Assembly techniquies

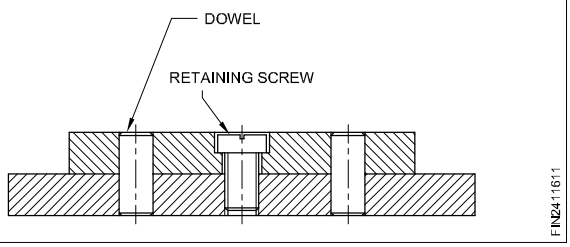
Objectives: At the end of this lesson you shall be able to
- **name the common techniques used for assembling components**
- **distinguish between the application of dowelling, pinning, staking, brazing and use of adhesives for assembling components.**

In machine shop assembly various methods are used for securing components together. A few of the common methods are:

- Dowelling
- Pinning
- Staking
- Brazing/Hard soldering
- Using of adhesives

Dowelling (Fig 1)

Fig 1



This is used for accurate positioning of two or more parts. This allows the parts to be separated and relocated in position. Different types of dowels are used depending on the type of assembly.

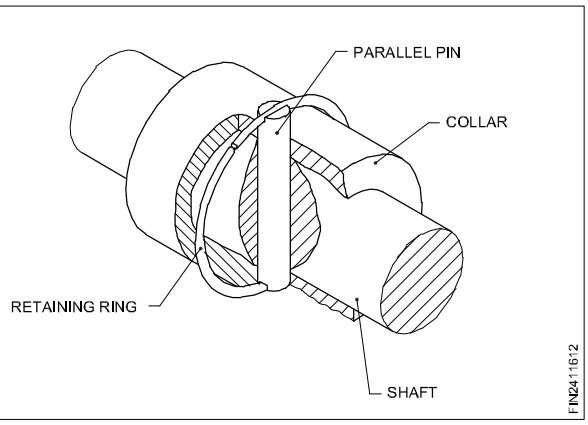
The components dowelled are always fixed with retaining screws in the assembly.

Pinning

This is also a method of locating and securing components together. Pins are of different types.

Parallel pins (Fig 2)

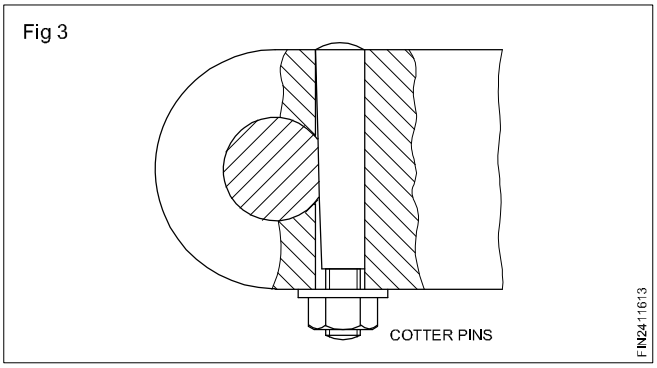
Fig 2



These are fitted like dowels in reamed holes and held in position by a retaining ring.

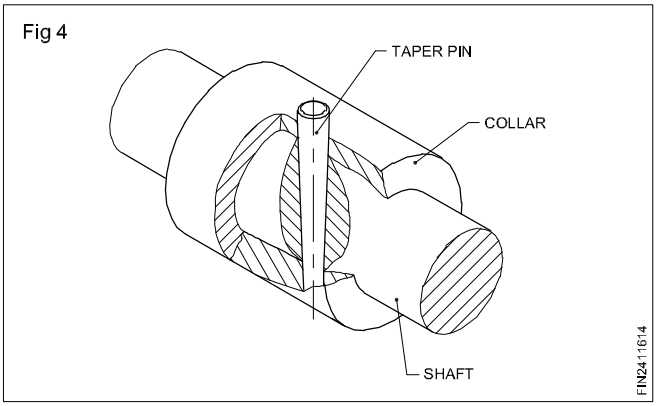
Cotter pins (Fig 3)

Fig 3



Taper pins (Fig 4)

Fig 4

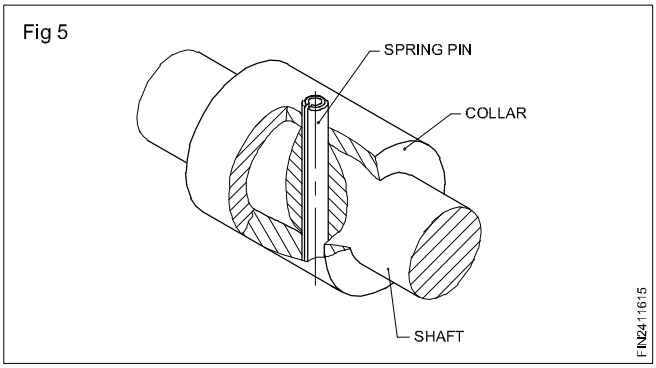


Taper pins will position parts accurately. The component can be dismantled easily and assembled without any change in location.

The holes for fitting taper pins are finished using taper pin reamers.

Spring pins (Fig 5)

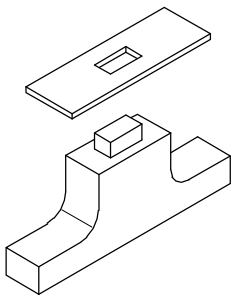
Fig 5



This eliminates the need for drilling and reaming of the assembly together. The spring pin adjusts itself in case of slight misalignment.

Peening (Fig 6)

Fig 6



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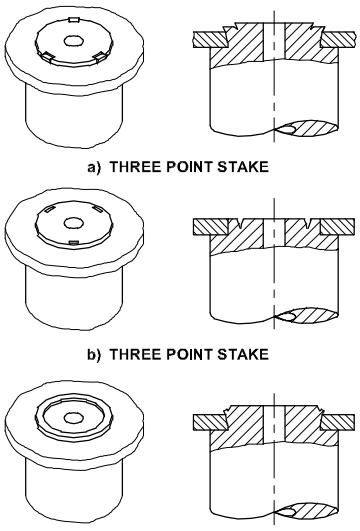
When parts are to be assembled together this is one method of assembly. Basically this is smimilar to reveting.

Staking (Figs 7a, b & c)

Fig 7



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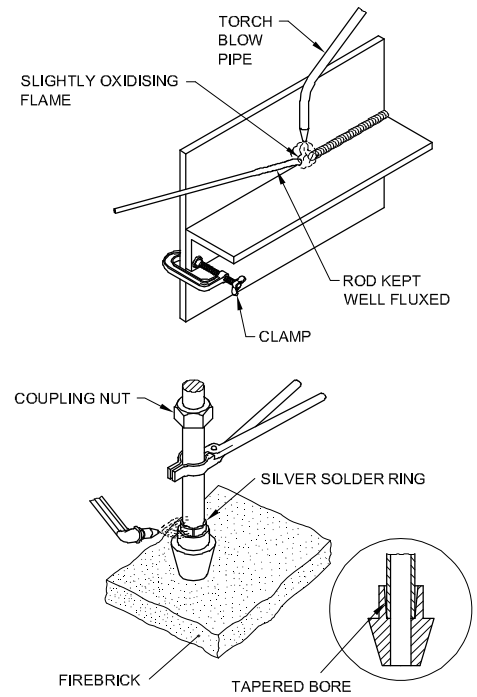
This is a method of retaining parts in an assembly in which a portion or all of a component is forced to flow on the other component. This increases the efficiency of the fit.

Brazing and hard soldering (Fig 8a & b)

This is a process of joining metals by using layer of non-ferrous metal between the surface to be joined.

The alloy used for brazing is known as spelter (combination of copper and zinc)

Fig 8



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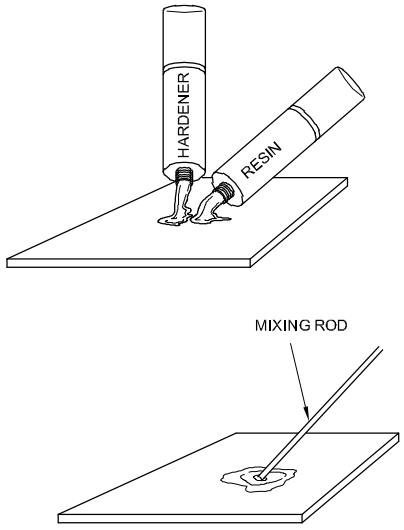
Adhesives (Fig 9)

The adhesives commonly used are epoxy adhesives. This adhesive gives a strong bond between materials to be assembled. This is not affected by moderate moisture or heat. It is usually supplied in two containers/tubes. One is resin and the other is the hardener.

Fig 9



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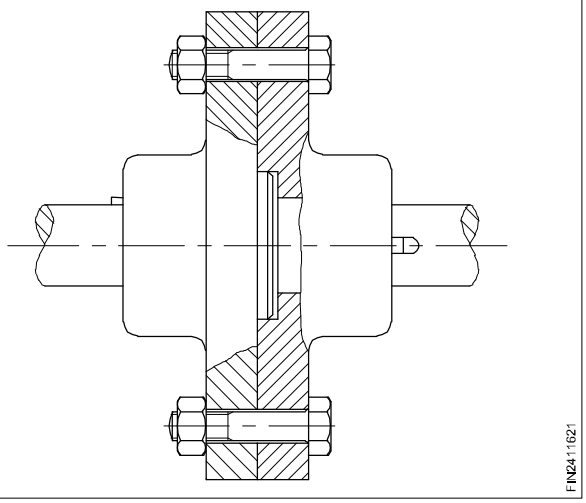
Threaded jointer

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**
- **identify 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)

Fig 1



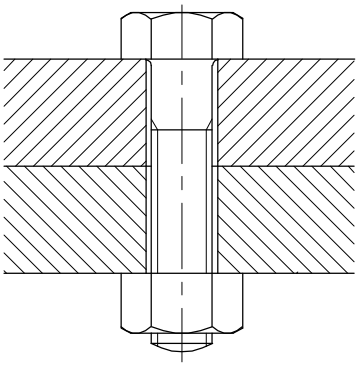
These are generally used to clamp two parts together.

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.

Bolts with clearance hole (Fig 2)

Fig 2

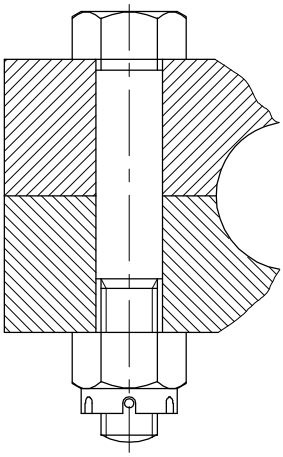


This is the most common type of fastening arrangement using bolts. The size of the hole is slightly larger than the bolt (clearance hole).

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

Body fit bolt (Fig 3)

Fig 3



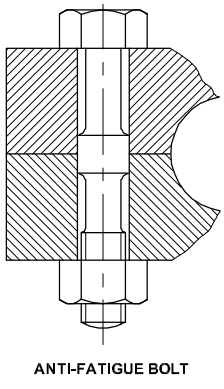
This type of bolt assembly is used when the relative movement between the workpieces has to be prevented.

The diameter of the threaded portion is slightly smaller than the shank diameter of the bolt.

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

Anti-fatigue bolt (Fig 4)

Fig 4

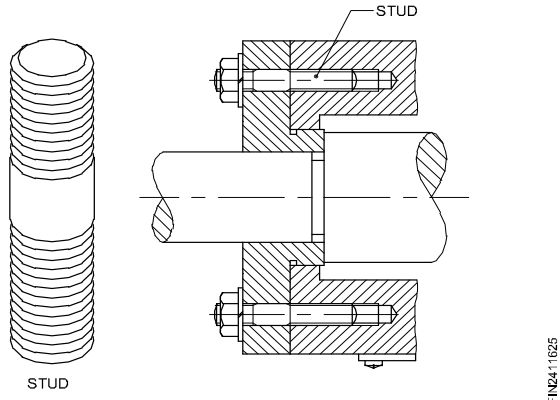


This type of bolt is used when the assembly is subjected to alternating load conditons continuously. Connecting rod big ends in engine assembly are examples of this application.

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

Studs (Fig 5)

Fig 5



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

When excessively tightened, the variation in the thread pitch allows the fine thread or nut end to strip. 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 60 mm and property class 4.8 shall be designated as:

Hexagon head bolt M10 x 60 - 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 = 40 kgf/mm^2 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 and '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 acutally 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.)

Cylindrical and taper pins

Objectives: At the end of this lesson you shall be able to
- **state the uses of cylindrical and taper pins**
- **specify cylindrical pins**
- **state the features and uses of different types of cylindrical pins**
- **state the advantages of of taper pins**
- **state the features and uses of the different types of taper pins**
- **designate standard taper pins**
- **distinguish the features and uses of the different types of taper pins**
- **state the uses of the different types of grooved pins**
- **state the features and uses of spring pins.**

Cylindrical and taper pins

– Locating hole position for assemblies whenever they are dismantled and assembled (Examples - jigs and fixtures, cover plates, machine tool assembly etc.) (Figs 1a and 1b)

– Assembling components. (Examples - wheels, gears, levers, cranks etc. to shafts) (Figs 2a and 2b)

Fig 1

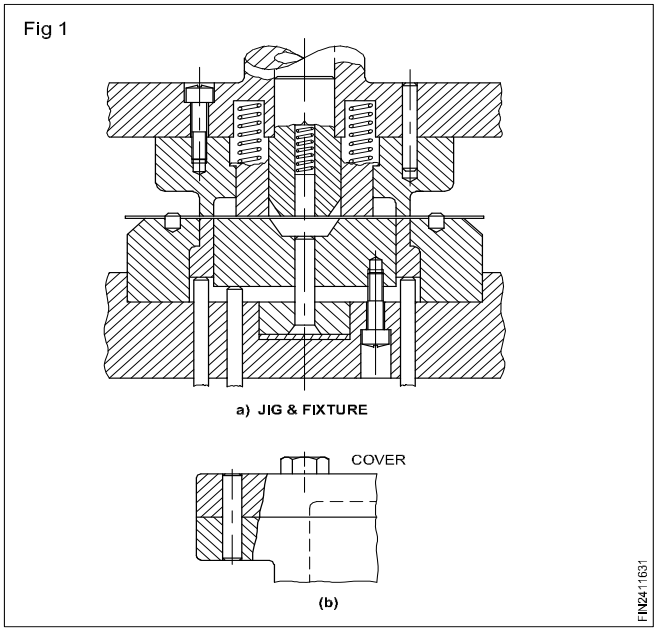
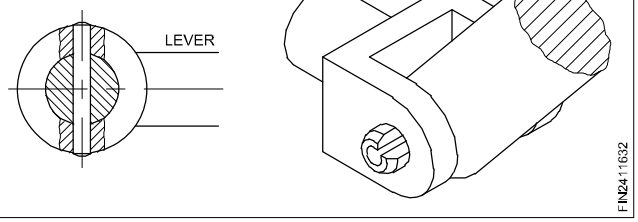


Fig 2



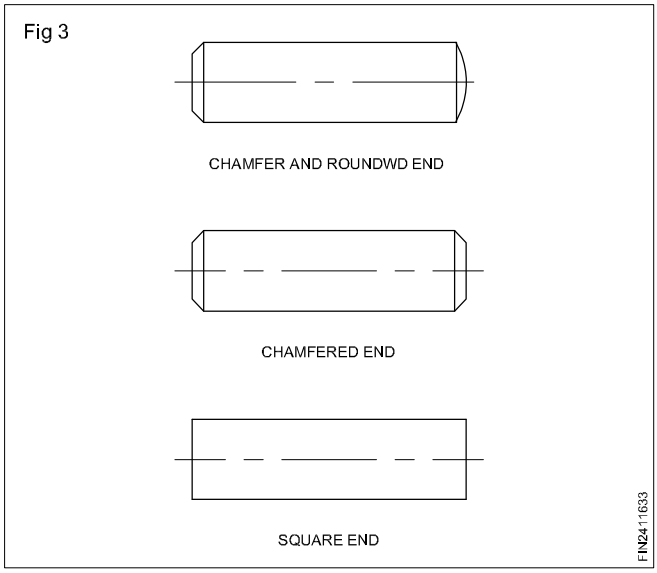
Cylindrical pins are available with different types of:

- Ends
- Tolerances
- Surface quality

Cylindrical pins are also available in un-hardened and hardened conditions.

Un-hardened cylindrical pins are of three types. (Fig 3)

Fig 3

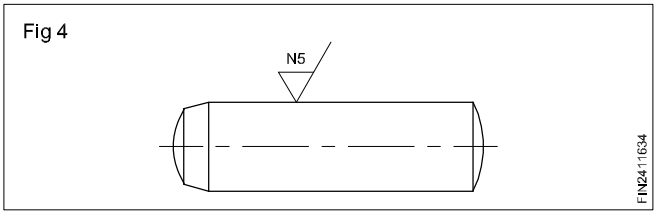


- Chamfered and rounded end
- Chamfered end
- Square end

They are useful in general assembly work.

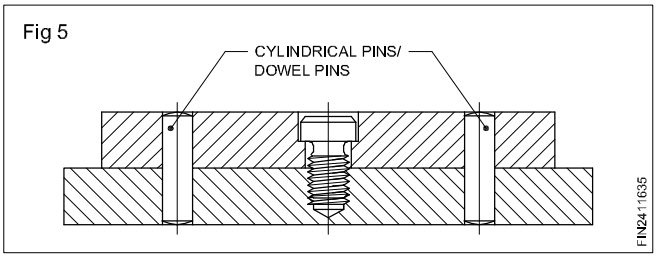
Hardened cylindrical pins are made of high grade steel and are finished by grinding. (Fig 4) These pins can withstand higher shearing force. These pins are used in precision assemblies like jigs and fixtures and other tool making works.

Fig 4



In tool assemblies the parts will be fixed by screws or bolts, (Fig 5) and are located by using cylindrical pins.

Fig 5



Hardened cylindrical pins are available with dimensional tolerance m6.

Un-hardened and hardened cylindrical pins are made to fit in the holes finished by standard reamers.

Cylindrical pins are designated by the name, nominal diameter, tolerance on diameter, nominal length and the number of B.I.S. Standard.

Example

A cylindrical pin of nominal diameter 10 mm, tolerance h8 and nominal length 20 mm shall be designated as-

Cylindrical pin 10h8x20 IS:2393.

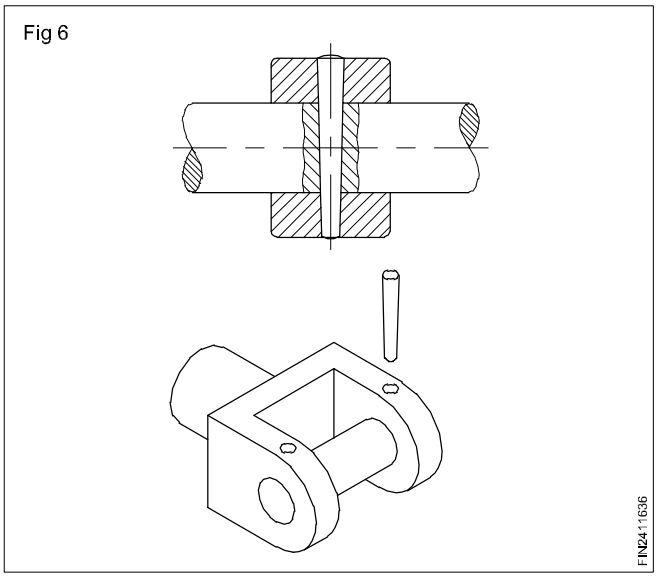
Note: The I.S. number refers to un-hardened cylindrical pins. Cylindrical pins are also referred to as dowel pins.

Taper pins

Taper pins of different types are used in assembly work.

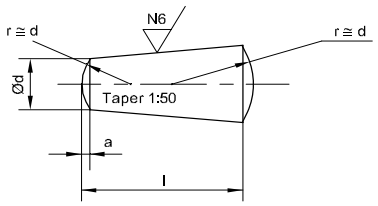
Taper pins allow for frequent dismantling and assembling of components without disturbing the precise nature of location. They are used to transmit small torques. (Fig 6)

Fig 6

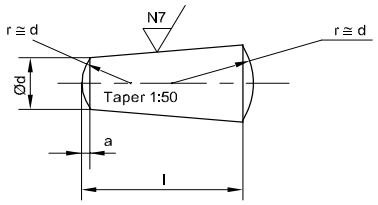


Taper pins are of three types. (Fig 7)

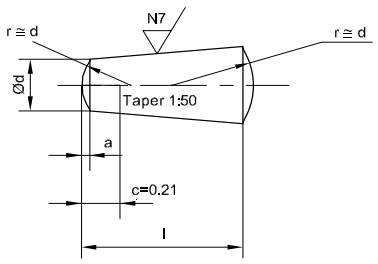
Fig 7



TYPE-A



TYPE-B



TYPE-C

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Type A - Taper pins with a surface finish of N6.

Type B - Taper pins with a surface finish of N7.

Type C - Split taper pins with a surface finish of N7.

All taper pins have a taper of 1:50 and are finished within a dimensional tolerance of h10.

Taper pin types A & B assembly is shown in Fig 8 and type C is shown in Fig 9.

Fig 8

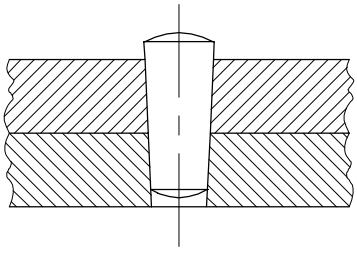

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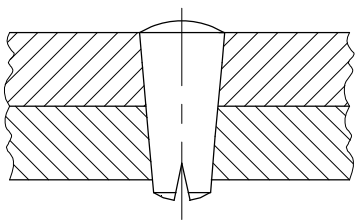
Fig 9



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Split taper pin

In the case of split taper pins the split end can be slightly opened to ensure a more positive locking.

Taper pins are designated by name, type (A, B or C) nominal diameter, nominal length and number of the standard.

Examples

i A taper pin of Type A of nominal diameter 10 mm and nominal length 50 mm shall be designated as - Taper pin A10 x 50 IS:6688.

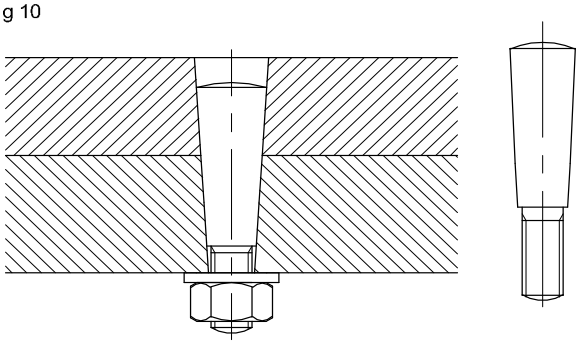
ii A split taper pin of nominal diameter 10 mm and nominal length of 60 mm shall be designated as - Split taper pin C10 x 60 IS: 6688.

The nominal diameter in the case of taper pins is the diameter at the small end of the taper.

Threaded taper pins are available for:

- Locking the pins and preventing loosening due to vibration (Fig 10)

Fig 10



LOCKING

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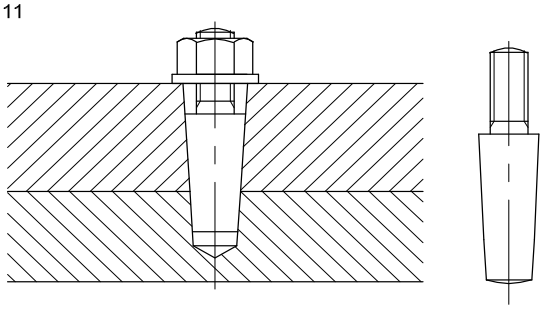
- Assisting in drawing the pins out of the blind holes. (Fig 11)

Fig 11



DRAWING OUT

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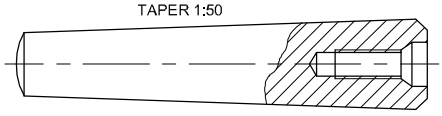
Threaded taper pins with internal threads are also available. (Fig 12)

Fig 12



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Grooved pins

These pins have three slots rolled on the outer surface. The sides of the grooves/slots bulge out. The holes in which slotted pins are used are not finished by reaming. Grooved pins are available as straight pins (Fig 13a), and tapered pins (Fig 13b). These are used in assemblies which are not dismantled frequently and where high accuracy is not required.(Fig 14)

Fig 13

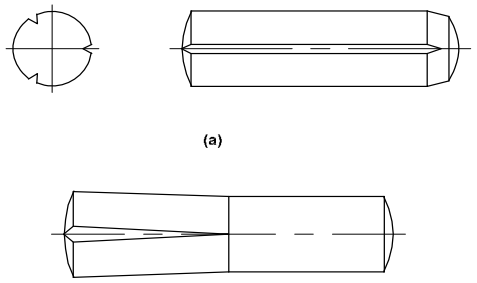
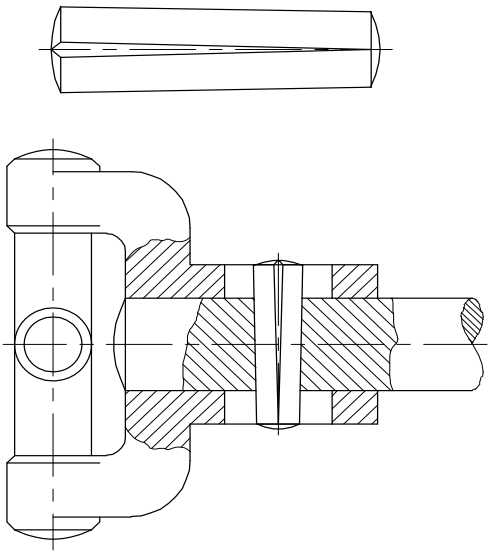
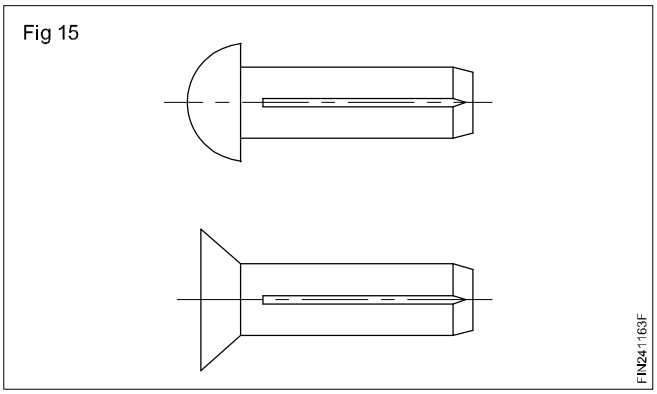


Fig 14



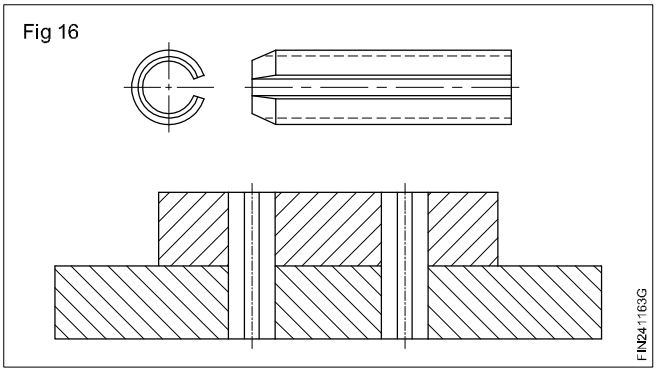
Grooved pins with head are also used in assembly involving small components. (Fig 15)

Fig 15



Spring pins (Fig 16)

Fig 16



Spring pins are used for locating assemblies with wide tolerance in the corresponding holes. These pins are manufactured from flat steel bands and rolled to form a cylindrical shape. These springs will stay tight in the fitting hole because of the spring action.

Seal

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a seal**
- **name the material used for static seal**
- **state the types of static seals and their applications**
- **name the materials used for dynamic seals**
- **state the types of dynamic seals and their applications.**

Purpose

A seal is used to prevent leakage.

It prevents dust, dirt and foreign particles from entering into the system.

Any machining process leaves behind a little imperfection of the surfaces of the mating components. A seal fills up the gap to prevent leakage from the system.

Types

- Static
- Dynamic

Static seal

It is used for sealing the contact areas between the surfaces where there is relative movement, eg. Gasket 'O' ring, bellows, etc.,

Materials used for gaskets

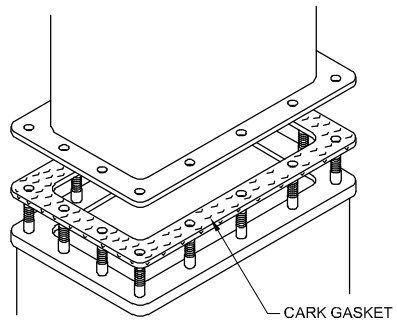
Static seal

- Compressed cork
- Oil-proof paper
- Graphite-impregnated cloth
- Asbestos with copper covering
- PTFE (Poly-tetrafluroethylene)
- Copper
- Steel

Types of static seals

Compressed cork gasket (Fig 1)

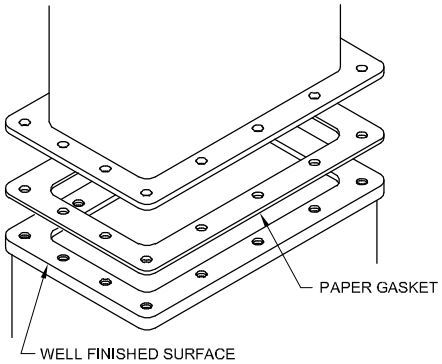
Fig 1



This is used for sealing between mating surfaces which are not having good surface finish. Compressed cork can be obtained in several thicknesses.

Paper (Fig 2)

Fig 2

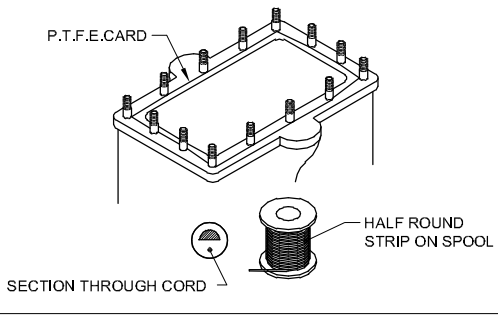


This is used between smooth and accurately finished joint surfaces. It can vary in thickness from thin paper to card and may be grease-proofed.

PTFE cord sealing (Fig 3)

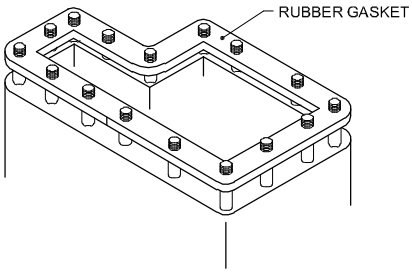
This is suitable for use at very low temperature applications. The material is chemically inert and can be made into soft flexible strips and used to make either flat seals or gland packings.

Fig 3



Rubber gaskets (Fig 4)

Fig 4

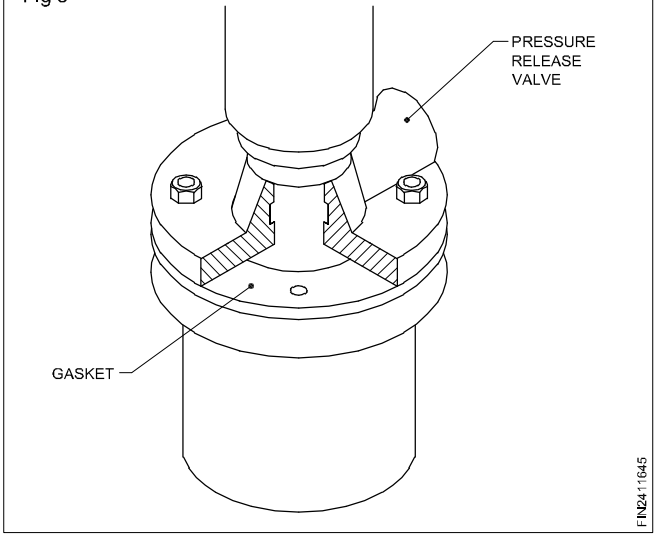


They are the good for sealing flanges of cold water connections. They are not suitable where oil comes in contact.

Graphite impregnated cloth (Fig 5)

This is a suitable material for hot water and steam joints.

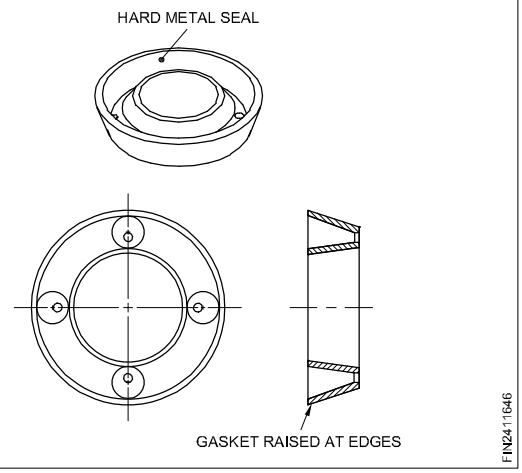
Fig 5



Metallic gaskets (Fig 6)

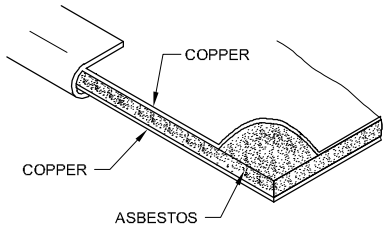
Hard metallic seals made of steel, copper or beryllium are used for high pressure joints found commonly in hydraulic system.

Fig 6



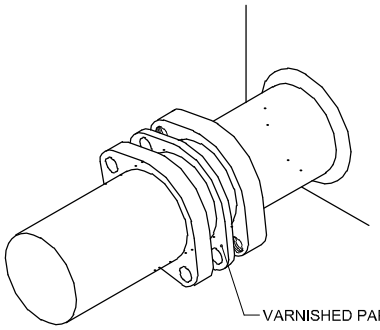
Asbestos covered with copper sheet gasket (Fig 7)

Fig 7



These are suitable for use in high temperature applications.
Varnished paper gasket (Fig 8)

Fig 8



It is suitable for use where liquids would be absorbed into plain paper. The surface of the varnished paper gasket must not be cracked or damaged in any way.

Material used for manufacturing dynamic seal

- Natural rubber
- Nitrile
- Viton
- PTFE plastics
- Flurosilicone
- Butyle
- Neoprene
- Flurocarbon

Table 1 shows the allowable temperature range for different materials.

Table 1

Material	Temp.°C	Material	Temp.°C
Natural rubber	-50 to +80	Flurosilicone	-50 to +100
Nitrile	-30 to +110	Butyle	-40 to +100
Viton	-40 to +180	Neoprene	-40 to +100
PTFE	-85 to +260	Flurocarbon	-20 to +140

Types of dynamic seals

Dynamic seals are required to work under more exacting conditions than static seals because movement lakes place between the surfaces being sealed.

O-ring seal (Figs 9 & 10)

Fig 9

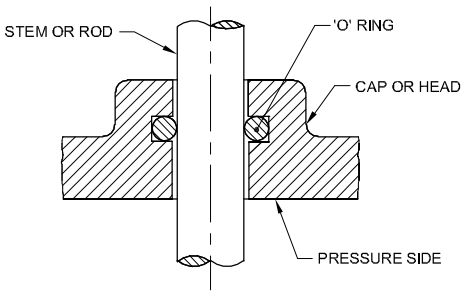
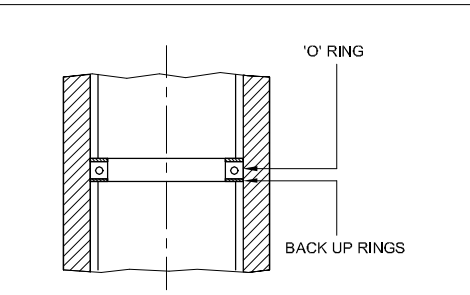


Fig 10



These are the most common types of dynamic seals in use and have many applications. When required to seal against high pressures, they are fitted with back-up rings. There are many similar seals made for special purposes that do not have a circular cross-section.

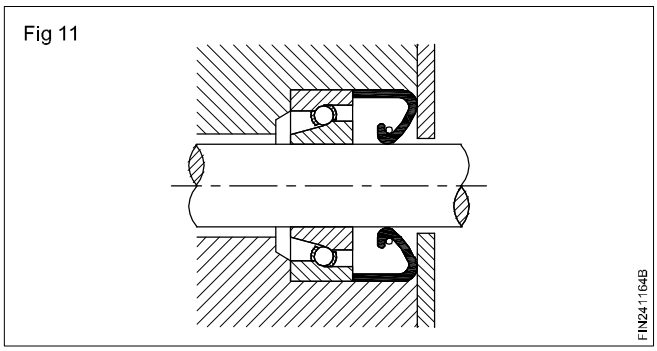
Radial lip seals

Radial lip seals are used primarily to retain lubricants in equipment with rotating, reciprocating or oscillating shafts. The secondary purpose is to exclude foreign matter.

Non-spring loaded seals

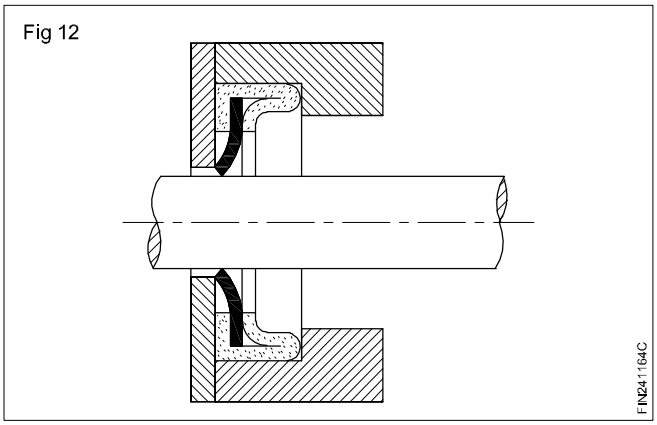
These are used to retain highly viscous materials like grease at shafts less than 600 m/min.

Spring-loaded seals (Fig 11)



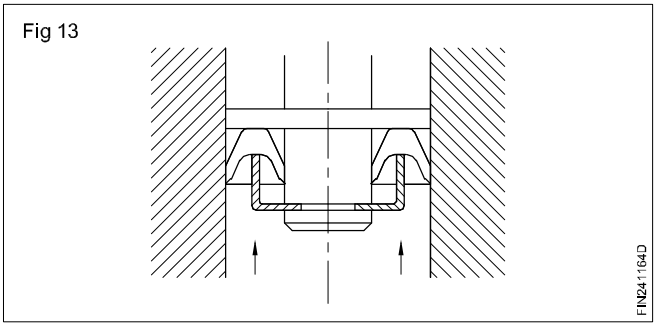
They are used to retain low viscosity lubricants such as oils at speeds up to 1000 m/min.

Wiper seal (Fig 12)



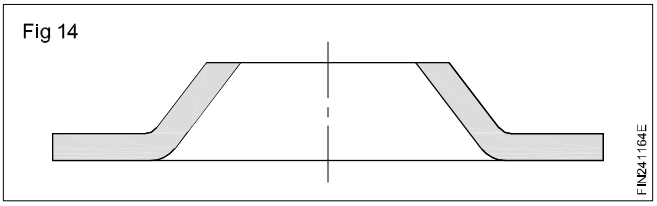
These seals are used in rotary and sliding operating conditions and are used to prevent dust or grit entering shaft bearings. The contacting surface of the seal wipes off the particles from the shaft.

'V' seals (Fig 13)

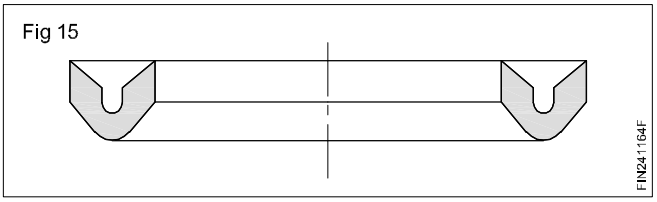


Fabric reinforced or leather seals are suitable for use against high pressure. These seals are available in various forms.

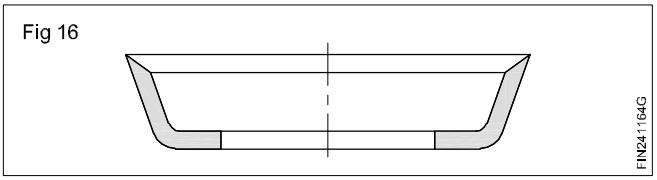
Flange seal (Fig 14)



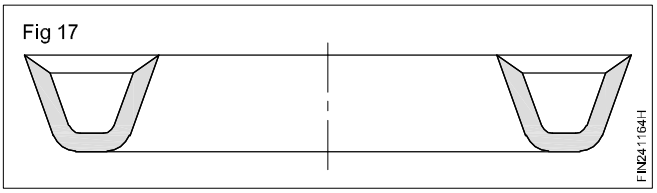
'V' type or Chevron seal (Fig 15)



Cup seal (Fig 16)

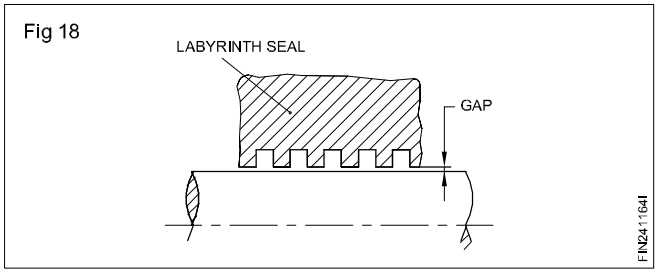


'U' type seal (Fig 17)



They are often used to form the seal between piston and cylinder assemblies in hydraulic equipment.

Labyrinth seals (Fig 18)



This is a clearance type of seal and it allows some amount of leakage. Labyrinth seals are used primarily to seal gases in compressors and steam turbines. This seal is commonly used in rotary operating conditions. The function of the seal is to provide radial clearance while preventing dust or dirt from entering into the system.

Torquing

Objectives: At the end of this lesson you shall be able to
- **state torque in assembling**
- **state precautions to be observed during assembling & installation.**

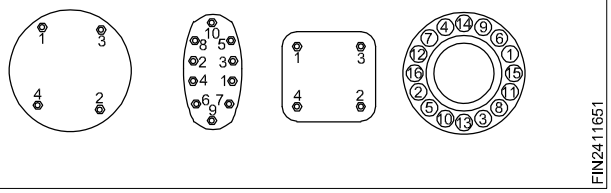
Torquing

While assembling, threaded fasteners are tightened as per thread manufacturer recommended torque value. If the torque is more than the recommendation, threads may damage on both fasteners and housing and tends to break.

Precautions observed during Assembling and installation

- Tighten the bolts to compress the gasket uniformly. Follow the sequence from side to side around the joint. (Fig 19).

Fig 1



- Use well lubricated fasteners and hardened flat wahser.
- All bolts should be tightened in one-third increments, according to proper bolting patterns.
- Make final check pass at the target torque value moving consecutively from bolt to bolt
- Never use liquid or metallic based anti-stick or lubricating compounds on the gaskets. It creats Premature failure.