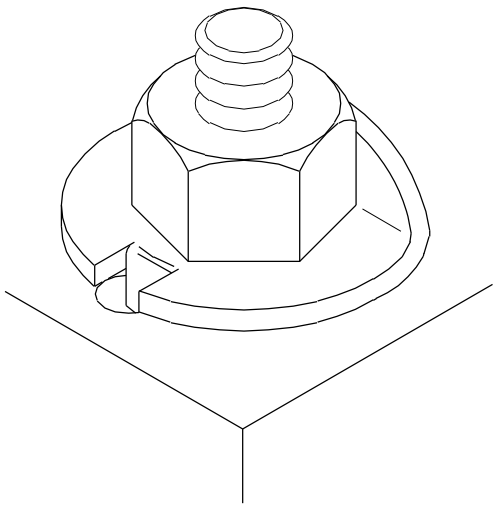
Fig 21



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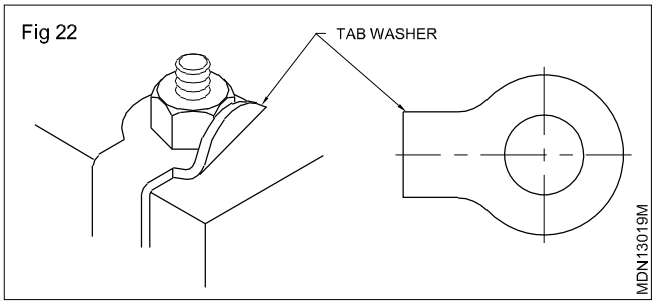
The movement of the nut is prevented by folding the washer against the nut.

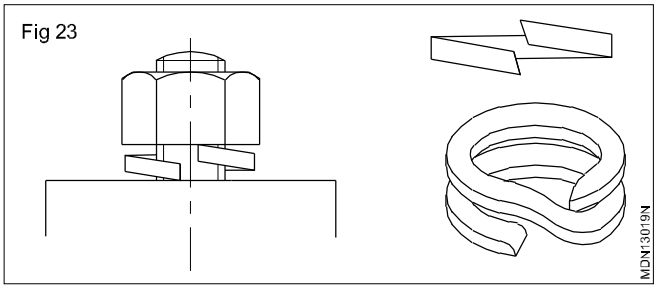
Tab washers (Fig. 22)

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.



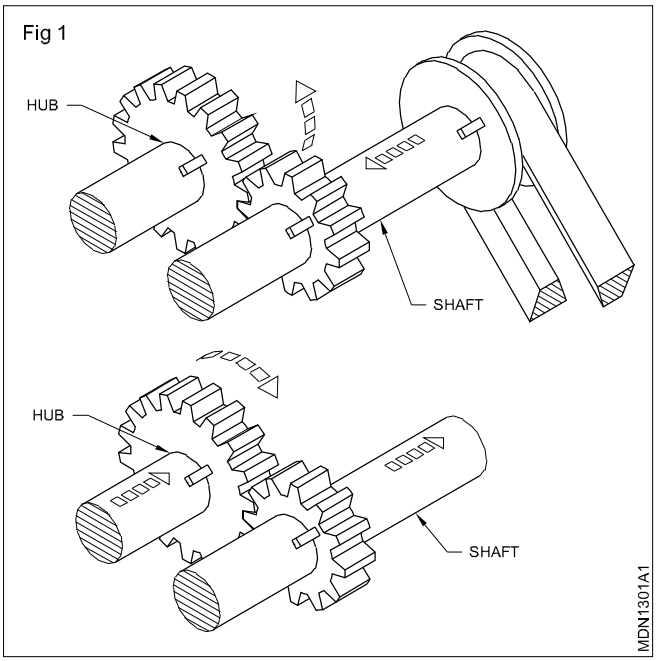


Keys and Splines

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

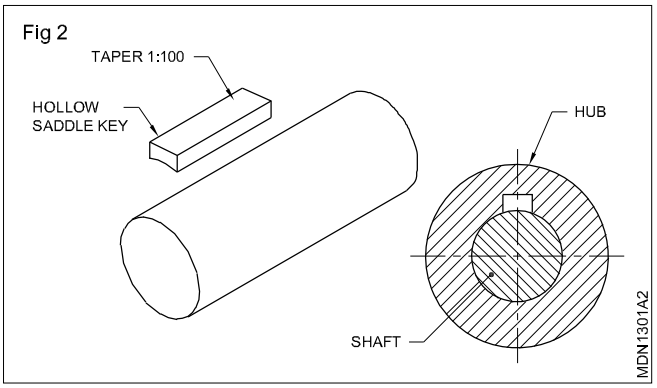
Keys are used for transmitting torque from a rotating shaft to a hub/wheel or from a hub/wheel to the shaft. (Fig.1)



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)

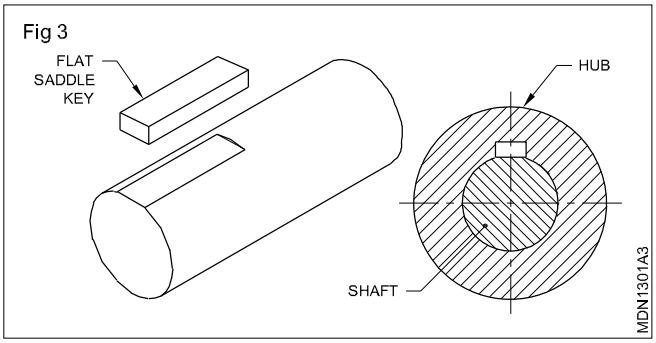


The hub is held on the shaft due to friction. This key is useful only for light duty transmission.

Flat saddle key

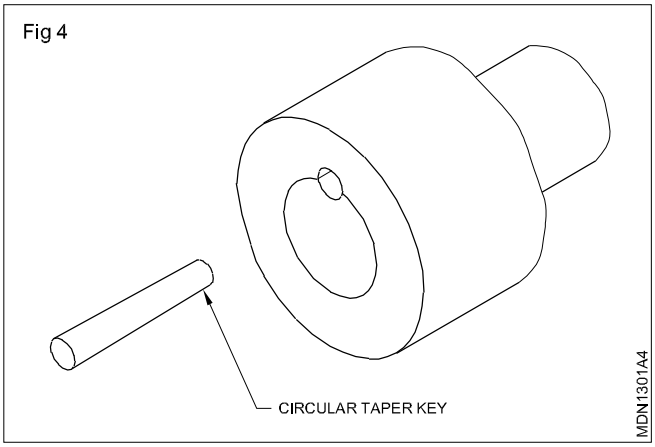
This key has a rectangular cross-section.

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

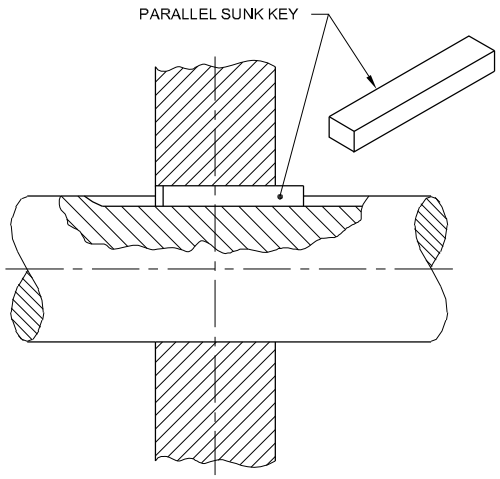
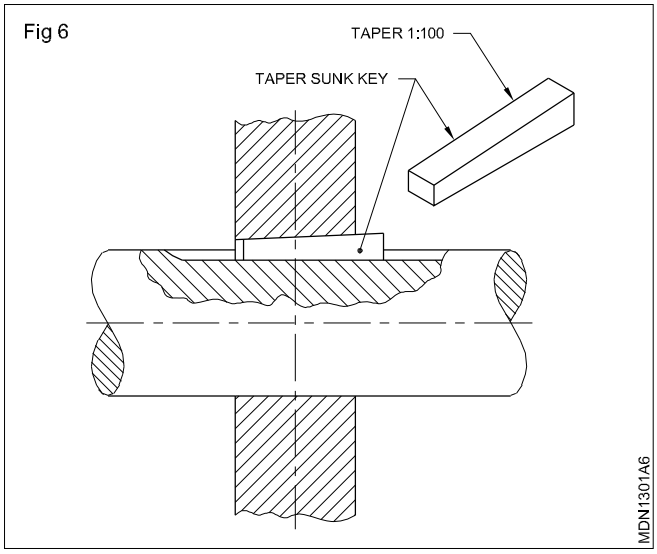


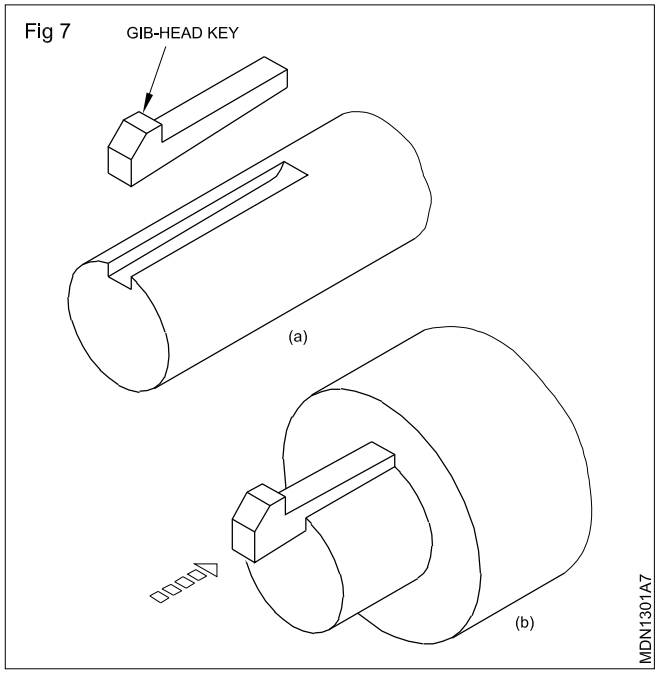
Fig 6



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)

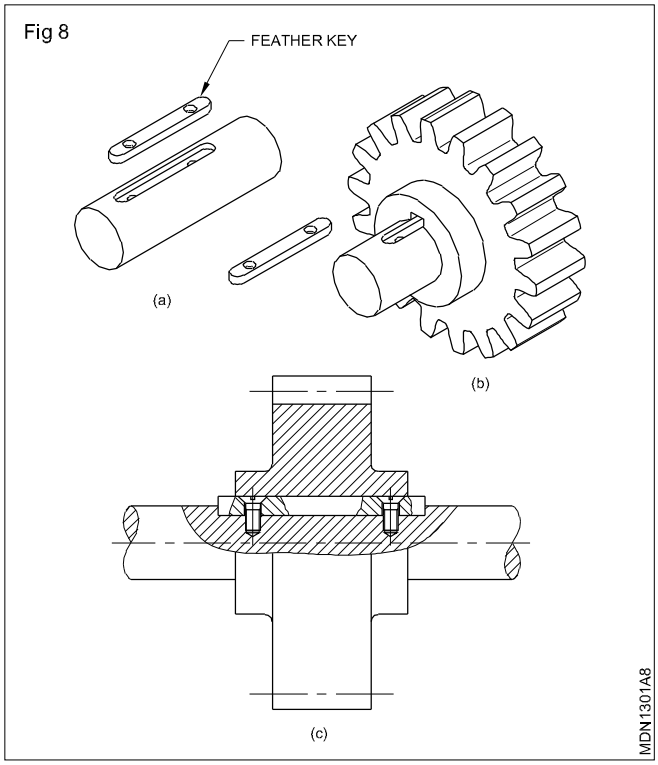
Fig 7



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.

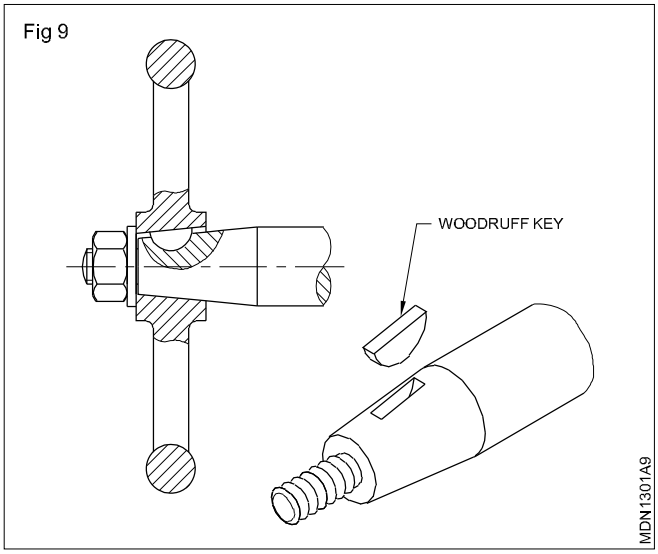
Fig 8



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

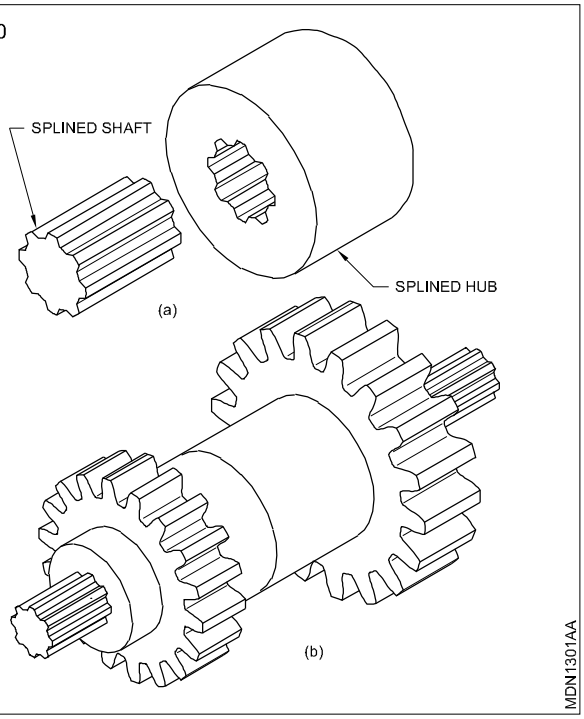
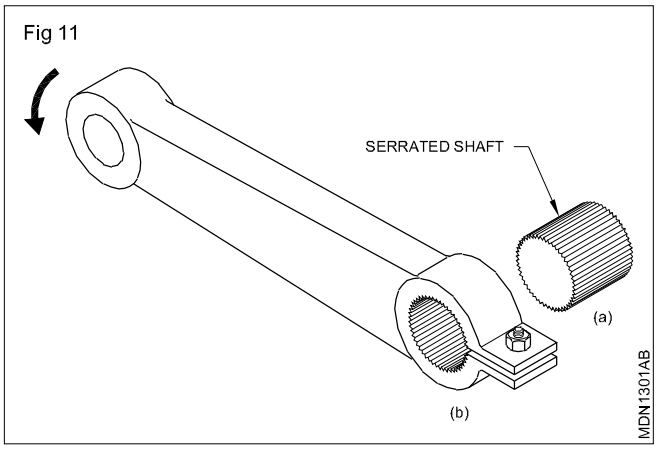


Fig 11



Circlips

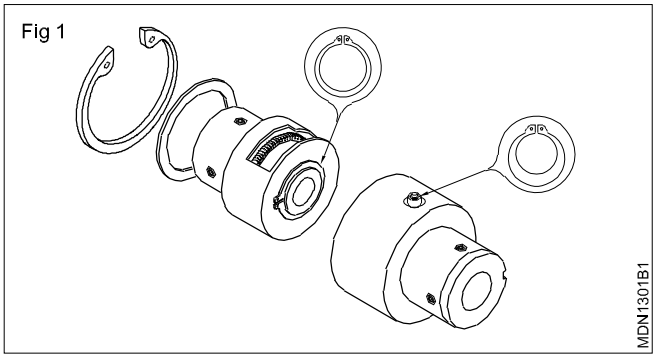
Objectives : At the end of this lesson you shall be able to

- **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



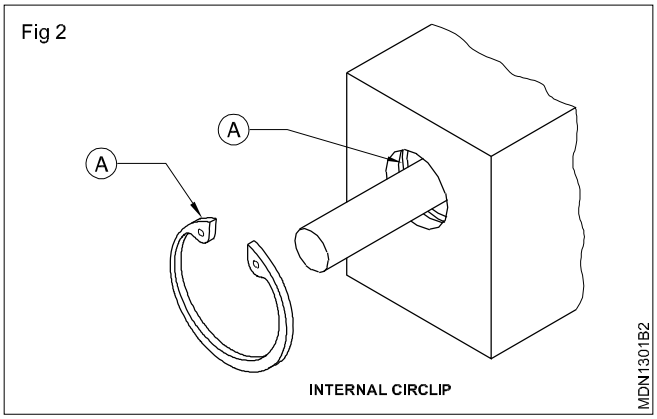
TYPES

There are two types.

Internal circlips (Fig.2)

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

Fig 2



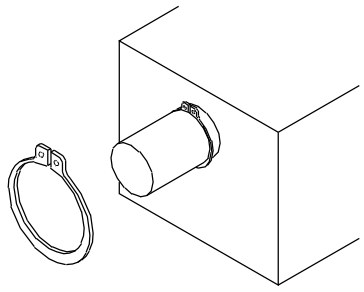
External circlip (Fig.3)

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.**

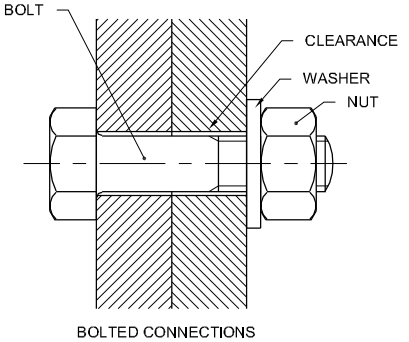
Purpose

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

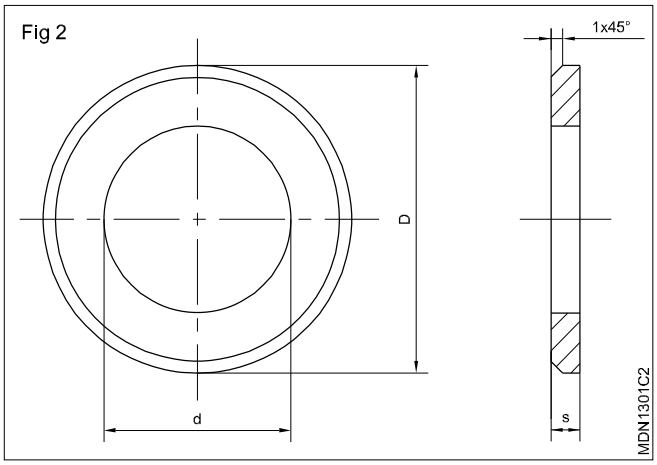
- plain or flat washers
- taper washers
- spring washers
- tab washers
- toothed lock washers.

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

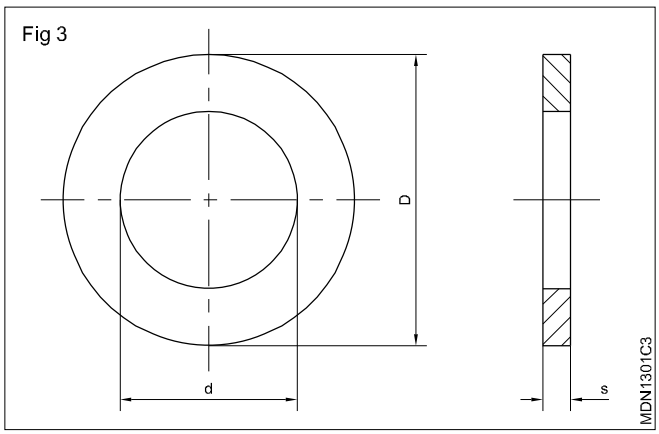


MDN1301C2

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

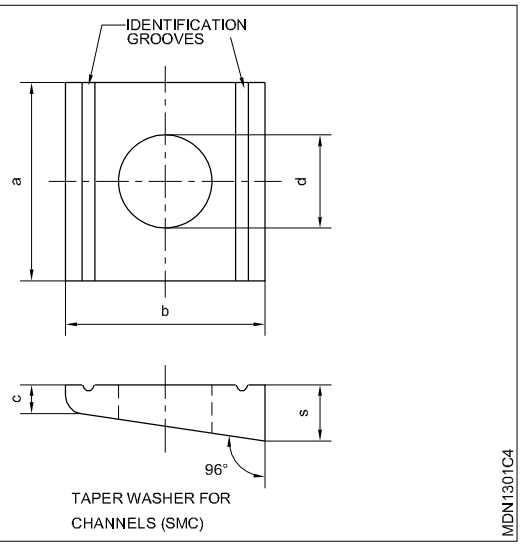
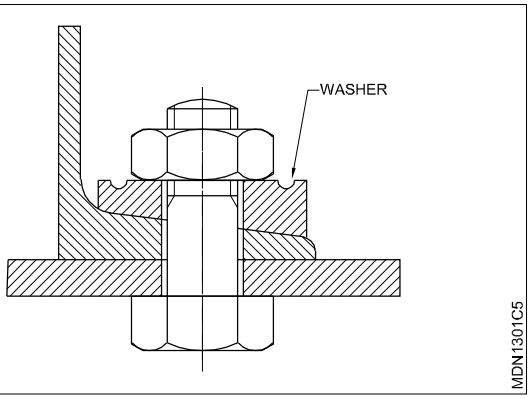


Fig 5



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

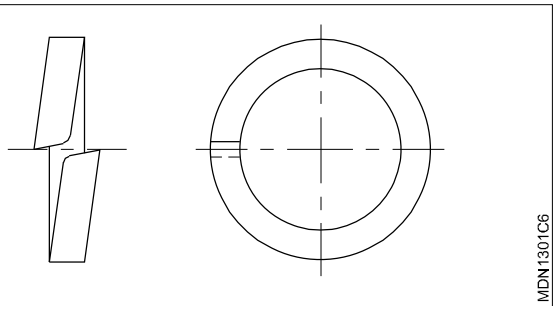
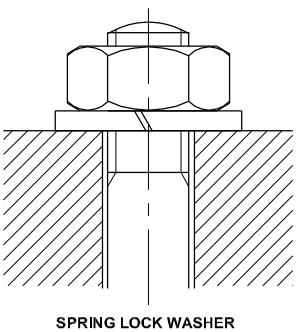


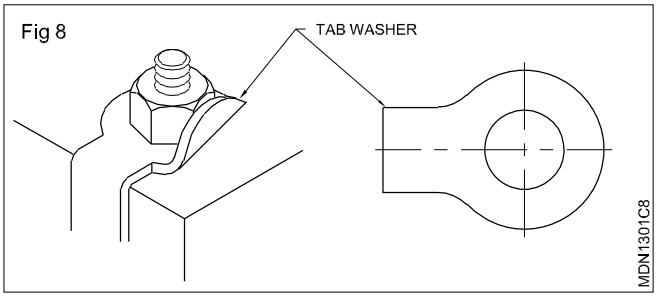
Fig 7



Tab washers (Fig. 8)

These washers are used for locking the nuts.

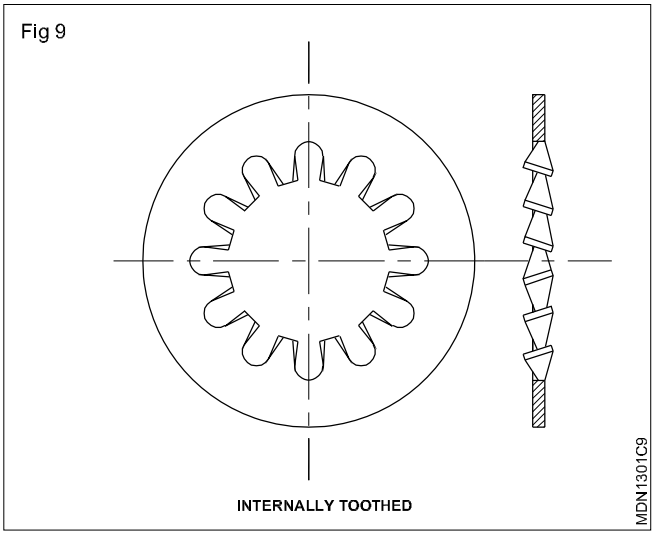
Fig 8



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.

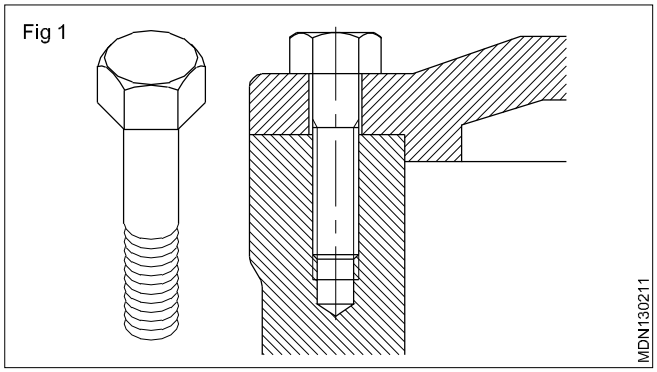
Taper washer	- IS: 5374 and IS: 5372
Tab washer	- IS: 8068
Toothed lock washer	- IS: 5371
Plain washer	- IS: 2016

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)



Types of machine screws (Heavy duty)

Hexagon head screws

Hexagon socket head cap screws

Square head countersink head screws

These are heavy duty screws.

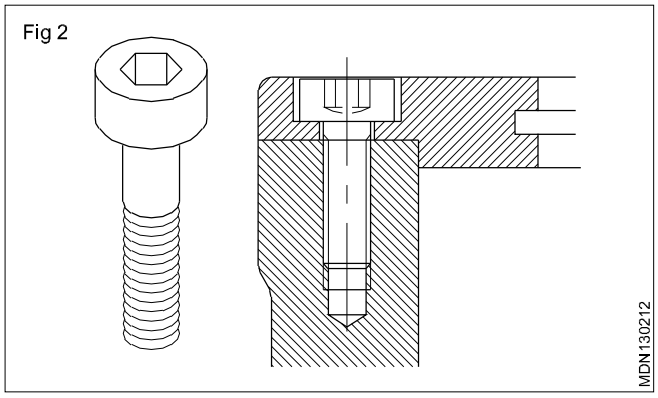
Hexagon head screws

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.

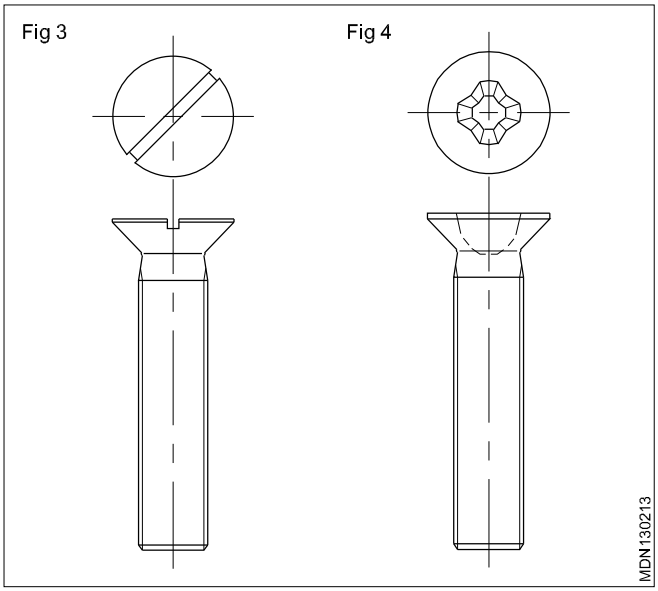


Countersink head screws

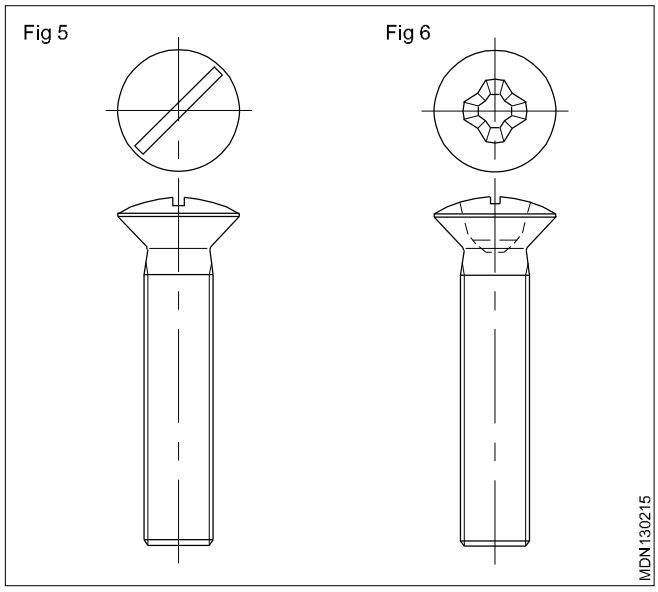
There are four types of countersink head screws in common use.

They are:

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



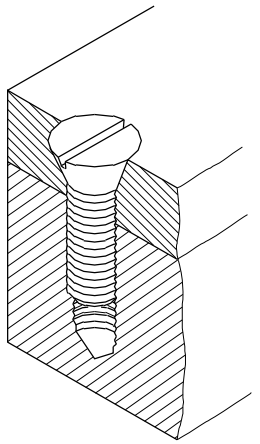
- slotted raised countersink head screws (Fig.5)
- cross recessed, raised countersink head screws. (Fig.6)



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.

Fig 7



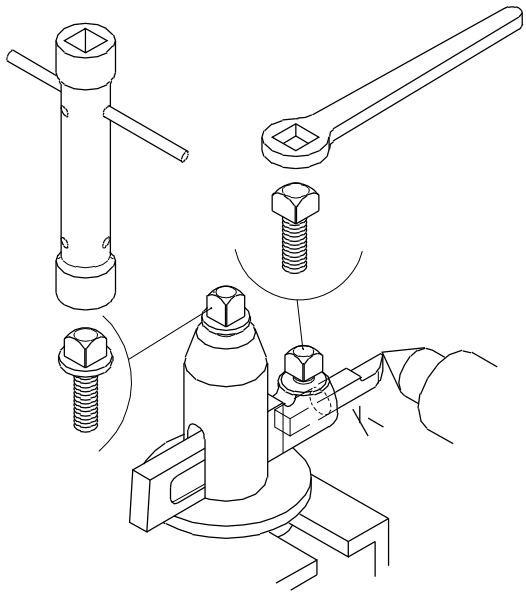
MDN130217

- 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.

Fig 8



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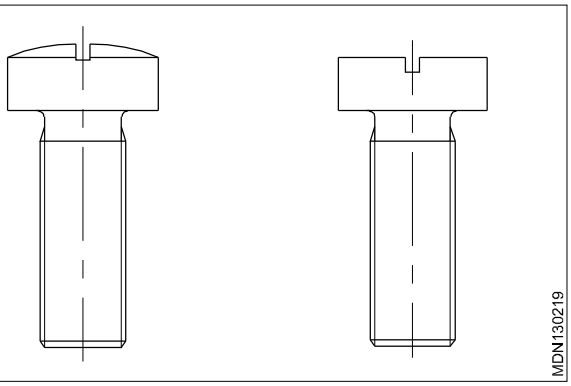
Other types of machine screws used in light assembly work are:

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

Fig 9



MDN130219

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

Fig 11

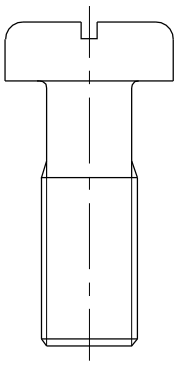
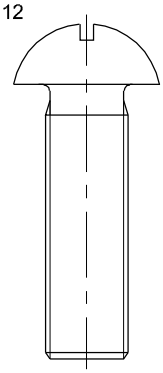


Fig 12



MDN13021B

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

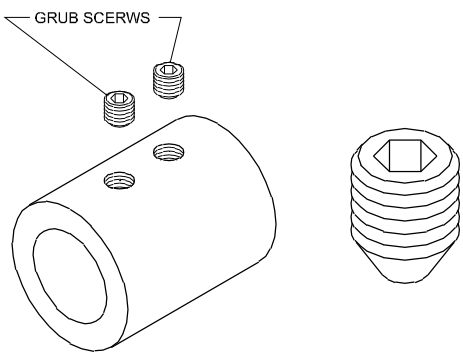
The screws used for light duty are normally available up to 10mm thread diameter.

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)

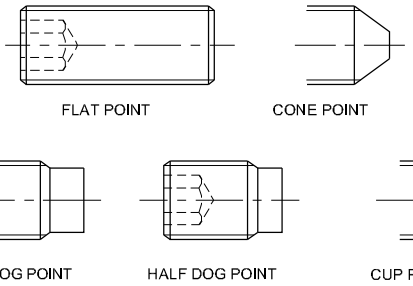
Fig 13



MDN13021D

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

Fig 14



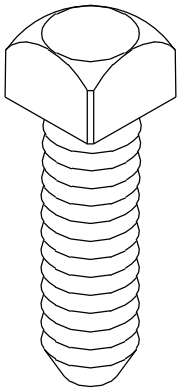
SET SCREW POINTS

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

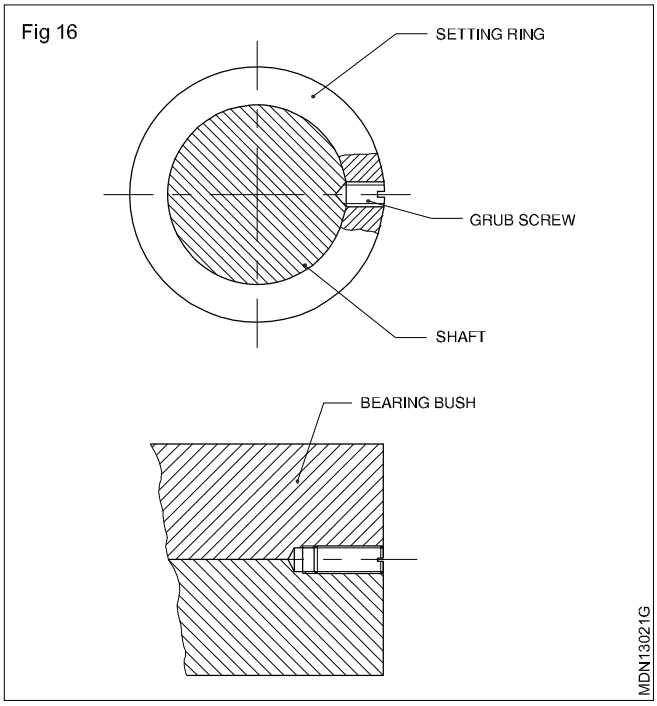


These are useful when the assembly needs frequent disassembly and setting.

Grub screws

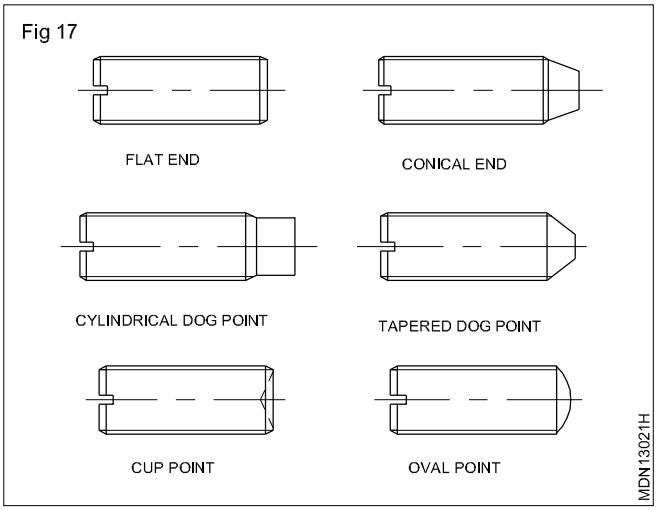
Grubs have similar application as hexagon socket set screws but are used for light holding. (Fig. 16)

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.

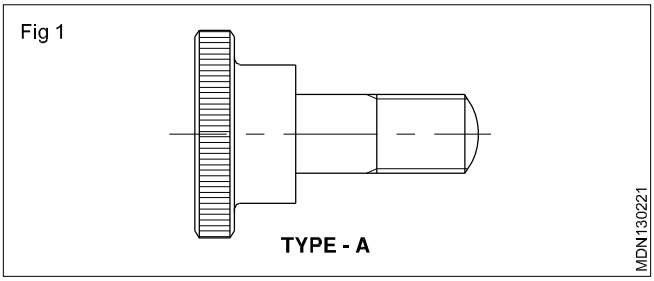
Types

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

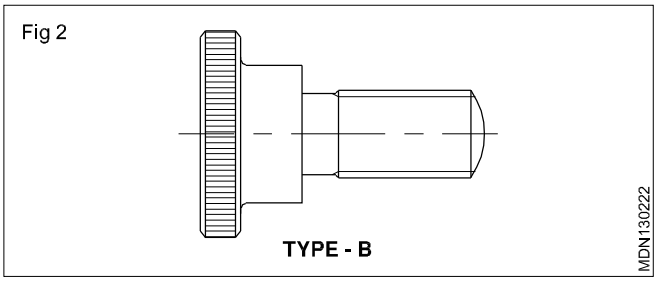
Type-A Thumb screws partially threaded (Fig 1)

Type-B Thumb screws fully threaded (Fig 2)

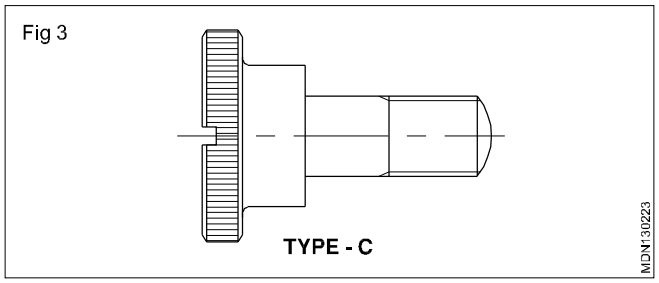
Fig 1



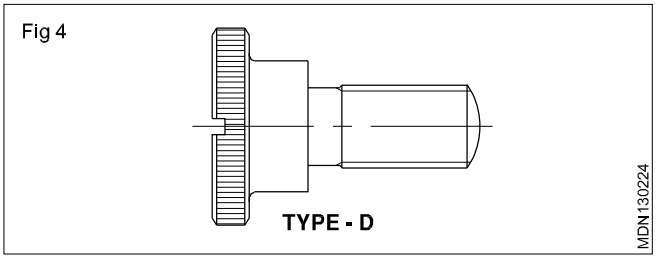
TYPE - A



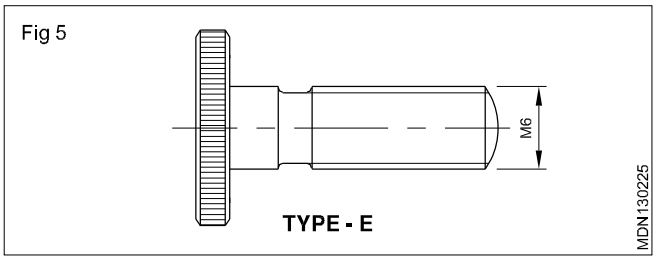
Type-C Slotted thumb screw partially threaded (Fig 3)



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

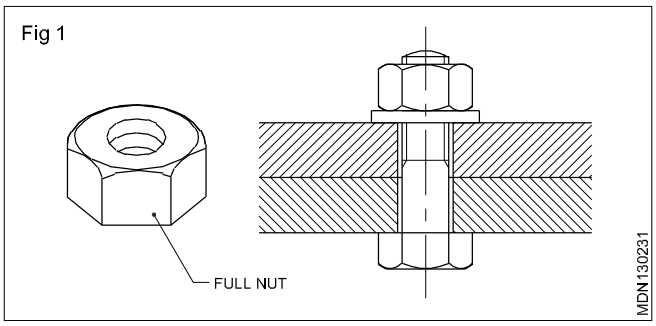
Objectives : At the end of this lesson you shall be able to
- **name the common types of nuts**
- **state the features and uses of the common types of nuts.**

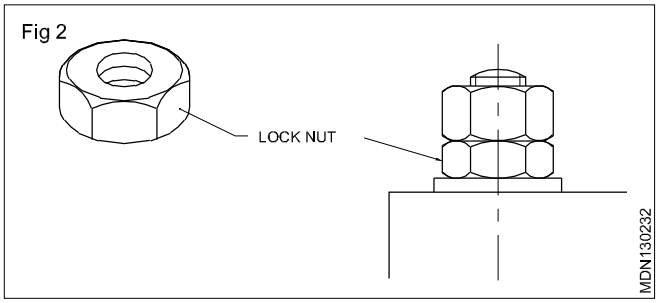
Different types of nuts are used depending on the requirement of the assembly.

Hexagonal nuts (Figs 1 & 2)

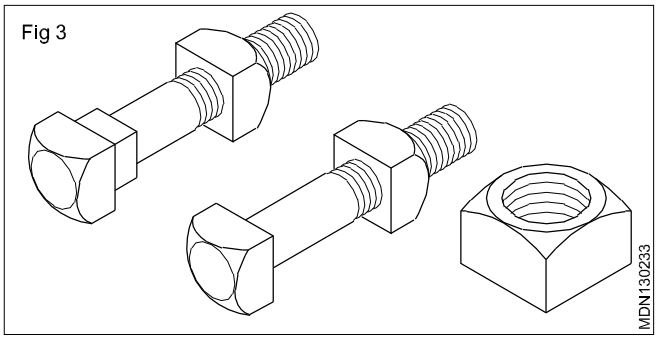
This is the most commonly used type of nut in structural and machine tool construction.

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)

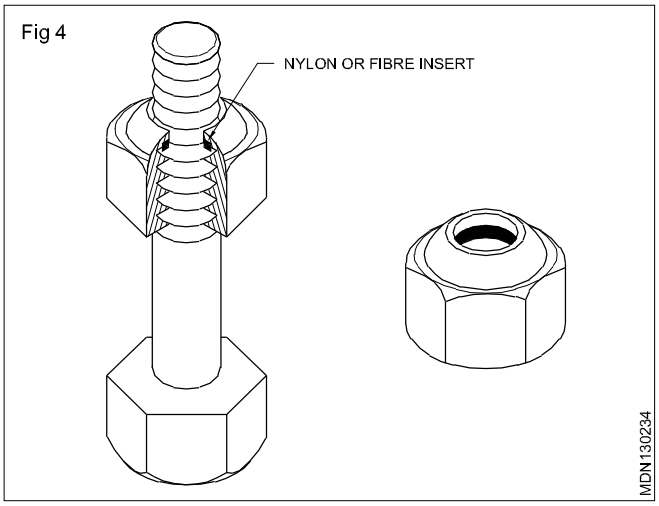
This nut has an internal groove cut in which a fibre or nylon ring is inserted. This ring holds the nut tightly on the bolt and serves as a locking device.

Self-locking nuts are not used with studs.

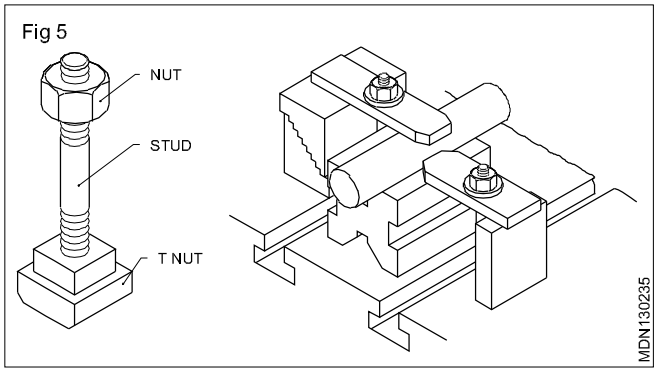
T-nuts.

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)



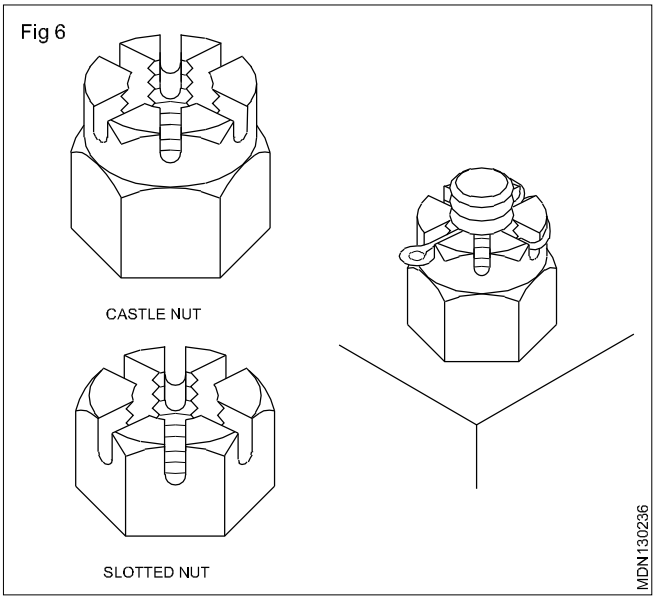
Round nuts of different types are available for special applications.

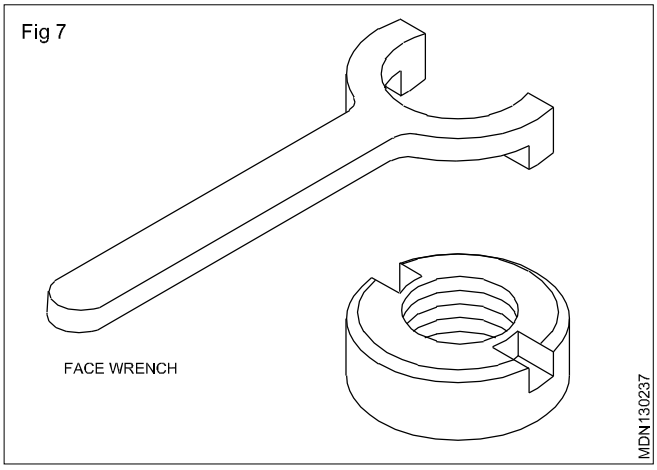
Slotted round nut (Figs 6, 7, 8, 9 & 10)

Slotted round nut for hook wrench.

Round nut with set pin holes on sides

Round nut with holes in the face.





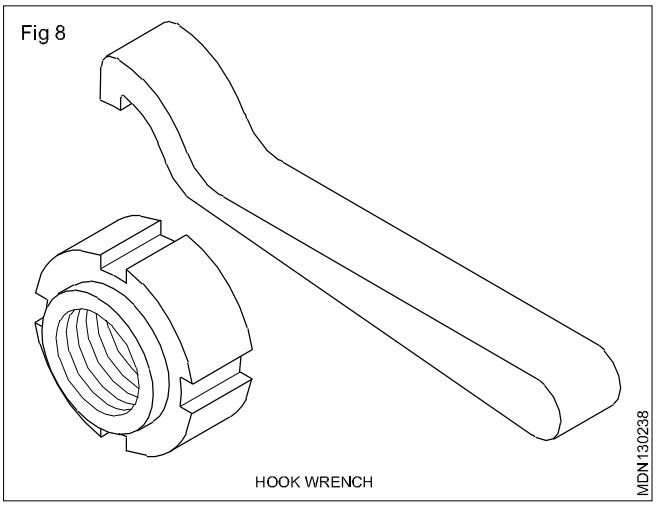
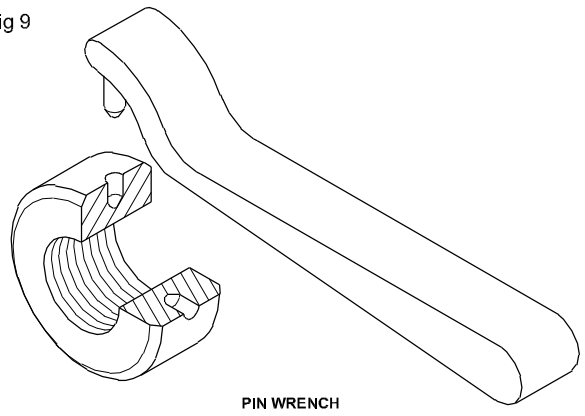


Fig 9



PIN WRENCH

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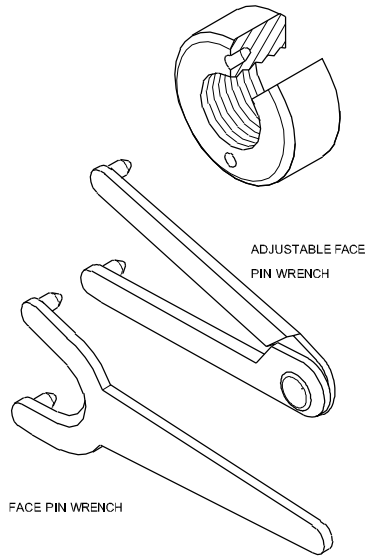
Fig 10



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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.

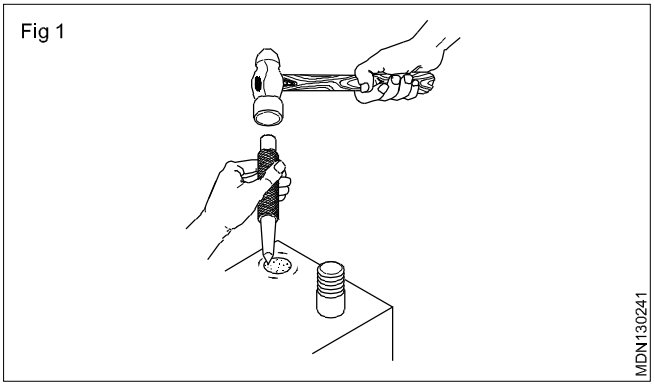
Threads are seized.

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.

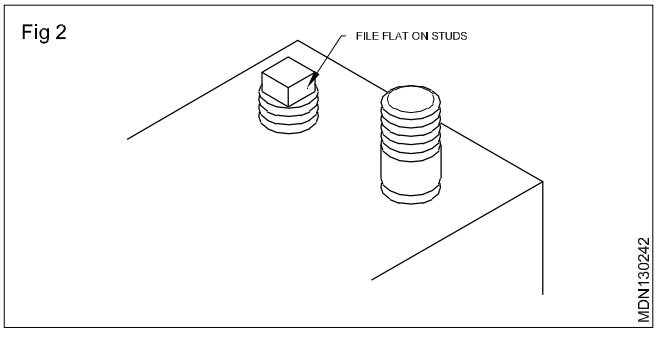
Fig 1



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.

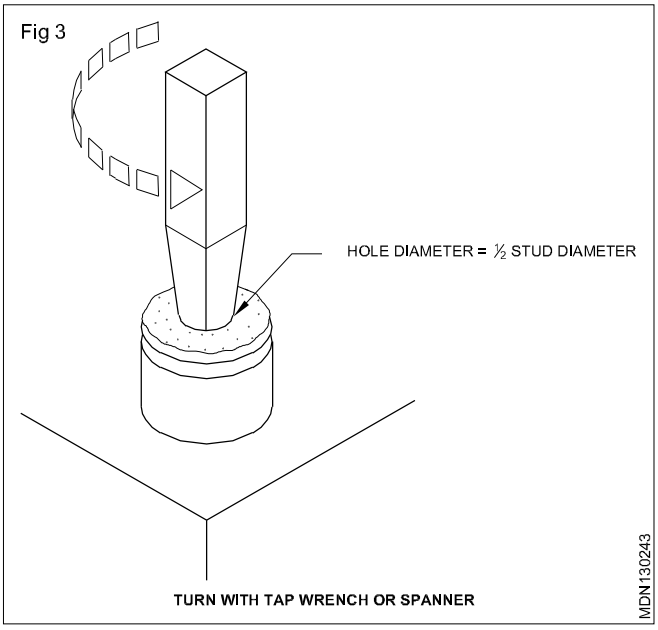
Fig 2



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

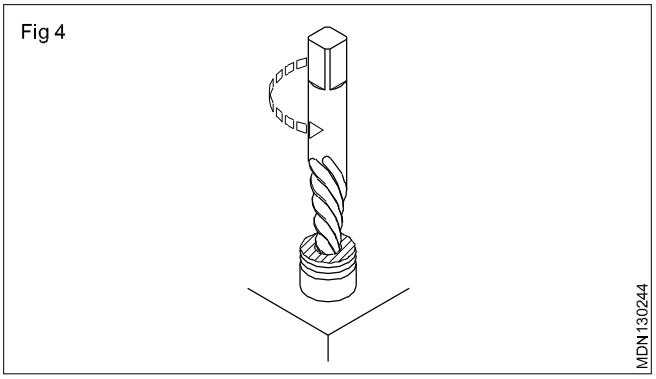


Ezy-out method (Fig 4)

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.

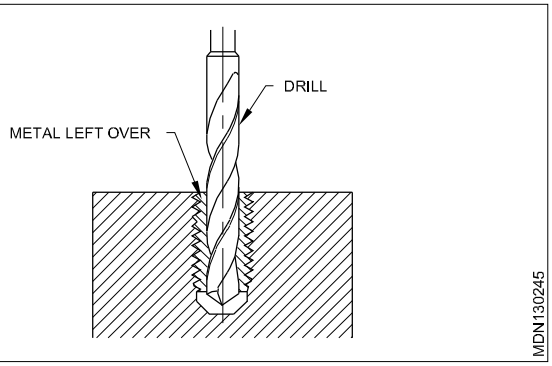
Drilling the hole, the recommended ezy-out is set on and turned in an anticlockwise direction by a tap wrench. As it is rotated it penetrates into the hole increasing its grip and in the process the broken stud gets unscrewed.

Fig 4



Making drill hole (Fig 5)

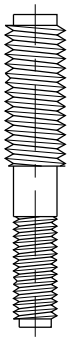
Fig 5



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.

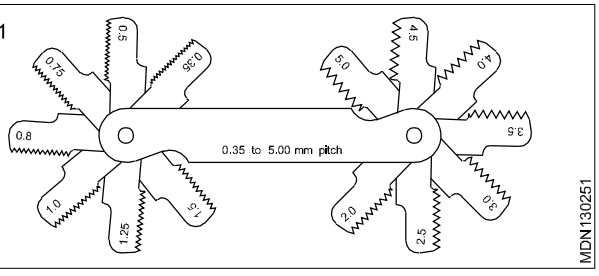
Constructional features

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.

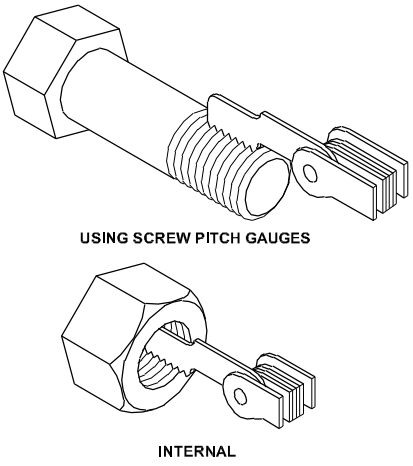
The thread profile on each blade is cut for about 25 mm or 30 m.. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 1)

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

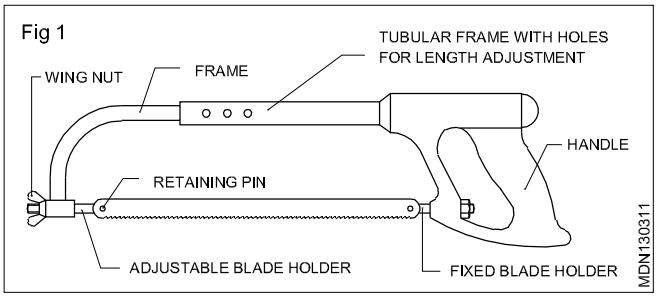


Hacksaw frame and blade

Objectives : At the end of this lesson you shall be able to
- **name the parts of a hacksaw frame**
- **specify hacksaw frames**
- **state the different types of hacksaw frames and their uses.**

The hand hacksaw is used along with a blade to cut metals of different sections. It is also used to cut slots and contours.

Fig 1



The parts are idenfified in the (Fig 1)

Types of hacksaw frames

The two different types of hacksaw frames are solid frame and adjustable frames.

Solid frame

Only a prticular standard length of blade can be fitted to this frame.

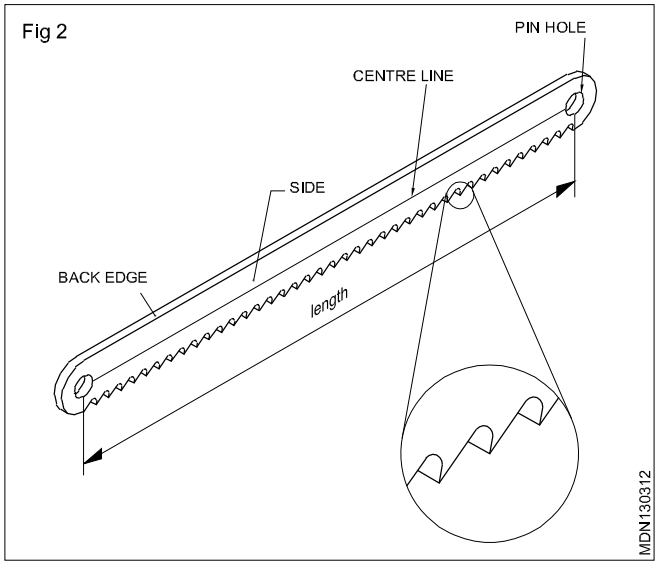
Adjustable frame (Flat type)

Different standard lengths of blades can be fitted to this frame.

Adjustable frame (Tubular type)

This is the most commonly used type. It gives a better grip and control, while sawing.

Fig 2



For proper working. It is necessary to have frames of rigid construction.

Hacksaw blades (Fig. 2)

A hacksaw blade is a thin narrow steel band with teeth and two pin holes at the ends. It is used along with a hacksaw frame. The blade is made of either low alloy steel (LAS) or high speed steel (HSS) and is available in standard lengths of 250 mm and 300 mm.

Types of hacksaw blades

Two types of hacksaw bladws are available - all hard blades and flexible blades.

All hard blades

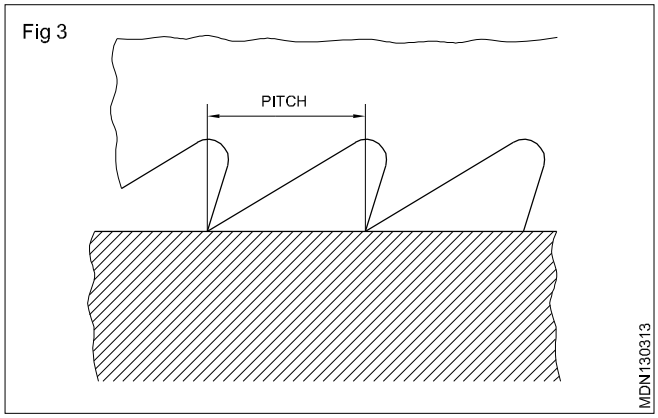
These are hardened to the full width between the pin holes.

Flexible blades

For these types of blades. Only the teeth are hardened. Because of their flexibility, these blades are useful for cutting along curved lines.

Pitch of the blade (Fig. 3)

Fig 3



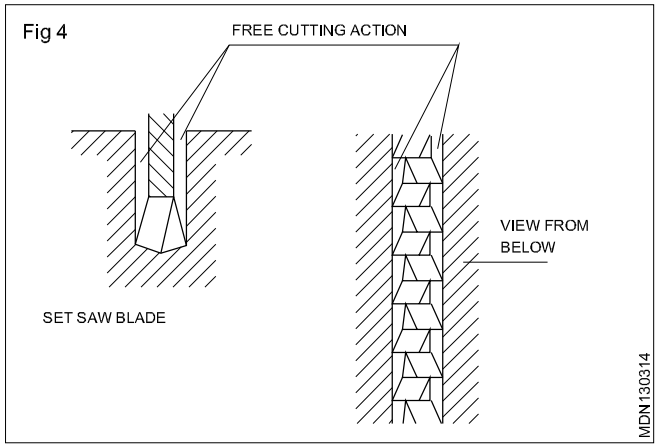
The distance between adjacent teeth is known as the pitch of the blade.

Classification	Pitch
Coarse	1.8 mm
Medium	1.4 mm & 1.0 mm
Fine	0.8 mm

Hacksaw blades are designated according to their length, pitch and type.

To prevent the saw blade binding when penetrating into the material and to allow free movement of the blade, the cut is to be broder than the thickness of the saw blade. This is achieved by the setting the saw teeth. There are two types of saw teeth settings.

Staggered set (Fig. 4)

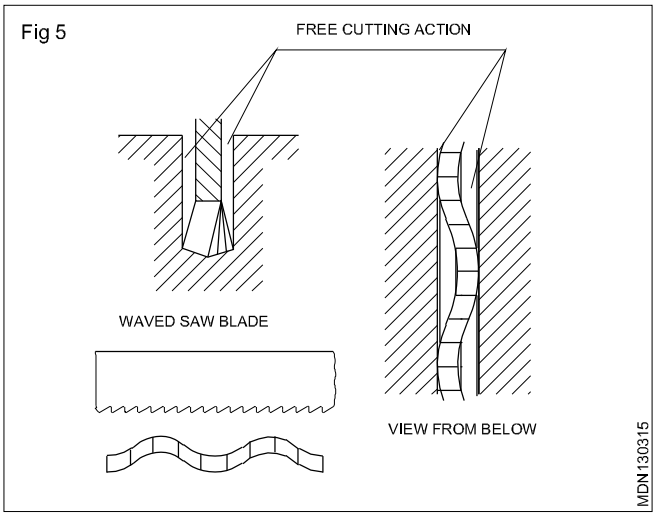


Alternate teeth or groups of teeth are staggered. This arrangement helps for free cutting and provides for good chip clearance.

Wave set (Fig. 5)

In this, the teeth of the blade are arranged in a wave form.

Sets of blades can be classified as follows



Pitch	Type of Set
0.8 mm	Wave -set
1.0 mm	Wave or staggered
Over 1.0 mm	Staggered

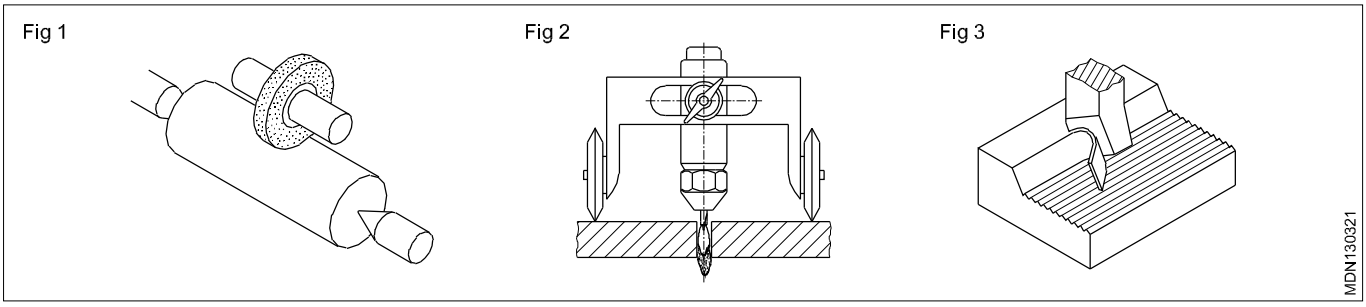
For the best results, the blade with the right pitch should be selected and fitted correctly.

Elements of a file

Objectives: At the end of this lesson you shall be able to
- **name the parts of a file.**

Methods of Material Cutting

The three methods of metal cutting are abrasion (Fig.1). Fusion (Fig 2) and Incision (Fig 3)



Filing is a method for removing excess material from a work pieces by using a file which acts as a cutting tool. (Fig 4) shows how to hold a file. Files are available many shapes and sizes.

Parts of a file (Fig 5)

The parts of a file as can be seen in figure 5, are

Tip or Point

The end opposite to tang

Face or side

The broad part of the file with teeth cut on its surface

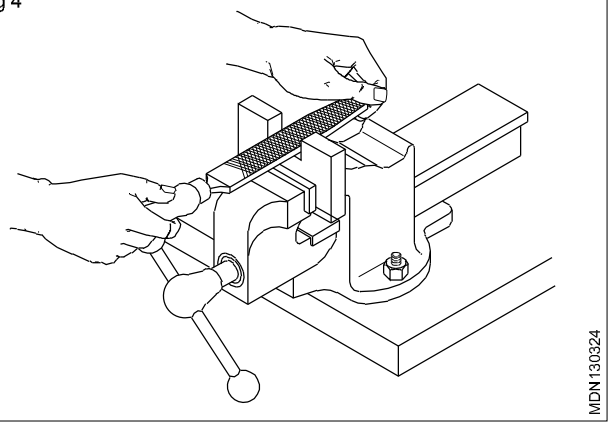
Edge

The thin part of the file with a single row of parallel teeth

Heel

The portion of the broad part without teeth.

Fig 4



Shoulder

The curved part of the file separating tang from the body

Tang

The narrow and thin part of a file which fits into the handle

Handle

The part fitted to the tang for holding the file

Parts of a file (Fig 5)

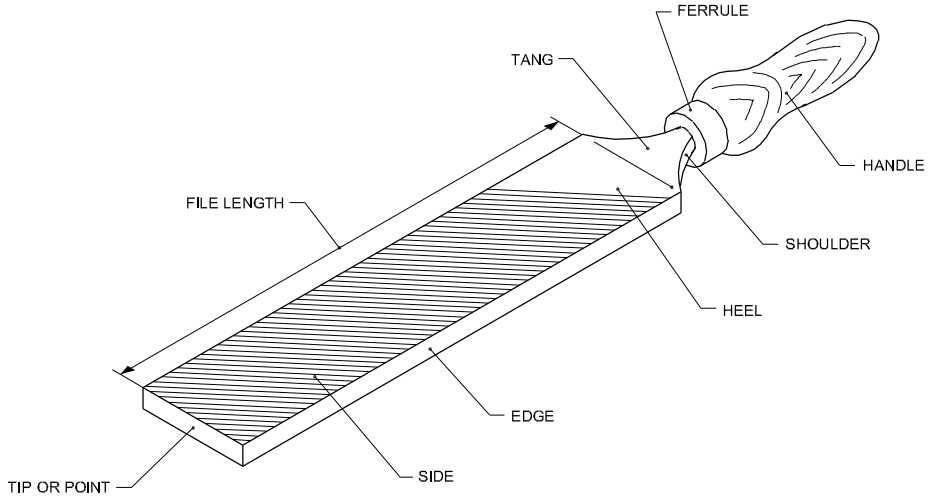
Ferrule

A protective metal ring to prevent cracking of the handle.

Materials

Generally files are made of high carbon or high grade cast steel. The body portion is hardened and tempered. The tang is however not hardended.

Fig 5



Cut of files

Objectives : At the end of this lesson you shall be able to
- **name the different cuts of files**
- **state the uses of each type of cut.**

The teeth of a file are formed by cuts made on its face. Files have cuts of different types. Files with different cuts have different uses.

Types of cuts

Basically there are four types.

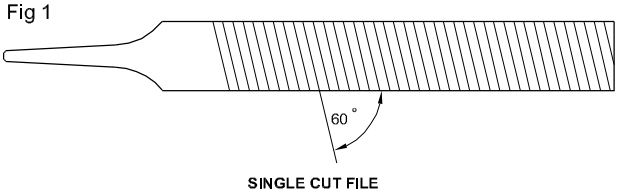
Single cut. Double cut. Rasp cut and curved cut.

Single cut file (Fig. 1)

A single cut file has rows of teeth cut in one direction across its face. The teeth are at an angle of 60° to the centre line. It can chips as wide as the cut of the file. Files with this cut are useful for filing soft metals like brass, aluminium, bronze and copper.

Single cut files do not remove stock as fast as double cut files, but the surface finish obtained is much smoother.

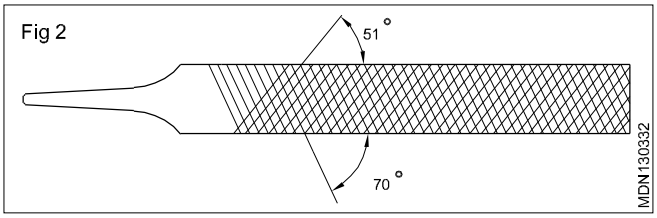
Fig 1



Double cut file (Fig. 2)

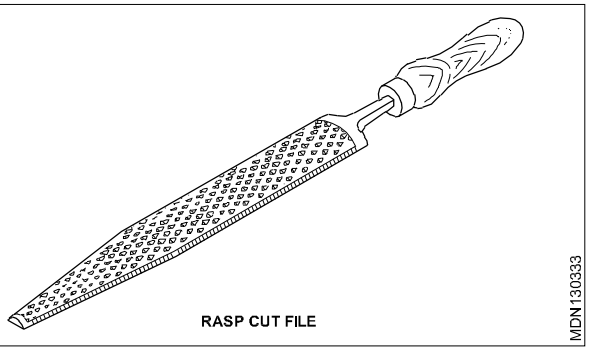
A double cut file has two rows of teeth cut diagonal to each other. The first row of teeth is know as OVERCUT and they are cut at an angle of 70°. The other cut, made diagonal to this, is known as UPCUT and is at an angle of 51°. This removes stock faster then the single cut file.

Fig 2



Rasp out file (Fig. 3)

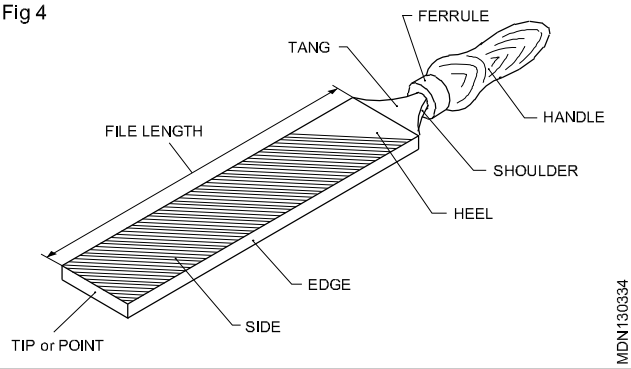
Fig 3



The rasp cut has individual sharp pointed teeth in a line and is useful for filing wood, leather and other soft materials. These files are available only in half round shape.

Curved cut file (Fig. 4)

Fig 4



These files have deeper cutting action and are useful for filing soft materials like - aluminium, tin, copper and plastic. The curved cut files are available only in a flat shape.

The selection of a file with a particular type of cut is based on the material to be filed. Single cut files are used for filing soft materials. But certain special files, for example, those used for sharpening saws are also of single cut.

File specifications and grades

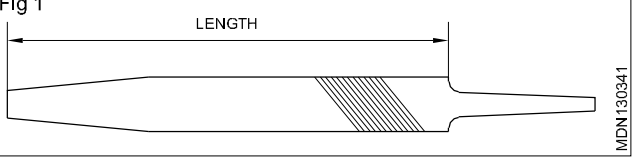
Objectives : At the end of this lesson you shall be able to
- **state how files are specified**
- **name the different grades of files**
- **state the application of each grade of file.**

Files are manufactured in different types and grades to meet the various needs.

Files are specified according to their length, grade, cut and shape.

Length is the distance from the tip of a file to the heel. (Fig 1)

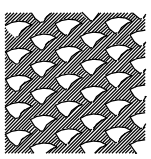
Fig 1



File grades are determined by the spacing of the teeth.

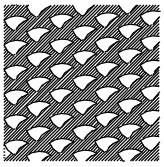
A round file (Fig 2) is used for removing rapidly a larger quantity of metal. It is mostly used for trimming the rough edges of soft metal castings.

Fig 2



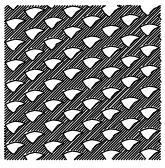
A bastard file (Fig 3) is used in cases where there is a heavy reduction of material.

Fig 3



A second cut file (Fig 4) is used to give a good finish on metals. It is excellent to file hard metals. It is useful for bringing the jobs close to the finishing size.

Fig 4



A smooth file (Fig 5) is used to remove small quantity of material and to give a good finish.

Fig 5

A dead smooth (Fig 6) file is used to bring to accurate size with a high degree of finish.

Fig 6

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The most used grades of files are bastard, second cut, smooth and dead smooth. These are the grades recommended by the Bureau of Indian Standars. (BIS)

Different sizes of files with the same grade will have varying sizes of teeth. In longer files, the teeth will be coarser.

File - Applications

Objectives : At the end of this lesson you shall be able to
- **state the features of flat and hand files**
- **state the application of flat and hand files.**

Files are made in different shapes so as to be able to file and finish components to different shapes.

The shape of files is usually specified by their cross section.

The files useful for this exercise are flat files and hand files.

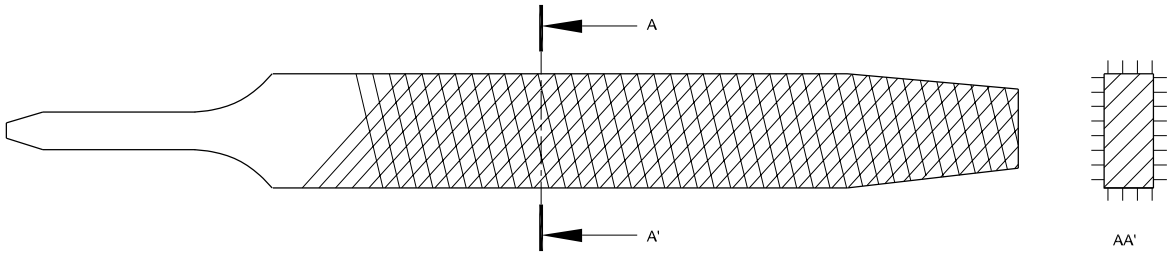
Flat files

These files are of a rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towrads the point. The faces are double cut, and the edges single cut. These files are used for general purpose work. They are useful for filling and finishing external and internal surfaces.

Hand files (Fig 1)

These files are similar to the flat files in their cross section. The edges along the width are parallel through the length. The faces are double cut. One edge is single cut whereas the other is safe edge. Because of the safe edge, they are useful for filling surfaces which are at right angles to surfaces already finished.

Fig 1



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Shapes of files

Objectives : At the end of this lesson you shall be able to
- **name the different shapes of files**
- **state the uses of Square, Round, Half Round, Triangular and Knife-edge files.**

For filing and finishing different profiles, files of different shapes are used.

The shape of files is stated by its cross section.

Common files of different shapes

Flat file, Hand file, Square file, Round file

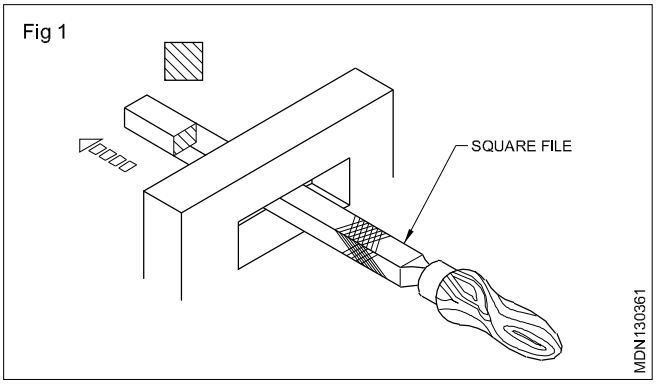
Half found file, Triangular file and Knife-edge file.

(Flat and hand files have already been discussed).

Square File

The square file is square in its cross sectiion. It is used for filling square holes, internal square corners, rectangular opening, keyways and spines. (Fig 1)

Fig 1



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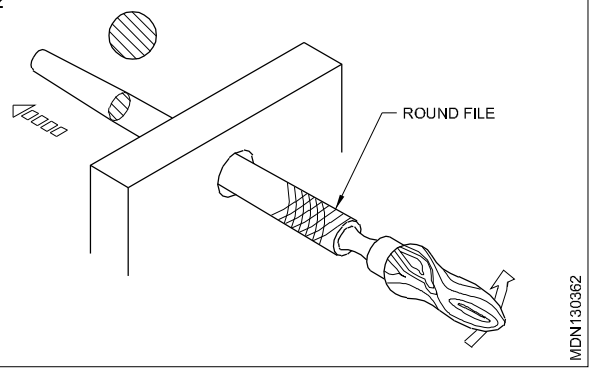
Round file

A round file is circular in its cross section. It is used for enlarging the circular holes and filing profiles with fillets. (Fig 2)

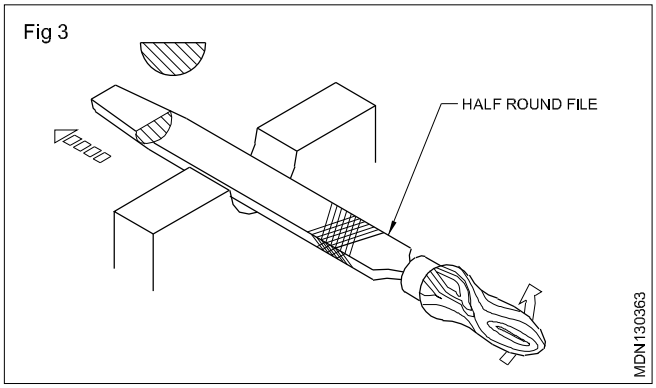
Fig 2



Half round File

A half round file is in the shape of a segment of a circle. It is used for filing internal curved surfaces (Fig 3)

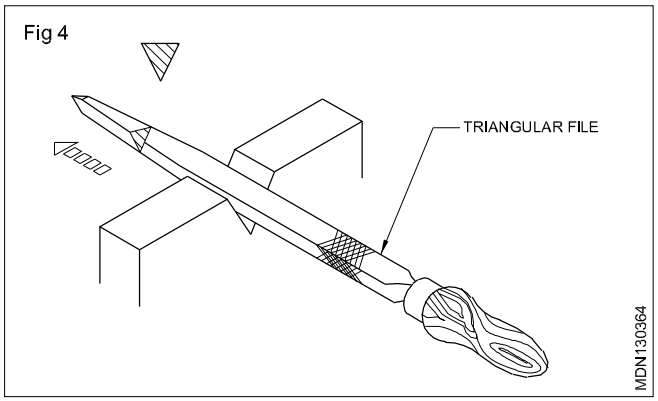
Fig 3



Triangular File

A triangular file is of a triangular cross section. It is used for filing corners and angles which are more than 60^0. (Fig 4)

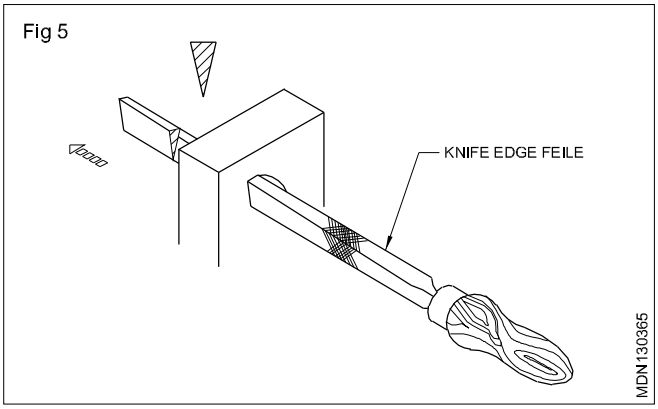
Fig 4



Knife-edge File

A knife-edge file has the cross section of a sharp triangle. It is used for filing narrow grooves and angles above 10^0. (Fig 5)

Fig 5



The above files have one third of their lengths tapered. They are available both in single and double cuts.

Square, round, half-round and triangular-files are available in lengths of 100, 150, 200, 250, 300 and 400 mm. These files are made in bastard, second cut and smooth grades.

Off- hand grinding with bench and pedestal grinders

Objectives : At the end of this lesson you shall be able to
- **state the purposes of off-hand grinding**
- **state the features of bench and pedestal grinders.**

Off-hand grinding is the operation of removing material which does not require great accuracy in size or shape. This is carried out by pressing the workpiece by hand against a grinding wheel.

Off-hand grinding is performed for rough grinding of jobs and resharpening of

scribers, punches, chisels, twist drills

single point cutting tools etc.

Off-hand grinding is performed with a bench or pedestal grinder (Fig 1 and 2)

Bench grinders

Bench grinders are fitted to a bench or table, and are useful for light duty work.

Pedestal grinders

Pedestal grinders are mounted on a base (pedestal), which is fastened to the floor. They are used for heavy duty work.

Fig 1

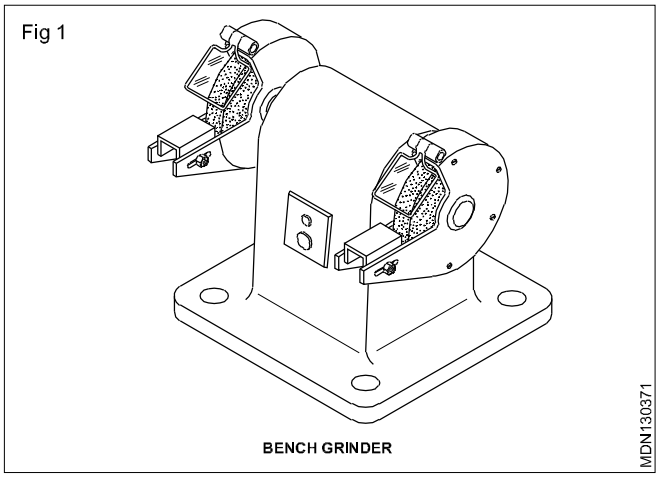
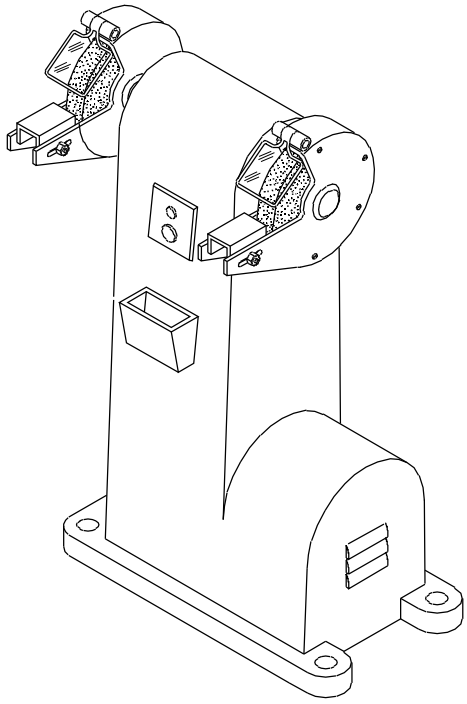


Fig 2



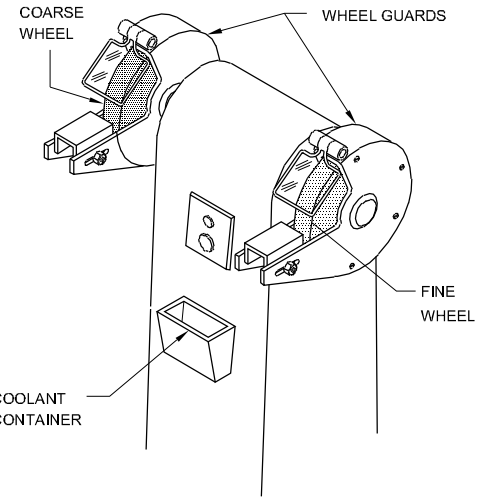
PEDESTAL GRINDER

MDN130372

These grinders consist of an electric motor and two spindles for mounting grinding wheels. On one spindle a coarse-grained wheel is fitted, and on the other, a fine grained wheel. For safety, while working, wheel guards are provided. (Fig 3)

A coolant container is provided for frequent cooling of the work. (Fig 3)

Fig 3



MDN130373

Adjustable work-rests are provided for both wheels to support the work while grinding. These work-rests must be set very close to the wheels. (Fig 4)

Extra eye-shields are also provided for the protection of the eyes. (Fig 4)

While grinding

Adjust the tool-rest as close to the wheel as possible. The maximum recommended gap is 2 mm. This will help to prevent the work from being caught between the tool-rest and the wheel. (Fig 5)

Small jobs should be held with pliers or other suitable tools. (Fig 5)

Fig 4

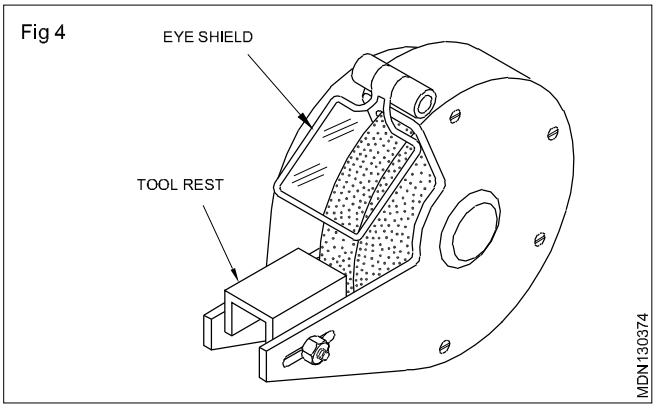


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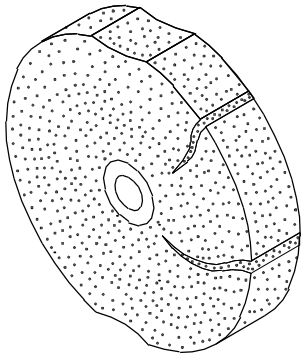
Fig 5



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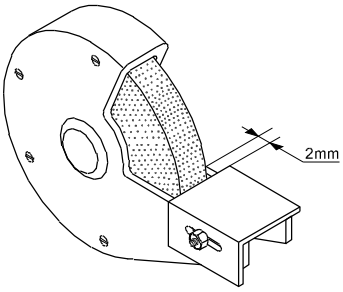
Never hold jobs with cotton waste or similar materials.

Use gloves for your hands while grinding heavy jobs.

Do not grind on the side of the grinding wheels. (Fig 6)

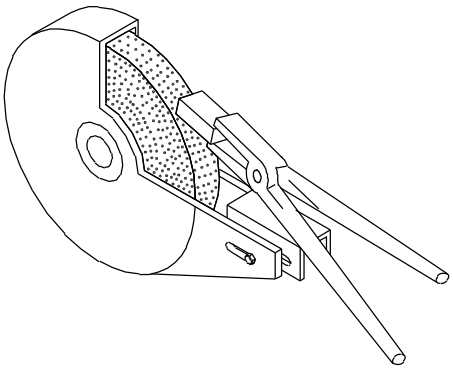
Fig 6



MDN130376

Move the work across the full face of the wheel to prevent uneven wearing of the grinding wheel. (Fig 7)

Fig 7



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Safe working on off - hand grinders

Objectives : At the end of this lesson you shall be able to
- **work safety on an off-hand grinder.**

How to work on an off-hand grinder?

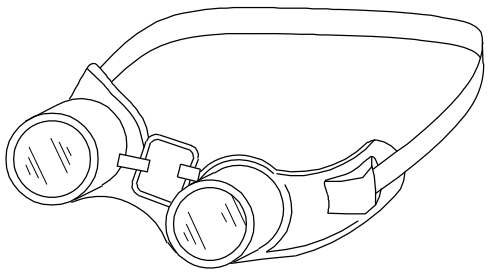
While working on off-hand grinders, it is important to observe the following safety measures.

BEFORE STARTING

Make sure the grinding wheel guards are in place.

Wear safety goggles while grinding. (Fig 1)

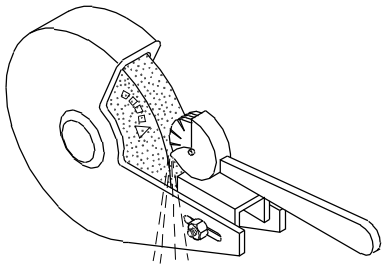
Fig 1



MDN130381

Do not work on grinding wheels which are loaded or glazed. Dress and true wheels whenever necessary. (Fig.2)

Fig 2



MDN130382

If any abnormal sound is noticed, stop the machine. Cracked or improperly balanced wheels are dangerous.

Stand on one side of the machine while starting.

Indian standard system of limits & fits-terminology

Objectives : At the end of this lesson you shall be able to
- **state the terms under the BIS system of limits and fits.**
- **define each term under the BIS system of limits and fits.**

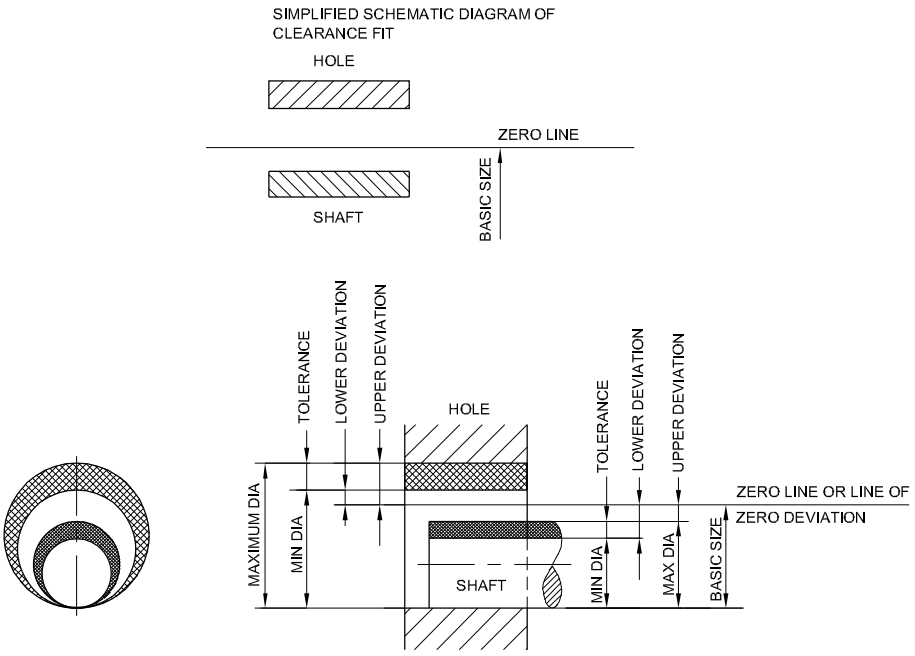
Size

It is a number expressed in a particular unit in the measurement of length.

Basic size

It is the size based on which the dimensional deviations are given. (Fig 1)

Fig 1



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Actual size

It is the size of the component by actual measurement after it is manufactured. It should be between the two limits of size if the component is to be accepted.

Limits of size

These are the extreme permissible sizes within which the operator is expected to make the component. (Fig 2) (Maximum and minimum limits)

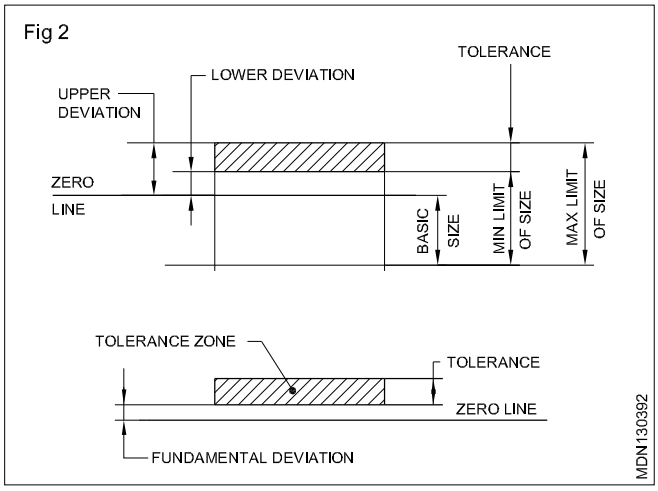
Maximum limit of size

It is the greater of the two limit sizes. (Fig 2) (Table 1)

Minimum limit of size

It is the smaller of the two limits of size. (Fig 2) (Table 1)

Fig 2



Hole

In the BIS system of limits & fits, all internal features of a component including those which are not cylindrical are designated as 'hole'. (Fig 3)

Shaft

In the BIS system of limits & fits, all external features of a component including those which are not cylindrical are designated as shaft. (Fig 3)

Deviation

It is the algebraic difference between a size, to its corresponding basic size. It may be positive, negative or zero. (Fig 2)

Fig 3

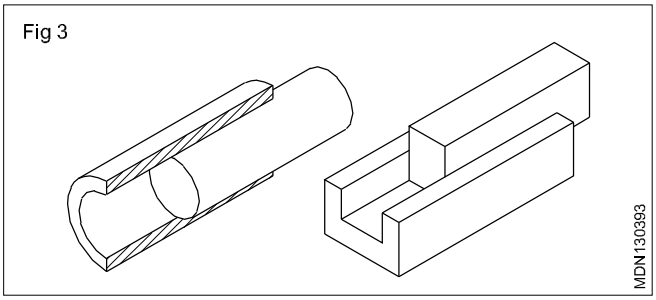


TABLE 1 (Examples)

Sl.No	Size of Component	Upper Deviation	Lower Deviation	Max-Limit of size	Min-Limit of Size
1	+.008 20-.005	+0.008	-0.005	20.008	19.995
2	+.028 20+.007	+0.028	+0.007	20.028	20.007
3	-.012 20-.021	-0.012	-0.021	19.988	19.979

Upper deviation

It is the algebriac difference between the maximum limit of size and its corresponding basic size. (Fig 2) (Table 1)

Lower deviation

It is the algebraic difference between the minimum limit of size and its corresponding basic size (Fig 2) (Table 1)

Upper divation is the deviation which gives the maximum limit of size. Lower deviation is the deviation which gives the minimum limit of size.

Actual deviation

It is the algebraic difference between the actual size and its corresponding basic size (Fig 2)

Tolerance

It is the difference between the maximum limit of size and the minimum limit of size. It is always positive and is expressed only as a number without a sign. (Fig 2)

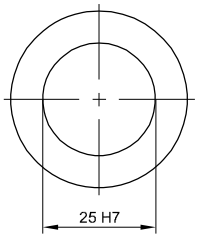
Zero line

In graphical representation of the above terms, the zero line represents the basic size. This line is also called as the line of zero deviation. (Fig 1 and 2)

Fundamental deviation

There are 25 fundamental deviations in the BIS system represented by letter symbols (capital letters for holes and small letters for shafts). i.e for holes - ABCD.....Z excluding I,L,O,Q&W. (Fig 4)

Fig 4



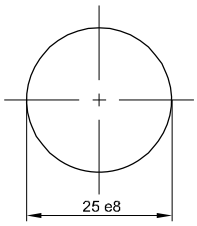
INDICATION FOR HOLES — CAPITAL LETTERS REFER TO HOLES OR INSIDE DIMENSIONS e.g 25 H7

MDN130394

In addition to the above, four sets of letters, JS, ZA, ZB & ZC are included. For fine mechanisms CD, EF and FG are added. (Ref. IS:919 Part II - 1979)

For shafts, the same 25 letter symbols but in small letters are used. (Fig 5)

Fig 5



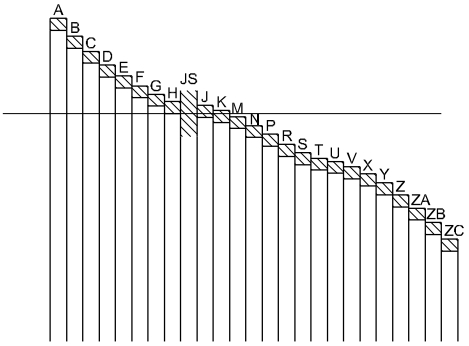
INDICATION FOR SHAFTS

SMALL LETTERS REFER TO SHAFTS OR OUTSIDE DIMENSIONS e.g. 25 e8

MDN130395

The position of tolerance zone with respect to the zero line is shown in figs 6 and 7

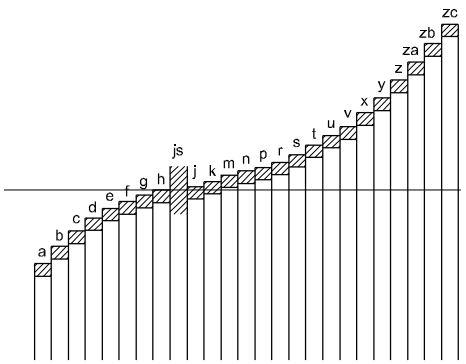
Fig 6



CAPITAL LETTERS INDICATE FUNDAMENTAL DEVIATION OF HOLES

AU1130976

Fig 7



SMALL LETTER INDICATE FUNDAMENTAL DEVIATION OF SHAFTS

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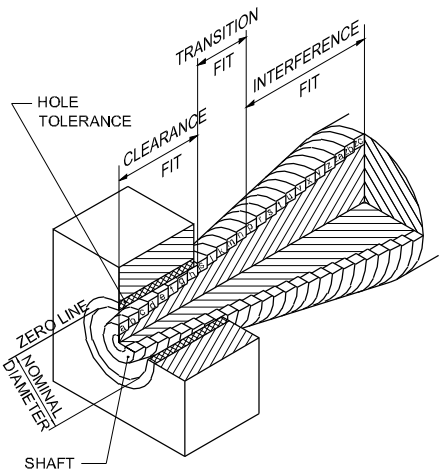
The fundamental deviations are for achieving the different classes of fits. (Fig 8 and 9)

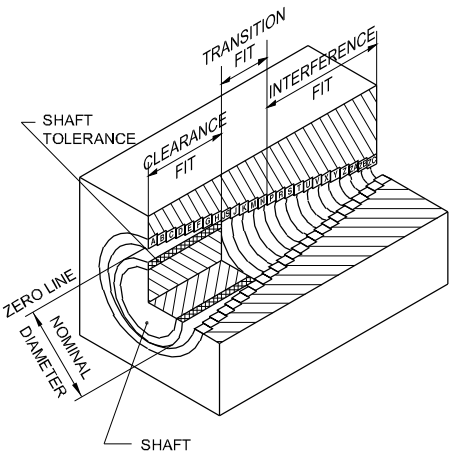
Fig 8



HOLE BASIS SYSTEM

MDN130398

Fig 9



SHAFT BASIS SYSTEM

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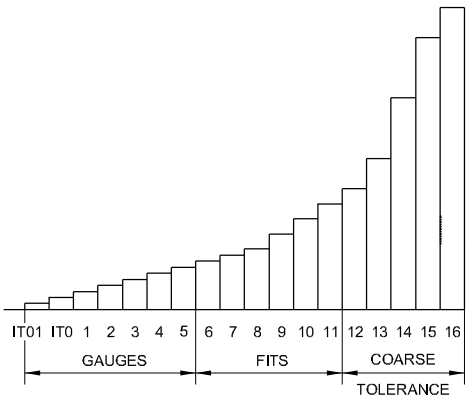
Fundamental tolerance

This is also called as 'grade of tolerance'. In the Indian Standard System, there are 18 grades of tolerances represented by number symbols, both for hole and shaft, denoted as IT01, IT0, IT1.... to IT16. (Fig 10) A high number gives a large tolerance zone.

Fig 10



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The grade of tolerance refers to the accuracy of manufacture.

In a standard chart, the upper and lower deviations for each combination of fundamental deviation and fundamental tolerance are indicated for sizes ranging upto 500 mm. (Refer to IS 919)

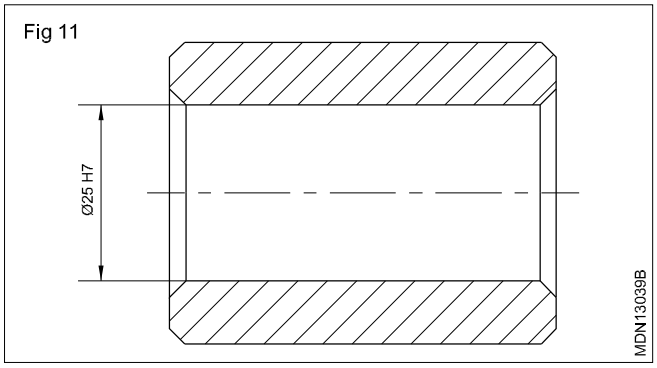
Toleranced size

This includes the basic size, the fundamental deviation and the grade of tolerance.

Example

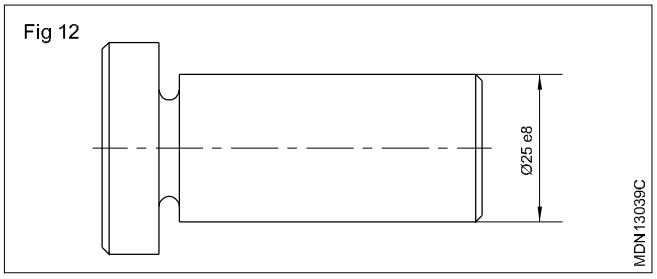
25H7 - toleranced size of a hole whose basic size is 25. The fundamental deviation is represented by the letter symbol H and the grade of tolerance is represented by the number symbol 7. (Fig 11)

Fig 11



25 e8 - is the toleranced size of a shaft whose basic size is 25. The fundamental deviation is represented by the letter symbol e and the grade of tolerance is represented by the number 8. (Fig 12)

Fig 12

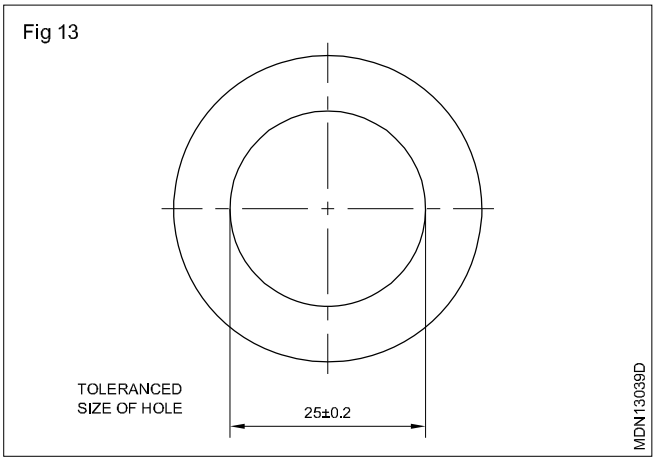


A very wide range of selection can be made by the combination of the 25 fundamental deviations and 18 grades of tolerances.

Example

In fig. 13, a hole is shown as 25 ± 0.2 which means that 25 mm is the basic dimension and ± 0.2 is the deviation.

Fig 13



As pointed out earlier, the permissible variation from the basic dimension is called 'DEVIATION'.

The deviation is mostly given on the drawing with the dimensions.

In the example 25 ± 0.2, ± 0.2 is the deviation of the hole of 25 mm diameter. (Fig 13) This means that the hole is of acceptable size if its dimension is between

25 + 0.2 = 25.2 mm

or 25 - 02 = 24.8 mm.

25.2 mm is known as the maximum limit. (Fig 14)

24.8 mm is known as the minimum limit. (Fig 15)

Fig 14 Fig 15

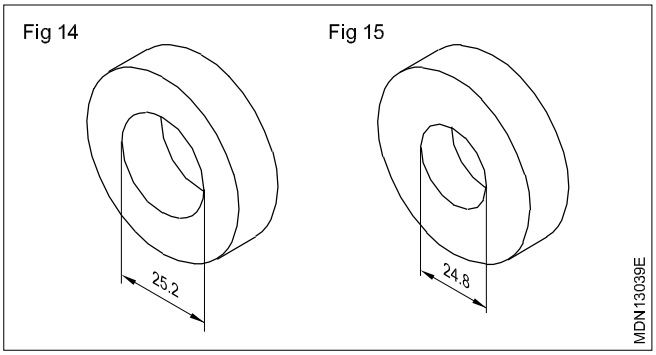
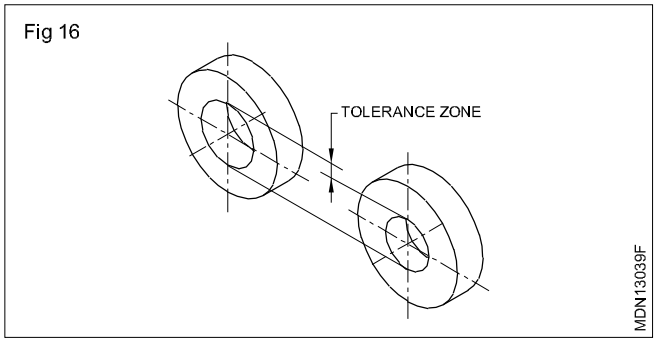


Fig 16

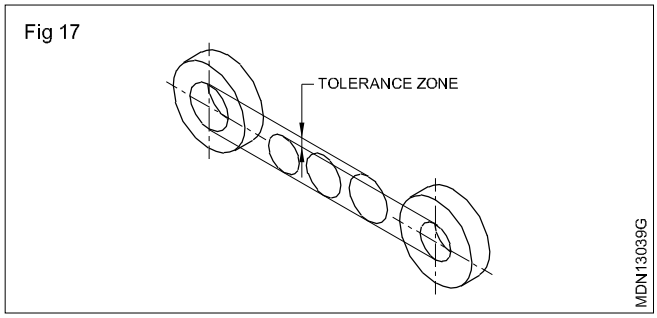


The difference between the maximum and minimum limits is the TOLERANCE. Tolerance here is 0.4 mm. (Fig 16)

All dimensions of the hole within the tolerance zone are of acceptable size as in Fig 17.

As per IS 696, while dimensioning the components as a drawing convention, the deviations are expressed as tolerances.

Fig 17



Fits and their classification as per the indian standard

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

- **define 'Fit' as per the Indian Standard**
- **list out the terms used in limits and fits as per the Indian Standard**
- **state examples for each class of fits**
- **Interpret the graphical representation of different classes of fits.**

Fit

It is the relationship that exists between two mating parts, a hole and a shaft, with respect to their dimensional difference before assembly.

Expression of a fit

A fit is expressed by writing the basic size of the fit first, (the basic size which is common to both the hole and the shaft) followed by the symbol for the hole, and by the symbol for the shaft.

Example

30 H7/g6 or 30 H7 - g6 or 30

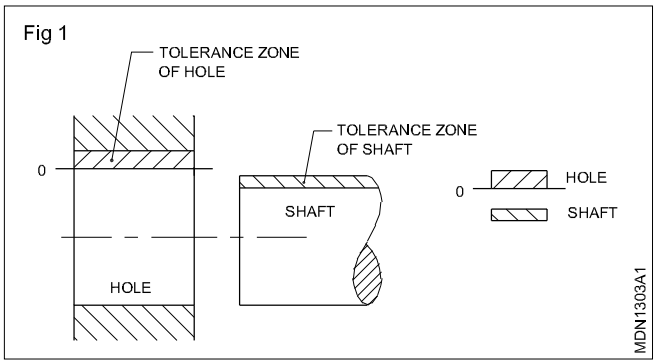
Clearance

In a fit the clearance is the difference between the size of the hole and the size of the shaft which is always positive.

Clearance fit

It is a fit which always provides clearance. Here the tolerance zone of the hole will be above the tolerance zone of the shaft. (Fig 1)

Fig 1



Example 20 H7/g6

With the fit given, we can find the deviations from the chart.

For a hole 20 H7 we find from the table +21mm.

These numbers indicate the deviations in microns.

(1 micrometre = 0.001 mm)

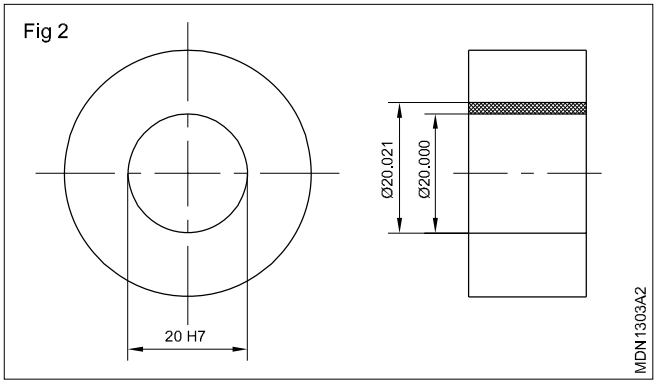
The limits of the hole are 20 = 0.021 = 20.021 mm and

20 + 0 = 20.000 mm. (Fig. 2)

For a shaft 20 g6 we find in the table - 7mm

- 20mm

Fig 2

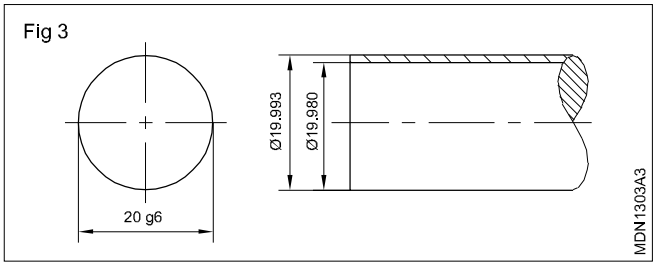


So the limits of the shaft are

20 - 0.007 = 19.992 mm

and 20 - 0.020 = 19.980 mm. (Fig 3)

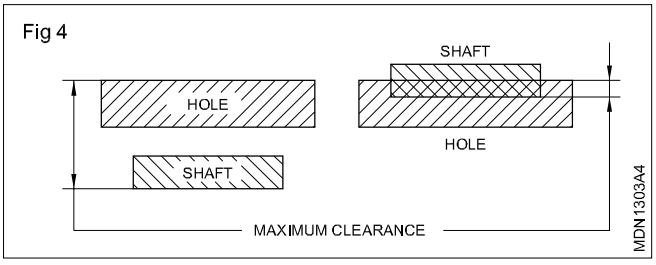
Fig 3



Maximum clearance

In a clearance fit or transition fit, it is the difference between the maximum hole and minimum shaft. (Fig 4)

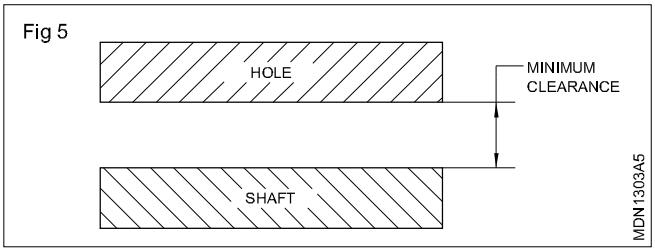
Fig 4



Minimum Clearance

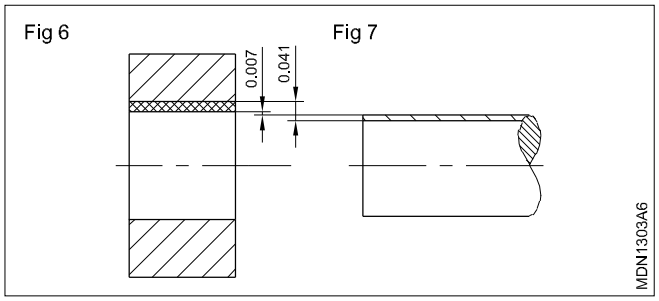
In a clearance fit, it is the difference between the minimum hole and the maximum shaft. (Fig 5)

Fig 5



The minimum clearance is 20.000 - 19.993 = 0.007 mm. (Fig 6)

The maximum clearance is 20.021 - 19.980 = 0.041 mm. (Fig 7)



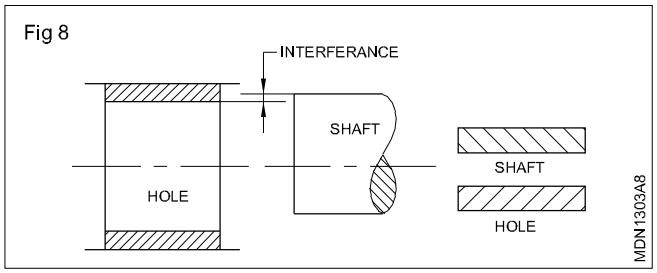
There is always a clearance between the hole and the shaft. This is the clearance fit.

Interference

It is the difference between the size of the hole and the shaft before assembly, and this is negative. In this case, the shaft is always larger than the hole size.

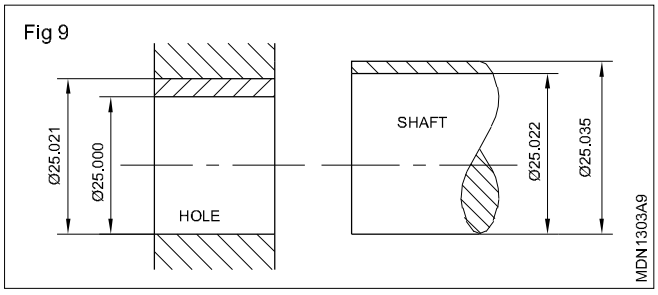
Interference Fit

It is a fit which always provides interference. Here the tolerance zone of the hole will be below the tolerance zone of the shaft. (Fig 8)



Example Fit 25 H7/p6 (Fig 9)

The limits of hole are 25.000 and 25.021 mm and the limits of the shaft 25.022 and 25.035 mm. The shaft is always bigger than the hole. This is an interference fit.



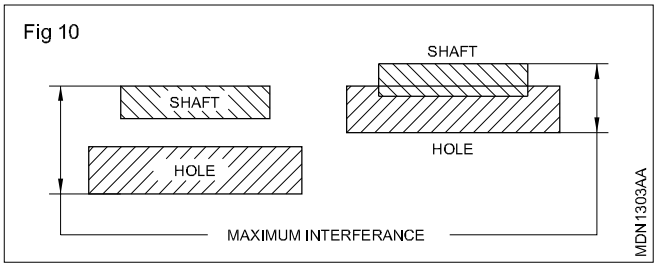
Maximum interference

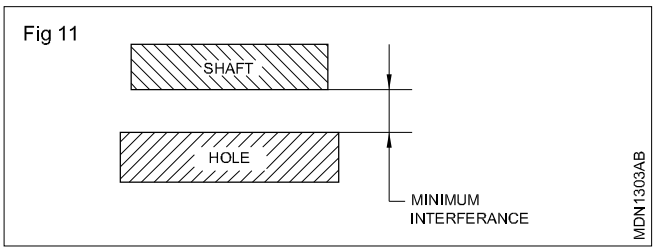
In an interference fit or transition fit, it is the algebraic difference between the minimum hole and the maximum shaft. (Fig 10)

Minimum interference

In an interference fit, it is the algebraic difference between the maximum hole and the minimum shaft. (Fig 11)

In the example (Fig 9)





The maximum interference is = 25.035 - 25.000

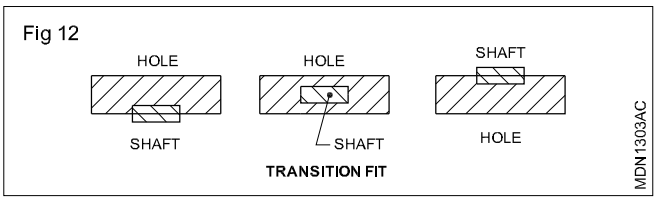
= **0.035**

The minimum interference is = 25. 022 - 25.021

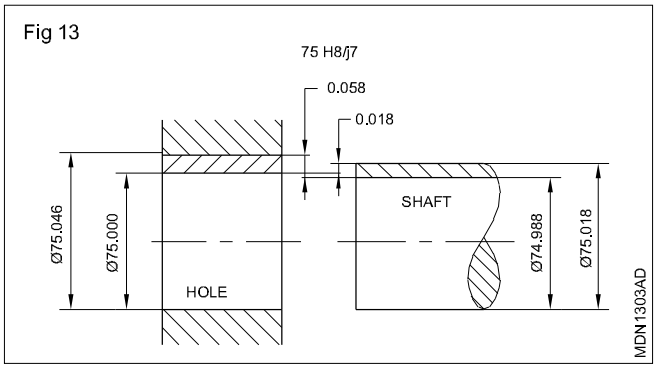
= **0.001**

Transition fit

it is a fit which may sometimes provide clearance, and sometimes interference. When this class of fit is represented graphically, the tolerance zones of the hole and shaft will overlap each other. (Fig 12)



Example Fit 75 H8/j7 (Fig 13)



The limits of the hole are 75.000 and 75.046 mm and those of the shaft are 74.018 and 74.988 mm.

Maximum Clearance = 75.046 - 74.988 = 0.058 mm.

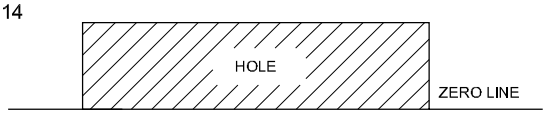
If the hole is 75.000 and the shaft 75.018 mm, the shaft is 0.018 mm, bigger than the hole. This results in interference. This is transition fit because it can result in a clearance fit or an interference fit.

Hole basis system

In a Standard system of limits and fits, where the size of the hole is kept constant and the size of the shaft is varied to get the difference class of fits, then it is known as, the hole basis system.

The fundamental deviation symbol ‘H’ is chosen for the holes, when the hole basis system is followed. This is because the lower deviation of the hole ‘H’ is zero. It is known as ‘basic hole’. (Fig 14)

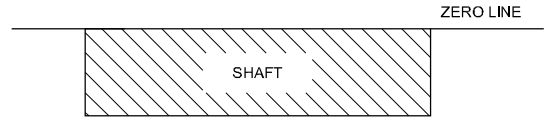
Fig 14



Shaft basis system

In a standard system of limits and fits, where the size of the shaft is kept constant and the variations are given to the hole for obtaining different class of fits, then it is known as shaft basis. The fundamental deviation symbol ‘h’ is chosen for the shaft when the shaft basis is followed. This is because the upper deviation of the shaft ‘h’ is zero. It is known as ‘basis shaft’. (Fig 15)

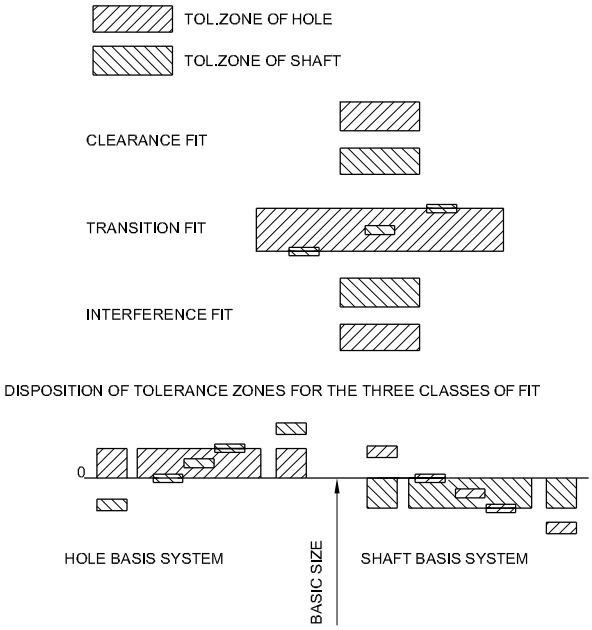
Fig 15



The hole basis systemis followed mostly. This is because, depending upon the class of fit, it will be always easier to alter the size of the shaft because it is external, but it is difficult to do minor alternations to a hole. Moreover the hole can be produced by using standard toolings.

The three classes of fits, both under hole basis and shaft basis, are illustrated in (Fig 16)

Fig 16



EXAMPLES ILLUSTRATING THE HOLE BASIS AND SHAFT BASIS SYSTEM

Soldering

Objectives : At the end of this lesson you shall be able to
- **state the process of soldering**
- **state the method of applicatoin of soldering iron**
- **state the different types of solder and their application**.

There are different methods of joining metallic sheets. Soldering is one of them.

Soldering is the process by which metallic materials are joined with the help of another liquified metal (solder)

The melting point of the solder is lower than that of the materials being joined.

The solder wets the base material without melting it.

Soldering iron (Fig 1)

The soldering iron is used to melt the solder and heat the metal that are to be joined together.

Fig 1

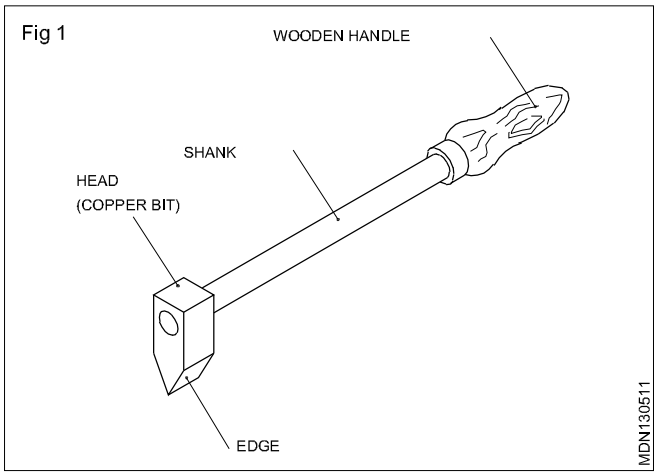


Fig 2

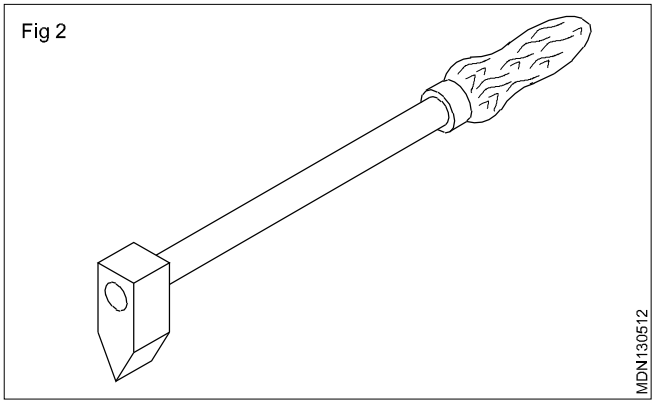


Fig 3

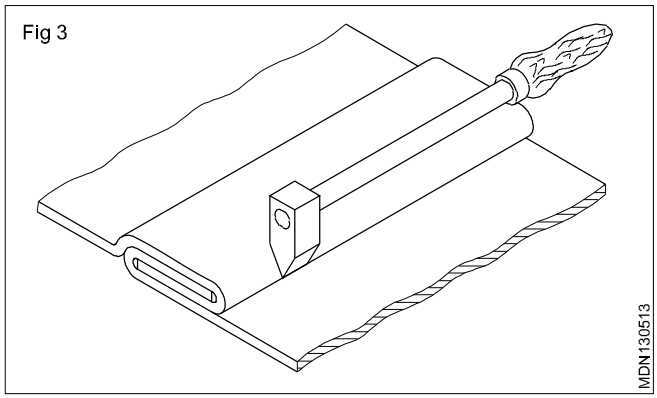
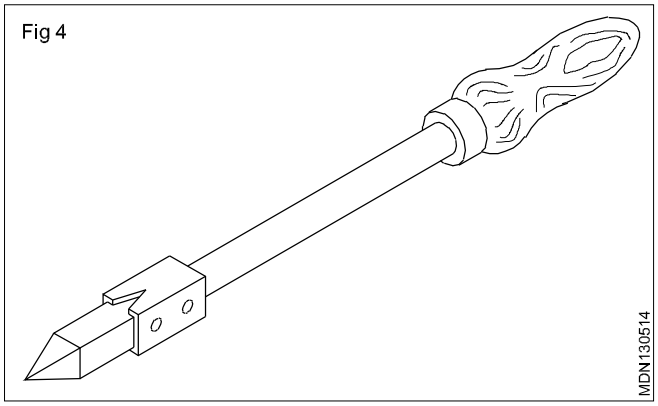


Fig 4



A soldering iron has the following parts.

- Head (copper bit)
- Shank

Fig 5

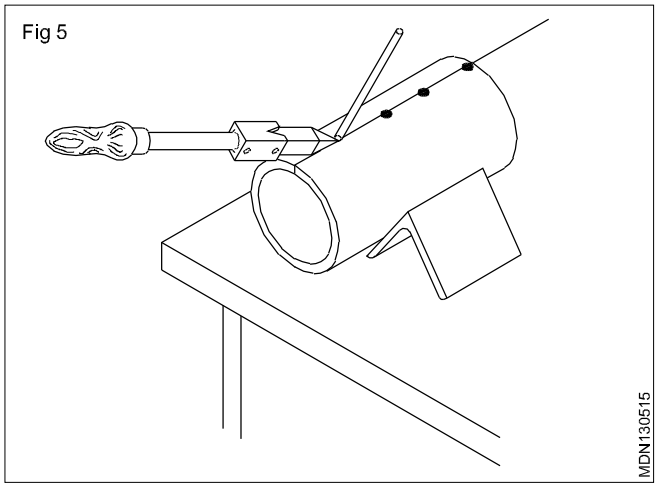
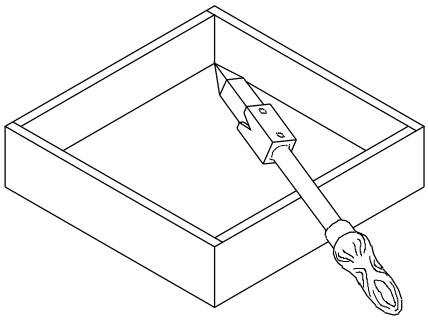


Fig 6



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- Wooden handle
- Edge

Shape of head (Fig 1, 2 & 3)

The head of the iron is made of forged copper. This is because copper has a good heat conductivity and has a strong affinity for the solder so that the solder melts easily and sticks to the bit.

The edge is V shaped from two sides of a square. This is called Hatchet type soldering iron

This type is used for straight soldering joints.

The other type is the square pointed soldering iron or a standard workshop pattern soldering iron. For this type the edge is shaped to an angle on four sides to form a pyramid shape.

Metal : The fitter metal is distributed between the closely fitted surfaces of the joint by capillary action' Coalescence is a joining or uniting of materials. (Figs 5 & 6)

Brazewelding : A welding process variation in which a filler metal, having a liquidus above 840°F (450°C) and below the solidus of the base metal, is used. Unlike brazing, in braze welding the filler metal is not distributed in the joint by capillary action.

Brazing has been used for centuries. Blacksmiths, jewelers, armorers and other crafters used the process on large and small articles before recorded history. This joining method has grown steadily both in volume and popularity. It is an important industrial process, as well as jewelry making and repair process. The art of brazing has become more of a science as the knowledge of chemistry, physics and metallurgy has increased.

The usual terms Brazing and Braze welding imply the use of a nonferrous alloy. These nonferrous alloys consist of alloys of copper, tin, zinc, aluminum, beryllium, magnesium, silver, gold and others

Brass is an alloy consisting chiefly of copper and zinc. Bronze is an alloy consisting chiefly of copper and tin. Most rods used in both brazing and braze welding on ferrous metals are brass alloys rather than bronze. The brands which are called bronze usually contain a small percent (about one percent) of tin.

Brazing and braze welding principles: Brazing is an adhesion process in which the metals being joined are heated but not melted; the brazing filler metal melts and flows at temperatures above 840°F (450°C). Adhesion is the molecular attraction exerted between surfaces.

A brazed joint is stronger than a soldered joint because of the strength of the alloys used. In some instances it is as strong as a welded joint. It is used where mechanical strength and leakproof joints are desired. Brazing and braze welding are superior to welding in some applications. since they do not affect the heat treatment of the original metals as much as welding.

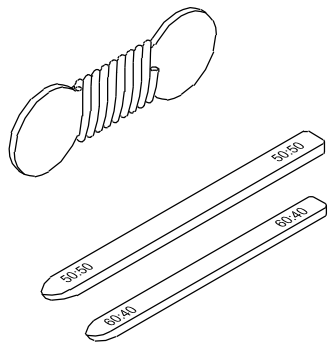
Brazing and braze welding wrap the original metals less and it is possible to joing dissimilar metals. For example. steel tubing may be brazed to cast iron, copper tubing brazed to steel and tool steel brazed to low carbon steel.

Brazing is done on metals which fit together tightly. The metal is drawn into the joint by capillary action (A liquid will be drawn between two tightly fitted surfaces. This drawing action is known as Capillary action). Very thin layers of filler metals are used when brazing. The joints and the material being brazed must be specially designed for the purpose. When brazing, poor fit and alignment result in poor joints and in inefficient use of brazing metal.

In braze welding, joint designs used for oxyfuel gas or arc welding are satisfactory. When braze welding, thick layers of the brazing filler metal is used.

Solders (Fig. 7)

Fig 7



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Pure metals or alloys are used for solders

Solders are applied in the form of wires, sticks, ingots, rods, threads, tapes, formed sections, powder and pastes

Types of solders

There are two types of solders

- soft solder
- hard solder

One distinguishes between soft solders whose melting points are below 450°C and hard solders whose melting points are above 450°C.

Soft solders

These are alloys of the metals-tin, lead, antinomy, copper, cadmium and zinc and are used for soldering heavy (thick) and light metals.

Hard solders

These are alloys of copper, tin, silver, zinc, cadmium and phosphorus, and are used for soldering heavy metals.

Brazing

Objectives : At the end of this lesson you shall be able to
- **describe the method of brazing**
- **state advatnages and disadvantages of brazing**
- **difference between soldering and brazing.**

Brazing (Fig. 1): Brazing is a metal joining process which is done at temperature of above 450°C as compared to soldering whihc is done at below 450°C.

Process:

Clean the area of the joint thoroughly by wire brushing, emerying and by chemical solutions for removing oil, grease paints etc.

Flame joints tightly using proper clamping, (Maximum gap permitted between the two joining surfaces is only 0.08mm)

Apply the flux in paste form (for brazing iron and steel a mixture of 75% borax powder with 25% boric acid (liquid form) to form a paste is used). Usually the brazing flux contains chlorides, fluorides, borax, borates, fluroborates, boric acid, wetting agents and water. So suitable flux combination is selected based on metal being used.

Brazing is employed where a ductile joint is required.

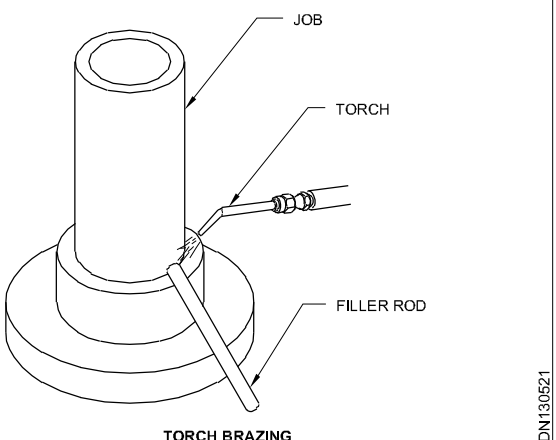
Brazing filler rods/metals melt at temperature from 860°C 950°C and are used to braze iron and its alloys.

Brazing fluxes: Fused borax is the general purpose flux of post metals.

It is applied on the joint in the form of a past made by mixing up with water.

Brazing is to be done at a lower temperature, fluorides of alkali materials are commonly used. These fluxes will remove refractory oxides of aluminium, chromium, silicon and berrylium.

Fig 1



TORCH BRAZING

Torch brazing: The base metal is heated to the required temperature by the application of the oxy-acetylene flame.

Conditions to obtain satisfactory brazed or soldered joint

Wet the base metal

Spread the filler metal and make contact with the joint surfces. The solder will be drawn into the joint by capillary action.

Suggested joint designs for solidering and brazing.

Advantages of brazing

The completed joint requires little or no finishing

The relatively low temperature at which the joint is made minimizes distortion.

There is no flash or weld spatter.

The brazing technique does not require as much skill as the technique for fusion welding

The process can be easily mechanised

The process is economical owing to the above advantages.

Disadvantages of brazing

If the joint is exposed to corrosive media, the filler metal used may not have the required corrosive resisteance.

All the brazing alloys loose strength at an elevated temperature.

The colour of the brazing alloy which ranges from silver white to copper red may not match the base metal very closely.

Brazing and braze welding: Both brazing and braze welding are metal joining processes which are performed at temperatures above 840°F (450°C) as compared to soldering which is performed at temperatures below 840°F (450°C)

The American Welding Society defines these processes as follows:

Brazing - `A group of welding processes which produces coalscence of materials by heating them to a suitable temperature and by using a filler metal having a liquids above 840°F (450°C) and below the solidus of the base.

Gasket

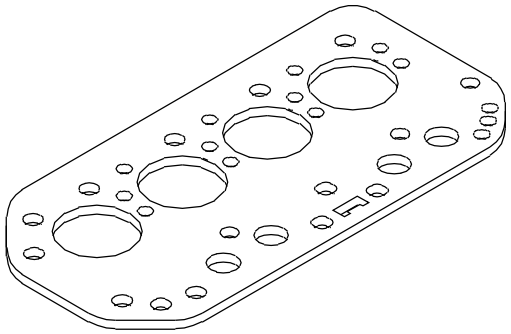
Objectives : At the end of this lesson you shall be able to
- **state the need of gaskets**
- **state the materials of gaskets**

The gasket (Fig. 1) in automobiles has to combat sealing problems caused by high and low temperatures, expansion and contraction, vibration, pressure or vaccum, corrosion and oxidation, inadequate sealing reduces the service life and efficiency of the components.

The seals which are used between two stationary components are called static seats. The most common static seal is gasket. Gaskets are designed to suit particular needs and are manufactured from different materials like copper, aluminium, cork fibre, asbestos, synthetic rubber, paper and various combinations of these materials. In latest In latest semi-liquid is also used as gasket.

Cylinder head gaskets are the most complicated in design and construction because they must withstand extreme pressure, vibration, high temperature and expansion changes. They must seal against compression, oil and coolants. They must resist extrusion, elongation, oxidation and chemicals. The cylinder head gasket consists of a multi-layer of materials with coolant and oil passages.

Fig 1



Oil seal

Objectives : At the end of this lesson you shall be able to
- **state the use of oil seals**
- **explain differnt types of oil seals**
- **state the material used for oil seals.**

Seals

Seals are sealing parts on static or moving inter faces of machines, devices pipes and tank reservoir seals are used for sealing spaces as different pressure against each other, ie combustion chamber & oilways etc. oil seals have flexible lip that rubs against a shaft or housing to prevent leakage of fluid (grease, oil etc.)

All seal are used to retain or seperate lubricant on fluid

Types of oil seal

i) Flexible lip

ii) radial lip

iii) rotary shaft seal

configuaration

a) single lip

b) double lip

c) triple lip

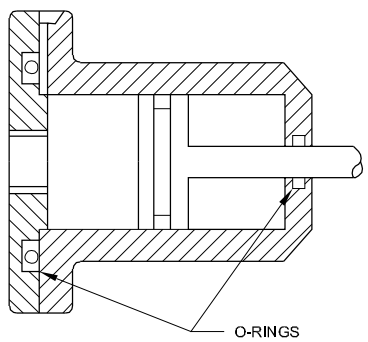
d) Fan lip

Seals capable of sealing two components which move or rotate insulation to each other are called dynamic seals. The most common dynamic seal is called 'O' rings which are moulded to close tolerances in the cross-sectional areas and to the inner and outer diameters.

Bearing Isolator (Fig. 1)

Bearing Isolator are dynamicsed designed to protect bearing from outside containant. The contain potor (rotating) & stater (Stationary) member same bearing Isolator are of labyrinth construction of other use o-rings.

Fig 1

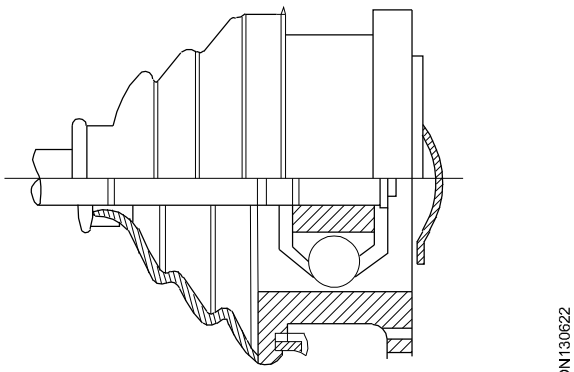


Specifications

Sealing orientation (Fig 2 & 3)

- Rod seals or shaft seals are type of radial seal.
- Radial seal are pressfit into a housing bore with the sealing up contacting the shaft.

Fig 2



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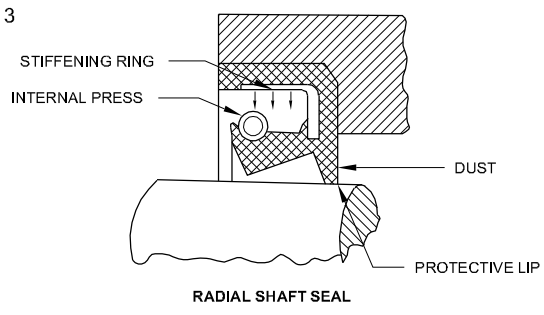
- Piston seals are radial seal. These seals are fit on a shaft with sealing lip contacting the housing bore. V rings are external lip seals.
- Symmetrical seal works equally as a rod or piston seal.
- An axial seal seals axially against a housing or machine component.
- Material - Nylon, Rubber, polythen, PTFE etc.

Fig 3



RADIAL SHAFT SEAL

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Sealants:

Type of sealant:

There are three types of sealant used.

1 The Teflon tape

2 Pipe tape

3 Anaerobic resin compound

1 Teflon tape

The purpose of this Teflon tape (whir), no sticking tape is the serve as a lubricant when threaded part of pipe a piping system are being assembles.

2 Pipe tape

This material relies on a solvent carrier and hardware when the solvent evaporator. The resulting seal adheres to all plastic, metal pipes and effective blocks leak paths.

3 Anaerobic resin compound

This sealant is confined within the threads of the metal pipe connection and air in exuded. It maintains the sealing properties even after heat aging, excellent then prelature and solvent remittance.

Key concepts

- Tape does not truly seal, it lubricator.
- Tape can harden and become brittle.
- Anaerobic must be combatable with pipe fitting material.

Sealant selection factors

- Material
- Temperature
- Pressure
- Vibration

Drilling machine (portable type)

Objectives : At the end of this lesson you shall be able to
- **name the different types of portable drilling machines**
- **state their distinctive features and uses.**

Necessity

Portable hand drills of different types are used for certain jobs which cannot be handled on stationary drilling machines.

Types

There are two types of portable drilling machines,

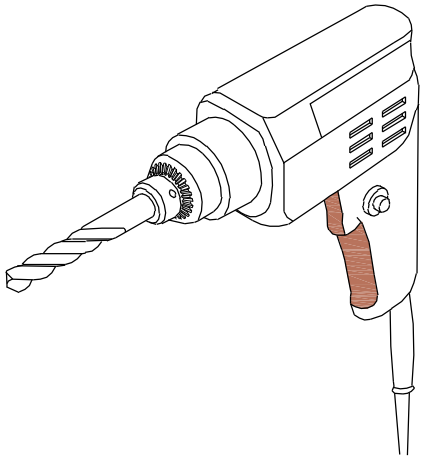
power operated and hand operated.

Power Operated drilling machines

Electric hand drill (light duty) (Fig 1)

These are available in different forms. The electric hand drill has a small electrical motor for driving the drill. On the end of the spindle, a drill chuck is mounted. Electric hand drills used for light duty will have, usually, a single speed.

Fig 1



Electric hand drill (heavy duty) (Figs 2 and 3)

This drill has an additional feature by which the drill speed can be varied through a system of gears. This is particularly useful for drilling larger diameter holes.

Fig 2

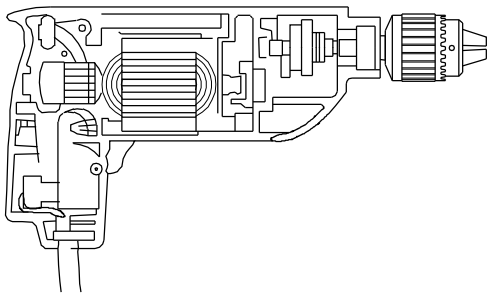
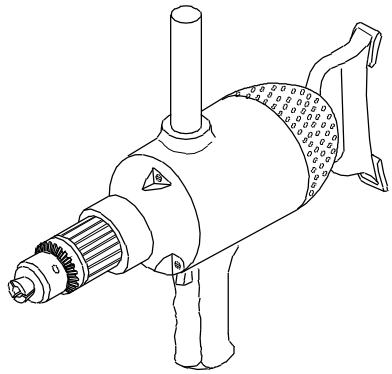


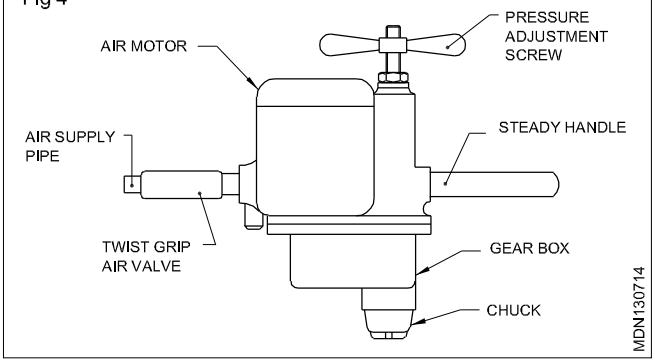
Fig 3



Pneumatic hand drill (Fig 4)

This type of drill is operated by compressed air. An air driven motor is housed in the casing, and a handle is fitted along with an air pipe to operate the drill conveniently.

Fig 4



This drill is used where electrically operated drills are prohibited i.e. explosives factories, petroleum refineries etc.

Hand operated drilling machines

Different types of hand operated drilling machines are shown below. They are used in structural fabrication, sheet metal and carpentry, particularly where electricity or pneumatic supply is not available.

The ratchet drilling machine (Fig 5) is commonly used in structural fabrication. Square head, taper shank drills are used on these machines.

The bevel gear type drilling machine (Fig 6) is used for drilling small diameter holes up to 6mm.

The breast drilling machine (Fig 7) is used for drilling holes of larger diameter as more pressure can be exerted. Drills between 6 mm to 12 mm can be used on these machines.

Fig 5

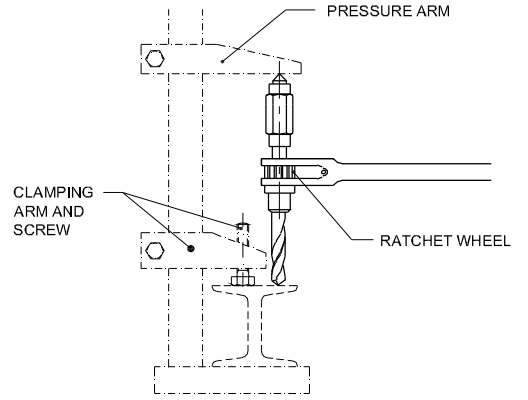


Fig 6

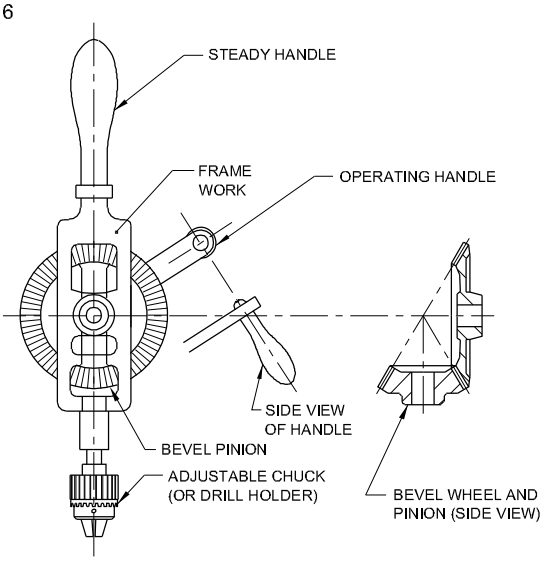
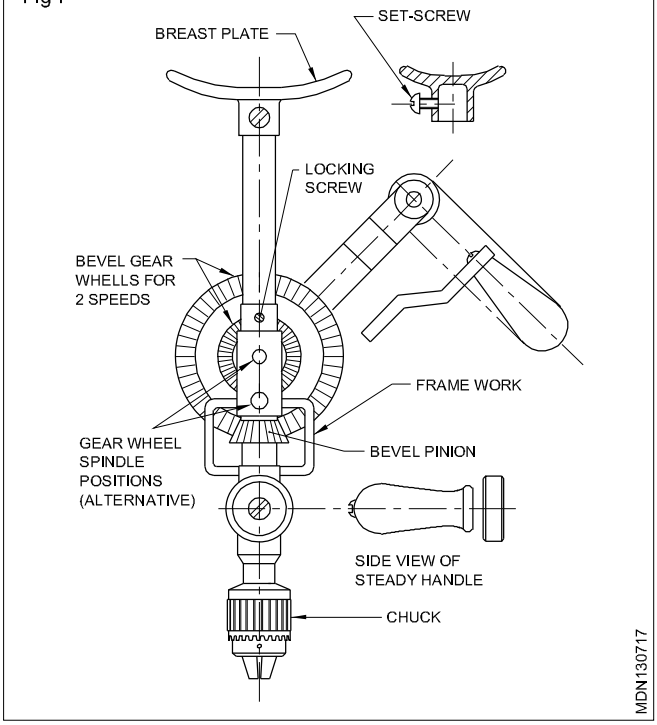


Fig 7



Drilling machines (bench and pillar type)

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

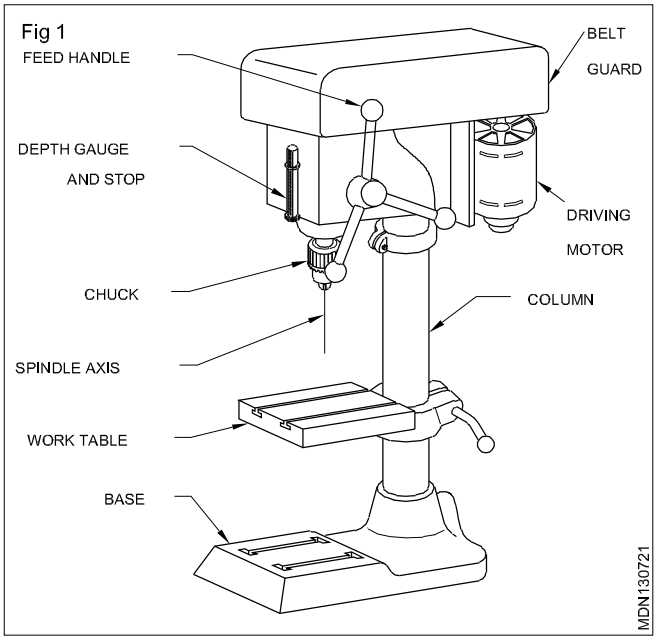
- **name the types of drilling machines**
- **list out the parts of bench type, pillar type and radial drilling machines**
- **compare the features of the bench type, pillar type and radial drilling machines.**

The principal types of drilling machines are :

- the sensitive bench drilling machine
- the pillar drilling machine
- the column drilling machine
- the radial arm drilling machine (radial drilling machine).

(You are not likely to use the column and radial types of drilling machines now. Therefore, only the sensitive and pillar type machines are explained here.)

Fig 1

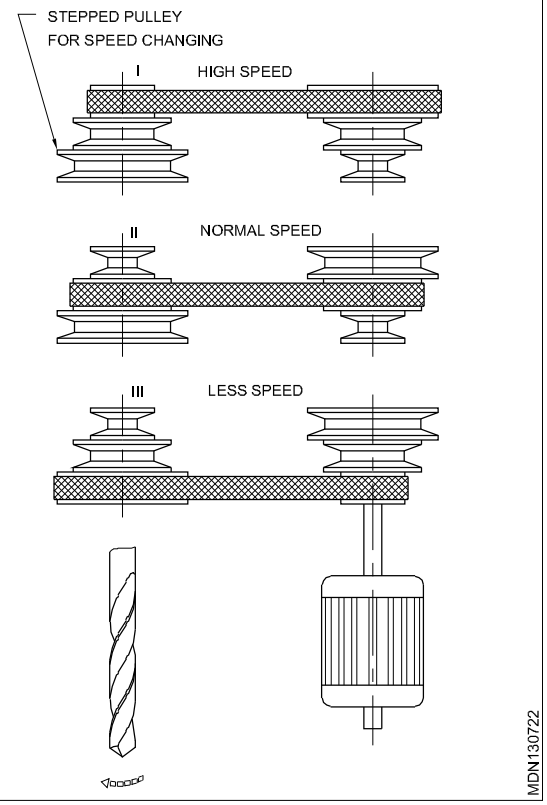


The sensitive bench drilling machine (Fig. 1)

The simplest type of sensitive drilling machines is shown in the figure with its various parts marked. This is used for light duty work.

This machine is capable of drilling holes upto 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

Fig 2

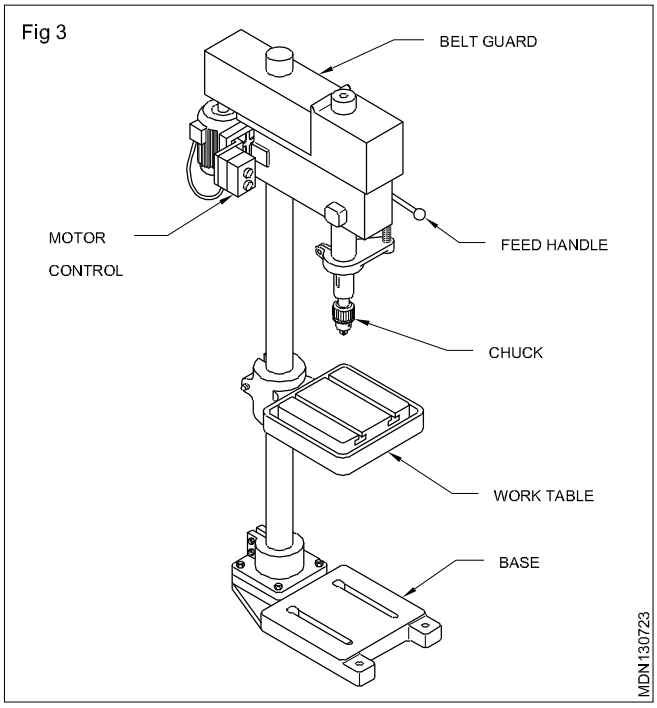


For normal drilling, the work-surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.

Different spindle speeds are achieved by changing the belt position in the stepped pulley. (Fig 2)

The pillar drilling machine (Fig 3)

Fig 3



This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounded on the floor and driven by more powerful electric motors. They are used for heavy duty work. Pillar drilling mechines are available in different sizes.

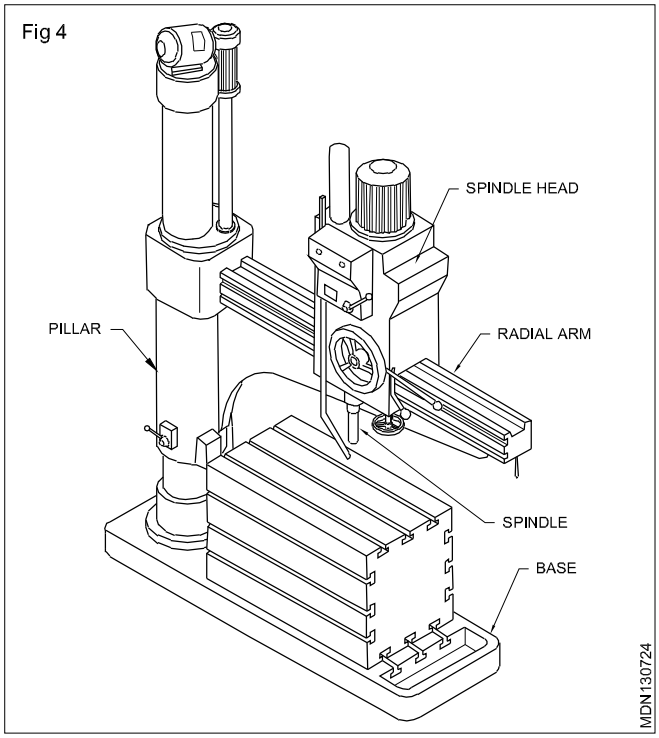
Large machines are provided with a rack and pinion machanism for moving the table for setting the work.

Radial drilling machines (Fig 4)

These are used to drill :
- large diameter holes
- multiple holes in one setting of the work
- heavy and large workpieces.

FEATURES

Fig 4



The radial drilling machine has a radial arm on which the spindle head is mounted.

The spindle head can be moved along the radial arm and can be locked in any position.

The arm is supported by a pillar (column). It can be rotated about with the pillar as centre. Therefore, the drill spindle can cover the entire working surface of the table. The arm can be lifted or lowered.

The motor mounted on the spindle head rotates the spindle.

The variable-speed gearbox provides a large range of r.p.m.

Cutting speed and RPM

Objectives : At the end of this lesson you shall be able to
- **define cutting speed**
- **state the factors for determining the cutting speed**
- **differentiate between cutting speed and r.p.m.**
- **determine r.p.m. spindle speed**
- **select r.pm. for drill sizes from tables.**

For a drill to give satisfactory performance, it must operate at the correct cutting speed and feed.

Cutting speed is the speed at which the cutting edge passes over the material while cutting, and is expressed in metres per minute.

Cutting speed is also sometimes stated as surface speed or peripheral speed.

The selection of the recommended cutting speed for drilling depends on the materials to be drilled, and the tool material.

Tool manufacturers usually provide a table of cutting speeds required for different materials.

The recommended cutting speeds for different materials are given in the table. Based on the cutting speed recommended, the r.p.m. at which a drill has to be driven, is determined.

Calculate r.p.m

$$V = \frac{n \times d \times \Pi}{1000} \text{ m/min}$$

$$n = \frac{v \times 1000}{d \times \pi} \text{ r.p.m}$$

n= r.p.m

v= cutting speed in m/min

d= diameter of drill in mm

Π= 3.14

Material being drilled for HSS	Cutting speed (m/min)
Aluminium	70 -100
Brass	35-50
Bronze (Phosphor)	20-35
Cast Iron (grey)	25-40
Copper	35-45
LC/MC steel/ Alloy steel	20-30
Thermosetting plastic (low speed due to abrasive properties)	5-8

Work - holding devices

Objectives : At the end of this lesson you shall be able to
- **state the purpose of work-holding devices**
- **name the devices used for holding work**
- **state the precautions to be observed while using.**

Workpieces to be drilled should be properly held or clamped to prevent them from rotating along with the drill. Improperly secured work is not only a danger to the operator but can also cause inaccurate work, and breakage to the drill. Various devices are used to ensure proper holding.

The machine vice (Fig 1)

Most of the drilling work can be held in a machine vice. Ensure that the drill does not drill through the vice after it has passed through the work. For this purpose, the work can be lifted up and secured on parallel blocks providing a gap between the work and the bottom of the vice.

Workpieces which are not accurate may be supported by wooden pieces.

Clamps and bolts (Fig 2,3,4 & 5)

Drilling machine tables are provided with T-slots for fitting bolt heads. Using clamps and bolts, the workpieces can be held very rigidly. While using this method, the packing should be, as far as possible, of the same height as the work, and the bolt nearer to the work.

There are many types of clamps and it is necessary to determine the clamping method according to the work.

Fig 1

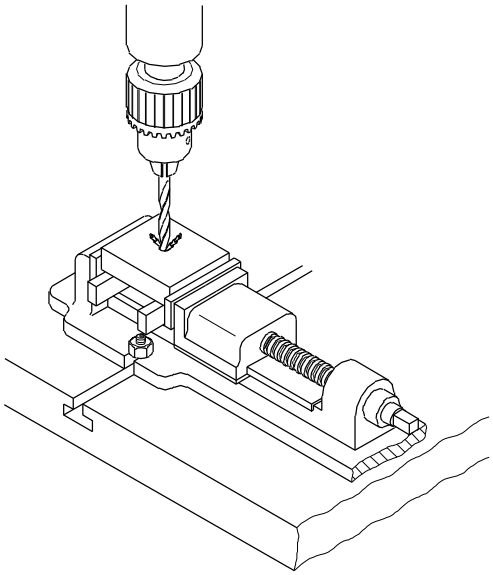


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Fig 2

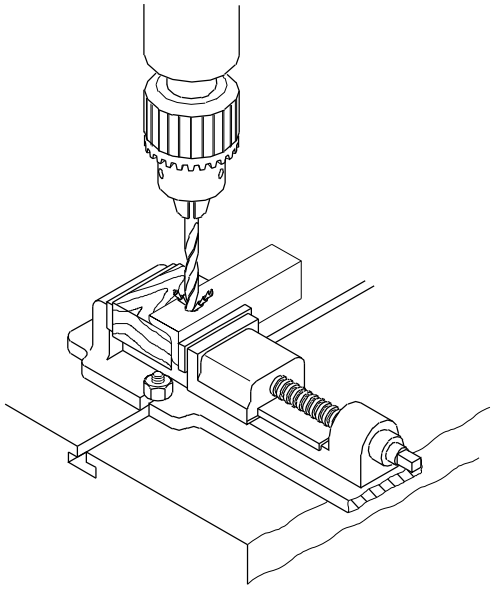

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Fig 3

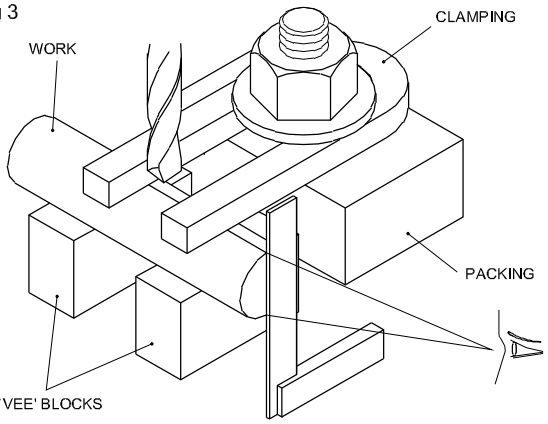

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Fig 4

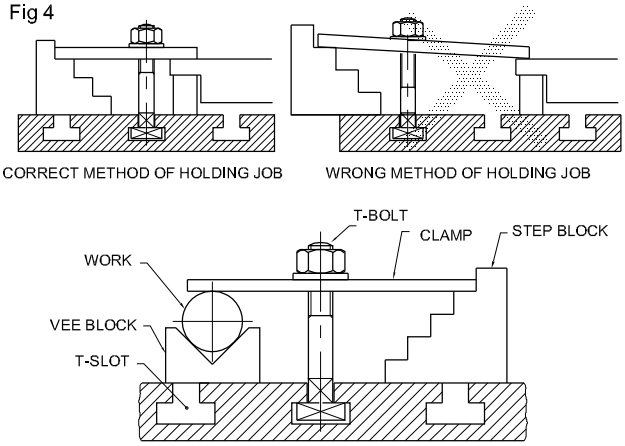

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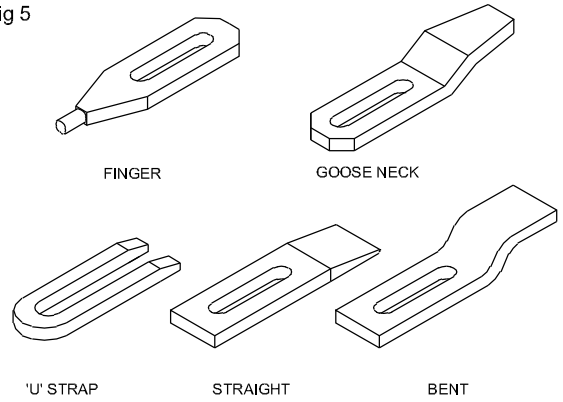
Fig 5



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Drill - holding devices

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

- **name the types of drill-holding devices**
- **state the features of drill chucks**
- **state the functions of drill sleeves**
- **state the function of drift.**

For drilling holes of material, the drills are to be held accurately and rigidly on the machines.

The common drill-holding devices are drill chucks and sleeves and sockets.

Drill Chuck

Straight shank drills are held in drill chucks. For fixing and removing drills, the chucks are provided either with a pinion and key or a knurled ring.

The drill chucks are held on the machine sprindle by means of an arbor fitted or the drill chuck. (Fig 1)

Taper Sleeves and Sockets (Fig 1)

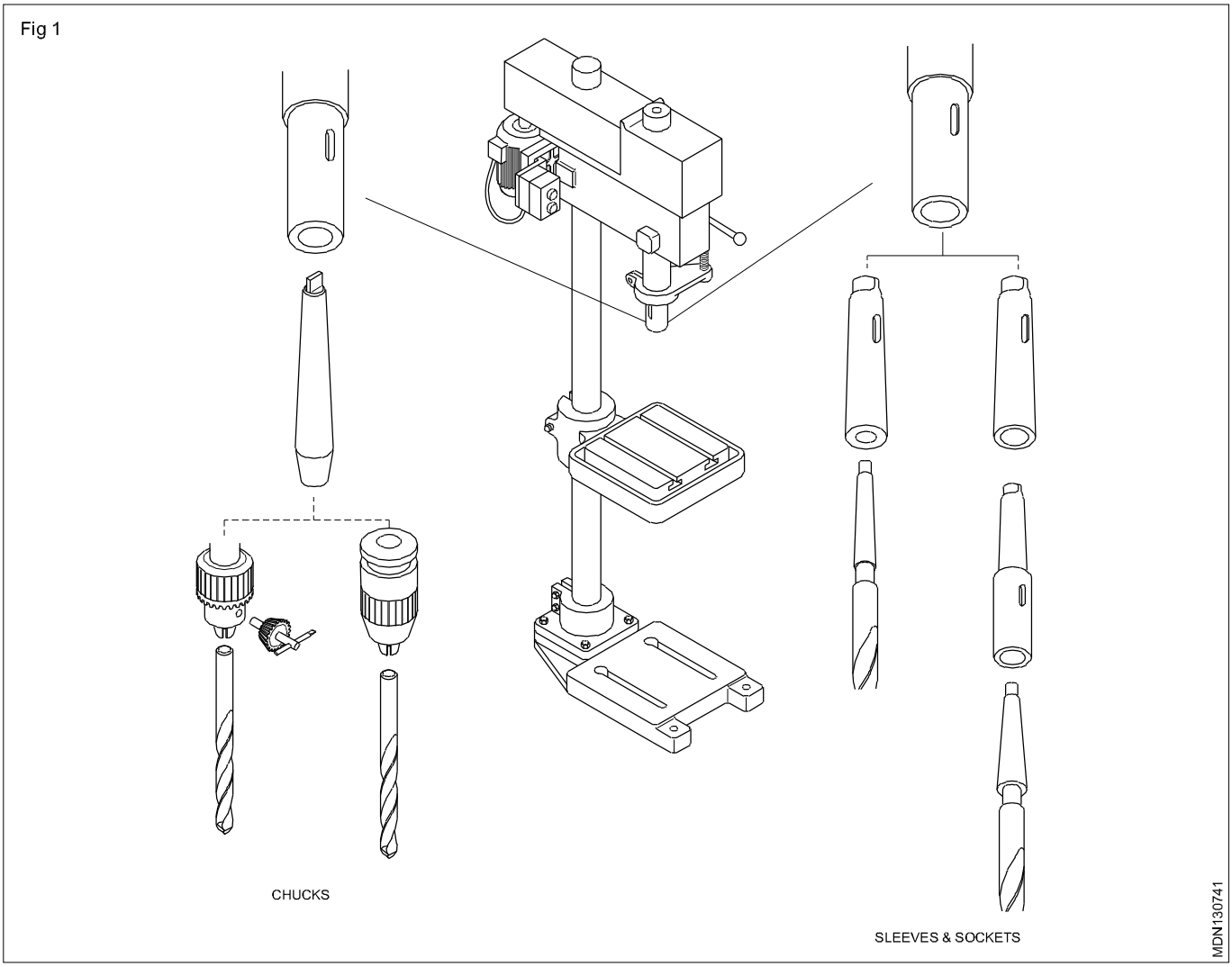
Taper shank drills have a morse taper.

Sleeves and sockets are made with the same taper so that the taper shank of the drill. When engaged, will give a good wedging action. due to this reason morse tapers are called self-holding tapers.

Drills are provided with five different sizes of morse tapers, and are numbered from MT 1 to MT5.

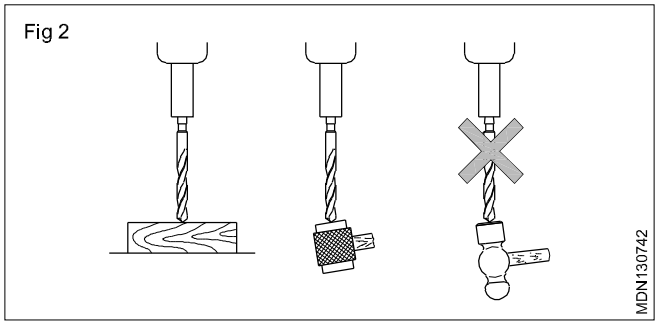
In order to make up the difference in sizes between the shanks of the drills and the type of machine spindles, sleeves of different sizes are used. When the drill taper shank is bigger than the machine spindle,taper sockets are used. (Fig 1)

Fig 1



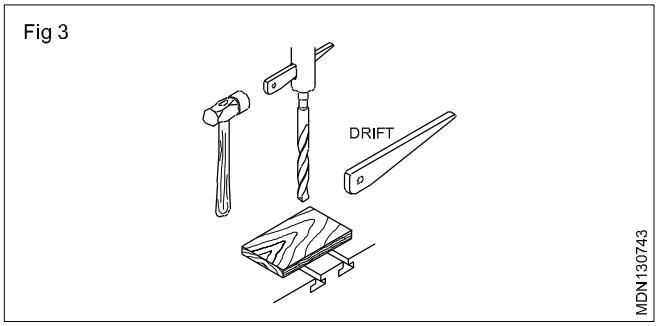
While fixing the drill in a socket or sleeves the tang portion should align in the slot (Fig 2). this will facilitate the removal of drill or sleeve from the machine spindle.

Fig 2



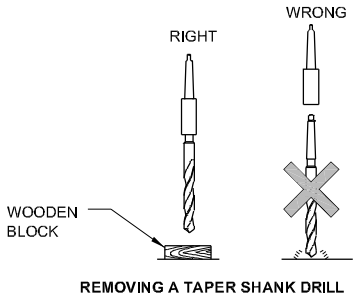
Use a drift remove drills and sockets from the machine spindle. (Fig 3)

Fig 3



While removing the drill from the sockets sleeves, don't allow it to fall on the table or jobs. (Fig 4)

Fig 4



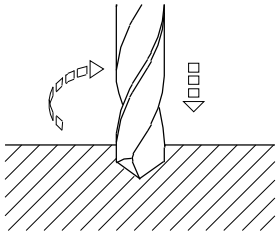
REMOVING A TAPER SHANK DRILL

Drill Bits

Objectives : At the end of this lesson you shall be able to
- **state the functions of drills**
- **name the parts of a drill**
- **state the functions of each part of a drill.**

Drilling is a process of making holes on workpieces. The drill used as a tool. For drilling the drill is rotated with a downward pressure causing the tool to penetrate into the material (Fig 1)

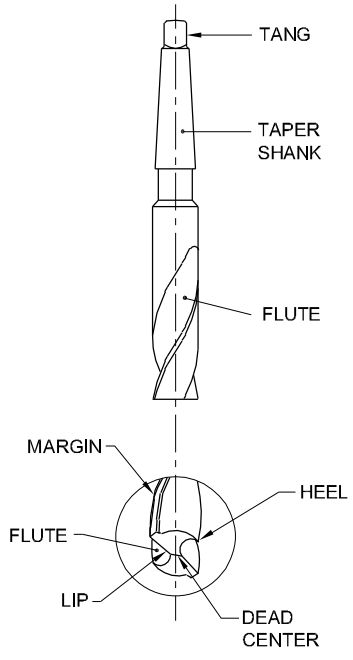
Fig 1



Parts of a Drill (Fig 2)

The Various parts of a drill can be identified from fig. 2

Fig 2



Point

The cone shaped end which does the cutting is called point. It consists of a dead centre, lips or cutting edges and a heel.

Shank

This is the driving end of the drill which is fitted on to the machine. Shanks are of two types.

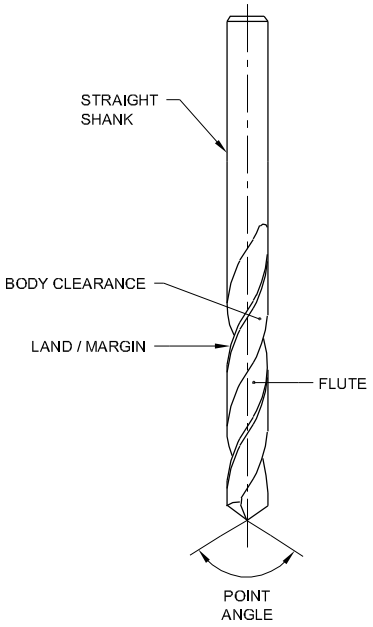
Taper shanks, used for larger diameter drills, and straight shank, used for smaller diameter drills.

Tang

This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

Body (Fig. 3)

Fig 3



The portion between the point and the shank is called the body of a drill.

The parts of the body are flute, land/margin, body clearance and web.

Flutes

Flutes are the spiral grooves which run to the length of the drill. The flutes help,

- to form the cutting edges
- to curl the chips and alow these to come out
- the coolant to flow to the cutting edge.

Land/Margin

The land/margin is the narrow strip which extends to the entire length of the flutes.

The diameter of the drill a measured across the land margin.

Body Clearance

Body clearance is the part of the body which is reduced in diameter to cut down the function between the drill and the hole being drilled.

Web

Web is the metal column which separates the flutes. It gradually increases in thickness towards the shank.

Drill Angles

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

- **list the various angles of a twist drill**
- **state the functions of each angle**
- **list the tool types for drill as per IS**
- **distinguish the features of different types of drills**
- **designate drills as per ISI recommendations.**

Angles

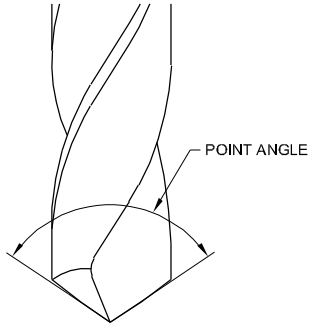
They are different angles for different purposes. They are listed below.

Point Angle, Helix angles,Rake angle, Clearance angle and chisel edge angle.

Point Angle/Cutting Angle

The point angle of a general purpose (standard) drill is 118°.This is the angle between the cutting edges (lips). This angle according to the hardness of the material to be drilled (Fig 1)

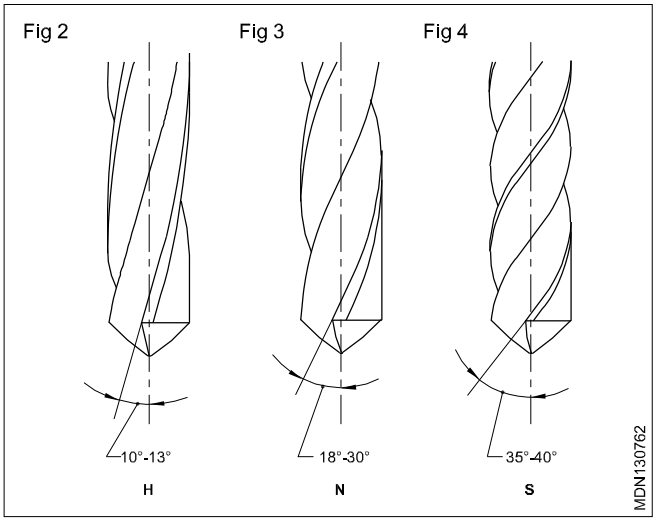
Fig 1



Helix Angle (Figs 2,3 and 4)

Twist drills are made with different helix angles. The helix angle determines the rake angle at the cutting edge of teh twist drill.

Fig 2 Fig 3 Fig 4



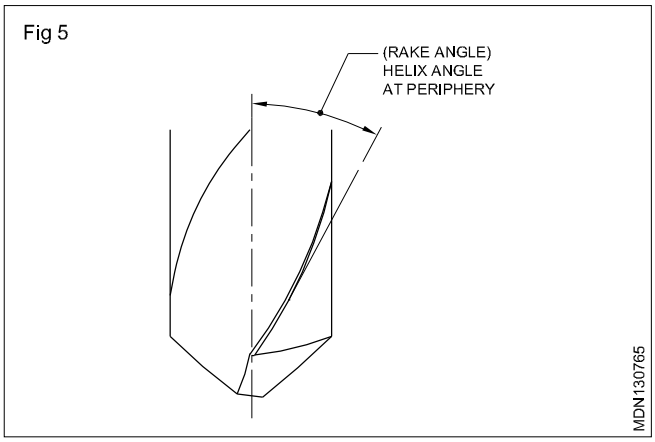
The helix angles vary according to the material being drilled. According to Indian Standards, three types of drills are used for drilling various materials.

- Type N-for normal low carbon steel
- Type H-for hard and tenaceous materials
- Type S- for soft and tough materials.

The type of drill used for general purpose drilling work is Type N.

Rake Angle (Fig 5)

Fig 5

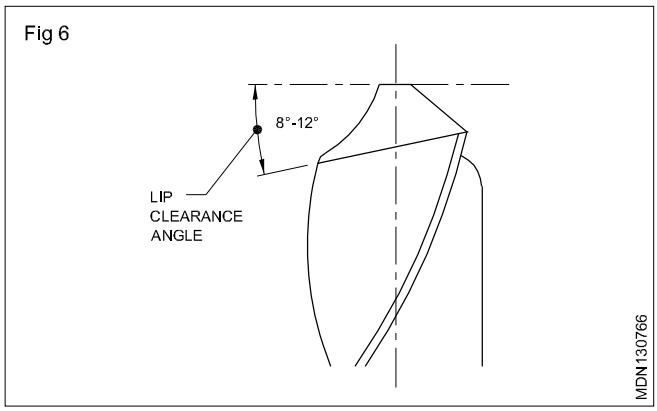


Rake angle is the angle of flute (helix angle)

Clearance Angle (Fig 6)

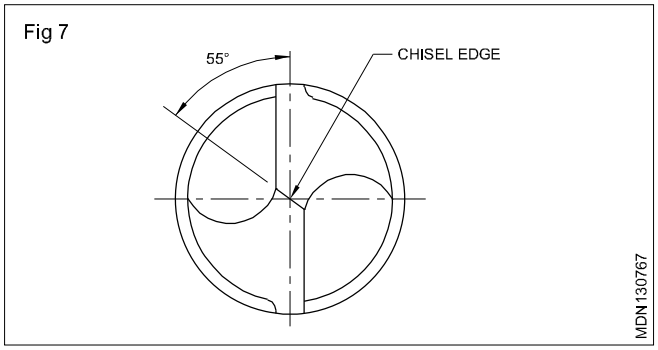
The clearance angle is to prevent the friction of the tool behind the cutting edge. This will help in the penetration of the cutting edges into the material. If the clearance angle is too much the cutting edges will be weak, and if it is too small the drill will not cut.

Fig 6



Chisel Edge Angle/ Web Angle (Fig 7)

Fig 7

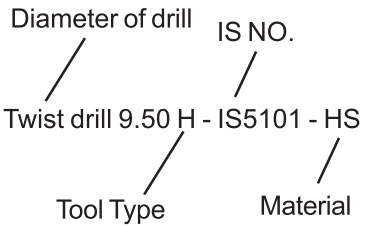


This is the angle between the chisel edge and the cutting lip.

Designation of drills

Twist drills are designated by the

- diameter



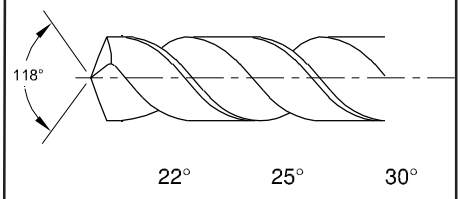
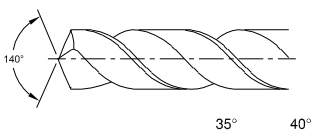
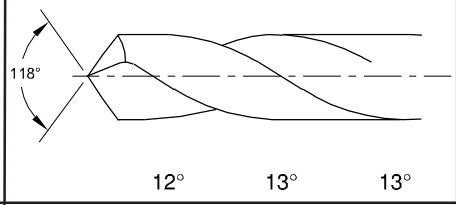
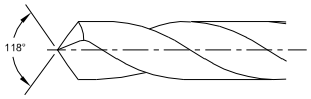
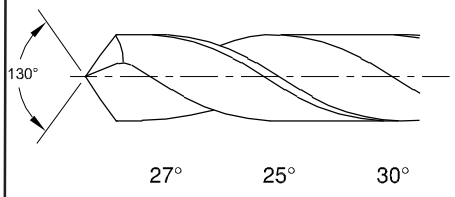
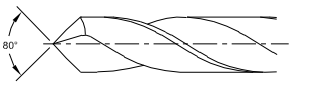
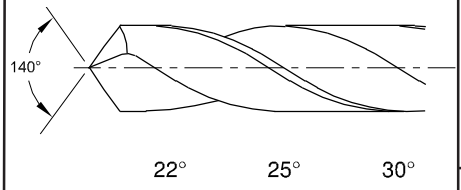
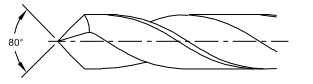
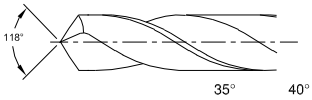
- tool type
- material

Example

A twist drill of 9.50mm dia of tool type “H’ right hand cutting and made from HSS is designated.

If the tool type is not indicated in the designation, it should be taken as type ‘N’ tool.

Drills for different materials

Recommended drills				
Material to be drilled	Point angle	Helix angle d=3.2-5 5-10	Material to be drilled	Point angle Helix angle d=3.5 -5
Steel and cast steel up to 70 kgf/mm^2 strength Gray cst iron Malleable cast iron Brass German silver, nickel			Copper (up to 30 mm drill diameter) Al-alloys, forming curly chips celluloid	
Brass, CuZn 40			Austentic steels	
Steel and cast steel 70.... 120 Kgfmm^2			Moulded plastics (with thickness s>d)	
Stainless steel; Copper (drill diameter) more than 30 mm) Al-alloy, forming short - broken chips			Moulded plastics, with thickness s<d Laminated plastics. hard rubber (ebonite) marble, state, coal	
			Zinc alloys	

Hand taps and dies

Objectives : At the end of this lesson you shall be able to
- **state the uses of threading hand taps**
- **state the features of hand taps**
- **distinguish between different taps in a set**
- **name the different types of tap wrenches**
- **state the uses of different types of wrenches.**

Use of Hand Taps

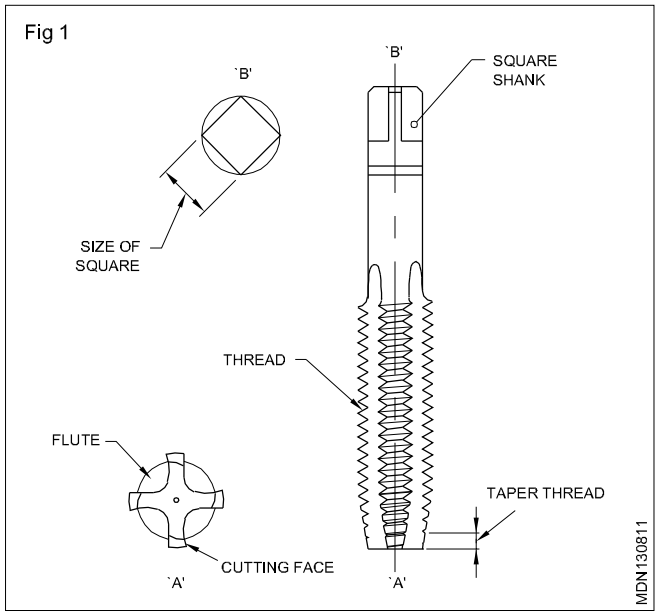
Hand taps are used for internal threading of components.

Features (Fig 1)

They are made from high carbon steel of high speed steel handened and ground

Threads are cut on the surface and are accurately finished.

Fig 1



To form the cutting edges, the flutes are cut across the thread.

For holding and turning the taps while cutting threads the ends of the shanks are squared.

The ends of the taps are chamfered (taper lead) for assisting aligning and starting of the thread.

The size of the taps and the type of the thread are usually marked on the shank.

In certain cases the pitch of the thread will also be marked.

Markings are also made to indicate the type of tap i.e first, second final or plug tap.

Types of Taps in a set

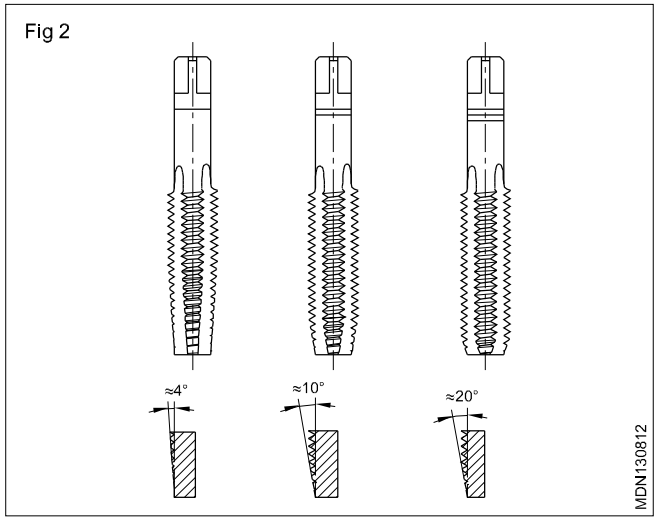
Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

These are

first tap or taper tap

second tap or intermediate tap

Fig 2



plug or bottoming tap

These taps are identical in all features except in the taper lead.

The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

for identifying the type of taps quickly - the taps are either numbered as 1,2 and 3 or rings are marked on the shank.

The taper tap has one ring the intermediate tap has two rings and the bottoming tap has three rings (Fig 2)

Tap Wrenches

Tap Wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

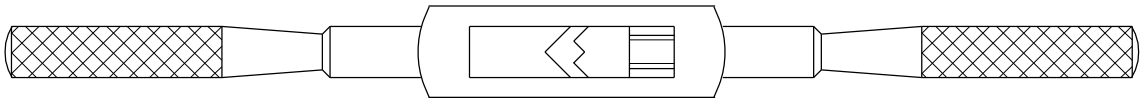
Tap Wrenches are of different types.

Double ended adjustable wrench, T handle tap wrench and solid type tap wrench.

Double ended adjustable tap Wrench or Bar Type Tap Wrench (Fig 3)

This is the most commonly used type of tap wrench. It is available in various sizes. These tap wrenches are more suitable for large diameter taps and can be used in open places where there is no obstruction to turn the tap. It is important to select the correct size of wrench.

Fig 3



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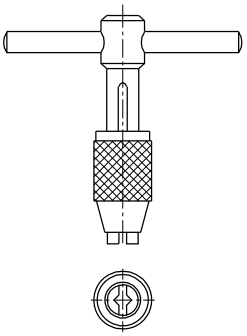
T- Handle Tap Wrench (Fig 4)

These are small adjustable chucks with two jaws and a handle to turn the wrench.

This tap wrench is useful to work in restricted places and is turned with one hand only.

Fig 4



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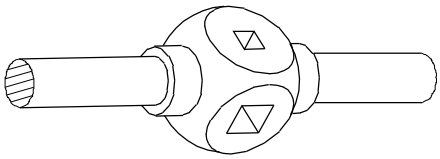
This is not suitable for holding large diameter taps.

Solid Type Tap Wrench (Fig 5)

These Wrenches are not adjustable

They can take only certain sizes of taps. This eliminates the use of wrong length of the tap wrenches and thus prevents damage to the taps.

Fig 5



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Tap drill size

Objectives: At the end of this lesson you shall be able to
- **state what is tap drill size**
- **choose the tap drill sizes for different threads from tables**
- **calculate the tap drill sizes for ISO metric and ISO inch.**

What is a tap drill Size?

Before a tap is used for cutting internal threads, a hole is to be drilled. The diameter of the hole should be such that it should have sufficient material in the hole for the tap to cut the thread.

Tap Drill Sizes for Different Threads

ISO Metric Thread

Tapping drill size

for M10 x 1.5 thread

Minor diameter = Major diameter – 2 x depth

depth of thread = 0.6134 x pitch of a screw

2 depth of thread = 0.6134 x 2 x pitch

=1.226 x 1.5 mm = 1.839 mm

Minor dia (D1)=10 mm – 1.839 mm

=8.161mm or 8.2 mm

This tap drill will produce 100% thread because this is equal to the minor diameter of the thread. For most fastening purposes a 100% formed thread is not required.

A standard nut with 60% thread is strong enough to be tightened until the bolt breaks without stripping the thread. Further it also requires a greater force for turning the tap if a higher percentage formation of thread is required.

Considering this aspect, a more practical approach for determining the tap drill sizes is

Tap drill size = Major diameter – pitch
= 10 mm - 1.5 mm
= 8.5 mm.

Compare this with the table of tap drill sizes for ISO metric threads.

ISO Inch (Unified) threads Formula

$$\text{Tap Drill size} = \text{Major diameter} - \frac{1}{\text{Number of thread per inch}}$$

For calculating the tap drill size for 5/8" UNC thread

Tap drill size = 5/8" – 1/11"
= 0.625" – 0.091"
= 0.534"
The next drill size is 17/32" (0.531 inches)

Compare this with the table of drill sizes for unified inch threads.

What will be the tapping size for the following threads?

(a) M 20
(b) UNC 3/8

Refer to chart for determining the pitches of the thread.

TABLE FOR TAP DRILL SIZES - ISO METRIC

PITCH / NOMINAL DIA	0.25	0.3	0.35	0.4	0.45	0.5	0.6	0.7	0.75	0.8	1	1.25	1.5	1.75		2.5	3	3.5	4	4.5	5	5.55
1	0.85																					
1.1	0.95																					
1.2	0.96																					
1.4		1.10																				
1.6			1.25																			
1.8			1.45																			
2				1.60																		
2.2			2.15		1.75																	
2.5			2.65		2.05																	
3			3.15			2.50																
3.5							2.90															
4						3.50		3.30														
4.5						4.00			3.70													
5						4.50				4.20												
5.5						5.00																
6									5.20		5.00											
7									6.20		6.00											
8									7.20		7.00	6.80										
9									8.20		8.00	7.80										
10									9.20		9.00	8.80	8.50									
11									10.20		10.00		9.50									
12											11.00	10.80	10.50	10.20								
14											13.00	12.80	12.50		12.00							
15											14.00		13.50									
16											15.00		14.50		14.00							
17											16.00		15.50									
18											17.00		16.50		16.00	15.50						
20											19.00		18.50		18.00	17.50						
22											21.00		20.50		20.00	19.50						
24											23.00		22.50		22.00		21.00					
25											24.00		23.50		23.00							
26													24.50									
27											26.00		25.50		25.00		24.00					
28											27.00		26.50		26.00							
30											29.00		28.50		28.00		27.00	26.50				
32													30.50		30.00							
33													31.50		31.00		30.00	29.50				
35													33.50									
36													34.50		34.00		33.00		32.00			
38													36.50									
39													37.50		37.00		36.00		35.00			
40													38.50		38.00		37.00					
42													40.50		40.00		39.00		38.00	37.50		
45													43.50		43.00		42.00		41.00	40.50		
48													46.50		46.00		45.00		44.00		43.00	
50													48.50		48.00		47.00					
52													50.50		50.00		49.00		48.00		47.00	
56																						50.50

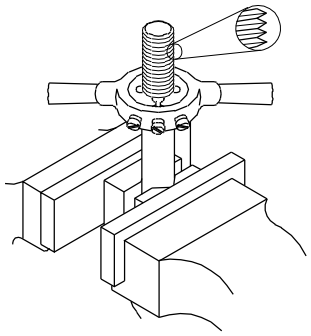
Die and die stock

Objectives: At the end of this lesson you shall be able to
- **name the different types of dies**
- **state the features of each type of die**
- **state the use of each type of die**
- **name the type of diestock for each type of die.**

Uses of Dies

Threading dies are used to cut external threads on cylindrical workpieces. (Fig 1)

Fig 1



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Types of Dies

The following are the different types of dies.

Circular Split Die (Button die)

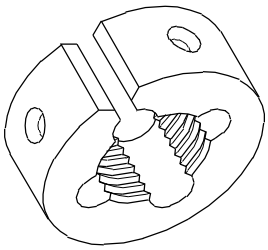
Half Die

Adjustable Screw Plate Die

Circular Split Die/Button Die (Fig 2)

This has a slot cut to permit slight variation in size.

Fig 2



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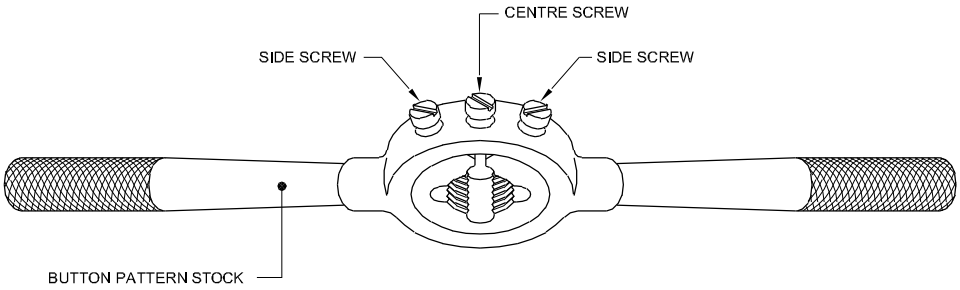
When held in the diestock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly.(Fig 3)

For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

Fig 3



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Half Die (Fig 4)

Half dies are stronger in construction.

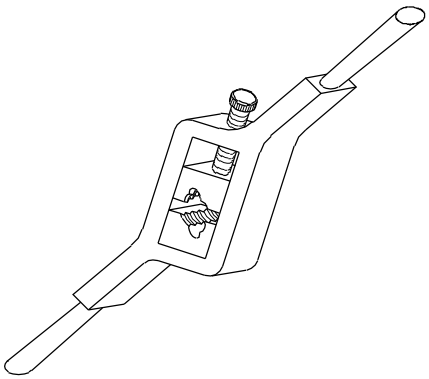
Adjustments can be made easily to increase or decrease the depth of cut.

These dies are available in matching pairs and should be used together.

By adjusting the screw of the diestock, the die pieces can be brought closer together or can be moved apart.

They need a special die holder.

Fig 4



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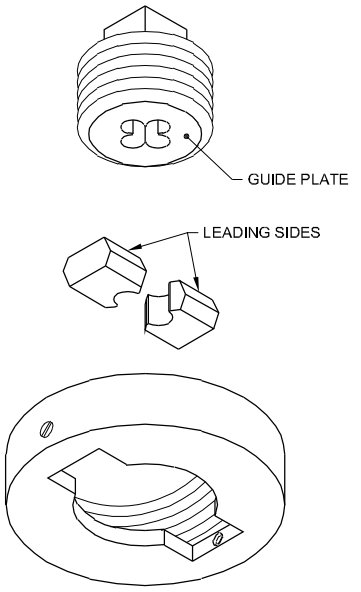
Adjustable Screw Plate Die (Fig 5)

Fig 5



This is another type of a two piece die similar to the half die.

This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading.

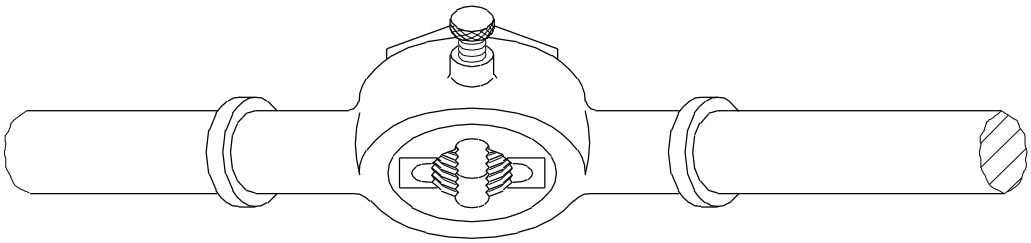
When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held. (Fig 5)

The die pieces can be adjusted, using the adjusting screws on the collar. This type of die stock used is called quick cut diestock. (Fig 6)

The bottom of the die halves is tapered to provide the lead for starting the thread. On one side of each die head, the serial number is stamped.

Both pieces should have the same serial numbers.

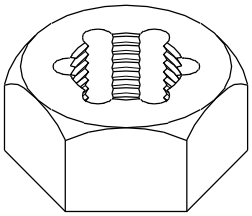
Fig 6



Die Nut (Solid Die) (Fig 7)

The die nut is used for chasing or reconditioning the damaged threads.

Fig 7



The die nut is turned with a spanner.

The die nuts are available for different standards and sizes of threads.

Die nuts are not to be used for cutting new threads.

Hand Reamers

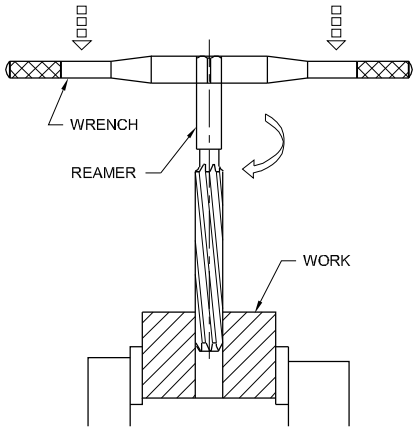
Objectives : At the end of this lesson you shall be able to
- **state the uses of reamers**
- **state the advantages of reaming**
- **distinguish between hand and machine reaming**
- **name the elements of a reamer.**

What is reamer?

A reamer is a multi-point cutting tool used for enlarging and finishing previously drilled holes to accurate sizes. (Fig 1)

Advantages of 'reaming'

Fig 1



Reaming produces high quality surface finish and dimensional accuracy to close limits.

Also small holes which cannot be finished by other processes can be finished.

Classification of reamers

Reamers are classified as hand reamers and machine reamers. (Fig 2 and 3)

Fig 2

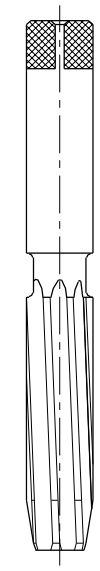


Fig 3

Reaming by using a hand reamer is done manually for which great skill is needed.

Hand reamers have straight sha nks with 'square' at the end for holding with tap wrenches. (Fig 2)

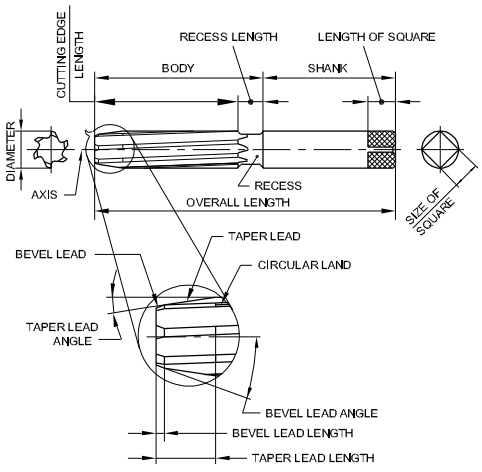
Machine reamers are fitted on spindles of machine tools by means of a floating chuck and are rotated for reaming.

Machine reamers are provided with Morse taper shanks for holding on machine spindles.(Fig 3)

Parts of a hand reamer

The parts of a hand reamer are shown in Fig 4

Fig 4



Hole size for reaming

Objectives : At the end of this lesson you shall be able to
- **determine the hole size for reaming.**

For reaming with a hand or machine reamer the hole drilled should be smaller than the reamer size.

The drilled hole should have sufficient metal for finishing with the reamer. Excessive metal will impose a strain on the cutting edge of the reamer and damage it.

Calculating drill size for reamer

A method generally practised in workshops is by applying the following formula.

Drill size = Reamed size - (undersize+oversize) of drilled hole.

Finished size

Finished size is the diameter of the reamer.

Undersize

Undersize is the recommended reduction in size for different ranges of drill diameter. (see Table)

TABLE -1

Undersizes for reaming

Diameter of ready reamed hole (mm)	Undersizes of rough bored hole (mm)
under 5	0.1...0.2
5....20	0.2...0.3
21....50	0.3....0.5
over 50	0.5....1

Oversize of drilled hole

It is generally considered that a twist drill will make a hole larger than its diameter. The oversize for calculation purposes is taken as 0.05 mm, for all diameters of drills.

For light metals the undersize will be 50% larger.

Example

A hole is to be reamed on mild steel with a 10mm reamer. What will be the diameter of the drill for drilling the hole before reaming?

Drill size = Reamed size - (undersize + oversize) (finished size) = 10mm

Undersize as per table = 0.2 mm

Oversize = 0.05 mm, finished size = 0.05+0.2=0.25mm

Drill size = 10mm-0.25mm

= 9.75mm

Determing the drill hole sizes for the following reamers.

i) 15mm ii) 44mm

iii) 4mm iV) 19mm

Answer

i) ----------

ii) ----------

iii) ----------

iv) ----------

If the reamed hole is undersize, the cause is that the reamer is worn out.

Always inspect the condition of the reamer before commending reaming.

For obtaining good suface finish, use a coolant while reaming. Remove metal chips from the reamer frequently advance the reamer slowly into the work.

DEFECTS IN REAMING - CAUSES AND REMEDIES

Reamer hole undersize

If a worn out reamer is used, it may result in the reamed hole being undersize. Do not use such reamers.

Always inspect the condition of the reamer before using.

Surface finish rough

The causes may be anyone of the following ara combination there of.

- incorrect application
- Swarf accumulated in reamer flutes
- in adequate flow of coolant
- feed rate too fast

While reaming apply a steady and slow feed rate.

Ensure a copious supply of the lubricant.

Do not turn the reamer in the reverse direction.

Lapping

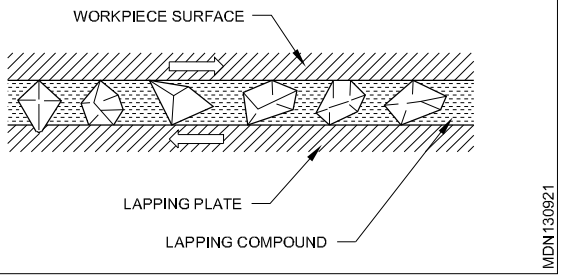
Objectives : At the end of this lesson you shall be able to
- **state the purpose of lapping**
- **state the features of a flat lapping plate**
- **state the use of changing a flat lapping plate**
- **state the method of charging a cast iron plate**

Lapping is a precision finishing operation carried out using line abrasive materials.

Purpose: This process

- improves geometrical accuracy
- refines surface finish
- assists in achieving a high degree of dimensional accuracy.
- improves the quality of fit between the mating components.

Fig 1



Lapping process: in the lapping process small amounts of material are removed by rubbing the work against a lap charged with a lapping compound. (Fig 1)

The lapping compound consists of the abrasive particles. Suspended in a vehicle such as oil, paraffin, grease etc.

The lapping compound which is introduced between the workpiece and the lap chips away the material from the workpiece. Light pressure is applied when both are moved against each other. The lapping can be carried out manually or by machine.

Hand lapping of flat surfaces: Flat surfaces are hand lapped using lapping plates made out of close grained cast iron. (Fig 2) The surface of the plate should be in a true plane for accurate results in lapping.

The lapping plate generally used in tool rooms will have narrow grooves out on its surface both lengthwise and crosswise forming a series of squares.

These grooves are usually about 12mm apart.

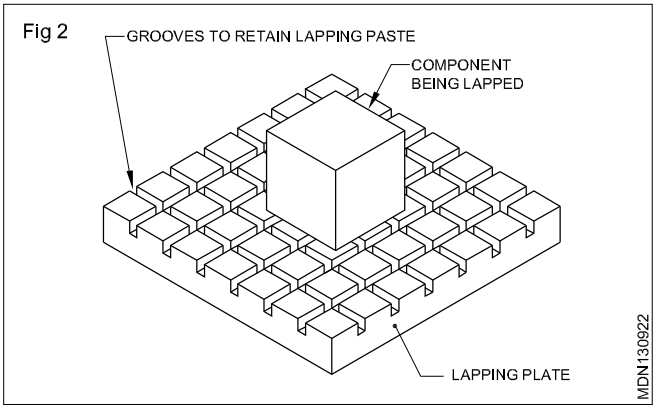
While lapping the lapping compound collects in the serrations and rolls in and out as the work a moved.

Before commencing lapping of the component, The cast iron plate should be CHARGED with abrasive particles.

This is a process by which the abrasive particles are embedded on to the surfaces of the laps which are comparatively softer than the component being lapped.

For charging the cast iron lap apply a thin coating of the abrasive compound over the surface of the lapping plate.

Fig 2



Use a finished hard steel block and press the cutting particles into the lap. While doing so, rubbing should be kept to the minimum. When the entire surface of the lapping plate is charged, the surface will have a uniform grey appearance. If the surface is not fully charged, bright spots will be visible here and there.

Excessive application of the abrasive compound will result in the rolling action of the abrasive between the work and the plate developing in accuracies.

The surface of the flat lap should be finished true by scraping before charging. After charging the plate, wash of all the loose abrasives using kerosene.

Then place the worpiece on the plate and move along and across, covering the entire surface areas of the plate. When carrying out fine lapping, the surface should be kept moist with the help of kerosene.

Wet and dry lapping: Lapping ca be carried out either wet or dry.

In wet lapping there is surplus oil and abrasives on the surface of the lap. As the workpiece which is being lapped is moved on the lap, there is movement of the abrasive particles also.

In the dry method the lap is first charged by rubbing the abrasives on the surface of the lap. The surplus oil and abrasives are then washed off. The abrasives embedded on the surface of the lap will only be remaining. The embedded abrasives act like a fine oilstone when metal pins to be lapped are moved over the surface with light pressure. However, while lapping, the surface being lapped is kept moistened with kerosene or petrol. Surfaces finished by the dry method will have better finish and appearance. Some prefer to do rough lapping by wet method and finish by dry lapping.

Lap Materials and lapping compounds

Objectives : At the end of this lesson you shall be able to
- **name the different types of lap materials**
- **state the qualities of different lap materials**
- **name the different types of abrasive materials used for lapping**
- **distinguished between the application of different lapping abrasives**
- **state the function of lapping vehicles**
- **name the solvents used in lapping.**

The material used for making laps should be softer than the workpiece being lapped. This helps to charge the abrasives on the lap. If the lap is harder than the workpiece, the workpiece will get charged with the abrasives and cut the lap instead of the workpiece being lapped.

Laps are usually made of

- close grained iron
- copper
- brass or lead.

The best material used for making lap is cast iron, but this cannot be used for all applications.

When there is excessive lapping allowance, copper and brass laps are preferred as they can be charged more easily and cut more rapidly than cast iron.

Lead is an in expensive form of lap commonly used for holes. Lead is cast to the required size on steel arbar. These laps can be expanded when they are worn out. Charging the lap is much quicker.

Lapping abrasives:

Abrasives of different types are used for lapping.

The commonly used abrasives are:

- silicon carbide
- aliminium oxide
- boron carbide
- diamond.

Silicon carbide: This is an extremely hand abrasive. Its grit is sharp and brittle. While lapping the sharp cutting edges contiuously break down exposing new cutting edges. Due to this reason this is considered as very ideal for lapping hardened steel and cast iron, particularly where heavy stock removal is required.

Aluminium oxide: Aluminium oxide is sharp but tougher than silicon carbide. Aluminium oxide is used in un-fused and fused forms.

Un-fused alumina(aluminium oxide) removes stock effectively and is capable of obtaining high quality finish.

Fused alumina is used for lapping soft steels and nonferrous metals.

Boron Carbide: This is an expensive abrasive material which is next to diamond in harness. While it has excellent cutting properties, it is used because of the high cost only in special application like dies and gauges.

Diamond: This being the hardest of all materials. It is used for lapping tungsten carbide. Rotary diamond laps are also prepared for accurately finishing very small holes which cannot be ground.

Lapping vehicles: In the preparation of lapping compounds the abrasive particles are suspended in vehicles. This helps to prevent concentration of abrasives on the lapping surfaces and regulates the cutting action and lubricates the surfaces.

The commonly used vehicles are:

- water soluble cutting oils
- vegetable oils
- machine oils
- petroleum jelly or grease
- vehicles with oil or grease base used for lapping ferrous metals.

Metals like copper and its alloys and other non-ferrousmetals are lapped using slouable oil, bentomite etc.

In addition to the vehicles used in making the lapping compound, solvents like water, kerosene, etc are also used at the time of lapping.

Types of sheet metals and their application

Objectives: At the end of this lesson you shall be able to
- **state the types of metals used in sheet metal work**
- **state the uses of the different types of metals.**

In sheet metal work, different types of metal sheets are used. The sheets are specified by standard gauge numbers.

It is very essential to know the different uses and applications of these metal sheets.

Black Iron

The cheapest sheet metal is black iron, which is rolled to the desired thickness. It has a bluish black appearance, and is often referred to as uncoated sheet. Since it is uncoated, it corrodes rapidly.

The use of this metal is limited to articles that are to be painted or enamelled such as tanks, fans, stoves, pipes etc.

Galvanised iron

Zinc-coated iron is known as 'galvanised iron'. This soft iron sheet is popularly known as GI sheet. The zinc coating resists rust, improves the appearance of the metal and permits it to be soldered with greater ease. Because it is coated with zinc, galvanised sheet iron withstands contact with water and exposure to weather.

Articles such as fans, buckets, furnaces, heating ducts, cabinets, gutters etc. are made mainly from GI sheets.

Stainless sheet

This is an alloy of steel with nickel, chromium and other metals. It has good corrosive resistance and can be welded easily. Stainless steel used in a sheet metal shop can be worked as galvanised iron sheets, but is tougher than GI sheets. The cost of stainless steel is very high. Stainless steel is used in dairies, food processing, chemical plants, kitchenware etc.

Copper sheet

Copper sheets are available either as cold-rolled or hot-rolled sheets. Cold-rolled sheets being resistant to corrosion and worked easily are commonly used in sheet metal shops. Copper sheet has better appearance than other metals.

Gutters, expansion joints, roof flashings, hoods, utensils and boiler plates are some of the common examples where copper sheet is used.

Aluminum

Aluminum cannot be used in its pure form, but is mixed with a very small amount of copper, silicon, manganese and iron. It is whitish in colour and is light in weight. It is highly resistant to corrosion and abrasion.

Aluminum is now widely used in the manufacture of articles such as household appliances, refrigerator trays, lighting fixtures, windows, and also in the construction of airplanes and in many electrical and transport industries.

Tinned plate

Tinned plate is sheet iron coated with tin to protect it against rust. This is used for nearly all solder work, as it is the easiest metal to join by soldering. This metal has a very bright silvery appearance and is used in the making of roofs, food containers, dairy equipment, furnace fittings, cans and pans, etc.

Lead

Lead is very soft and heavy. Lead sheets are used for making the highly corrosive acid tanks.

Properties of an auto body sheet metal

Objectives: At the end of this lesson you shall be able to
- **describe the properties of an auto body sheet metal.**

Properties of auto body sheet metal: The sheet metal used in the production of automobile surface panels must contain certain properties of qualities such as plasticity, elasticity and work hardening.

Direct and indirect damages: Damage to the body sheet metal can be classified as either direct or indirect damage.

Direct damage results from the impact of an object stilling the sheet metal. The area of damage is called the point of impact. Direct damage can be in the form of deep scratches, gauges, tears in the metal or in the case of severe impact, crumpled or mangled sheet metal.

The force of the direct damage is transmitted or transferred from the impact area to different parts of the panel thus causing indirect damage in the form of roll buckles, valleys or sharp ridges.

When straightening a panel with direct and indirect damage, the indirect damage should be straightened first.

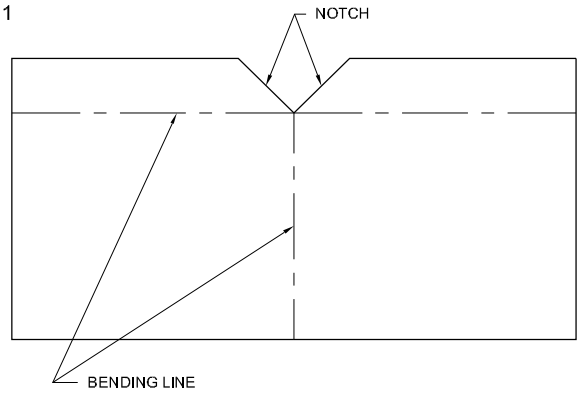
Notches in sheet metal

Objectives : At the end of this lesson you shall be able to
- **state the purpose of notches**
- **name the types of notches**
- **distinguish the features of different notch forms.**

Notches

Notches are the spaces provided for joining the edges when sheet metals are cut form the layout.

Fig 1



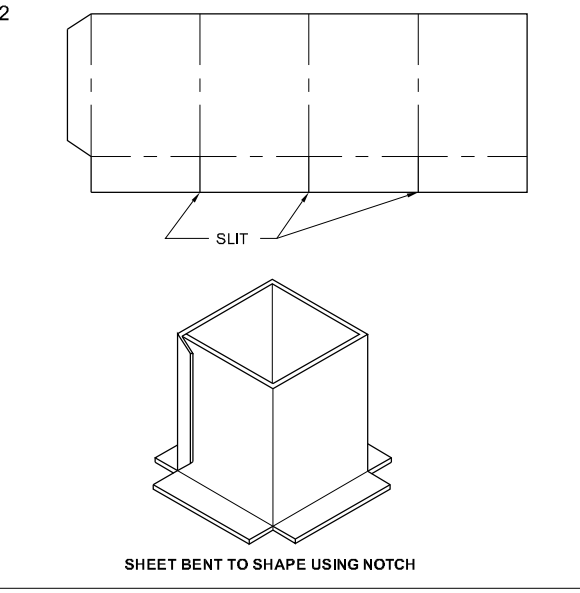
Purpose of notches

Notch helps:
- to prevent surplus material from overlapping and causing a bulge at the seam and edges.
- to allow the work to be formed to the required size and shape.
- to allow the work to assemble better.

Types of notches

Straight notch of slit (Figs 1 & 2)

Fig 2



Straight cuts made in the edge of the sheet where it is to be bent is know as a straight notch.

Square notch (Figs 3, 4 & 5)

A square notch is used for forming a square or rectangular box.

Fig 3

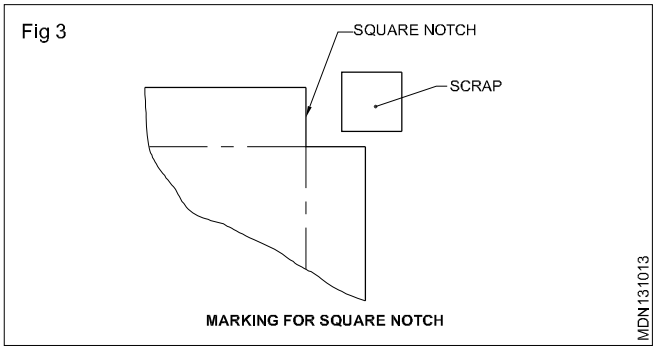


Fig 4

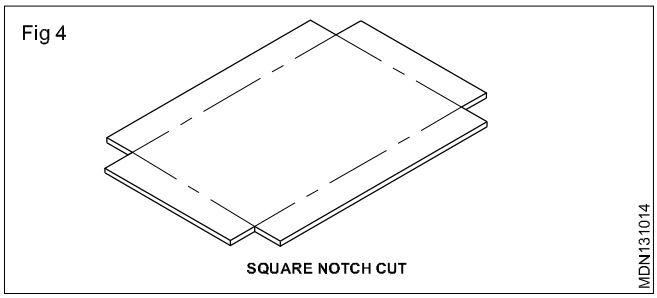
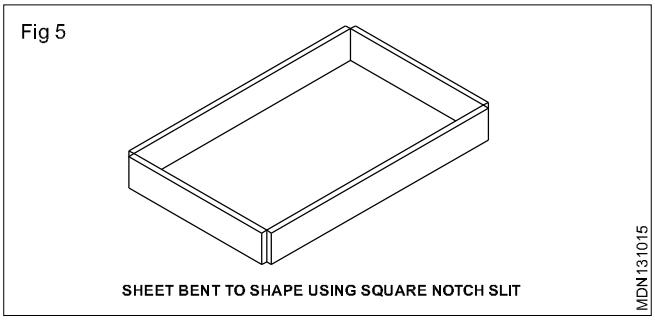


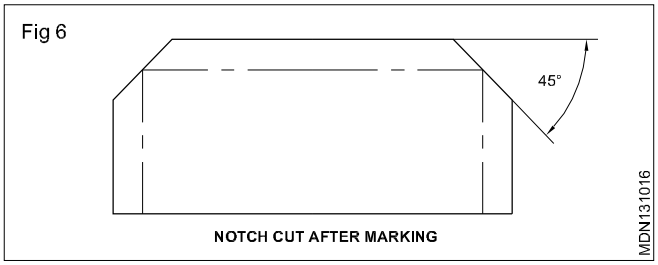
Fig 5



Slant notch (Fig. 6)

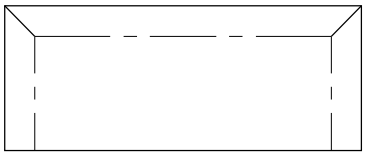
This Notch is cut at an angle of 45° to the corner of the sheet. It is used when a single hem meets at right angles.

Fig 6



'V' Notch (Figs 7 & 8)

Fig 7



BENT TO SHAPE USING SLANT NOTCH

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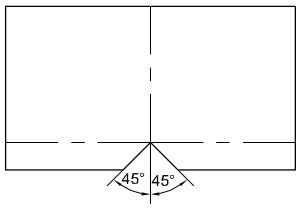
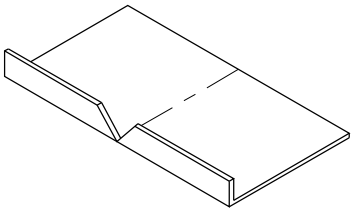
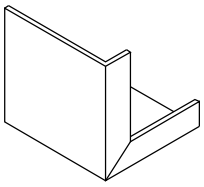
Fig 8



`V' NOTCH MARKED AND OUT



FIRST FOLDING NOTCH



BENT TO SHAPE USING `V' NOTCH

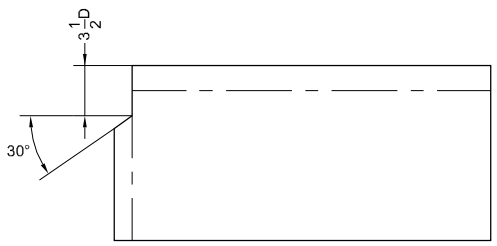
MDN131018

In this notch, both the sides are cut at a 45° angle to the edge of the sheet.

The sides of the notch meet at 90° . This notch is used when making a job with a 90° bend and an inside flange.

Wire notch (Figs 9 & 10)

Fig 9



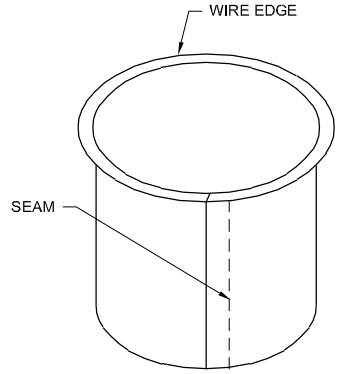
MDN131019

The angle of this notch is usually 30° and the distance from which the notch is started is 3 times the diameter of the wire.

Uses

The wire notch is used on a work which has wired edges. This notch must be provided to prevent the wired edge from overlapping at the seam.

Fig 10



AN EDGE WIRED USING WIRE NOTCHES

MDN131101A

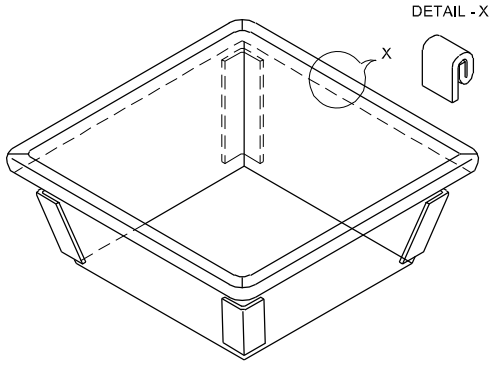
Edge Stiffening

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

- **state what is a hem**
- **state the types of hems**
- **state the uses of the different types of hems.**

The edges of light gauge sheet metal articles (Fig. 1) are very sharp and unsafe to handle. Safe edges are provided to strengthen the sheet metal and to enhance the appearance of the finished article.

Fig 1



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What is a hem?

A hem is an edge or border made by folding.

It stiffens the sheet of the metal and avoids sharp edges.

Types of hems

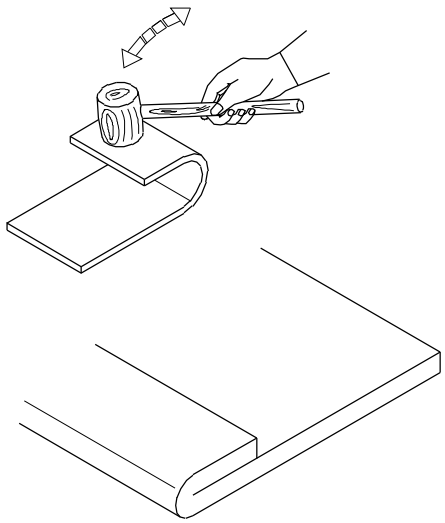
- Single hem
- Double hem
- Wired edge

Single hem (Fig. 2)

A single hem is made by folding the edge of the sheet metal with a single folding.

It makes the edge smooth and stiff and is done while making small articles.

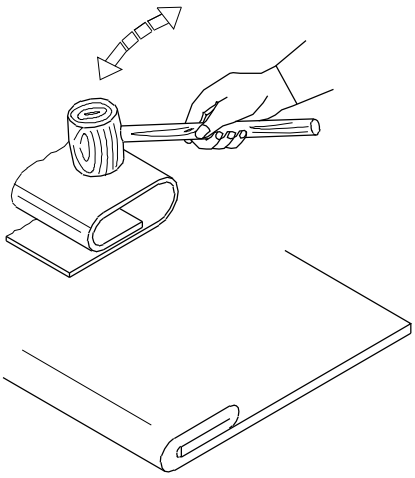
Fig 2



Double hem (Fig. 3)

A double hem is made by folding the edges over twice to make it smooth and this is done normally to strengthen the edges of lengthy articles.

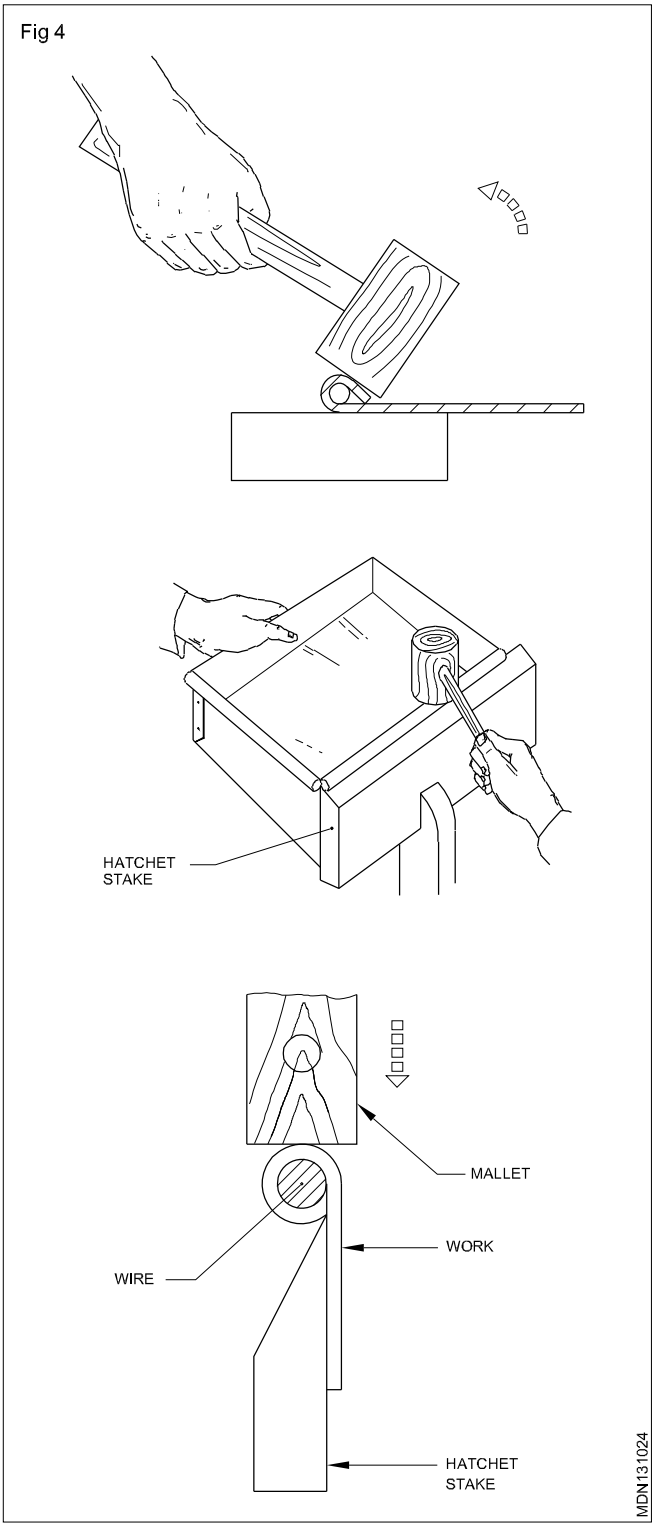
Fig 3



Wired edge (Fig. 4)

The wired edge is done for round and lengthy articles to enhance the appearance and increase the strength. The wired edge is smooth and is very strong.

Fig 4



Sheet Metal Joints

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

- **state what is a seam**
- **state the types of seams**
- **state the uses and application of the different types of seams.**

Sheet metal working incorporates a wide variety of seams

What is a seam?

A seam is a joint made by the fastening of two edges of two pieces of metal together.

Types of seams

Lap seam

The lap seam is the simplest type of seam and can be prepared as a lap joint. This joint is also known as edged

on joint. This joint is used to fit the top and bottom to cylindrical shapes. This joint is finally secured by soldering or brazing.

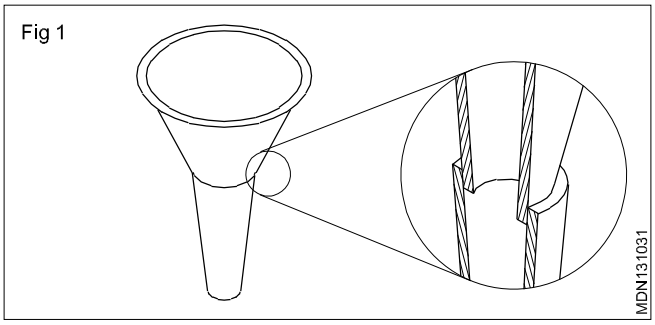
Grooved seam

A grooved seam is used to join two pieces of straight or curved metal of light gauge and then locking them by a groove.

Single seam (Fig. 1

The single seam is used to join a bottom to vertical bodies of various shapes. This joint is called paned-down joint. This joint is also secured by soldering or brazing.

Fig 1



Double seam (Figs 2 & 3)

The double seam is similar to a single seam joint except that its forward edge is bent upward against the body. This joint fulfils the same function as the edged-on and paned-down joints, but it is the strongest of the three.

Fig 2

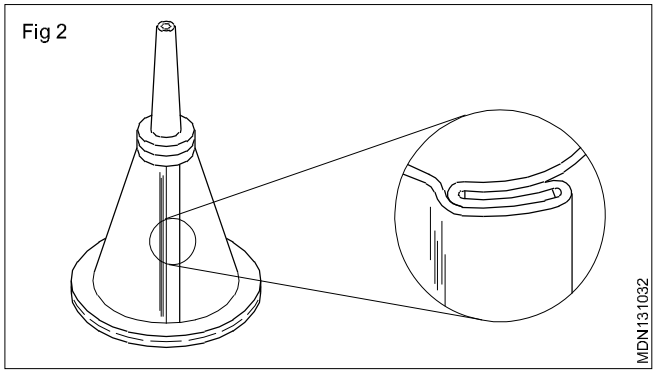
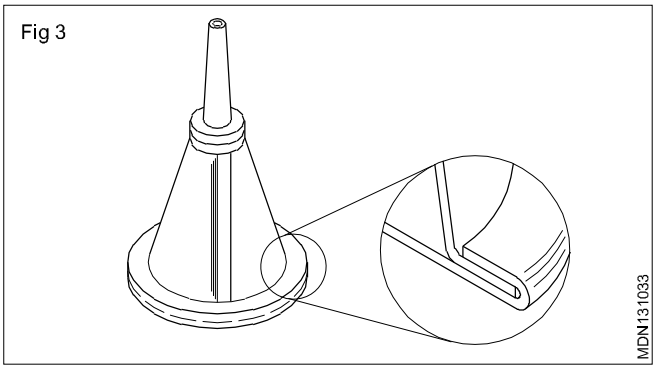


Fig 3



Double grooved seam (Figs 4 & 5)

The double grooved seam (Fig. 5) is similar to the dovetail joint in carpentry and it is used for roofing and paneling joints.

Fig 4

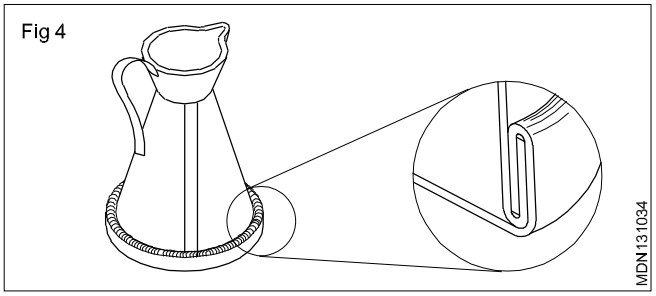
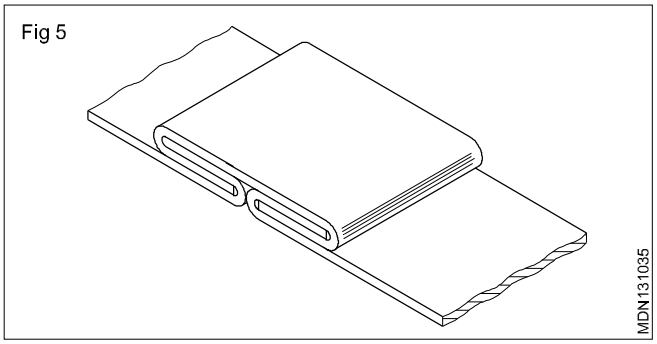


Fig 5



Folding and Joining Allowances

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

- **state the necessity for providing allowances in sheet metal operations.**

When making self-secured joints or seams, it is necessary to make an allowance for the extra material to be added for the preparation of the edges and seams.

The allowance is necessary for maintaining the correct size of the finished product and for improving the strength at joints of all edges.

Allowance is also necessary for avoid cracking or warping, and for obtaining the required finish.

This allowance depends upon the width of the folded edge and the thickness of the metal.

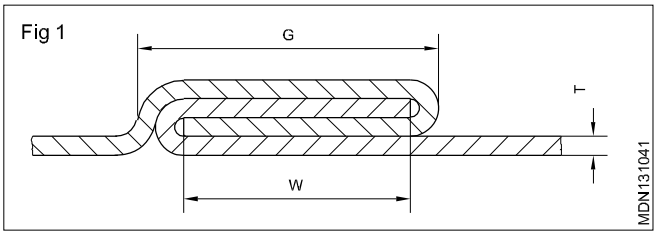
Allowances

In the making of various types of hems and seams, no allowance is necessary for thinner sheets of 0.4 mm or less.

Allowance for grooved joints/seams (Fig. 1)

If we fold over the edges to width W and form the joint, the final completed width of the joint G will be greater than W. It can be seen that the final width of the groove will have a minimum value of W + 3T, where T represents the metal thickness.

Fig 1

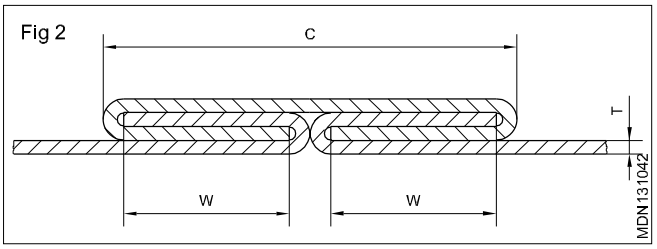


The allowance for a grooved seam is three times the thickness of the sheet.

Allowance for double grooved seam/joint (Fig. 2)

It will be seen from the figure that the width of the capping strip is equivalent to two times the width of the folded edge plus four times the thickness of the metal size.

Fig 2



C = 4W + 4T

The complete allowance for the double grooved seam/joint will be four times the width of the folded edge plus four times the thickness of the metal.

Allowance for paned down and knocked-up joints (Figs 3 & 4)

The size of paned down and knocked-up joints is determined by the width of the single folded edge.

'P' represents the size of the paned down joint and 'K' represents the size of the knocked-up joint.

P = 2W + 2T

K = 2W + 3T

Fig 3

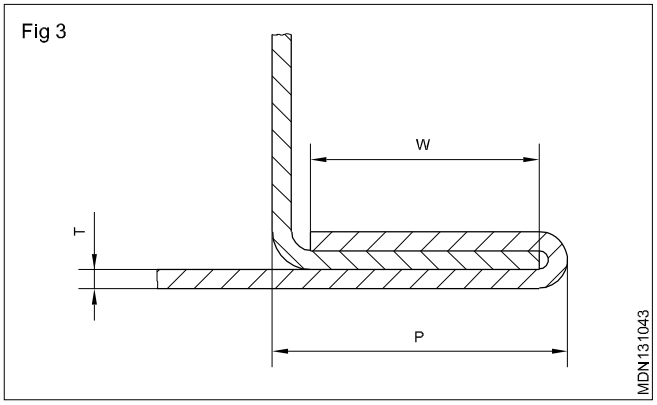
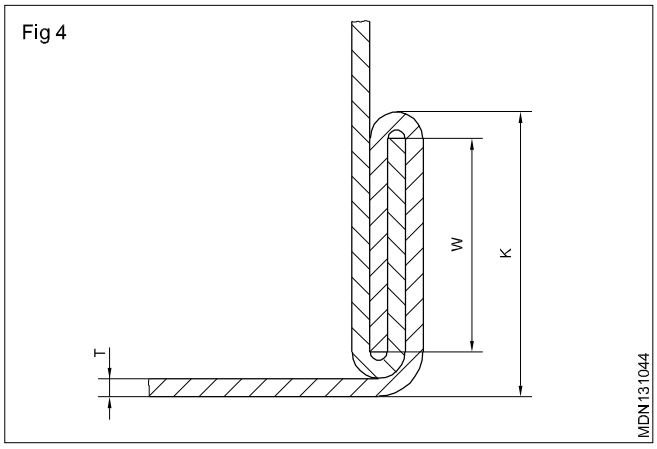


Fig 4



Groovers

Objectives : At the end of this lesson you shall be able to
- **state what is a groover**
- **state the sizes of groovers**
- **state the uses and application of groovers.**

Any seam in sheet metal should be locked or closed properly for effective functioning. Otherwise the joint will be a failure.

What is a groover?

A groover is a hand tool used for closing and locking of seams in sheet metal work.

The end of the tool is recessed to fit over the lock making the grooved seams.

Sizes (Figs 1 & 2)

Groovers are available in various sizes viz.3mm, 4mm, 5mm etc.

Generally a groover 1.5 mm wider than the width of the fold is used.

For thicker materials, a groover 3 mm larger than the width of the fold is used.

The width of the groove is stamped on the tool body.

Fig 1

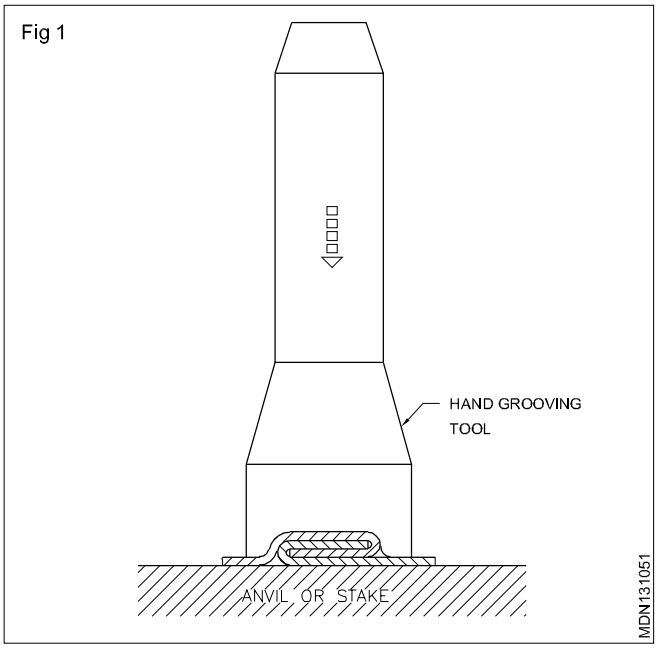
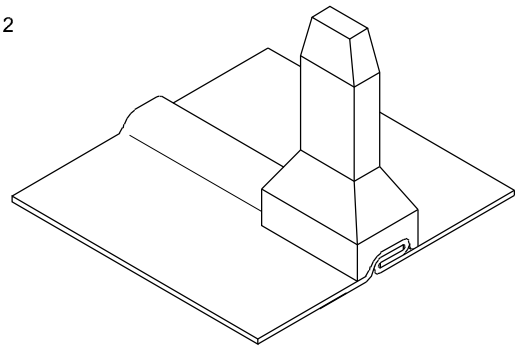


Fig 2



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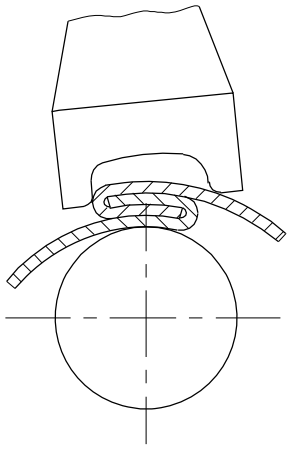
Closing and locking (Figs 3, 4 & 5)

Fig 3



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First the joint is held in position and then it is closed with a mallet.

Then the groover is placed over the closed end of the joint. The groover is positioned at a very slight angle. The edge of the joint acts as a guide to the groover position.

The grooving operations are repeated for the other end of the joint.

The joint is locked working along the joint in stages.

The seam is tightened using a mallet or a light planishing hammer.

Failure to lock the joints in stages with the end of the groover will result in bite marks along the joint.

Using too small groover will mark the metal and prevent locking.

Fig 4

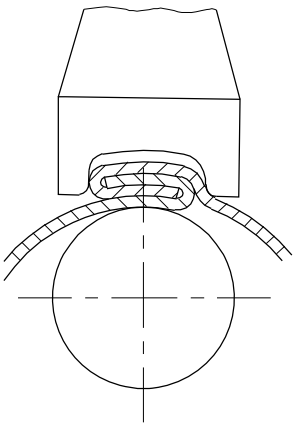

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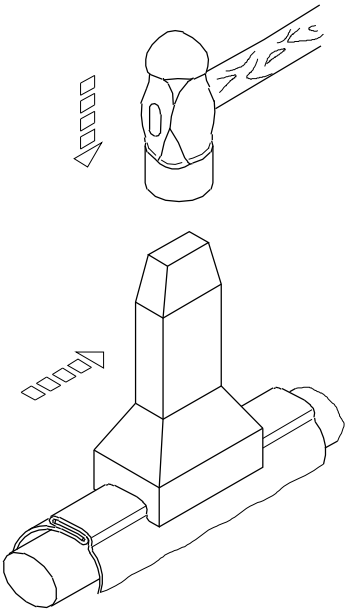
Fig 5



MDN131055

Standard wire gauge

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

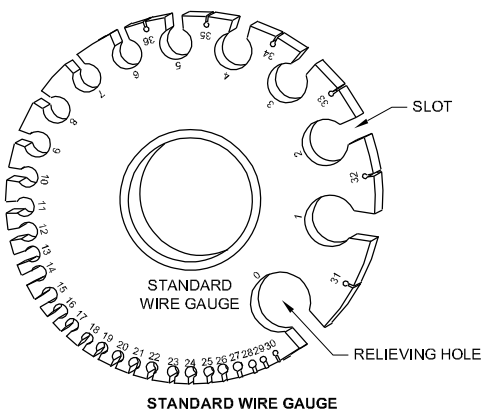
- **state the use of the standard wire gauge**
- **state some important hints in using standard wire gauge**
- **state the metal thickness in mm for the given gauge numbers.**

The job drawing indicates only gauge or thickness of the meet to be used. Before starting the work identify the correct thickness of the sheet. The thickness of the sheet is measured with the help of the standard wire gauge.

The gauge consist of a disc shape smoothened steel metal piece with numerous slots around the outside edge. These slots are of various width and correspond to certain gauge number (Fig.1)

Gauge number is stamped on one side of each slot and on the other side, the decimal part of an inch is stamped to show the thickness of the sheet and the diameter of the wire.

Fig 1



STANDARD WIRE GAUGE

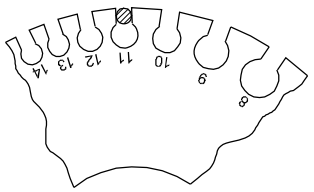
MDN1310611

Thickness of the sheet is checked by inserting the edge of the sheet in the appropriate slot of the standard wire gauge.

Wire diameter is checked by inserting the wire only in the slot, and not in the circle (Fig.2)

Higher the SWG gauge number lessen the thickness of the sheet.

Fig 2



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Following is the table showing the thickness in inch and mm corresponding to the gauge No.

Table for G.No.to inches and mm

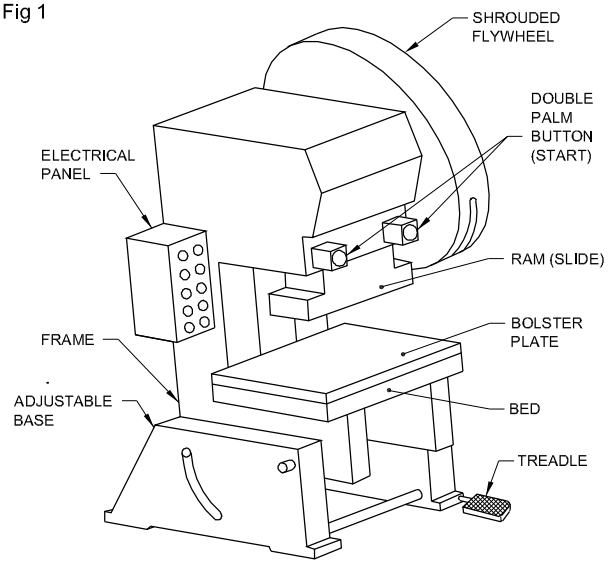
No. of the gauge	Approx. Th. in inch	Approx. Th. in mm	No. of the gauge	Approx. Th in inch	Approx Th. in mm
00	.3437	8.729	18	0.480	1.257
0	.3125	7.937	19	.0418	1.118
1	.2812	7.142	20	0.359	0.996
2	.2656	6.846	21	0.329	.886
3	.2391	5.895	22	.0299	.794
4	.2321	5.895	23	.0269	.707
5	.2092	5.312	24	.0230	.629
6	.1943	4.935	25	.0179	.498
7	.1793	4.770	26	.0179	.498
8	.1644	3.988	27	.0164	.443
9	.1495	3.551	28	.0149	.396
10	.1280	3.175	29	.0135	.353
11	.1196	2.827	30	.0120	.315
12	.1046	2.517	31	.0109	.276
13	.0897	2.240	32	.0101	.256
14	.0747	1.994	33	.0093	.236
15	.0673	1.775	34	.0085	.251
16	.0640	1.587	35	.0073	.185
17	.0538	1.412	36	.0070	.177

Sheet metal shearing, drawing, squeezing .

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of the power press**
- **name the different types of power presses**
- **state and explain the different operations that can be performed on the power press**
- **state the safety precautions while working in the press shop.**

The constructional feature of the power press is almost similar to that of a fly press or hand press. (Fig 1) Except that the ram is driven by power. The power presses may be identified as Mechanical or Hydraulic, according to the type of working mechanism used to transmit power to the ram. In a mechanical press, the rotary motion of the electric motor is converted into a reciprocating motion of the ram by using various mechanical devices. In a hydraulic press, the fluid under high pressure is pumped on one side of the piston and then to the other side in a hydraulic cylinder to drive the reciprocating movement. The power presses are designated according to the power sources, Frame construction, Number of slides in action.

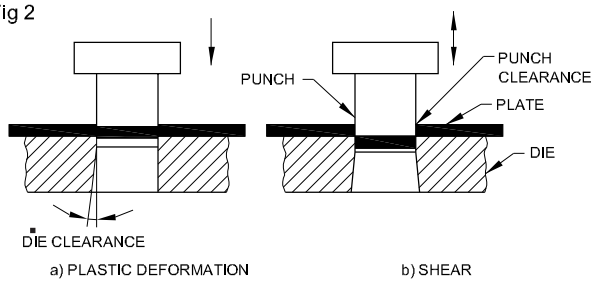
Fig 1



POWER PRESS

Power press operations (Fig 2)**:** The press operations are classified based on the operations performed.

Fig 2

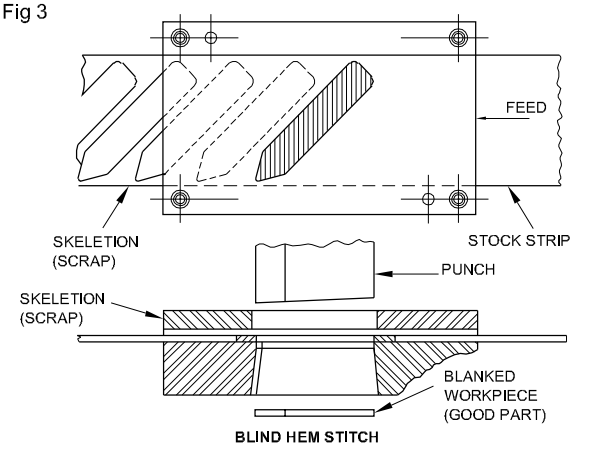


SHEARING OPERATION

Shearing : Shearing is an operation of cutting sheet metal with the help of a punch and die on a power press. The sheet is placed on the die and when the punch descends on the metal, it causes a rupture and forces the metal to be severed and ram the sheet metal. As the clearance between the punch and die is very small it forces the metal to drop down from the die opening.

a) Blanking (Fig 3)**:** Blanking is an operation of producing a flat component from a strip of sheet metal. The metal cutout is the required component and the sheet with the cut on the die is the scrap. In blanking, the size of the blank is governed by the size of the die and the clearance is left on the punch.

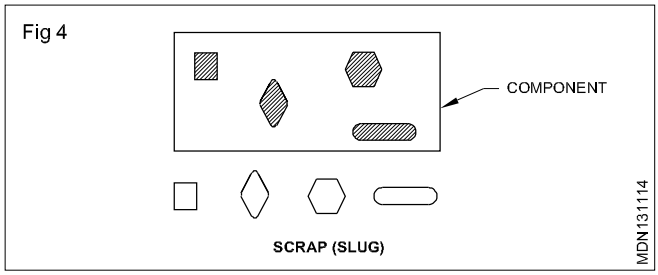
Fig 3



BLIND HEM STITCH

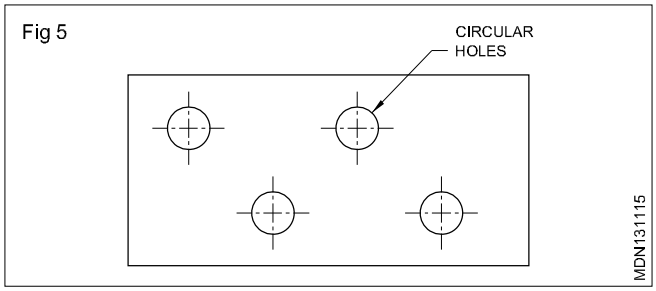
b) Piercing (Fig 4)**:** Piercing is an operation of making a cutout on a component. The cutout can be of any shape. The material punched out which comes out of the die is the scrap and the metal with the cutout which is on the die is the component. The punch governs the size of the cutout and the clearances is provided on the die.

Fig 4



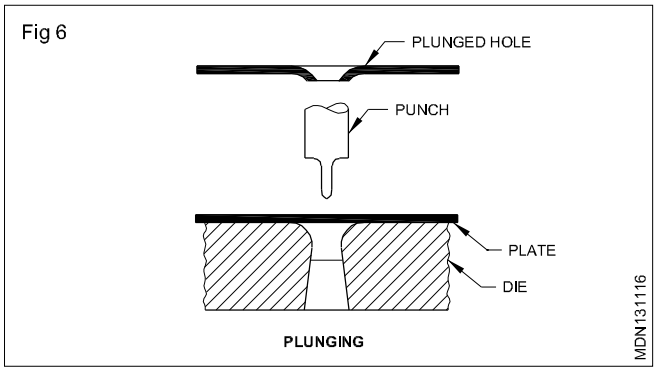
c) Punching (Fig 5)**:** Punching is an operation of punching out circular holes. The difference between punching and piercing is that this cutout made by piercing can be of any shape. But in punching only circular holes are made. The size of the hole is governed by the size of the punch and the clearance is provided on the die. (Fig. 4)

Fig 5



d) Perforating (Fig. 6)**:** Perforating is an operation of punching circular holes in a regular pattern or evenly spaced. Metal this is done by dimpling operation where the metal will be punched and a dimpling tool will be kept at the extreme of the hole and using a hammer the forming will be completed to accommodate the heads of countersunk screws and countersunk rivets.

Fig 6



PLUNGING

Drawing: Drawing is the operation of producing cup shaped articles from flat sheet metal blanks. The blank is placed on the die and while the punch comes down, the pressure pad holds the blank firmly on the die. As the punch further comes down the metal blank is pushed into the die opening and the metal is made to flow down the die plastically to form the sides of the cup. The pressure pad avoids the formation of wrinkles developed while forming. The size of the blank required to draw out a cup can be calculated by the formula given below.

D = O d2 +4dh

Where D = The diameter of the blank

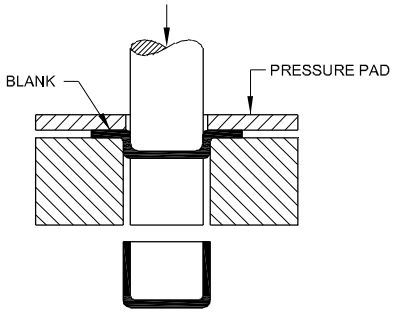
d = The diameter of the cup

h = The height of the cup

a) Cupping (Fig. 7)**:** Cupping is the operation of forming cup shaped articles by drawing operation.

Squeezing: Squeezing operation is the most sever of all cold press operations. More pressure is required to squeeze the metal into the cavity of the die and punch to get the required shape. Hydraulic presses are most suited for this operation.

Fig 7

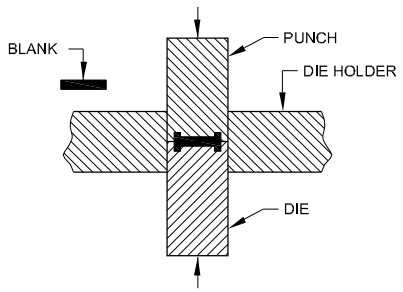


DRAWING OPERATION

b) Coining (Fig. 8)**:** Coining is the operation of producing coins, medals or other ornamental work. The metal having good plasticity and correct size is places into the tool and pressure is applied on the tool form both ends.

Compressive load the metal flows under severe and fills into the cavity of the punch and die. The component gets sharp impression on both sides according to the engravings on the punch and die.

Fig 8

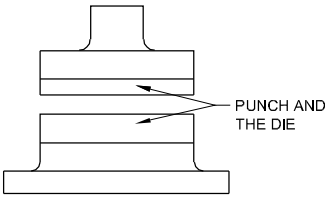


COINING

c) Embossing: Embossing is the operation of forming impressions of figures, letters or designs on sheet metal. The punch or the die or both of them may have the design engraved on them which are formed on the sheet metal by squeezing and with the plastic flow of metal.

Flattening or Planishing (Fig. 9)**:** Flattening or Planishing is the operatioin of straightening the curved or bent sheet metal parts, on a press using a planishing tool.

Fig 9



PLANISHING PUNCH AND DIE SET UP

Bending Sheet Metal

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

- **state what is a bend radius**
- **state the need for a bend radius**
- **state what is a spring back**
- **state the factors governing spring back.**

Bending sheet metal neutral line (Figs 1, 2 & 3)

Fig 1

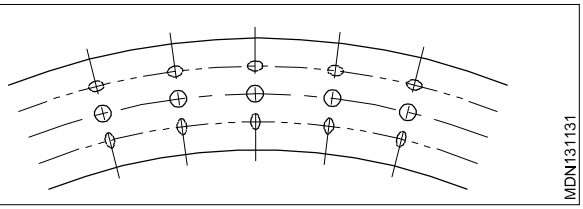


Fig 2

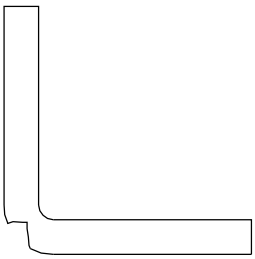
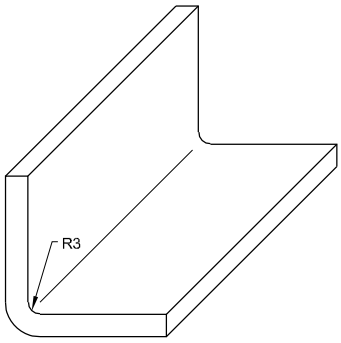


Fig 3



When a sheet metal is bent the plane (or line) Where neither extension nor contracton occurs but only a bend takes place, is called the neutral plane (or line).

While performing a bend, if the inside of the sheet is not rounded, the outside of the sheet will be much pulled. In order to avoid it, the sheet is often bent after providing the radius as shown in the (Fig 3).

The radius of the roundness is called the bend radius.

Least bend radius

The radius of the least roundness with which the sheet can be bent without occurances of a crack in the outside of the bend is called the least bend radius.

The least bend radius varies depending on the :

- material
- thickness
- direction of the plate
- working temperatures. etc.

Table 1 gives the least bend radius generally used.

Where the material is soft and the bend line is at right angle to the rolling direction of the sheet, a small value is used, and where the metal is hard and the bend line is parallel with the rolling direction, a higher value is used.

Table 1

Least bend radius

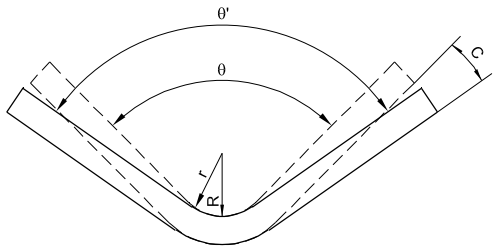
Material	Least bend radius R
Cold rolled steel plate	t x (0 - 0.5)
Semi-hard steel plate	t x (0.3 - 1.5)
(C 0.35 - 0.40%)	
Sheet of copper group	t x (0 - 2.0)
Brass/Aluminium sheet	t x (0 - 1.0)
Soft Aluminium	t x (1.0 - 2.5)
Duralumin	t x (2.0 - 4.0)

Plate thickness

What is spring back (Fig. 4)

When a sheet of steel is bent, if the bending force is removed, a part of the elastic deformation returns to the original state of the material before deformation. This phenomenon is called spring back.

Fig 4



Factors governing spring back

The spring back varies depending on the :

- material
- thikness of the sheet
- system of working
- bend radius
- bending pressure, etc.

It is difficult to calculate the accurate degree of spring back. When the job is actually performed, the sheetis experimentally bent and the pressure adjusted so that an accurate bend angle can be made after allowing for the spring back.

Manual Bending

Objectives : At the end of this lesson you shall be able to
- **state the function of the folding bar**
- **state the method of bending a sheet over the hatchet stake**
- **define a hand seamer and its function**
- **state the method of bending by a fly press.**

Folding bars (Fig 1 & 2)

The sheet metal to be bent is clamped in the folding bar. The folding line coincides with the top of the folding bar. The folding bar clamped in the vice as shown in the figure. While tightening the vice, pull the projecting part of the folding bar towards yourself to prevent the sheet from dropping from the bars, in most cases a wooden or rubber mallet is used for bending at right angles with bending bar.

Fig 1

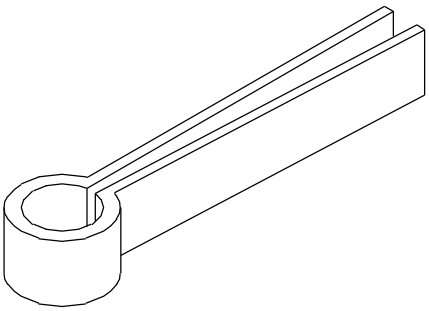
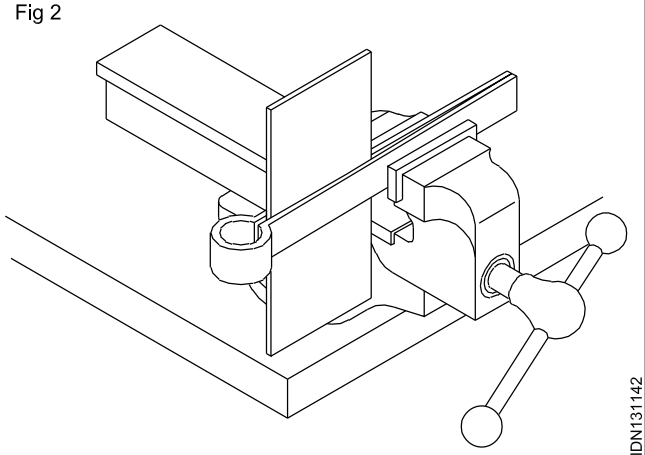


Fig 2



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Bending over hatchet stake (Fig 3 & 4)

The folding line is to coincide with the edge of the stake, and the sheet pressed with both the hands and hammered for the required bend.

Fig 3

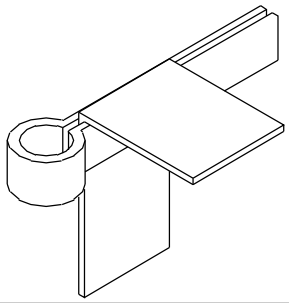

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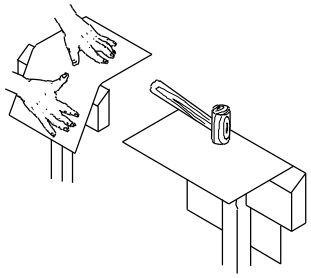
Fig 4



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Another method of bending is shown in the figure. The work is clamped to the edge of the bench by means of a piece of hardwood and two `C' clamps (Fig. 5). Then the projecting parts of the plate can be folded downwards.

If folding bars are not available, two pieces of angle iron (Fig. 6) can be used. The ends are clamped together by means of a `C' clamp.

For bending narrow edges (Fig. 7) on small pieces of sheet, for eg. if seams must be folded, a hand seamer can be used.

Fig 5

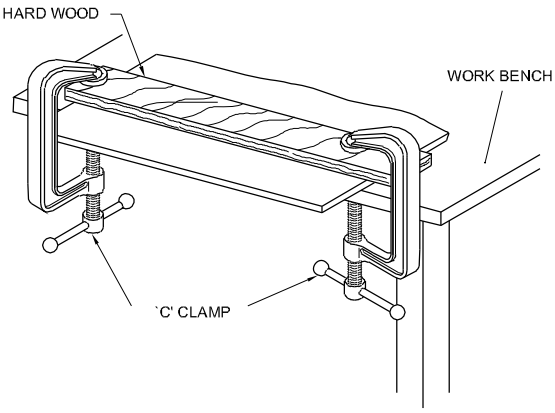

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Fig 6

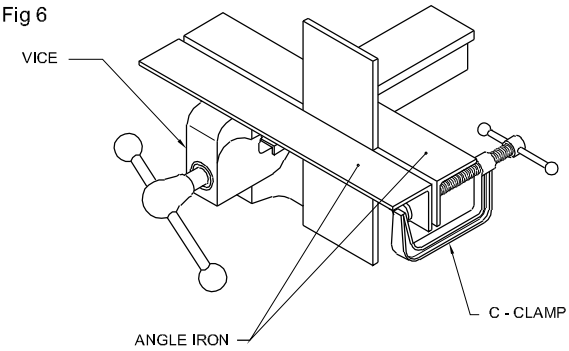

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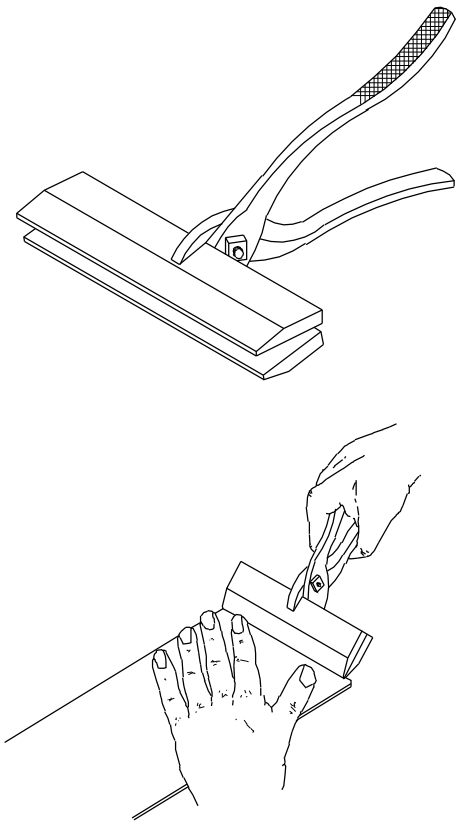
Fig 7



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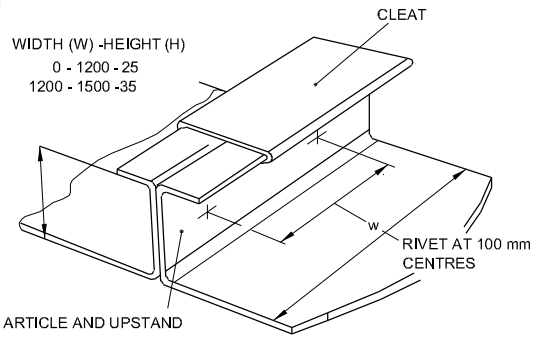
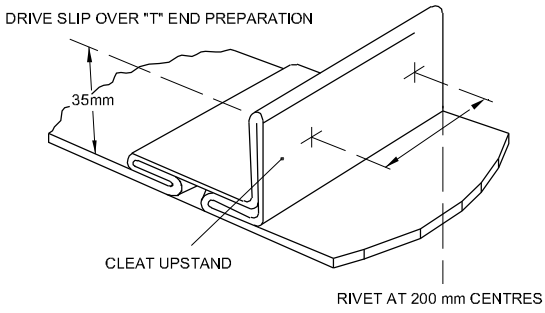
Bending metals to an angle

Objectives : At the end of this lesson you shall be able to
- **state the methods of bending rods and pipes in a bench vice**
- **state the methods of bending rods and pipes with a fixture.**

Bending is a process of shaping materials without cutting.(Fig.1)

Fig 1





STANDING DRIVE SLIP JOINT DESIGN VARIATION

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Different methods are used for bending rods, sheets and pipes.

Bending on vice

Work is held in the vice and bent with hand force or with a hammer according to the diameter of the rod or the thickness of the sheet. (Fig. 2) A hammering block (Fig 3 and 4) is used to prevent hammer marks and also to direct the force at the correct place.

Fig 2

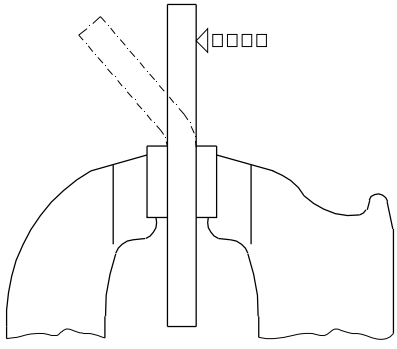

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Fig 3

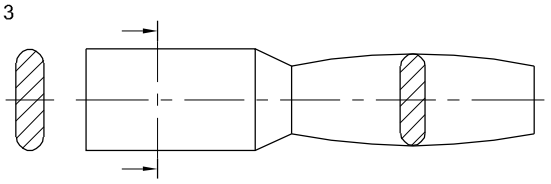

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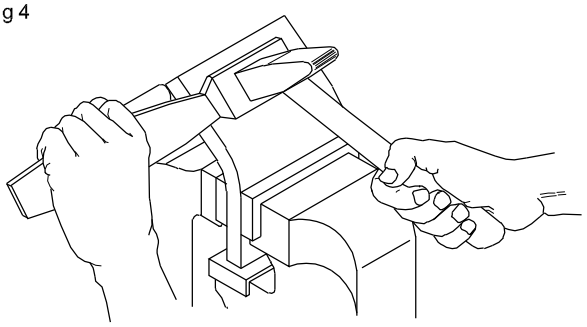
Fig 4



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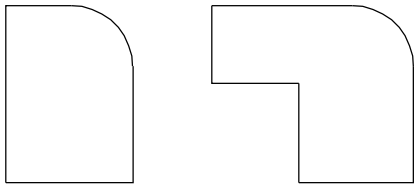
Bending using bending jaw or bending block

To form bends to a required radius on workpieces, bending jaws or bending blocks are used (Figs 5 and 6)

Fig 5



FORMERS

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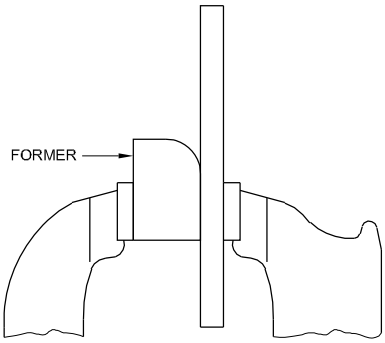
Fig 6



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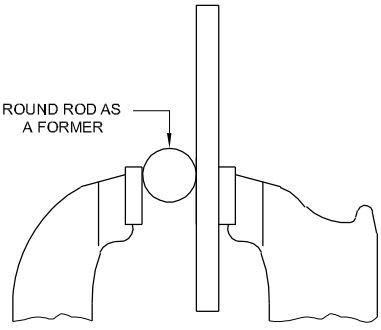
Round rods are also used sometimes for forming radius on sheets or rods (Fig 7)

Fig 7



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Bending with fixtures (Figs 8, 9 & 10)

A bending fixture can be prepared and used when a large number of workpieces is required to be bent (Fig 8a and 8b)

Fig 8

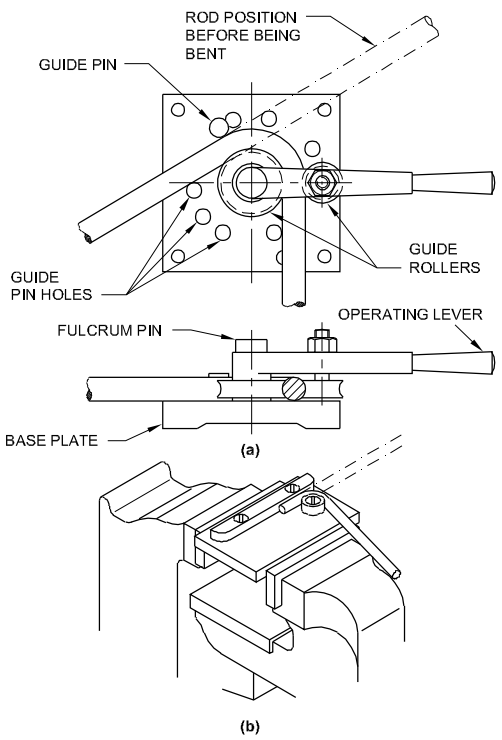
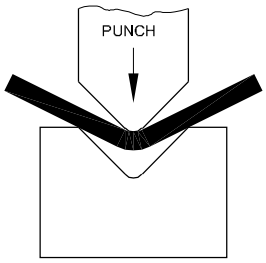


Fig 9



BENDING DIE

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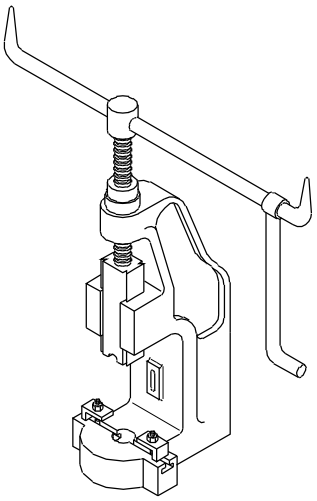
Fig 10



FLY PRESS

MDN13115A

Pipe bending machines

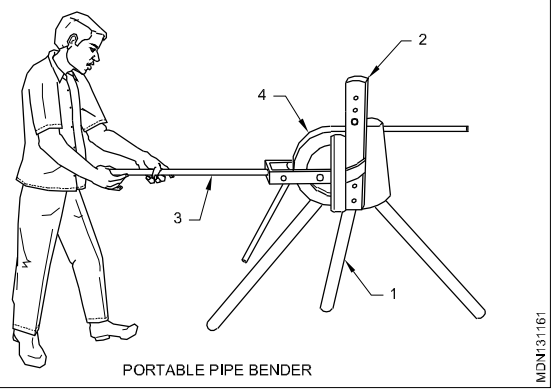
Objectives : At the end of this lesson you shall be able to
- **name the three most common pipe benders**
- **differentiate their constructional features**
- **name the parts of bending machines**
- **state the uses of bending machines.**

There are some situations in plumbing jobs, where it is preferable to bend a pipe rather than use a pipe fitting.

The most common pipe benders are listed here.

Portable hand operated pipe bending (Fig.1)

Fig 1



PORTABLE PIPE BENDER

The portable hand-operated pipe bender consists of the following parts.

1 Tripod stand

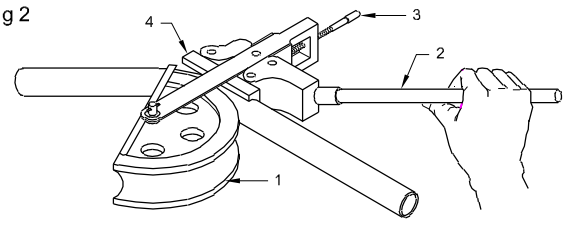
2 Pipe stop lever

3 Handle or lever

4 Inside former

Bench type hand operated pipe bender (Fig 2)

Fig 2



MANUAL PIPE BENDER

This consists of the following parts. It is used for bending galvanized iron and steel pipes.

1 Inner former

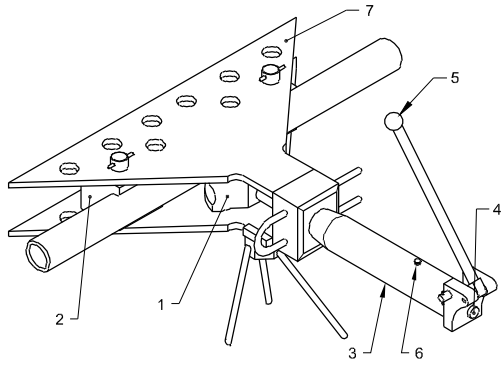
2 Lever or handle

3 Adjusting screw with lock nut

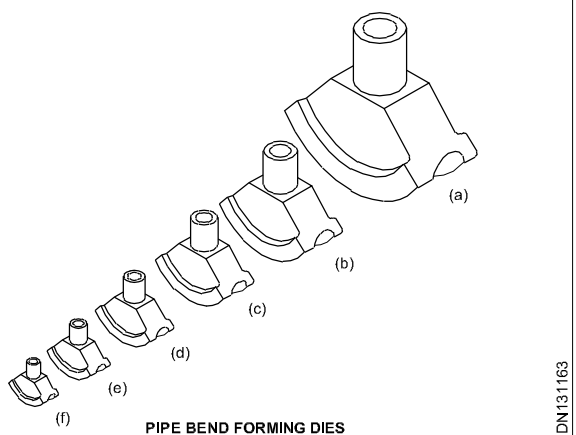
4 Pipe guide

Hydraulic bending machine (Fig 3)

Fig 3



HYDRAULIC PIPE BENDER



PIPE BEND FORMING DIES

This machine can be used bending G.I. and M.S. pipes without sand filling to any direction.

It consists of the following the parts.

1 Inner former

2 Back former

3 Hydraulic ram

4 Pressure release valve

5 Operating lever

6 Bleed screws

7 Base plate.

Inner formers are interchangeable and are able to bend pipes up to 75 mm diameters (Figs 3a, b, c, d, e & f)

Pipes and pipe fittings

Objectives : At the end of this lesson you shall be able to
- **state the uses of pipes**
- **name the common types of pipes**
- **list the standard pipe fittings and state their uses.**

Various types of pipes and tubes are used for the following purposes.

- Domestic hot and cold water supplies
- Waste water outlets
- High pressure steam supplies.
- Hydraulic oil supplies
- Lubricating oil supplies
- Special fluid and gases for industrial processes.
- Pneumatic systems
- Refrigeration systems
- Fuel oil supplies

The common types of pipes classified according to material are:

- galvanized iron pipes
- mild steel pipes
- C.I. soil pipes
- copper pipes
- aluminum pipes
- brass pipes
- lead pipes
- P.V.C. pipes
- rubber pipes
- plastic pipes
- stoneware pipes

Standard pipe fitting: Pipe fittings' are those fittings that may be attached to pipes in order to:

- change the direction of the pipe
- connect a branch with a main water supply pipe
- connect two or more pipes of different sizes
- close the pipe ends

Standard Pipe Fittings

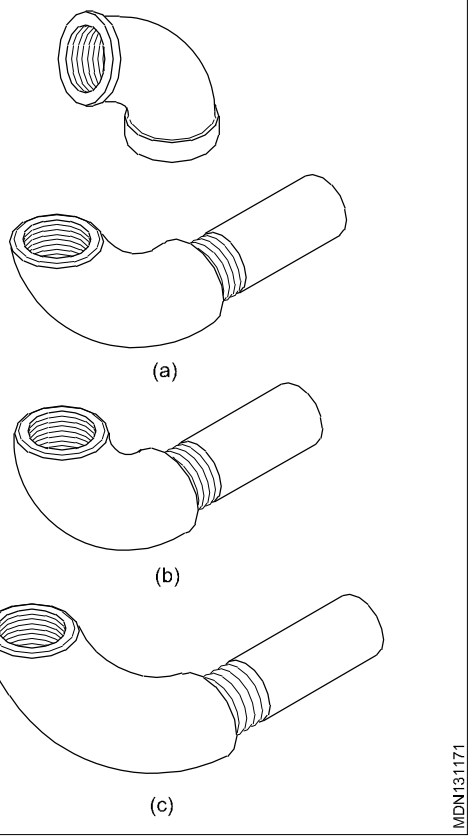
Elbows (Fig 1**):** Elbows and bends provide deviations of 90 and 45o in pipe work systems.

Long radius elbows have a radius equal to 1 1/2 times the bore of the pipe (Fig 1a)

Short radius elbows have a radius equal to the bore of the pipe. (Fig 1b)

The 45° elbows allow pipe deviation of 45° (Fig 1c)

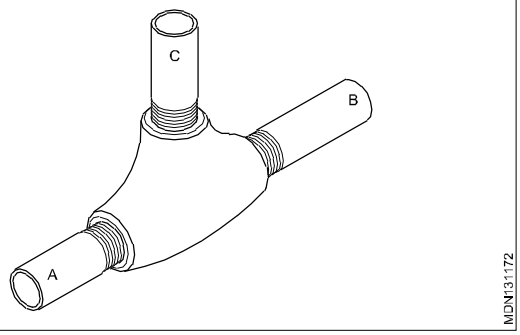
Fig 1



Tee branch: A tee joint helps the pipe line to branch off at 90°. The branches may be equal in diameter or there may be one reducing branch.

Dimensions of a branch are always quoted as A x B x (Fig 2)

Fig 2



Reducing tee branch : Reducers are fitted where a change in pipe diameter is required (Fig 3)

Eccentric reducer : Used mainly in horizontal position (Fig 4)

Fig 3

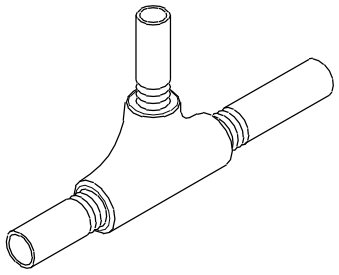


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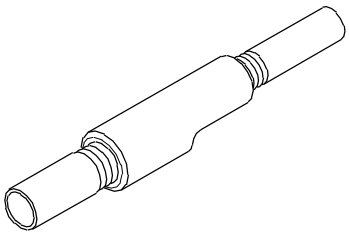
Fig 4



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Concentric reducer : Used mainly in vertical position (Fig5)

Caps: Caps are used for closing the end of a pipe or fitting which has an external thread. (Fig 6)

Plug: A plug is used for closing a pipeline which has an internal thread (Fig 7)

Fig 5

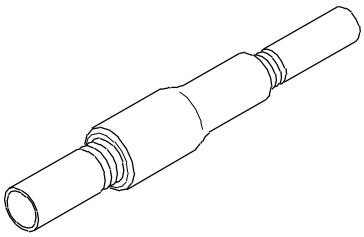

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Fig 6

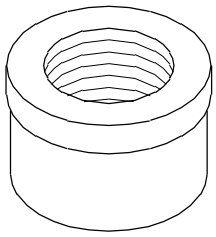

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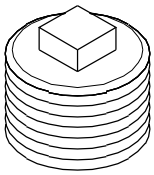
Fig 7



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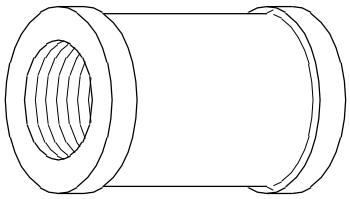
Coupling: (Fig 8) A coupling is used to connect two pipes. Couplings have internal threads at both ends of fit the external threads on pipes.

Fig 8



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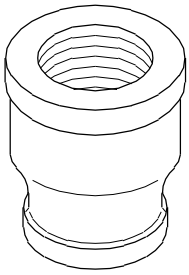
Reducer (Fig 9)**:** A reducer coupling is used to connect two pipes with different diameters.

Fig 9



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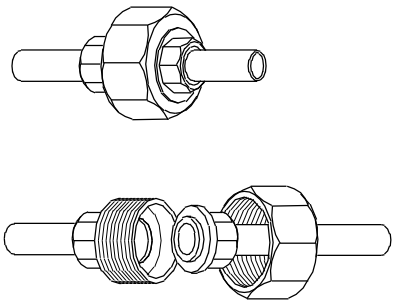
Union : A device used to connect pipes. Unions are inserted in a pipe line to permit connections with little change to the position of the pipe. (Fig10)

When unions are used in pipe lines, it is easy to dismantle and repair.

Pipe nipples (Figs 11, 12, 13 & 14)**:** Pipe nipples are tubular pipe fittings used to connect two or more pipes of different sizes

Fig 10



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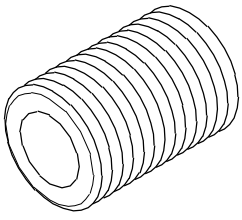
Close nipple (Fig 11)

Fig 11



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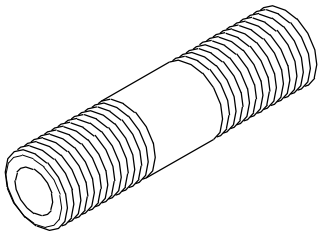
Short nipple (Fig 12)

Fig 12



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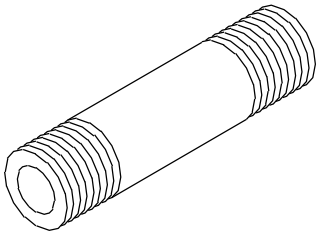
Long nipple (Fig 13)

Fig 13



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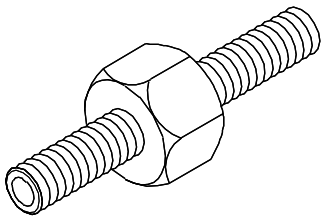
The hexagonal nut (Fig 14)**:** The hexagonal nut in the centre of the nipple is for tightening with a spanner or wrench (Fig 14)

Fig 14



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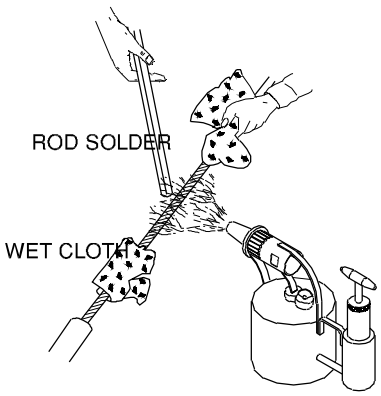
Blow lamp

Objectives : At the end of this lesson you shall be able to
- **state the constructional feature of blow lamp**
- **name the parts of blow lamp**
- **describe the operation of blow lamp.**

Blow lamp (Fig 1)**:** the kerosene is pressurized to pass through pre-heated tubes, thus becoming vaporised. The kerosene vapour continues through a jet to mix with a air and when ignited directed through a nozzle, producing a forceful flame.

Fig 1



SOLDERING WITH BLOWLAMP

The flame within the housing provides the heat to maintain vaporisation of the kerosene. The free flame at the nozzle outlet is used to heat the soldering bit.

Blow lamp is a portable heating appliance used as a direct source of heat for soldering irons or other parts to be soldered. Fig.1 shows parts of blow lamp.

It has an tank made of brass, filler cap is fitted at its top to fill kerosene. A pressure relief valve is connected to the mouth to switch ON/OFF and control the flame.

Priming trough is provided for filling mentholated spirit for lighting the blow lamp. Set of nozzle is provided to direct the kerosene vapor to produce forceful flame. Burner housing is mounted on support brackets on which soldering iron is placed for heating as shown in figure.

Pump is provided to pressurise the kerosene in the tank.

Flux

Objectives : At the end of this lesson you shall be able to
- **state the criteria for the selection of fluxes**
- **distinguish between corrosive and non-corrosive fluxes**
- **name the different types of flux and their application.**

Fluxes are non-metallic materials which are used at the time of soldering.

Functions of flux

- Flux removes oxides from the soldering surface.
- It prevents corrosion.
- It helps molten solder to flow easily in the required place.
- It promotes the wet surface.

Selection of flux

The following criteria are important for selecting a flux.

- Working temperature of the solder
- soldering process
- materials to be joined

Classes of flux

Flux can be classified into corrosive flux, and non corrosive flux

Corrosive flux in acid form is corrosive and should be washed immediately after the soldering operation is completed.

Non-corrosive flux is in the form of lump, powder, paste or liquid.

DIFFERENT TYPES OF FLUX

Hydrochloric acid

Concentrated hydrochloric acid is a liquid which fumes when it comes into contact with air. After mixing with water, 2 or 3 times the quantity of the acid, it is used as dilute hydrochloric acid.

Hydrochloric acid combines with zinc forming zinc chloride and acts as a flux. So it cannot be used as a flux for sheet metals other than zinc, iron or galvanised sheets.

Zinc chloride

It is mainly used for soldering copper sheets, brass sheets and tin plates.

As it is extremely corrosive, the flux must be perfectly washed off after soldering.

Ammonium chloride

This is the form of powder or lump. It evaporates when heated.

Ammonium chloride is used as a flux for soldering steel.

A solution of a mixture of hydrogen chloride, zinc chloride and ammonium chloride is used as a flux for stainless steel sheets.

Resin

As resin is not very effective for removing oxidation coating, and, as it is not highly corrosive, it is used as flux for copper and brass. Resin melts at about 80° to 100°C.

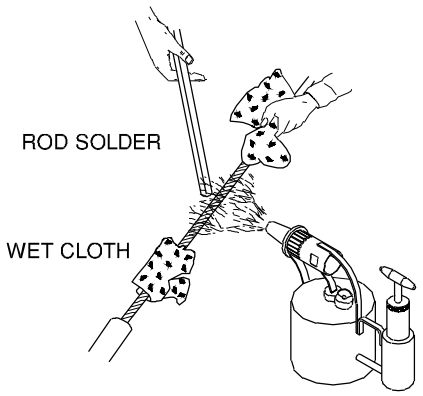
Paste

This is a mixture of Zinc chloride, resin, glycerin and others and is available as a paste.

As it is effective for removing oxidation coating, it is used for soldering small handworks and radio wiring.

Soldering with blowlamp

Fig 1



SOLDERING WITH BLOWLAMP

MDN131221

Soldering with a blowlamp is done when the heat capacity of a soldering iron is not sufficient.

The method, shown in Fig 1, permits rapid heating and is used primarily for larger jobs, such as piping and cable work, vehicle, body repairs and some applications in the building trade.

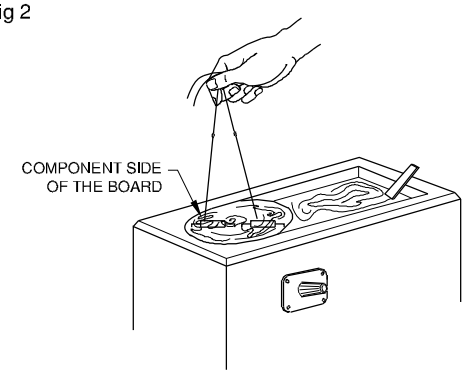
This requires skillful management of the flame.

Dip soldering

This method, shown in Fig 2, is used for bulk production and for tinning work similar to component soldering on printed Circuit Boards (PCB). Components to be soldered or tinned are dipped into a bath of molten solder, which is heated electrically. The solder is kept in motion by an agitator in order to obtain an even temperature and to keep the surface free from oxides. If no agitator is provided, the surface must be protected or skimmed at regular intervals to remove the oxides.

The temperature can be controlled very accurately.

Fig 2



DIP SOLDERING

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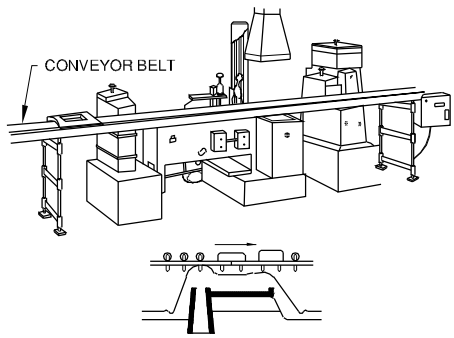
Machine soldering

The method, shown in Fig 3, is used for quantity production and is based on the principle, when molten solder is set in rapid motion, the oxide film breaks without setting on the surface. The solder comes into direct contact with the components to be soldered.

Fig 3



MACHINE SOLDERING

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Soldering machines are of different designs for wave soldering, cascade soldering and jet soldering.

Equipment for machine soldering is expensive and the cost of production is high.

Accurate temperature control can be arranged.

Brazing Techniques

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

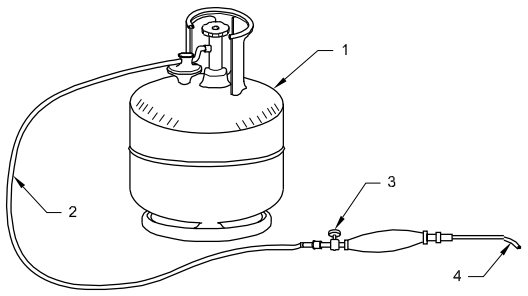
- **explain the brazing technique**
- **Study copper to copper pipe brazing swaged joint**
- **Studies braze copper with MS tube**

Brazing techniques

Acetylene torch (Fig 1): (Danger: Acetylene is very inflammable, Do not allow anyone to smoke while you are brazing)

- Connect the torch with a flexible hose to the gas regulating valve of the acetylene cylinder; make sure that all of the connections are tight to prevent gas leakage. Check all connections for leaks with soap water before lighting the torch.

Fig 1



ACETYLENE TORCH

MDN131231

- Open the cylinder valve one turn, only. Open the regulating valve fully. Open the torch control valve just enough to give a flow of gas. Light the escaping gas at the tip of the torch.
- Adjust the torch control valve to get the correct flame. The flame should be blue. It should have a sharp bright cone in the middle with pale outer flame. If the flame is yellow more gas is required. open the control valve.
- The size of the torch tip or nozzle determines the size of the inner cone. use a cone size that gives the required amount of heat.

Propane turbo torch (Fig 2): (Danger: Propane is very inflammable. Do not allow anyone to smoke while you are brazing)

- This gives a smaller outside flame. The tip of the inner cone is much hotter than an acetylene flame of the same size. Always work with a smaller flame than acetylene.
- Connect, adjust and use this torch in the same way as acetylene described above, check all connections for gas leaks with soap water before lighting the torch.
- Follow exactly the instruction supplied with the torch.

1 This is the cylinder that holds the gas for brazing

2 Check the connections for leaks at each end of this hose with soap water.

3 Use the torch control valve to control the gas flow.

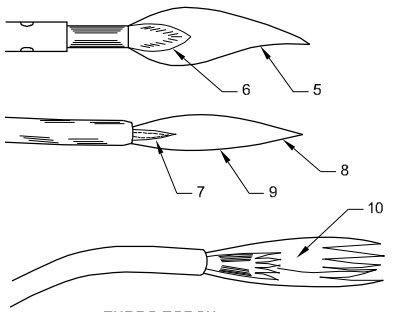
4 Fit a torch tip which gives the correct flame.

5 This is an acetylene flame suitable for pipe brazing

6 The bright cone is the hottest part of the flame work with the tip of the cone.

7 The high bright cone is the hottest part of the flame with the tip of the cone

Fig 2



TURBO TORCH

MDN131232

8 This is an acetylene flame suitable for capillary tube brazing required.

9 The other flame should be pale yellow. If it is yellow,

10 This is a propone turbo torch flame. The end tractions will tell you what size of flame of use.

Kerosene blow lamp

- This gives a larger flame than a propane or acetylene torch.
- When lighting, follow carefully the instructions supplied with the torch. Wherever possible light the blow lamp in an open space for safety.

Silver brazing: One of the best method of connection copper pipes after swaging or by the use of coupling, in a leak proof manner is by silver brazing,. By this method the copper pipes can be connected to the compressor, service valves and the other parts also.

Silver brazing can be easily done if the correct procedure is followed.

Clean the inside and outside of the tube end using sand paper of wire brush. Fit the joint closely and support the joint. Apply flux required for the brazing rod. (Flux is used to prevent chemical action during heating the metal. The flux used for soldering refrigeration fittings is made of alcohol and resin.

There are various silver alloys in the market. The rod used to join copper pipes is called copper to copper brazing rod'. These have 35 to 45 percent silver content. This material melts at 1120°F and flows 1145°F

Precautions: Do not apply the solder at the joint if it is not red hot

Any oxy-acetylene torch is excellent heat source for silver brazing. While using blow lamp the joint is to be heated longer time.

To join copper pipe to steel pipe and any pipe to the compressor dome only oxy acetylene torch can be used. This torch can also used for refrigerator cabinet patch work.

While brazing keep away the flame from rubber plastic parts and insulating materials of the refrigerator or AC.

The pipes joined by brazing can be separated by heating it again.

Flux: Flux is a substance which works as an agent help the solder to flow easily. It cleans the surface and prevents oxidation. Melting point of flux is much less than that of solder.

Various types of flux and their uses are given below.

Ammonium chloride NH_4Cl - For soldering cast iron

Hydrochloric acid HCL - For soldering G.I sheets

Zinc chloride $ZnCl_2$ - For soldering mild iron sheets

Tallow - For soldering lead and electrical joints

Resin - For soldering electrical joints

Phosphoric - For soldering stainless steel

Braze a copper tube with swaged joint

Fit two pipes to braze. If it is a loose fit the joint will be weak. Insert the end of one pipe into the swage of the other. Apply a small amount of flux to the surfaces to be joined, with the help of blow torch heat the joint. The brazing rod must be meted by the heat. Complete ring of brazing material can be seen at the end of the swage remove the torch and allow the joint to cool.

Braze copper with ms tube: In most tube and fitting connections are made by either soldering or silver brazing. Soldering joints are used for water pipes and drains. silver brazed joint are used for refrigerant pipes and rubbing.

The best methods of making leak proof connection while providing maximum strength is to silver braze the joints. These joints are very strong and will stand up under the most extreme temperature condition.

An oxyacetylene torch is an excellent heat source for silver brazing. The proper silver brazing temperature will be indicated by the colour of green shade.