# GOVERNMENT POLYTECHNIC, SIRSA

**BRANCH: MECHANICAL ENGINEERING**

**SUBJECT: MECHANICAL ENGINEERING DRAWING**

**SEMESTER: 3RD**

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# CHAPTER- 1

## 1.1 NEED OF LIMIT, FITS AND TOLERANCE, MAXIMUM LIMIT OF SIZE, MINIMUM LIMIT OF SIZE, DEVIATION, UPPER DEVIATION, LOWER DEVIATION, TOLERANCE, ALLOWANCE,

### Need of Limits, Fit and Tolerance

The need of limits, fit and tolerance is due to following reasons:

1. Mass production and specialization
2. Standardization
3. Interchangeability

- **Mass production and specialization:** Due to various advantages of mass production, it is not possible for an industry to produce all the components of a machine. This concept leads to the need of maximum and minimum limit of sizes of machine components.
- **Standardization:** The growing technology has introduce elements of standardization specifying the size of machine components nationally and internationally in order to enjoy the benefits of large scale production. It helps in reducing the time and efforts to make the new machine. It minimizes the production cost. It helps in improving the quality of finishing goods.
- **Interchangeability:** It ensures the possibility of assembling a unit or machine without indulging in extra machining. If various machines are provided with interchangeability for spare parts, they can be repairable for replacement of worn out parts in service condition.

### Important Terms used in Limit System

- **Basic Dimension:** It is also known as Nominal dimension. It is dimension of machine element derived from design calculation.
- **Limit if Sizes:** These are extreme permissible sizes for dimension. The largest permissible size is called Maximum limit of size or upper limit while the smallest permissible size is called minimum limit of size or lower limit.
- **Deviation:** It is the algebraic difference between actual measured size and corresponding basic size.
- **Upper Deviation:** It is the algebraic difference between maximum limit of size and corresponding basic size.
- **Lowe Deviation:** It is the algebraic difference between minimum limit of size and corresponding basic size.
- **Tolerance:** It is the difference between upper limit and lower limit of the sizes of a component. It is of two types:

  (i) Unilateral Tolerance

  (ii) Bilateral Tolerance
- **Allowance:** It is the intentional difference between maximum material condition of mating parts.

## 1.2 FUNDAMENTAL DEVIATION, CLEARANCE, MAXIMUM CLEARANCE, MINIMUM CLEARANCE. FITS – CLEARANCE FIT, INTERFERENCE FIT AND TRANSITION FIT. HOLE BASIS SYSTEM, SHAFT BASIS SYSTEM

### Important Terms used in Limit System

- **Basic Dimension:** It is also known as Nominal dimension. It is dimension of machine element derived from design calculation.

- **Fundamental deviation:** It is one of the two deviation which is easily chosen in order to define the position of tolerance zone with respect to zero line.
- **Clearance:** It may be defined as the difference between the dimension of the hole and the shaft given intentionally to get particular type of fit. Clearance may be positive or negative.
- **Maximum Clearance:** It is the difference between the maximum size of hole and minimum size of shaft.
- **Minimum Clearance:** It is the difference between the minimum size of hole and maximum size of shaft.

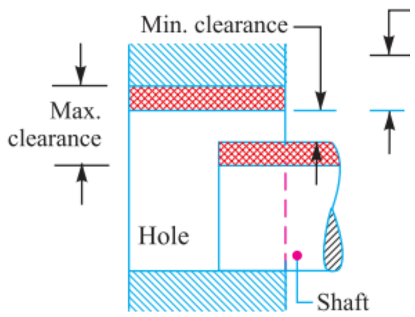
## Fit

The assembly of two mating parts is called fit. The fits are given as under in ordinary machine condition:

1. Force fit e.g. Railway fit, Tram card.
2. Running fit e.g. shaft is rotating in bearing.
3. Push fit e.g. Shaft rotate in locating plugs.
4. Driving fit. e.g. pulley fitted on a shaft with key.

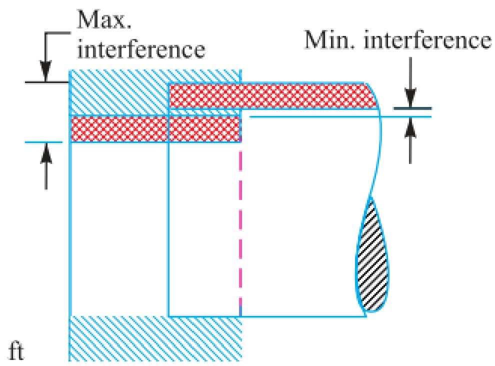
## Types of Fit

1. **Clearance Fit:** In this fit, minimum hole diameter is larger than maximum shaft diameter. Here both maximum and minimum clearances are always positive.



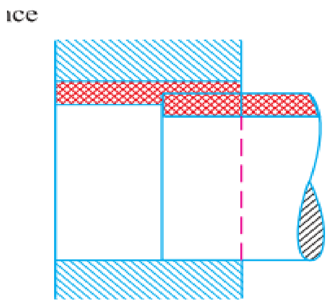

(*a*) Clearance fit.

2. **Transition Fit:** In this fit, tolerance zone of both shaft and hole overlap. Here maximum clearance is positive while minimum clearance is negative.




(*b*) Interference fit.

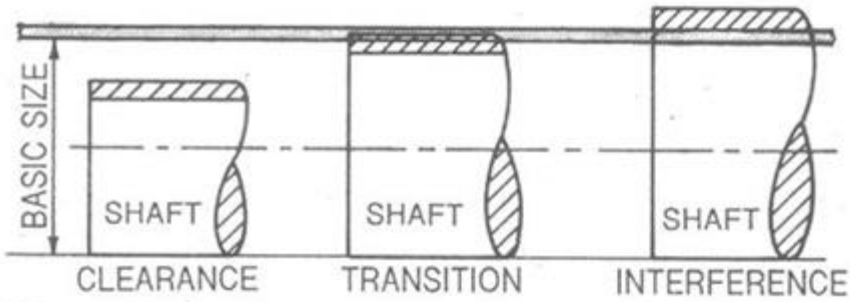
3. **Interference Fit:** In this fit, maximum hole diameter is always smaller than minimum shaft diameter. Here both maximum and minimum clearances are always negative.



(*c*) Transition fit.

## Hole Basis System:

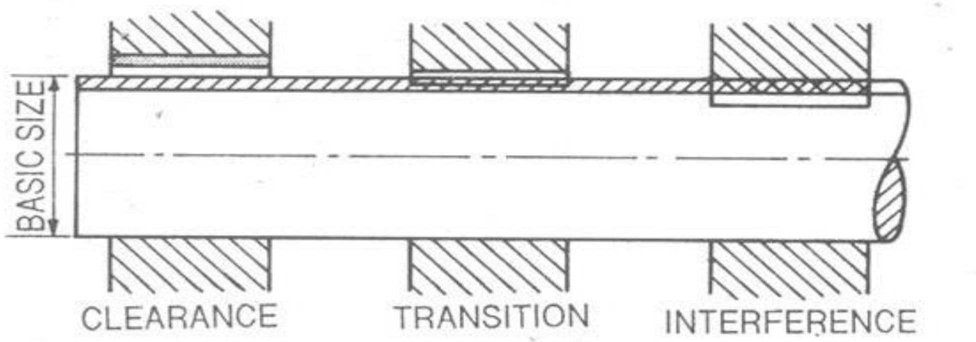
In this system, tolerance zone of hole is kept constant while tolerance zone of shaft is varied above and below the zero line. The hole basis system is used for engine building, locomotive construction etc. In this system lower deviation for hole is zero.




(i) HOLE BASIS SYSTEM

## Shaft Basis System:

In this system, tolerance zone of shaft is kept constant while tolerance zone of hole is varied above and below the zero line. In this system upper deviation for shaft is zero.



(ii) SHAFT BASIS SYSTEM

## 1.3 TOLERANCE GRADES, CALCULATING VALUES OF CLEARANCE, INTERFERENCE, HOLE TOLERANCE, SHAFT TOLERANCE WITH GIVEN BASIC SIZE FOR COMMON ASSEMBLIES LIKE H7/G6, H7/M6, H8/P6.

**Table 1.2 : Fundamental Tolerance of Grades**

| Basic size (mm) | | Fundamental Tolerance of Grades (microns) or International Tolerance Grades (microns) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Over | Upto | *01* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* |
| 0 | 3 | 0.3 | 0.5 | 0.8 | 1.2 | 2.0 | 3 | 4 | 6 | 10 | 14 | 25 | 40 | 60 | 100 | 140 | 250 | 400 | 600 |
| 3 | 6 | 0.4 | 0.6 | 1.0 | 1.5 | 2.5 | 4 | 5 | 8 | 12 | 18 | 30 | 48 | 75 | 120 | 180 | 300 | 480 | 750 |
| 6 | 10 | 0.4 | 0.6 | 1.0 | 1.5 | 2.5 | 4 | 6 | 9 | 15 | 22 | 36 | 58 | 90 | 150 | 220 | 360 | 580 | 900 |
| 10 | 18 | 0.5 | 0.8 | 1.2 | 2.0 | 3 | 5 | 8 | 11 | 18 | 27 | 43 | 70 | 110 | 180 | 270 | 430 | 700 | 1100 |
| 18 | 30 | 0.6 | 1.0 | 1.5 | 2.5 | 4 | 6 | 9 | 13 | 21 | 33 | 52 | 54 | 130 | 210 | 330 | 520 | 840 | 1300 |
| 30 | 50 | 0.6 | 1.0 | 1.5 | 2.5 | 4 | 7 | 11 | 16 | 25 | 39 | 62 | 100 | 160 | 250 | 390 | 620 | 1000 | 1600 |
| 50 | 80 | 0.8 | 1.2 | 2.0 | 3 | 5 | 8 | 13 | 19 | 30 | 46 | 74 | 120 | 190 | 300 | 460 | 740 | 1200 | 1900 |
| 80 | 120 | 1.0 | 1.5 | 2.5 | 4 | 6 | 10 | 15 | 22 | 35 | 54 | 87 | 140 | 220 | 350 | 540 | 870 | 1400 | 2200 |
| 120 | 180 | 1.2 | 2 | 3.5 | 5 | 8 | 12 | 18 | 25 | 40 | 63 | 100 | 160 | 250 | 400 | 630 | 1000 | 1600 | 2500 |
| 180 | 250 | 2.0 | 3 | 4.5 | 7 | 10 | 14 | 20 | 29 | 46 | 72 | 115 | 185 | 290 | 460 | 720 | 1150 | 1850 | 2900 |
| 250 | 315 | 2.5 | 4 | 6 | 8 | 12 | 16 | 23 | 32 | 52 | 81 | 130 | 210 | 320 | 520 | 810 | 1300 | 2100 | 3200 |
| 315 | 400 | 3.0 | 5 | 7 | 9 | 13 | 18 | 25 | 36 | 57 | 89 | 140 | 230 | 360 | 570 | 890 | 1400 | 2300 | 3600 |
| 400 | 500 | 4.0 | 6 | 8 | 10 | 15 | 20 | 27 | 40 | 63 | 97 | 155 | 250 | 400 | 630 | 970 | 1500 | 2500 | 4000 |

Tolerance Grades

## 1.16 CLEARANCE

It may be defined as *the difference between the dimensions of the hole and the shaft assigned intentionally to obtain a particular type of fit*. It may be positive or negative. When the shaft size is smaller than the hole size, it will be positive and when the shaft size is bigger than the hole size, it will be negative.

### 1.16.1 Maximum Clearance

*In a clearance fit, the maximum clearance is the difference between the maximum size of hole and minimum size of shaft.*

### 1.16.2 Minimum Clearance

*In a clearance fit, the minimum clearance is the difference between the minimum size of hole and the maximum size of shaft.*

**Problem 1.1. Determine the tolerance for the basic dimension in the steps of 50 mm to 80 mm.**

**Solution.** Geometric mean of two diameters,

$$D = \sqrt{50 \times 80} = 63.25 \text{ mm}$$

Standard tolerance unit, $i = 0.45 \times D^{1/3} + 0.001D$

$$= 0.45 \times (63.25)^{1/3} + 0.001 \times 63.25 = 1.856$$

Now tolerance for any grade can be calculated.

Let us take IT11 grade.

$\therefore$ Tolerance $= 100\, i = 100 \times 1.856$

$= 185.6$ microns **Ans.**

which is approximately the same as given is table 1.2.

**Problem 1.7. Explain the meaning of $\phi$30 H7/g6.**

**Solution.** $\phi$30 indicates the basic size of hole.

Hole : H7 + 21 microns

00 microns

$$\text{Hole size} = \phi^{30.021 \text{ mm}}_{30.000 \text{mm}} \quad \textbf{Ans.}$$

Shaft : g6 – 7 microns

– 20 microns

$$\text{Shaft size} = \phi^{29.993 \text{mm}}_{29.980 \text{ mm}} \quad \textbf{Ans.}$$

As the shaft size is smaller than hole size, therefore, the mating pair provides clearance fit. **Ans.**

**Problem 1.8. Explain the meaning of $\phi$50 H7/p6.**

**Solution.** $\phi$50 indicates the basic size of hole.

Hole : H7 + 25 microns

0 microns

$$\text{Hole size} = \phi^{50.025 \text{mm}}_{50.000 \text{mm}} \quad \textbf{Ans.}$$

Shaft : $p6$ + 42 microns

+ 26 microns

$$\text{Shaft size} = \phi^{50.042\text{ mm}}_{50.026\text{ mm}} \quad \textbf{Ans.}$$

Allowance = Lower limit of hole – Upper limit of shaft

= 50.000 –50.042

= –0.042 mm

Negative sign indicates interference fit. **Ans.**

## Symbols of Fit

**Table 1.9 : Fits for Various Engineering Applications**

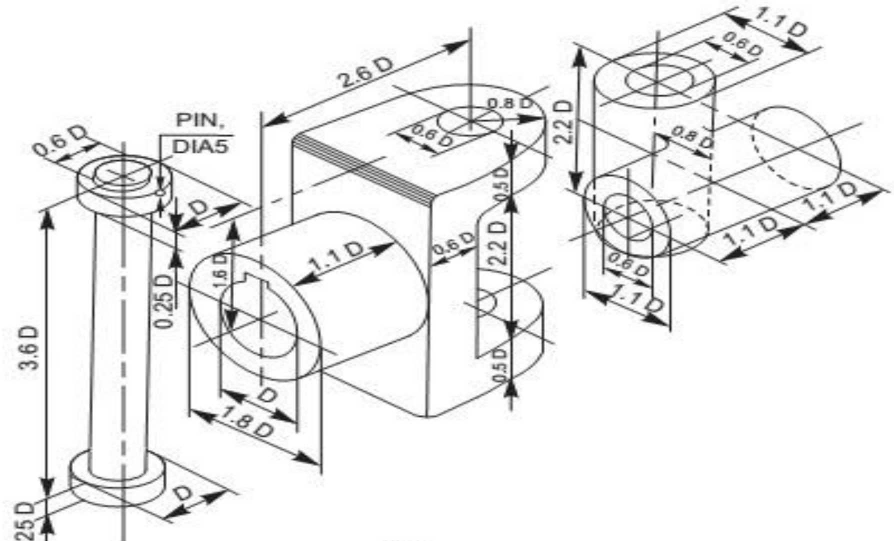
| Type of Fit | Symbol | Applications |
|---|---|---|
| **Clearance Fit :** | | |
| Slack running fit | H8/*c*11 | Oil seals |
| Loose running fit | H8/*d*9 | Low speed sleeve bearings, plastic bearings. |
| Easy running fit | H8/*e*8 | Medium speed sleeve bearings, grease lubricated bearings, sliding blocks, gear sliding on shafts. |
| Close running fit | H7/*f* 7 | Sleeve bearings with high revolutions, crank and connecting rod bearings. |
| Sliding fit | H7/*g*6 | Clutches, spline shafts |
| Locational fit | H7/*h*6 | Milling cutters on milling mandrels, sealing rings. |
| **Transition Fit :** | | |
| Easy push fit | H7/*i*6 | Pulleys, bushes, bearing shells, pistons on piston rods. |
| Push fit | H7/*k*6 | Gears, pulleys, inner race of ball bearings, couplings. |
| Force fit | H7/*m*6 | Gears, pulleys, inner race of ball bearings, couplings. |
| Light press fit | H7/*n*6 | Worm wheels, press tools, rotors on motor shaft. |
| **Interference Fit :** | | |
| Press fit | H7/*r*6 | Valve seats, couplings on shaft ends. |
| Medium press fit | H7/*p*6 | Gear wheels. |
| Heavy press fit | H7/*s*6 | Couplings. |
| Shrunk fit | H8/*u*8 | Wheel steel tyres. |

# CHAPTER-2

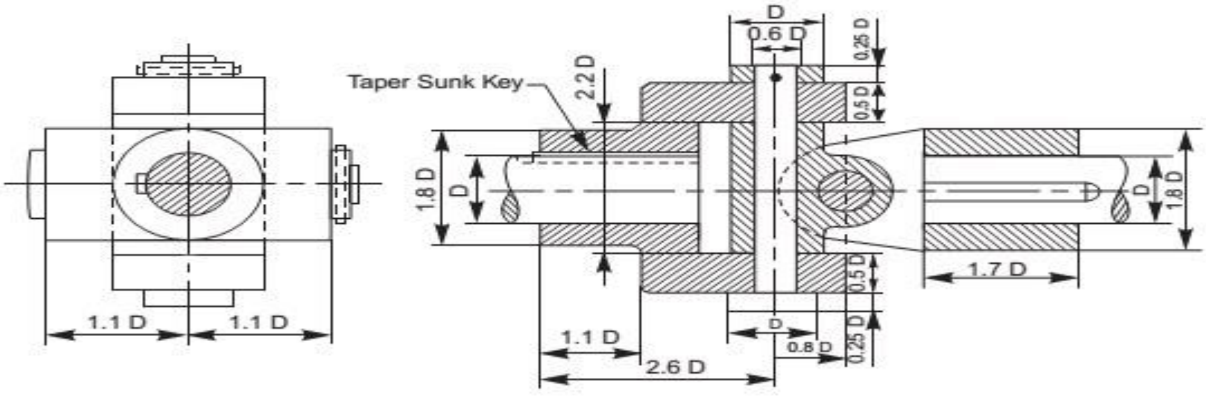
## 2.1 UNIVERSAL COUPLING AND OLDHAM COUPLING (ASSEMBLY)

### ➢ UNIVERSAL COUPLING

Universal coupling is also known as Hooke's joint. It is used to couple two shafts whose axes are not in line with each other, but intersecting at small angle 30 degree.



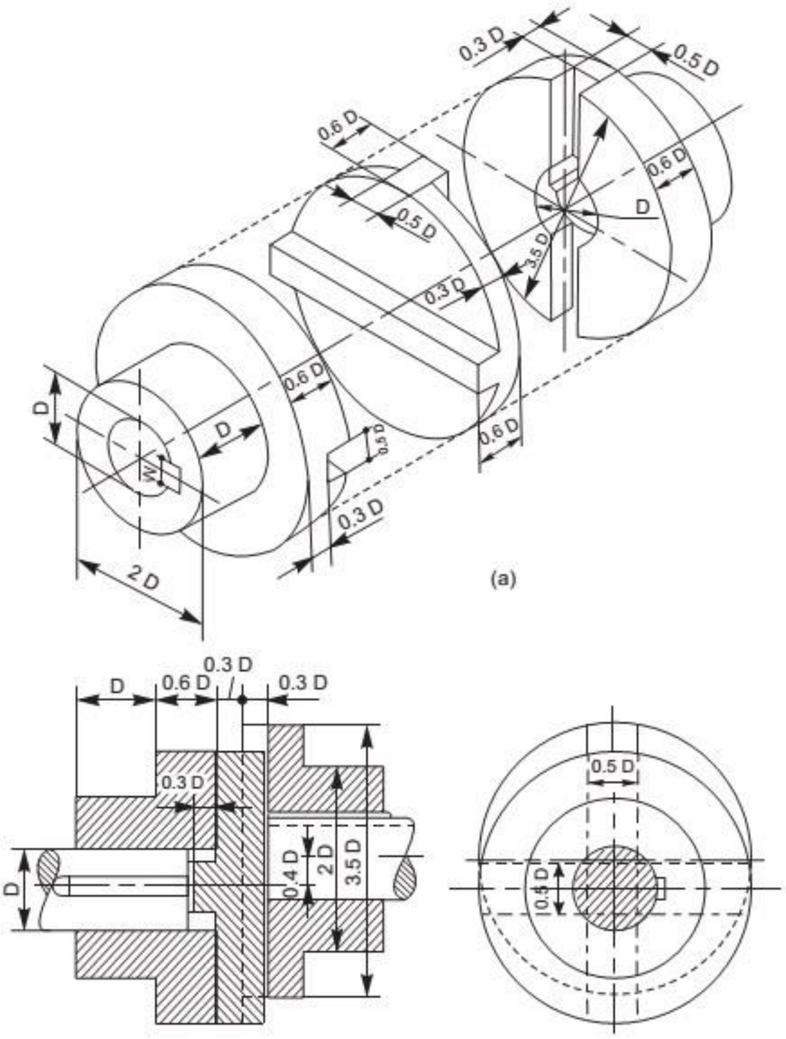

(a)




(b)

## ➢ OLDHAM COUPLING

This Coupling is used to connect two shafts where axes are parallel, but not in alignment. This type of coupling is suitable for transmitting heavy running at constant speed even when axial alignment varies.

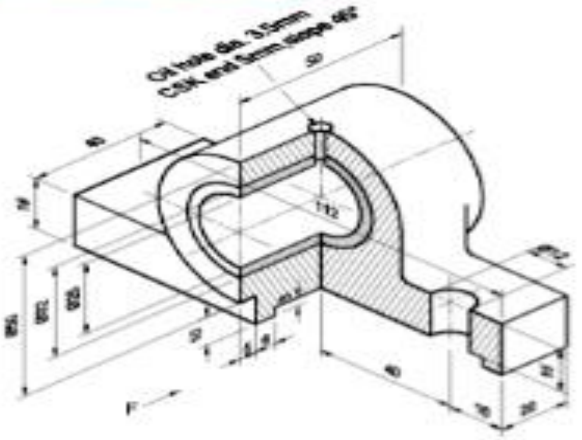


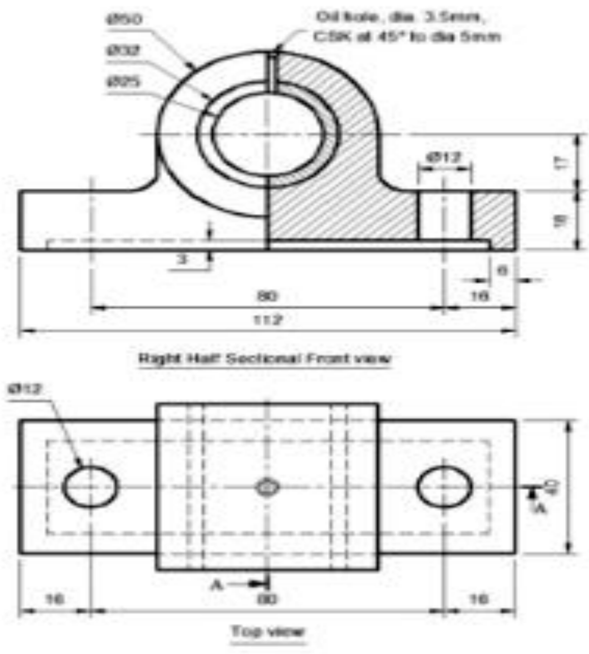
# 2.2 BEARINGS

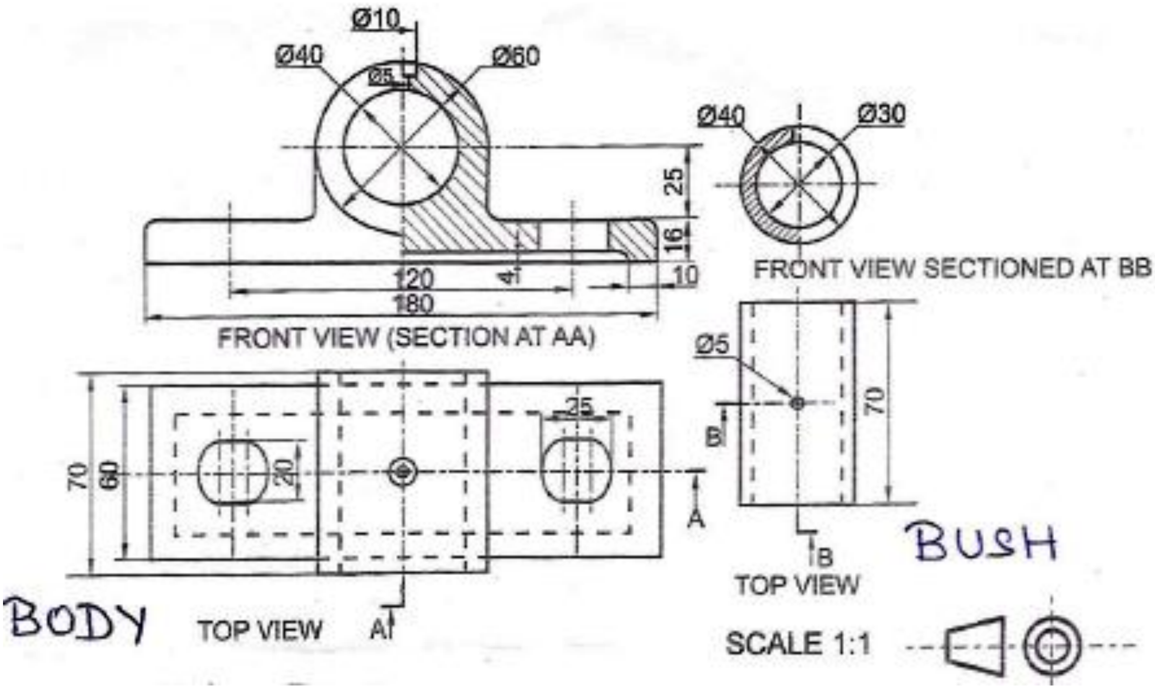
## 2.2.1 BUSHED BEARING (ASSEMBLY)

It is the modification of solid bearing. There is hole which support the rotating shaft. The bush should not rotate with shaft.

***10) Pictorial view of a bushed bearing is shown below. Draw the right half sectional front view and top view.***





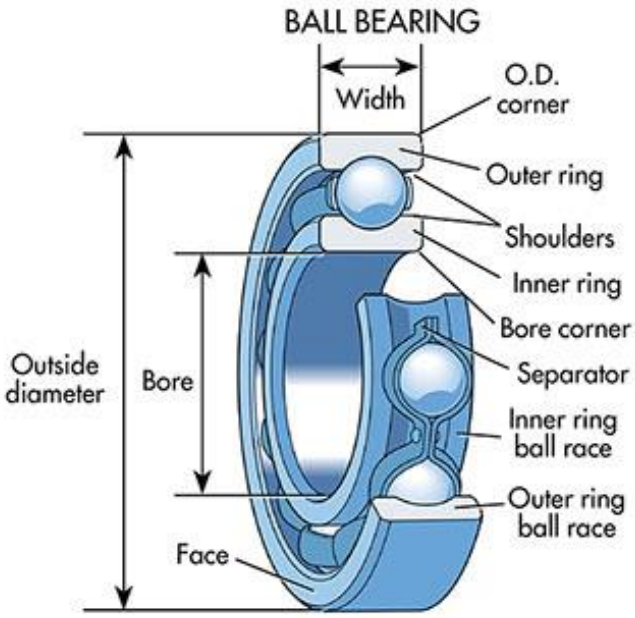


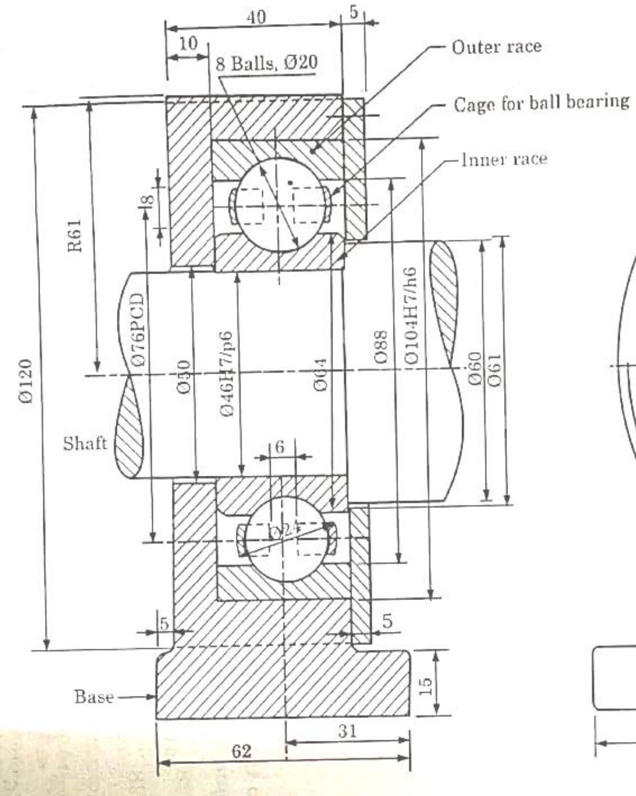

Either there should be force fit between the body and the bush. The material used for the bush is brass, gun metal and phosphor-bronze.

## 2.2.2 BALL BEARING AND ROLLER BEARING (ASSEMBLY)

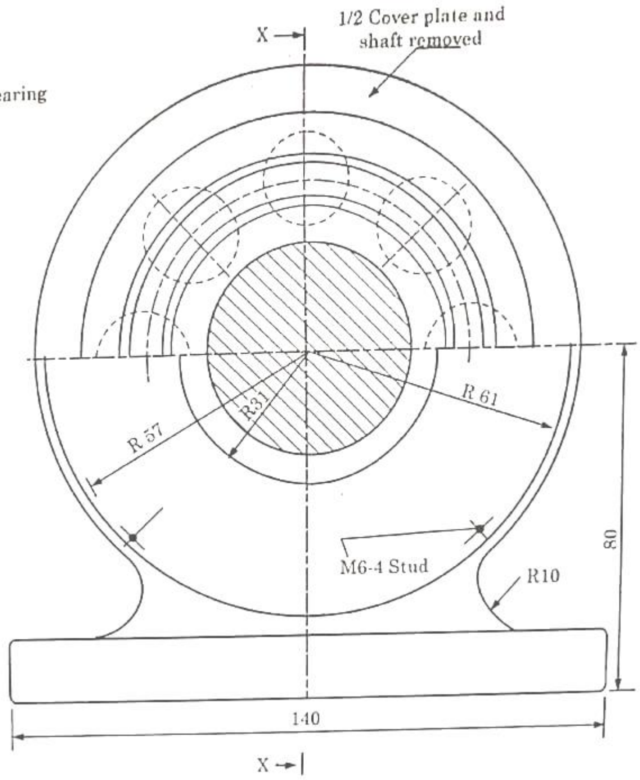
- **Ball Bearing**

  Ball bearing is used to minimize the friction. These are used on large and fast moving machine. Wear and tear is practically negligible. These bearing require small space and much small quantity of lubricant. The balls are made of high carbon chrome steel hardened and polished whereas the cage is made of steel or brass.






**Sectional Front Elevation**




**Side View**

## ➢ Roller Bearing

Roller bearing is used to change the sliding friction into pure rolling friction. Roller bearing are used on large and fast running machines such that electric motor, automobile etc. The roller are made of high carbon steel hardened and polished whereas cage is of steel or brass.

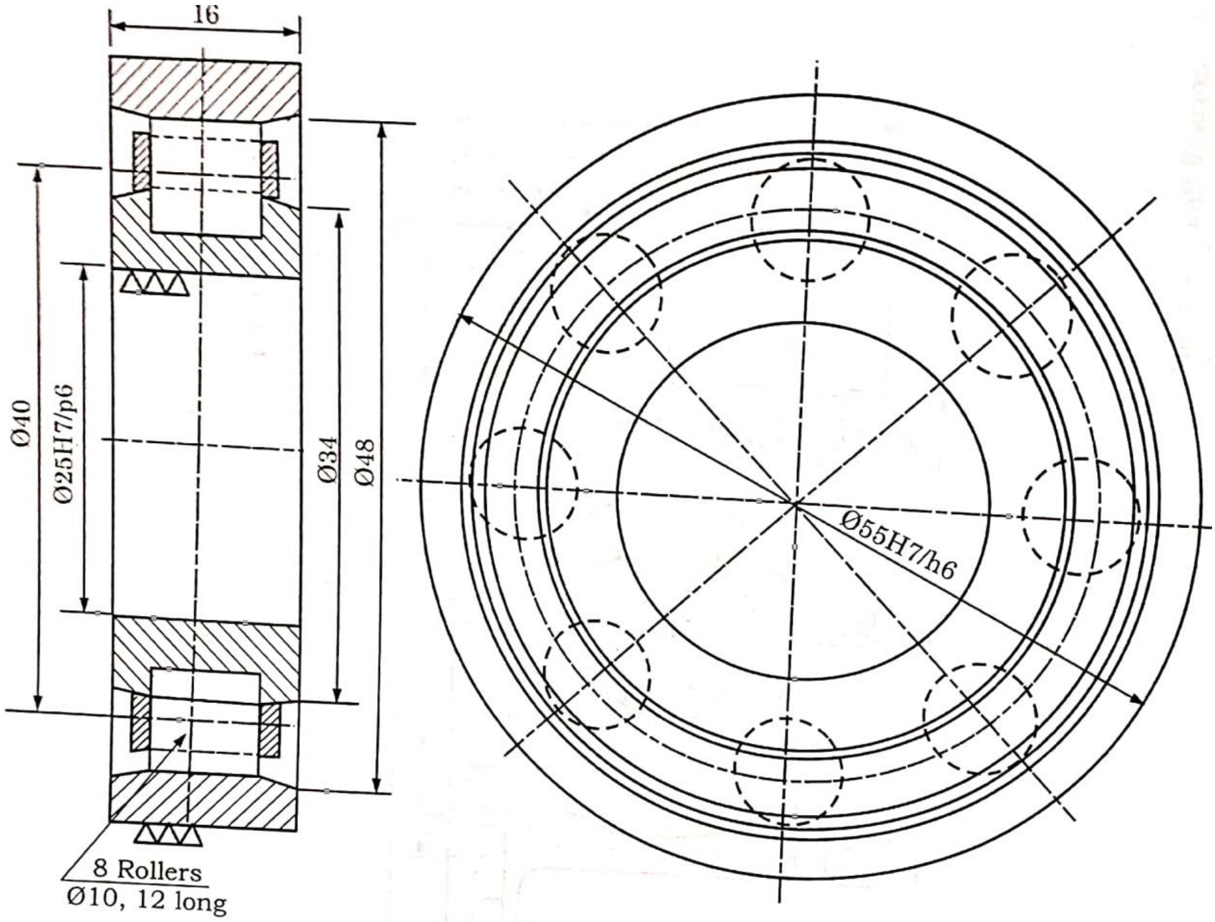
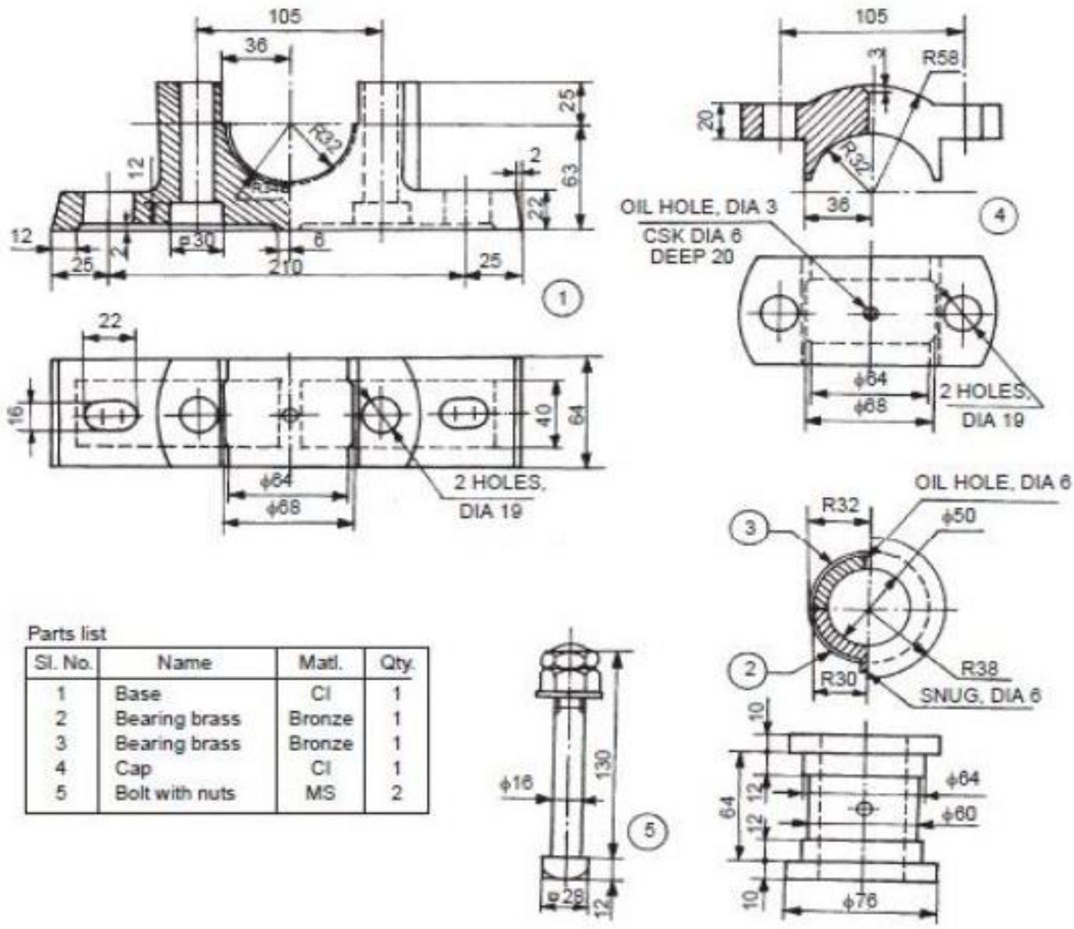



Fig. 4.13 : Roller Bearing

## 2.2.3 PLUMMER BLOCK (ASSEMBLY)

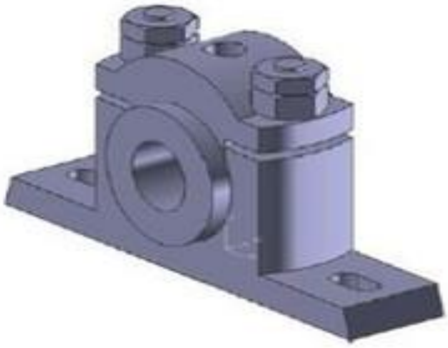
Plumber block is like a journal bearing. When load varies and speed of rotating shaft is too high, plumber block is used.




Parts list

| Sl. No. | Name | Matl. | Qty. |
|---|---|---|---|
| 1 | Base | CI | 1 |
| 2 | Bearing brass | Bronze | 1 |
| 3 | Bearing brass | Bronze | 1 |
| 4 | Cap | CI | 1 |
| 5 | Bolt with nuts | MS | 2 |

# 1] PLUMMER BLOCK (PEDASTAL BEARING)



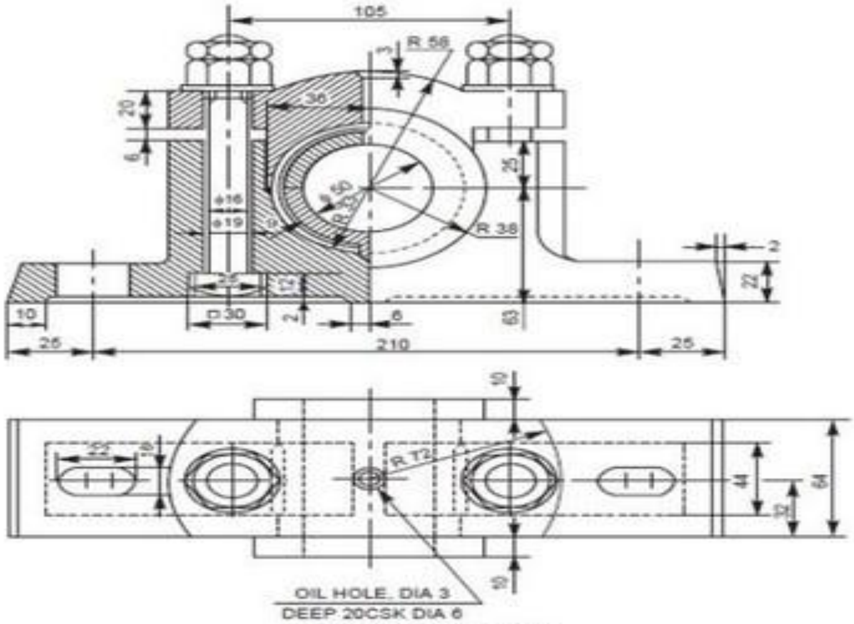
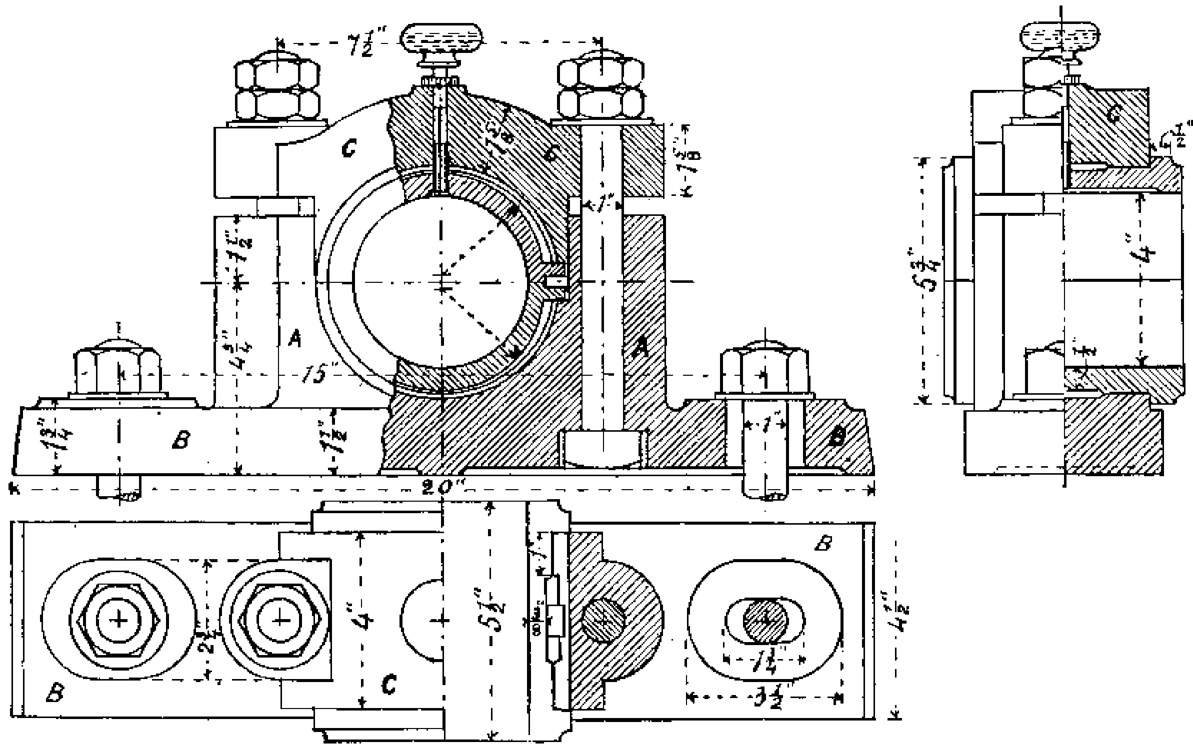
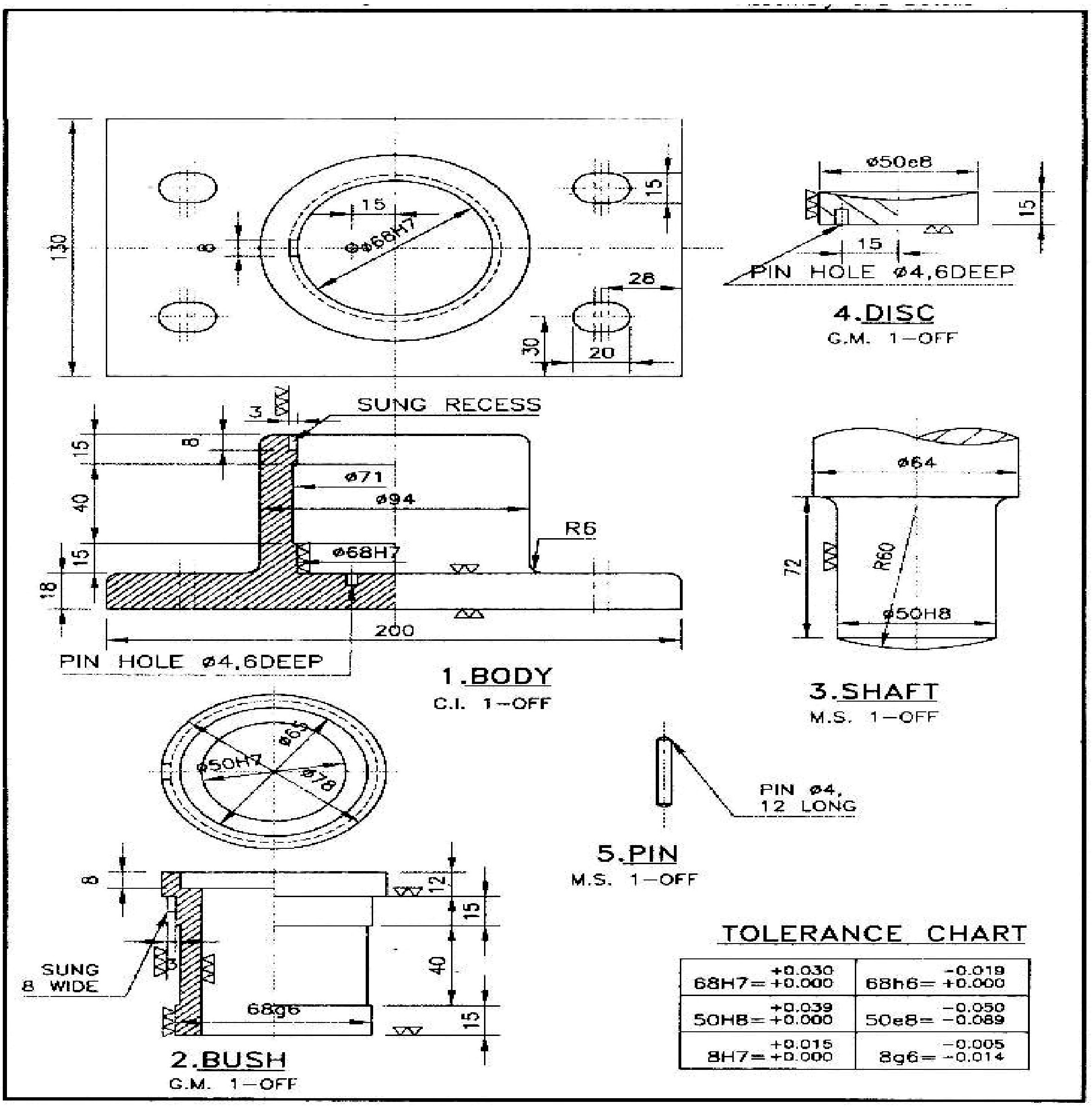


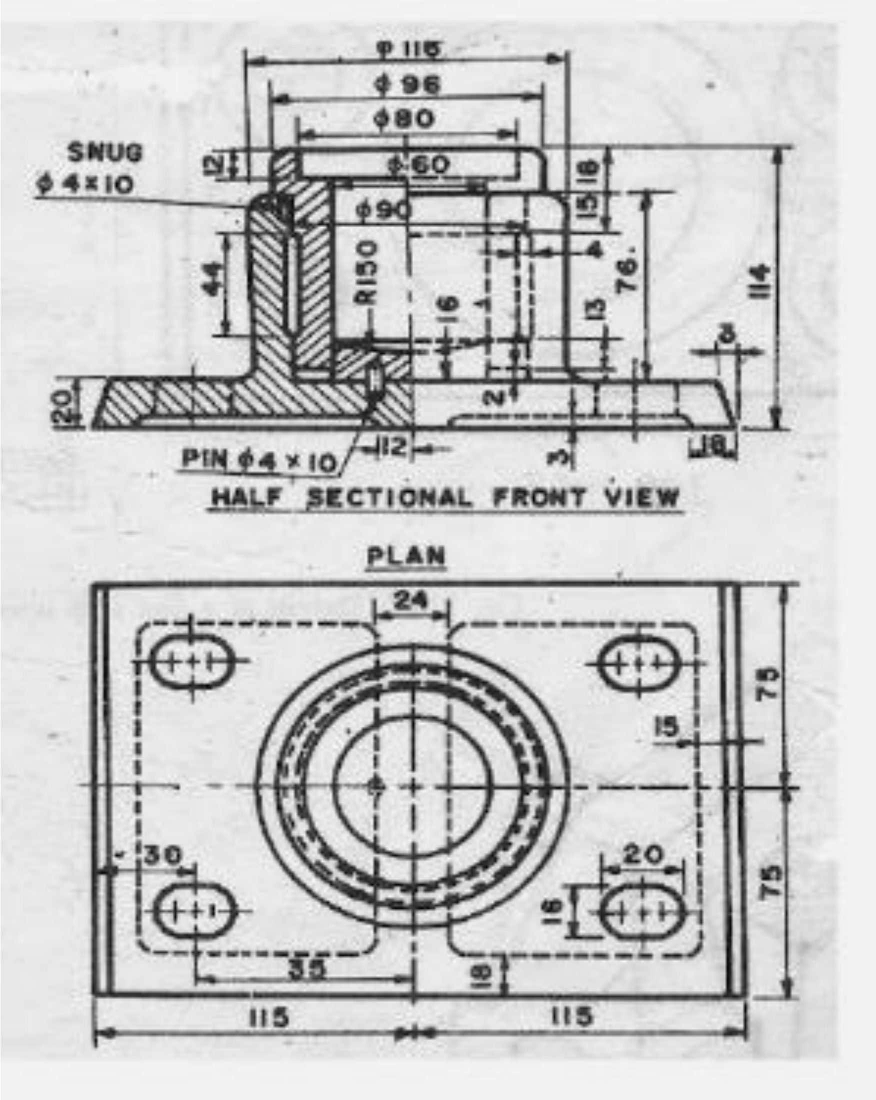

Fig. 12.4 Plummer block


A
B
C
20"
15"
4"

# 2.2.4 FOOT STEP BEARING (ASSEMBLY)

It is used to support the lower end of a rotating shaft. It consist of cast iron circular block with a base.






A footstep bearing consists of a cast iron block into which a bush consisting of a collar at the top is fitted. The shaft rests on a pad. The pad is prevented from rotating by a pin, inserted half inside the block and half in the pad and away from the center. The collar of the bush is made hollow to serve as an oil sump for lubrication of the bearing. Since, it is subjected to heavy thrust loads along the axis of the shaft and operates without clearance between the conjugate parts, an adequate supply of oil to the rubbing surfaces is extremely important for footstep bearings.

## 2.3 PULLEYS

### 2.3.1 PULLEYS, FUNCTION OF PULLEY, TYPES AND MATERIALS OF PULLEY

- **Pulley:** Pulleys are used to transmit power from one shaft to another shaft with the help of belts and ropes at a distance. Pulleys are generally consist of three parts:
  (i) Hub or boss
  (ii) Rim
  (iii)Web or arms

- **Types of Pulley:**
  (1) Stepped Pulley
  (2) Fast and Loose pulley
  (3) V- Belt Pulley

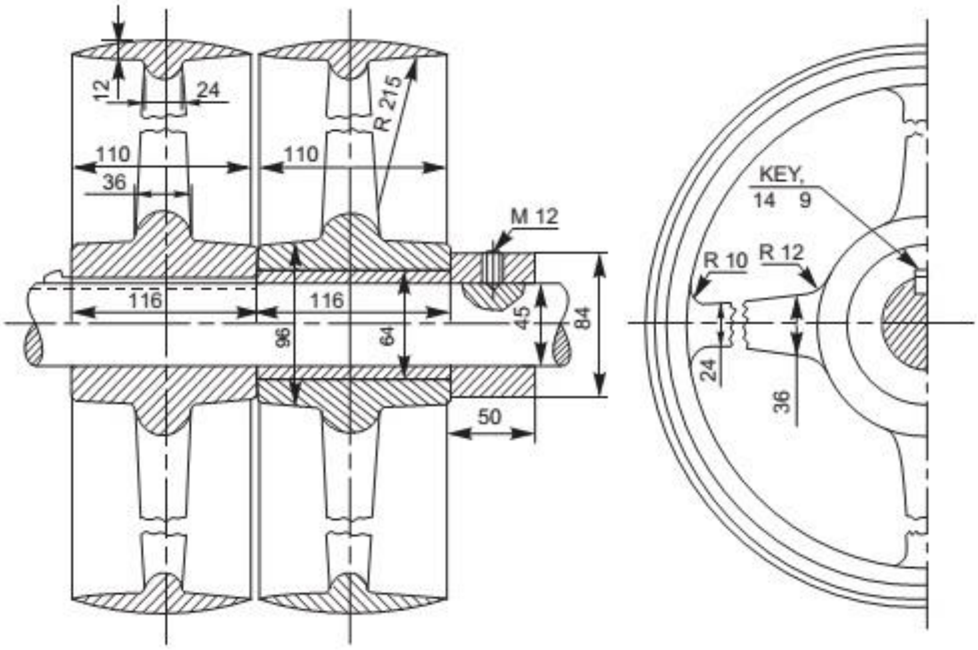
- **Material of Pulley:**
  Pulleys are Generally made of Cast iron, wrought iron, steel and wood.

### 2.3.2 FREE HAND SKETCH OF VARIOUS TYPES OF PULLEYS

- **To be drawn the Students at their own by taking proportionate dimentions**

### 2.3.3 FAST AND LOOSE PULLEY

A fast pulley is keyed to the machine shaft while the loose pulley runs freely. The belt runs over the fast pulley to transmit power by the machine and it is shifted to the loose pulley when the machine is not required to transmit power. By this way, stopping of one machine does not interfere with the other machines which run by the same line shaft. Paper Pulleys, Fast and Loose Pulleys. The loose pulley is provided with a cast iron or gun-metal bush with a collar at one end to prevent axial movement. The rim of the fast pulley is made larger than the loose pulley so that the belt may run slackly on the loose pulley. The loose pulley usually have longer hub in order to reduce wear and friction and it requires proper lubrication. Fast and loose pulley drive, is used when the driven or machine shaft is to be started or stopped when ever desired without interfering with the driving shaft. A pulley which is keyed to the machine shaft is called fast pulley and runs at the same speed as that of machine shaft. A loose pulley runs freely over the machine shaft and is incapable of transmitting any power.



## 2.4 PIPE JOINTS

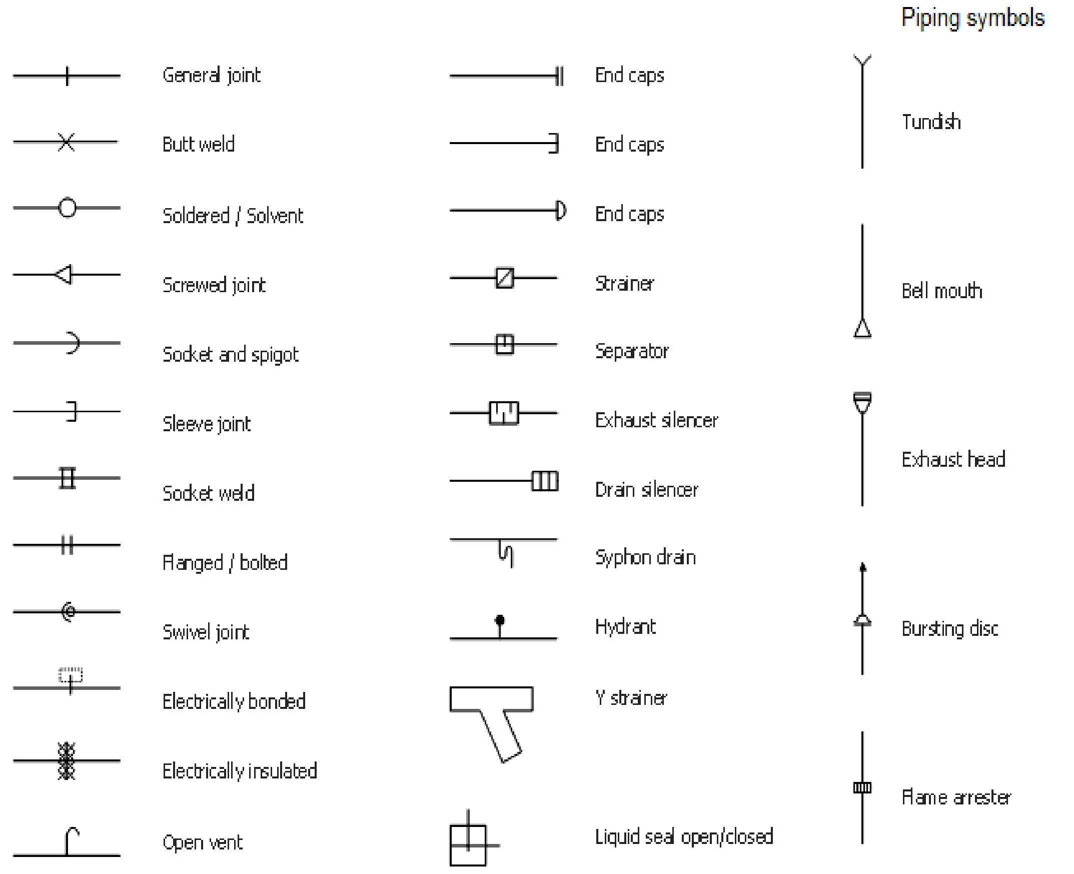
## 2.4.1 TYPES OF PIPE JOINTS, SYMBOL & LINE LAYOUT OF PIPE LINES

- **Pipe Joint :**

  Pipe joints can be connected together to increase the length of pipe or pipes can be connected to different fittings to obtain the required layout. Types of pipe Joints:

  (iv) Cast Iron Flanged Joint
  (v) Socket and Spigot Joint
  (vi) Hydraulic Joint
  (vii) Union Joint
  (viii) Expansion Joint

- **Symbol:**



## 2.4.2 EXPANSION JOINT

The pipe which carry steam at very high pressure have the provision of longitudinal expansion due to change in temperature. The expansion pipe joint is provided with gland and stuffing box to make it steam tight perfectly. The pipe which is inserted in the stuffing box is free to move in the box. To prevent the leakage of steam asbestos packing is used. A brass liner is also attached to prevent corrosion.

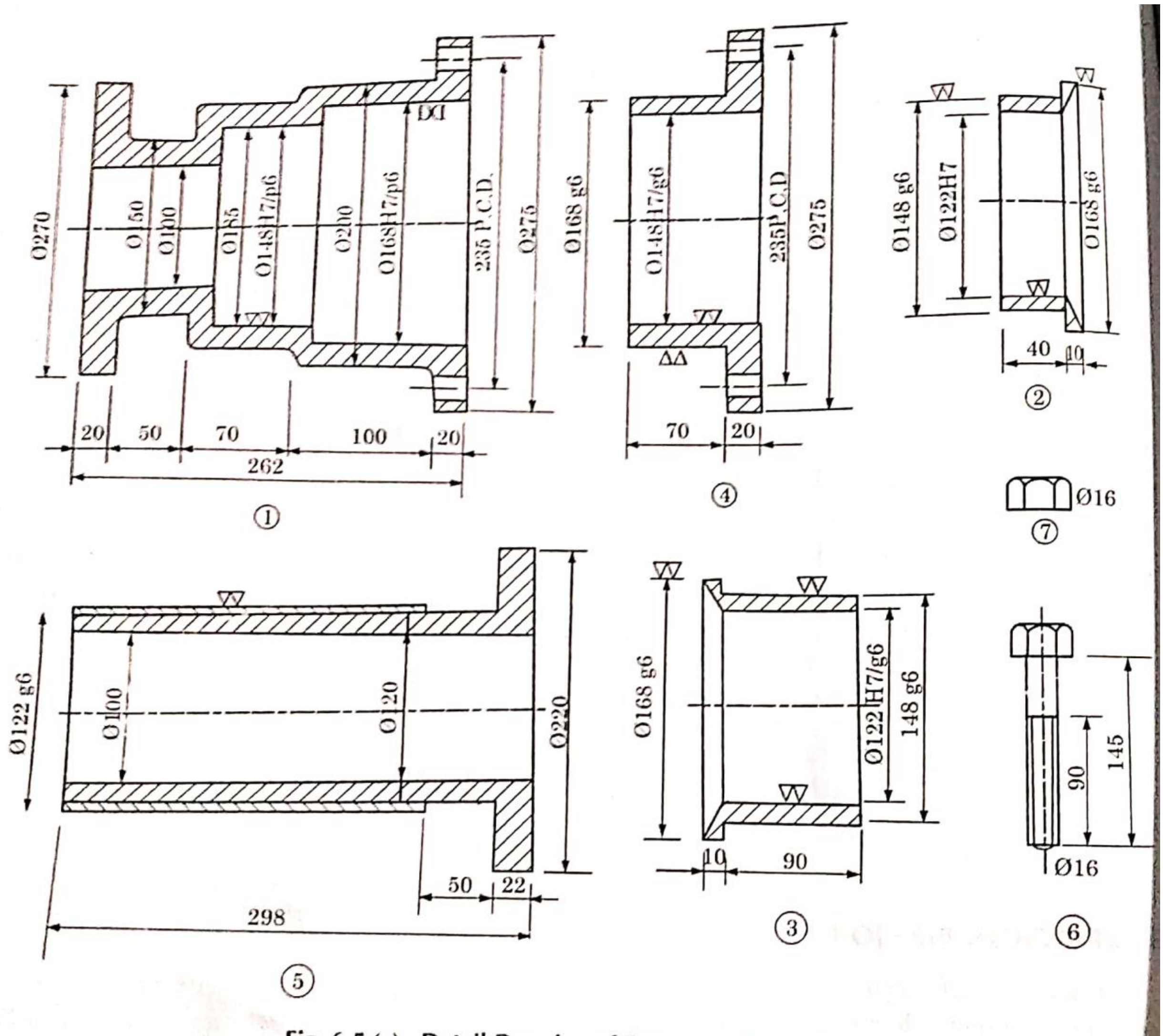



Fig. 6.5 (a) : Detail Drawing of Expansion Pipe Joint

Bill of Materials- Expansion Pipe Joint - Fig. 6.5(*a*)

| Part No. | Name of Part | Material | No. Off. |
|---|---|---|---|
| 1. | Body | C.I. | 1 |
| 2. | Neck bush | Brass | 1 |
| 3. | Gland bush | Brass | 1 |
| 4. | Gland | Brass | 1 |
| 5. | Pipe | C.I. | 1 |
| 6. | Bolt | M.S. | 4 |
| 7. | Nut | M.S. | 4 |

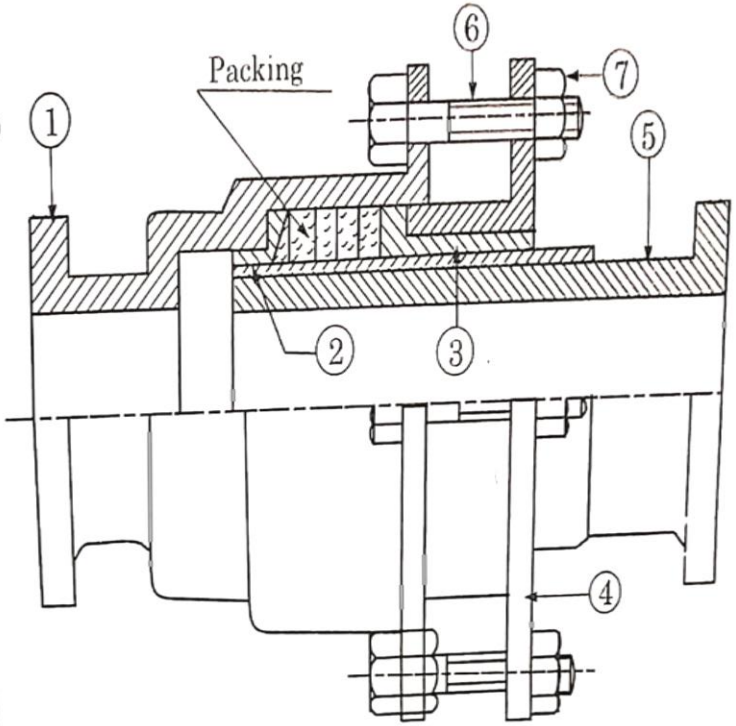
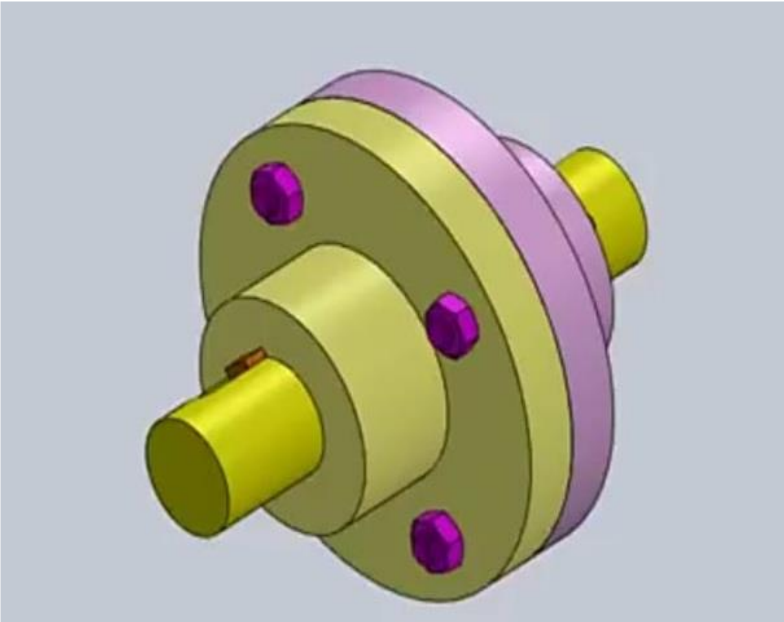
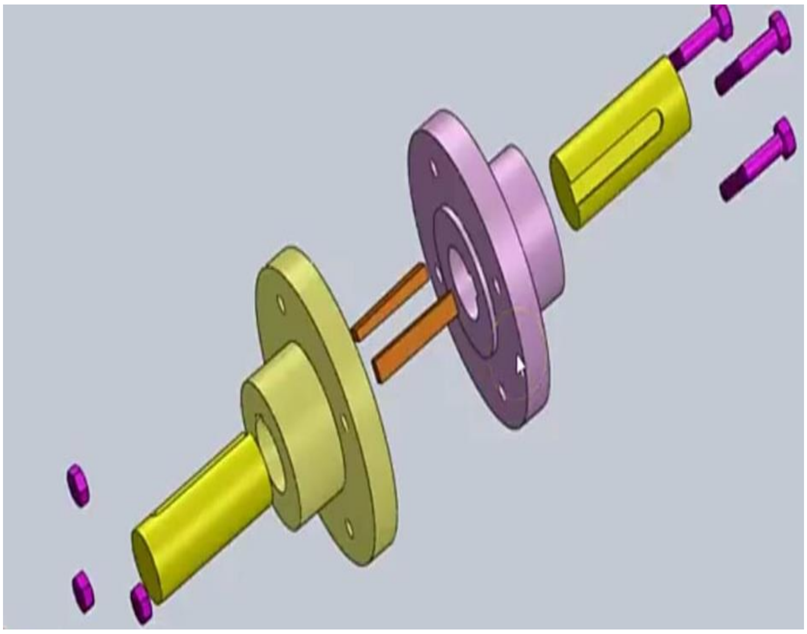


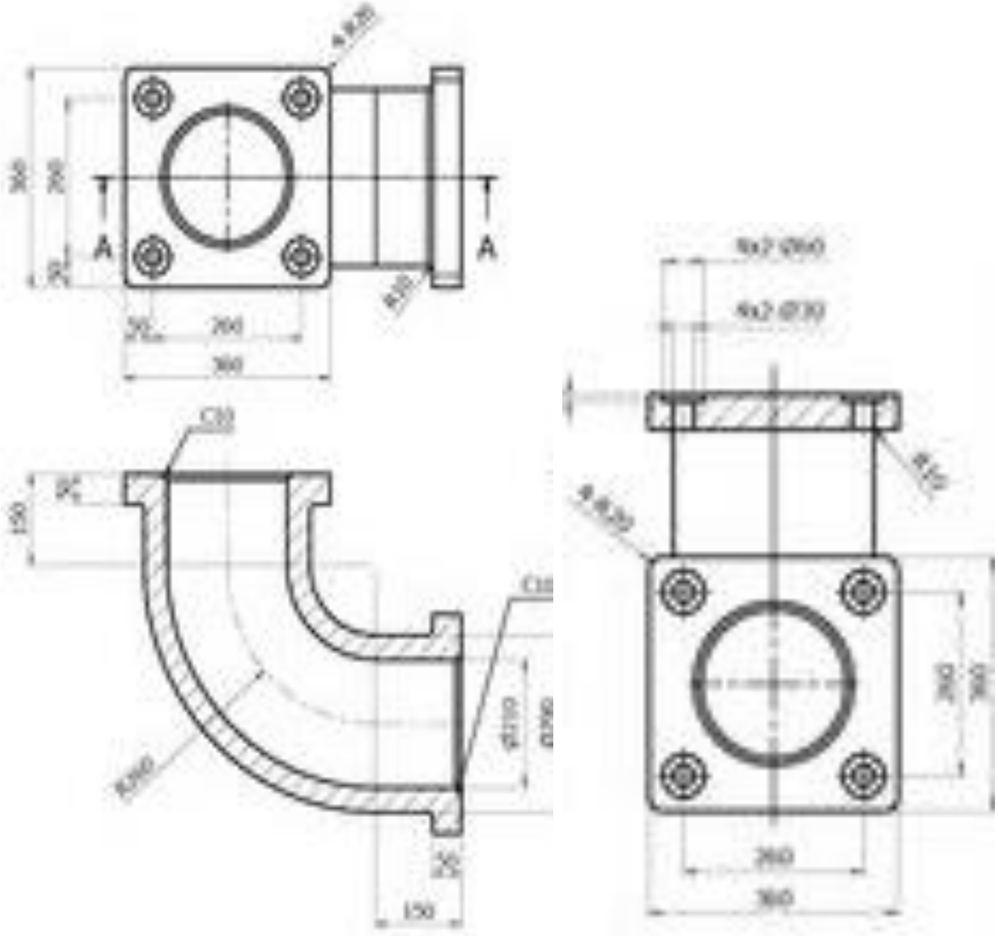

Fig. 6.5 (*b*) : Assembly Drawing of Expansion Pipe Joint

## 2.4.3 FLANGED PIPE AND RIGHT ANGLED BEND JOINT (ASSEMBLY DRAWING)



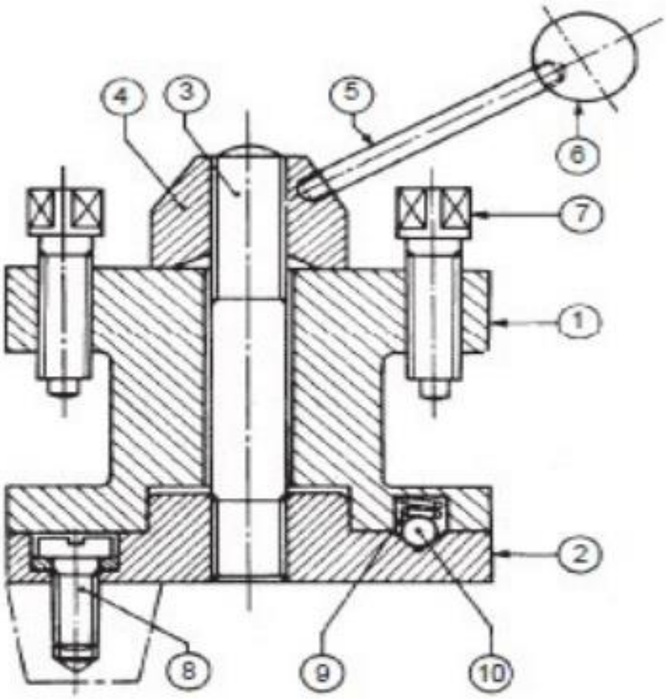


**FLANGED PIPE JOINT**




**RIGHT ANGLED BEND JOINT**

# 2.5 LATHE TOOL HOLDER (ASSEMBLY DRAWING)




## 2.6 READING AND INTERPRETATION OF MECHANICAL COMPONENTS AND ASSEMBLY

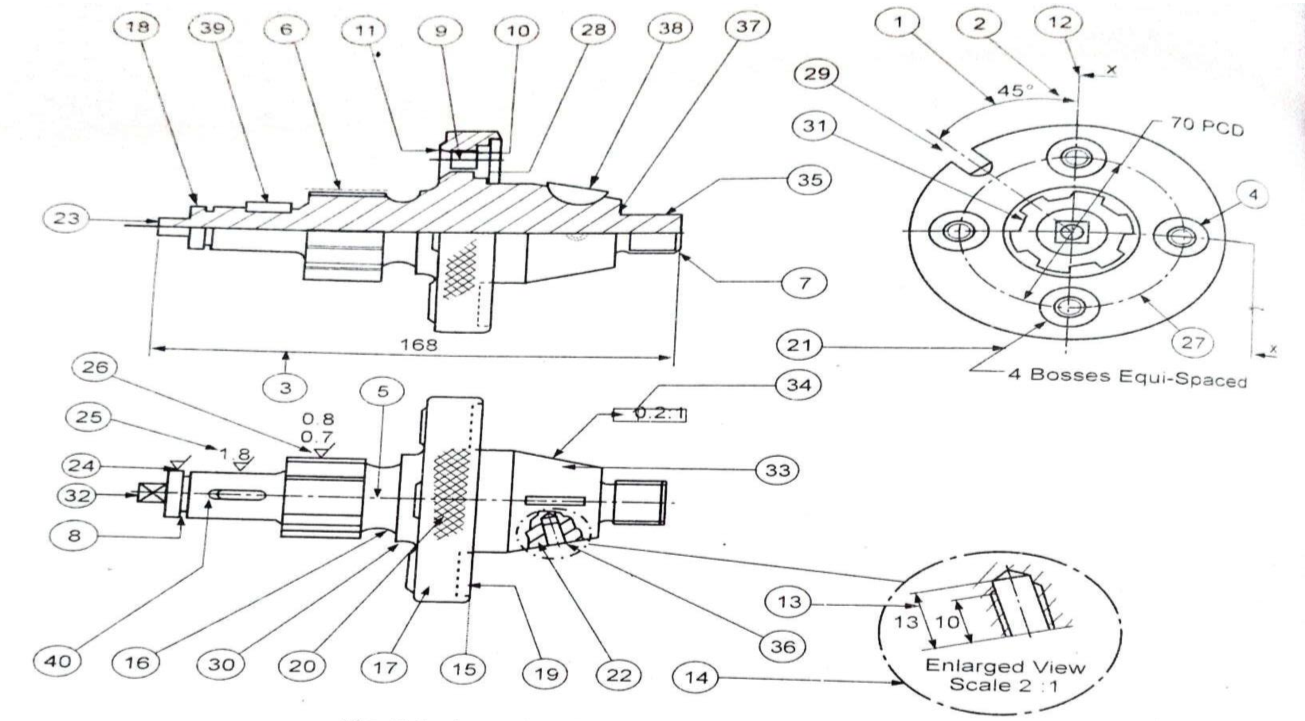
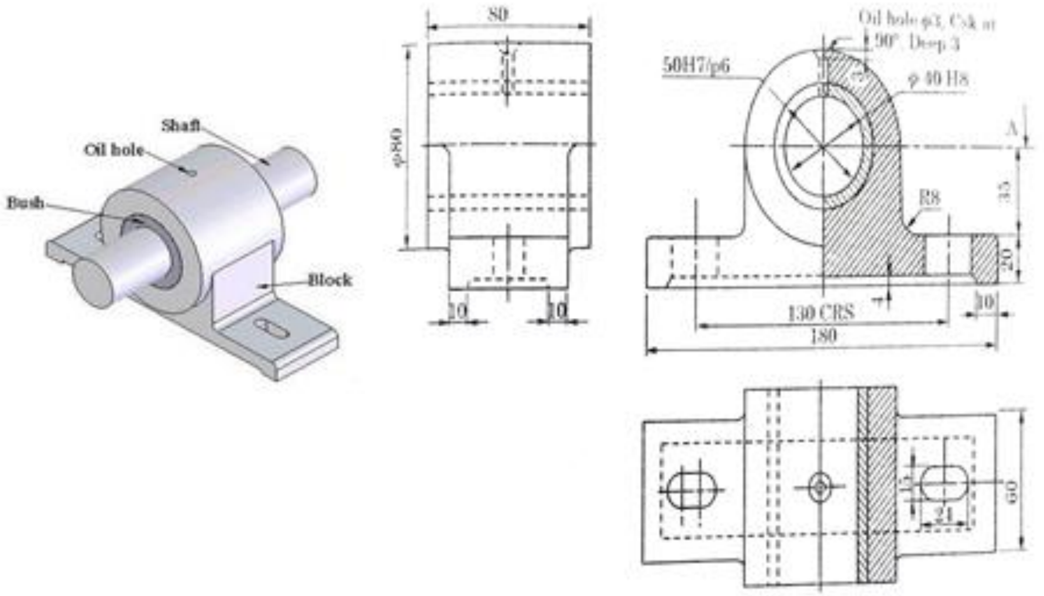



Fig. 7.1 : Important Features in a Machine Drawing

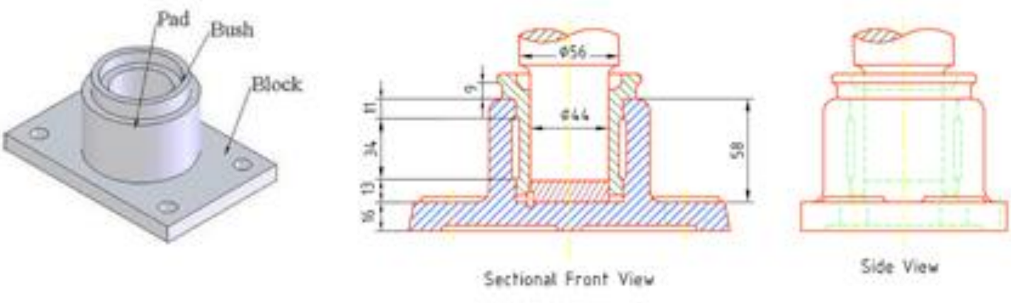
1. Angular Dimension
2. Arrow Head
3. Auxiliary Dimensions
4. Boss
5. Centre Line
6. Chain line
7. Chamfer
8. Circlip Grooves
9. Clearance Hole
10. Counter Bore
11. Countersunk
12. Cutting Plane
13. Dimension Line
14. Enlarged view
15. Round
16. Fillet
17. Flange
18. Hatching
19. Hidden Detail
20. Knurl
21. Leader Line
22. Local Section
23. Machining Centre
24. Machining Symbol
25. Surface Finish
26. Surface Finish
27. Pitch Circle
28. Recess
29. Slot
30. Spigot
31. Spline Shaft
32. Square
33. Taper
34. Taper Symbol
35. External Thread
36. Internal Thread
37. Undercut
38. Woodruff key
39. Key
40. Keyway

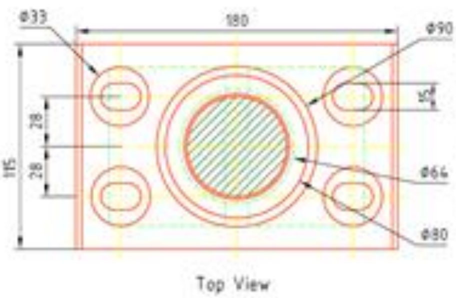
## 2.7 SKETCHING PRACTICE OF BEARINGS AND BRACKET.

# Bushed Bearing



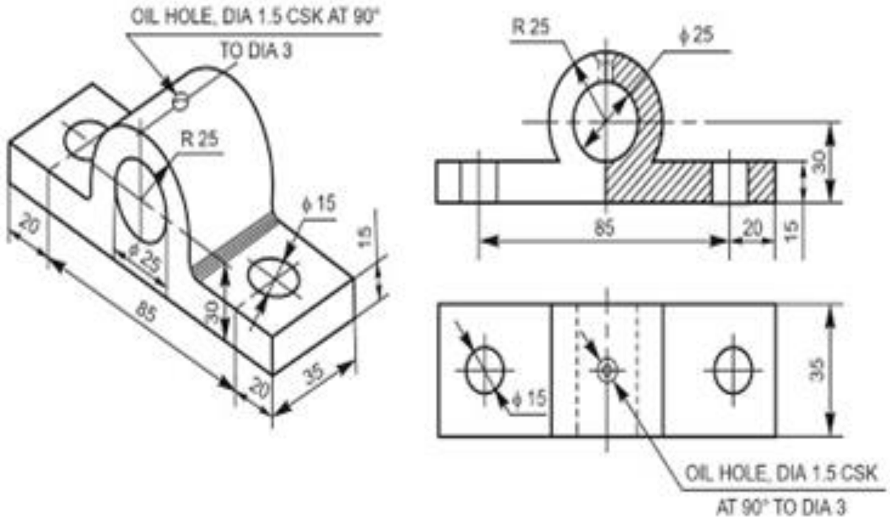

# Foot Step Bearing



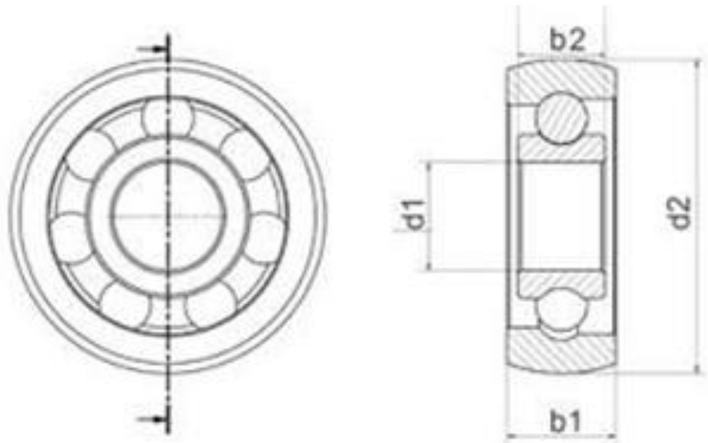




| S.No. | PART NAME | MATERIAL | NO. OFF |
|---|---|---|---|
| 1. | BODY | CAST IRON | 1 |
| 2. | BUSH | BRASS | 1 |
| 3. | DISC OR PAD | BRASS | 1 |
| 4. | SHAFT | STEEL | 1 |

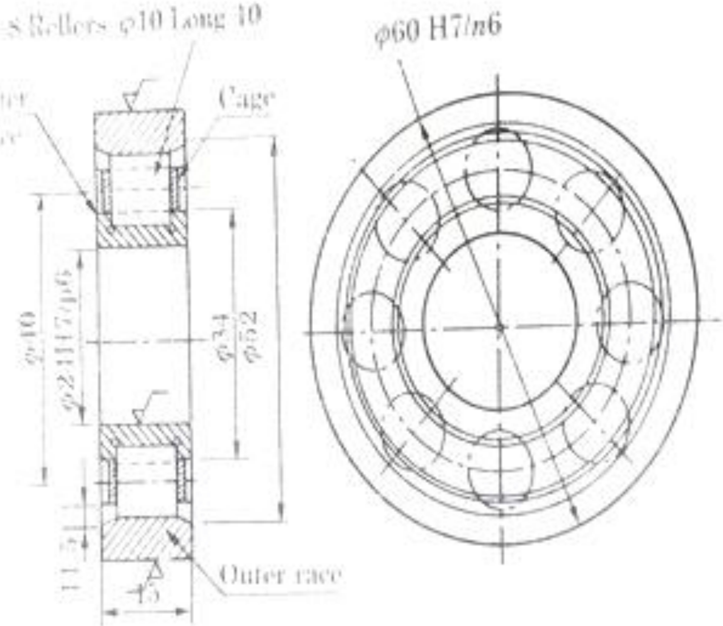
# Simple Journal Bearing



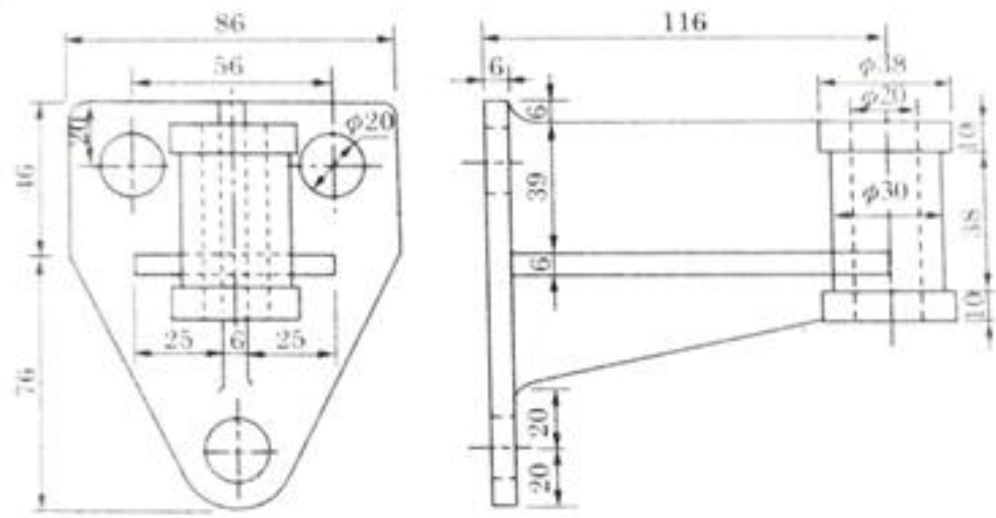

# Ball Bearing



# Roller Bearing

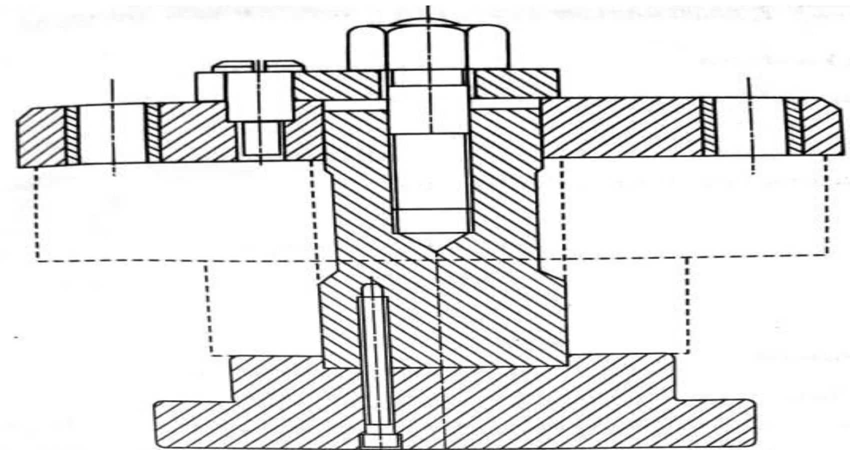



# Wall Bracket

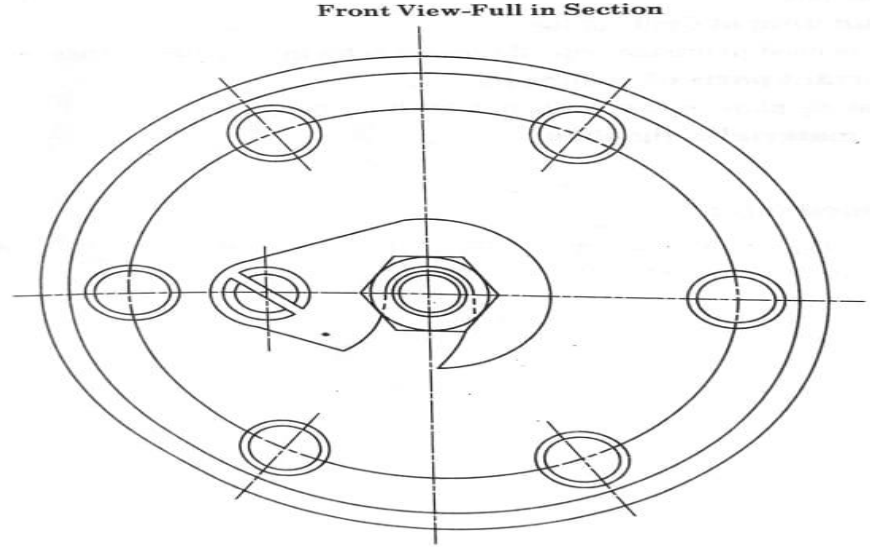


# CONTENTS

# CHAPTER 3.
# Drilling Jig (Assembly Drawing)

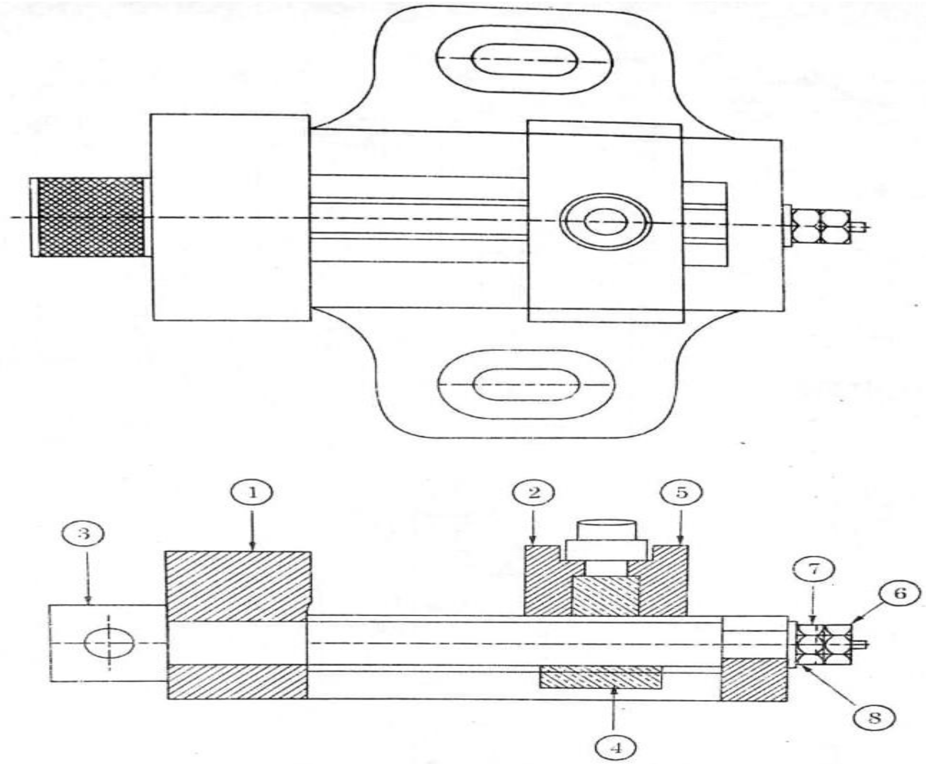


Front View-Full in Section



Top View

# CHAPTER 4. Machine Vice



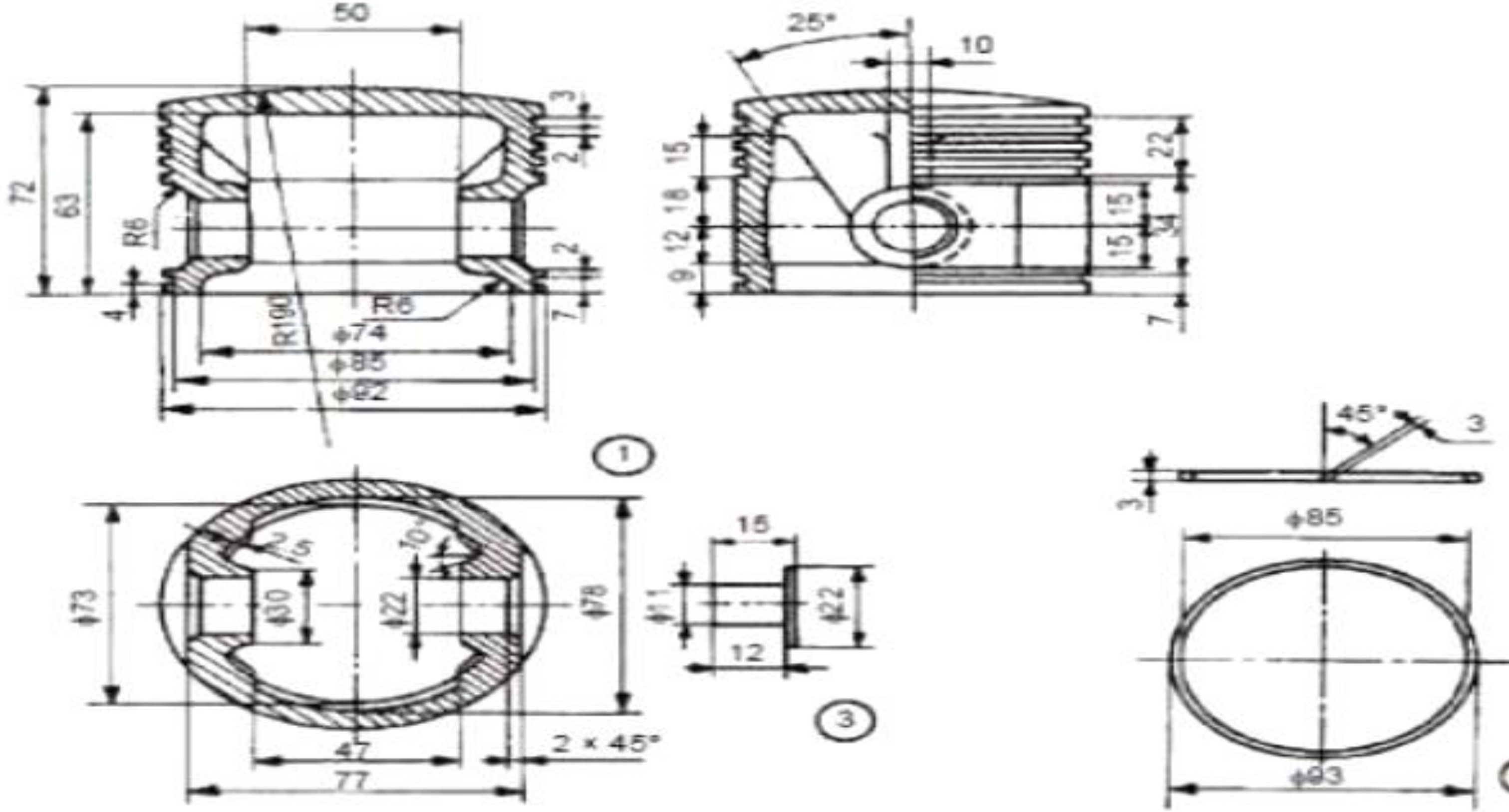

Bill of Materials Machine Vice - Fig. 9.3

| Part No. | Name of Part | Material | No. Off. |
|---|---|---|---|
| 1. | Base | C.I. | 01 |
| 2. | Movable jaw | M.S. | 01 |
| 3. | Screw | M.S | 01 |
| 4. | Movable jaw clamping bolt | M.S | 01 |
| 5. | Circular nut | M.S | 01 |
| 6. | Hexagonal nut | M.S | 01 |
| 7. | Lock nut | M.S | 01 |
| 8. | Washer | M.S | 01 |

# CHAPTER 5. I.C. Engine Parts

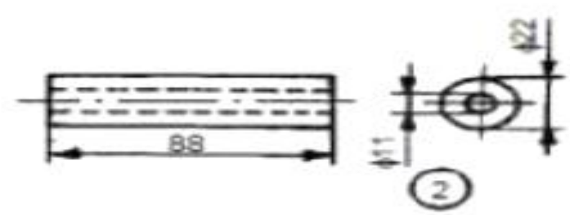
- Piston
- Connecting Rod
- Crank Shaft and flywheel

# Piston
# (Petrol Engine)

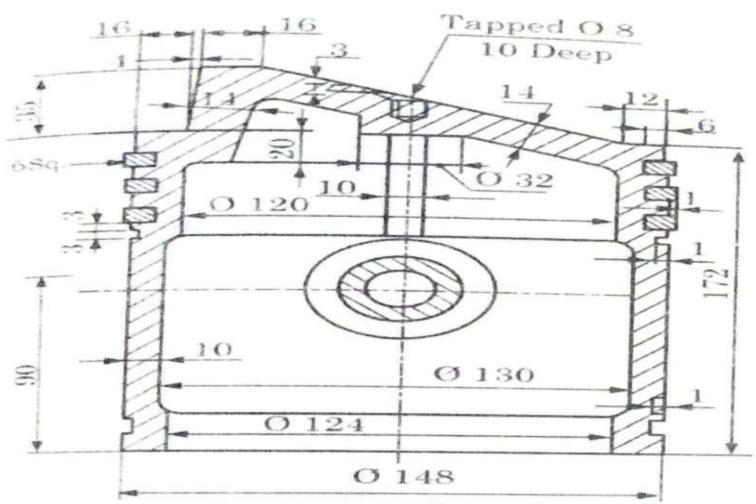



Parts list

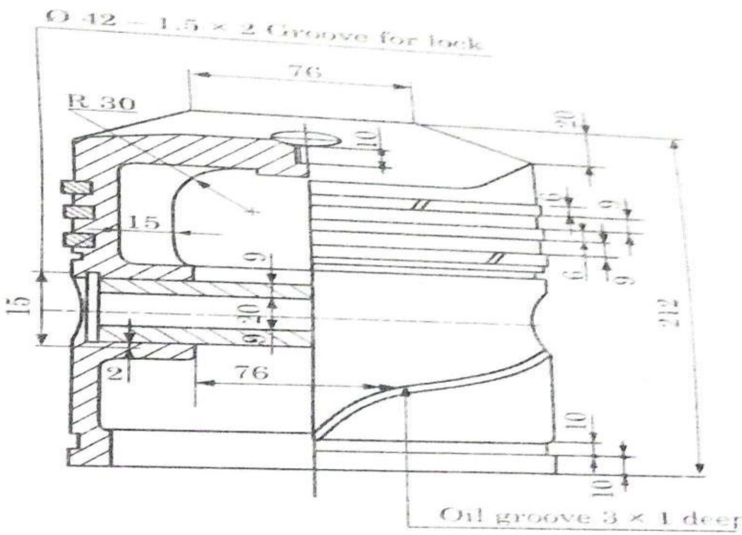
| No. | Name | Matl | Qty |
|---|---|---|---|
| 1 | Piston | Al-alloy | 1 |
| 2 | Piston pin | HCS | 1 |
| 3 | Piston pin plug | HCS | 2 |
| 4 | Piston ring | CI | 5 |



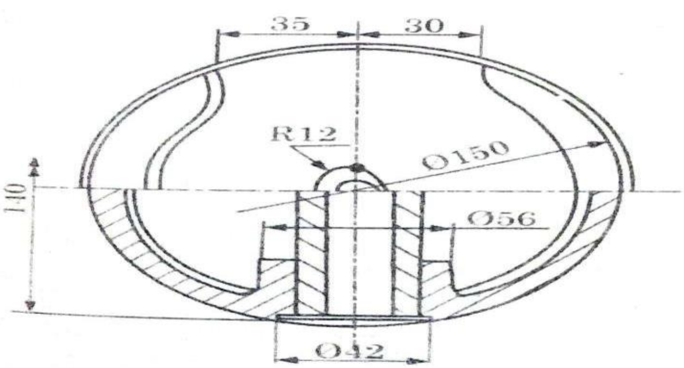
# Piston
# (Diesel Engine)




Sectional Elevation

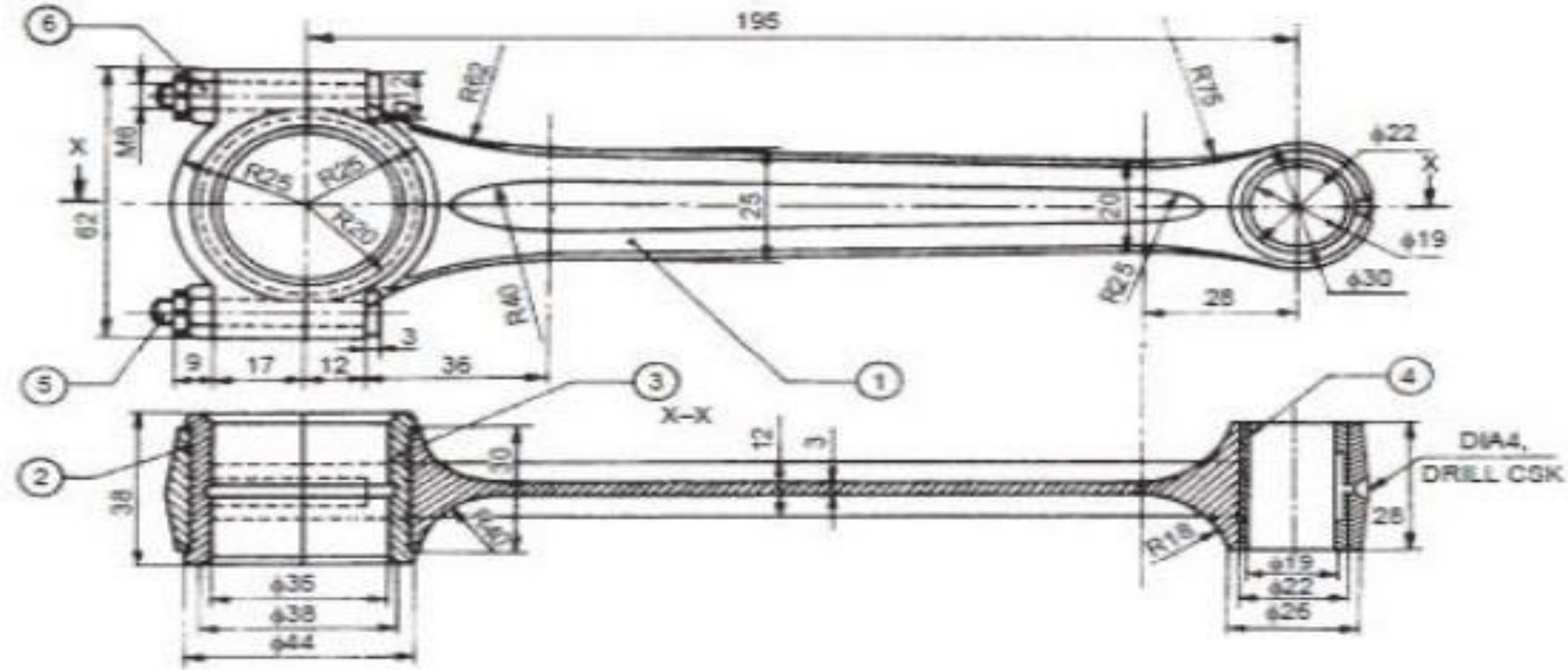



Half Sectional
Side View




Half Sectional Plan

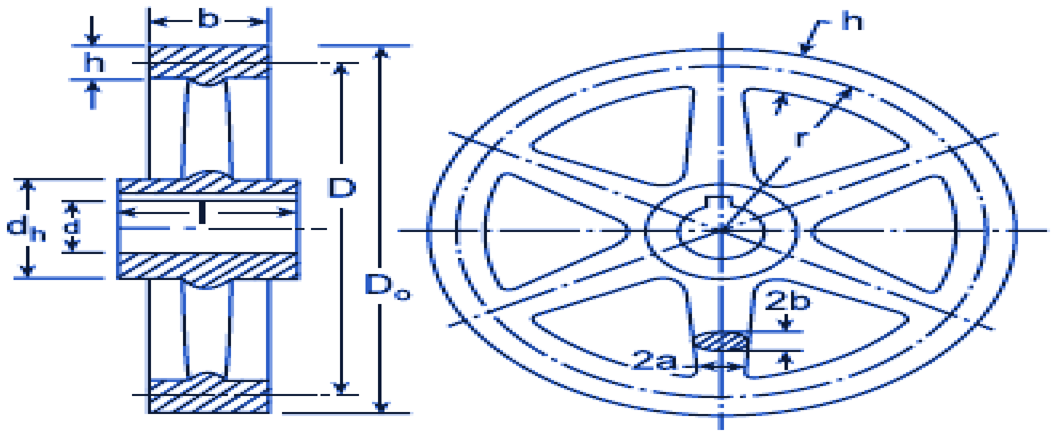
# Connecting Rod



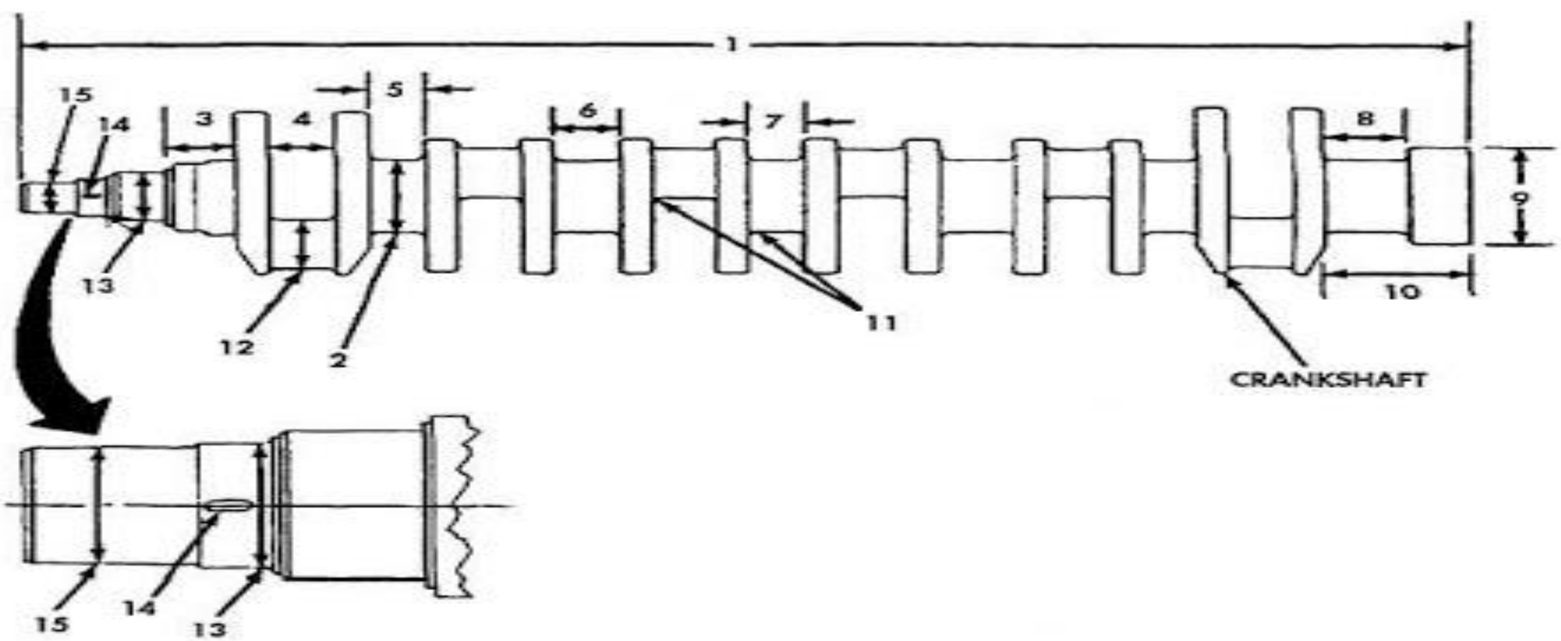

Parts list

| Part No. | Name | Matl. | Qty. |
|---|---|---|---|
| 1 | Rod | FS | 1 |
| 2 | Cap | FS | 1 |
| 3 | Bearing brass | GM | 2 |
| 4 | Bearing bush | P Bronze | 1 |
| 5 | Bolt | MCS | 2 |
| 6 | Nut | MCS | 2 |

# Crank Shaft and Flywheel

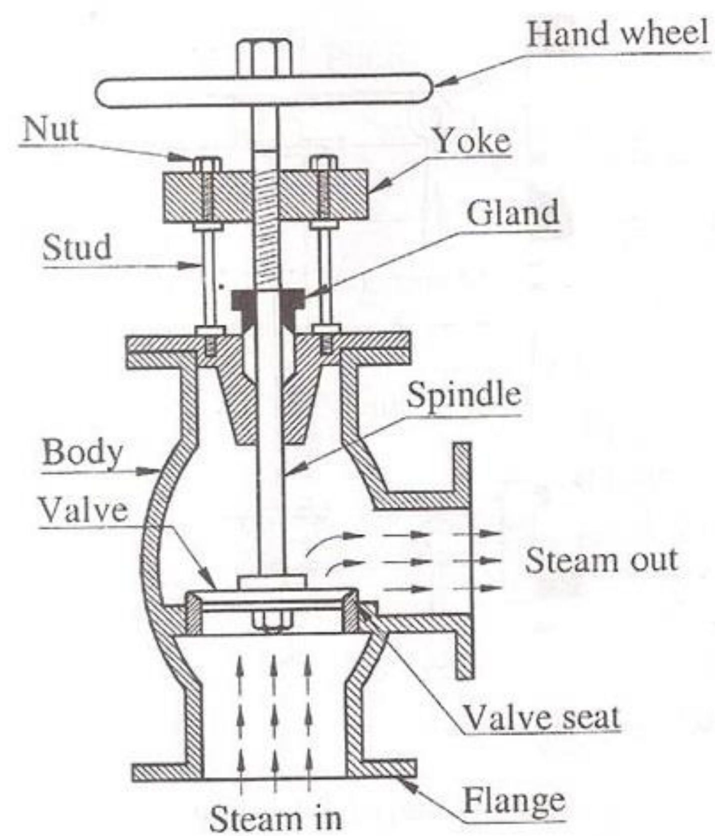



FLYWHEEL



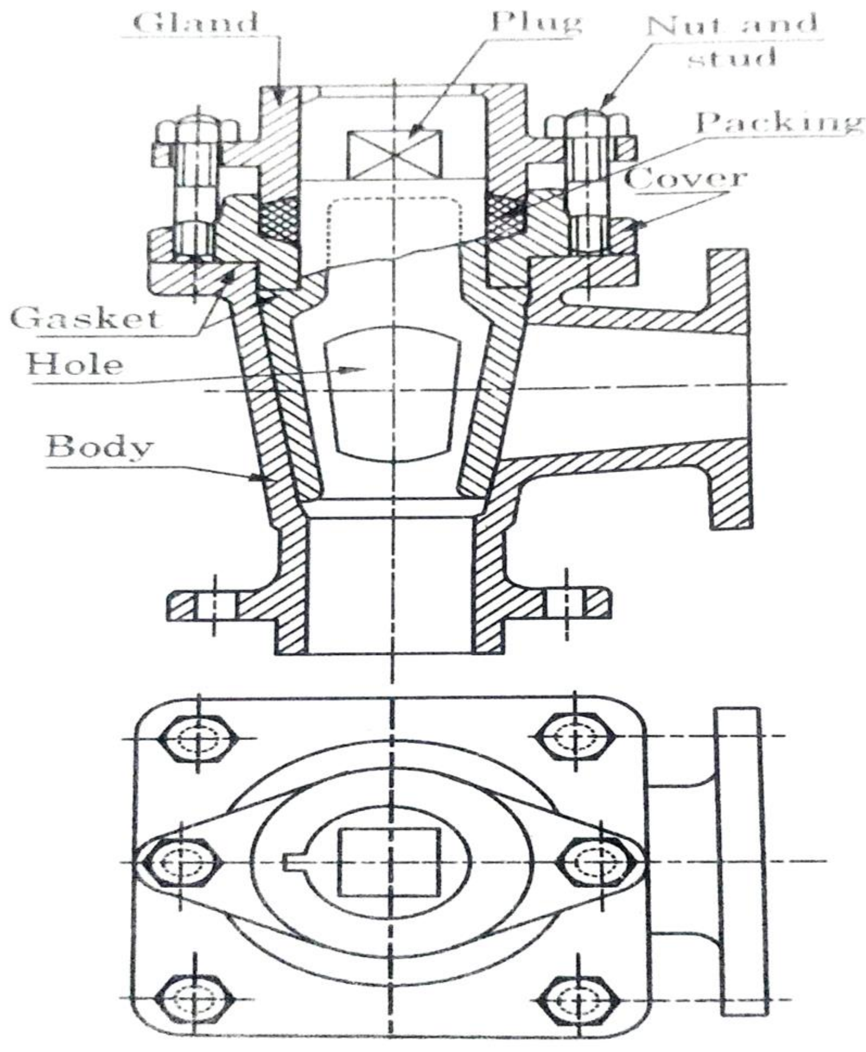
# CHAPTER 6
# Boiler Parts

**Blow Off Cock**

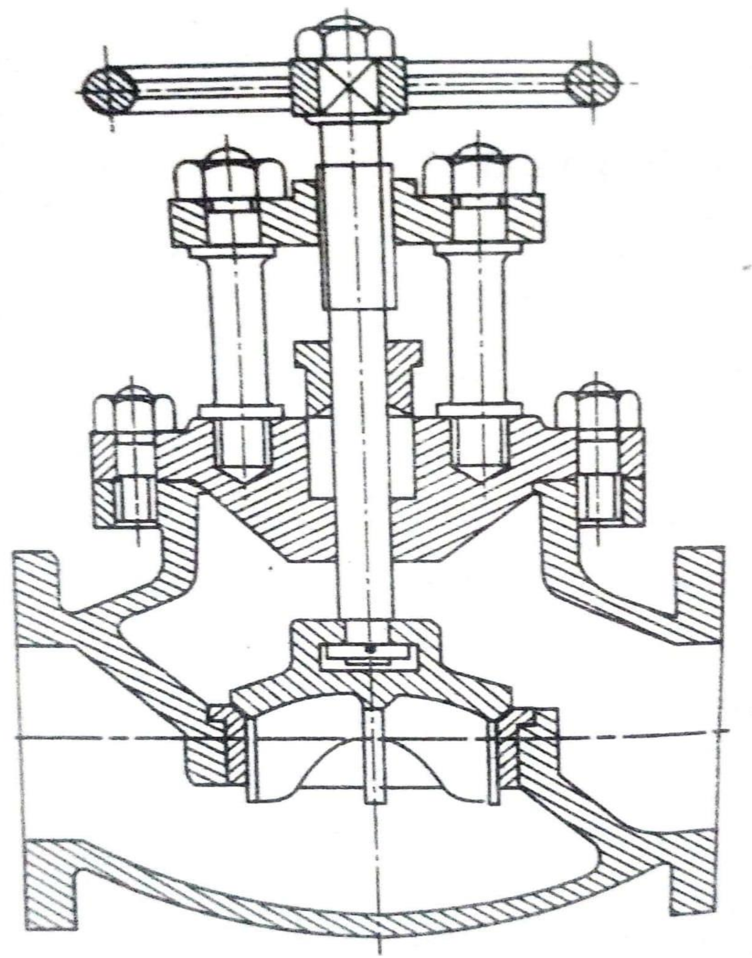



**Steam Stop Valve**

# Blow Off Cock

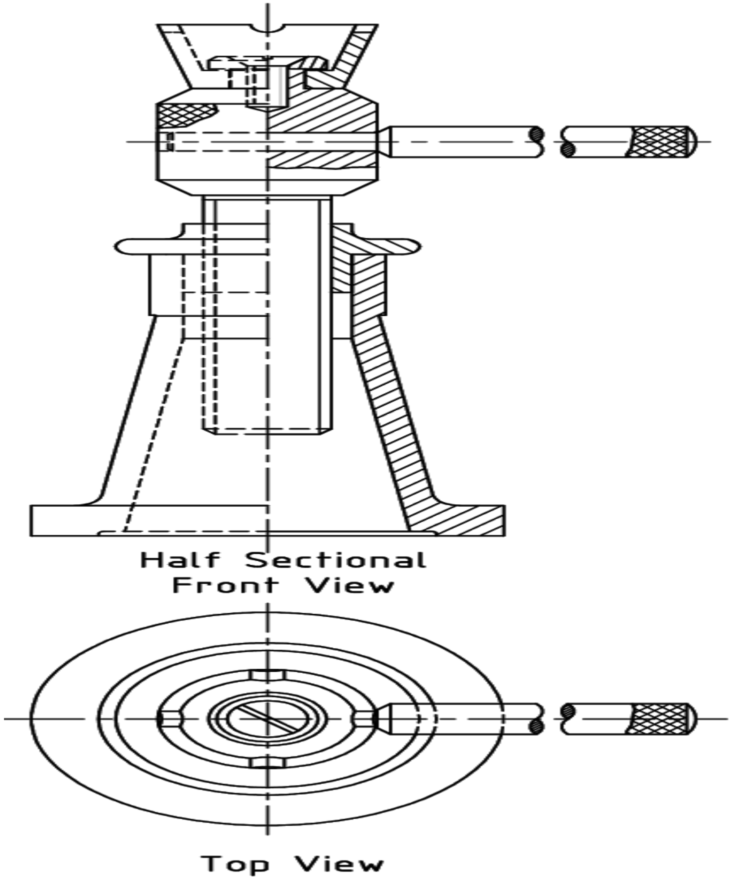


# Steam Stop Valve



# CHAPTER-7

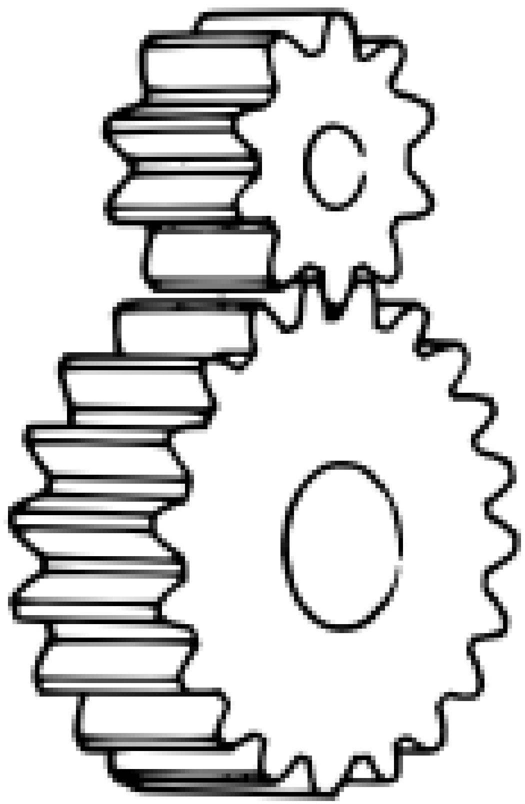
# Mechanical Screw Jack (Assembled Drawing)




ASSEMBLY
DRAWING OF
SCREW JACK

# CHAPTER-8
# Gears

A **gear** is a rotating machine part having cut teeth



# Classification of Gear

The gears can be classified in the following way:-

1. Depending on the relative position of the geometrical axes of the driving and driven shaft
2. Depending upon the housing design.
3. Depending upon the peripheral Velocity.
4. Depending upon the shape of teeth.

# Depending on the relative position of the geometrical axes of the driving and driven shaft

**Parallel Shaft**

1. Spur Gears
2. Helical Gears
3. Herringbone

**Intersecting Shafts**

1. Miter Gears
2. Face Gears
3. Zero Bevel Gears
4. Straight Bevel Gears
5. Spiral Bevel Gears

**Non-parallel, Non Intersecting Shafts**

1. Spiral Gears
2. Hypoid Gears
3. Worm Gears

# Depending upon the housing design

- **Open Drives**:- The gear drive is without a casing and is subjected to the action of dust and dirt.
- **Closed Drives**:- The gear Drives are enclosed in special casings and are protected against dirt and dust and are properly lubricated.

# Depending upon the peripheral Velocity

1. **Low Velocity:** V is < 3 m/s.
2. **Medium Velocity:** V=3 to 15 m/s.
3. **High Velocity:** V is>15 m/s.

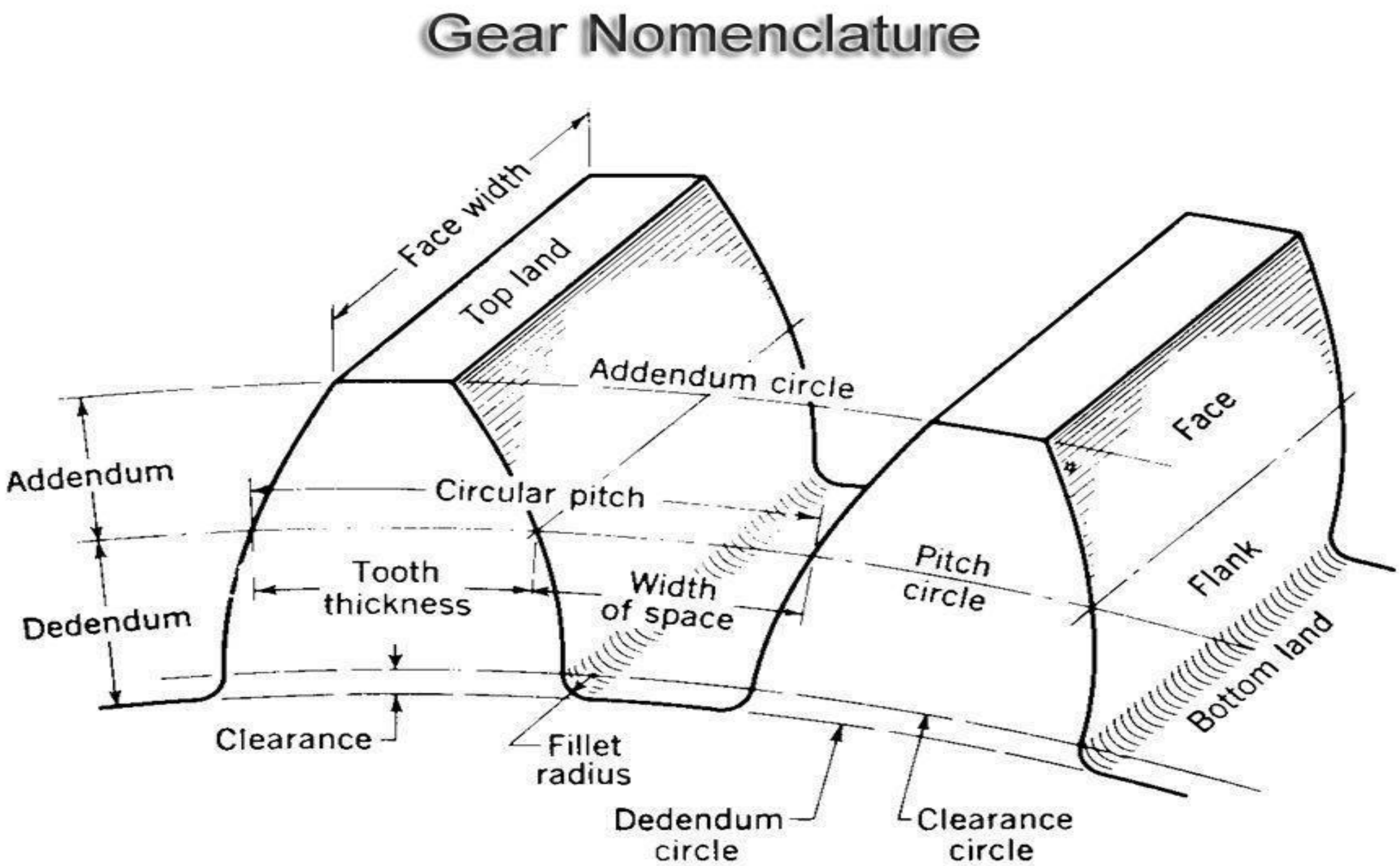
# Depending Upon the Type of Gearing

- External Gearing The teeth are provided on the external surfaces
- Internal Gearing The teeth are provided on the internal surfaces
- Rack and Pinion it has infinite Pitch Diameter

# Depend upon shape of teeth of the Gear

- Straight teeth Gear it has straight Teeth
- Helical teeth Gear it has helical Teeth
- Herringbone Teeth Gear same as double helical gears but there is no space between the opposite sets of teeth
- Curved Teeth Gear the teeth are Curved

# Gear Nomenclature



# Gear Nomenclature

**1. Pitch circle**

Pitch circle is the imaginary circle that rolls without slipping with a pitch circle of a mating gear.

**2. Pitch Circle Diameter**

The pitch circle diameter is the diameter of the pitch circle. It is also known as pitch diameter.

**3. Pressure angle**

Pressure angle is the angle between the common normal at the point of tooth contact and the common tangent to the pitch circle. The usual pressure angles are 14½° and 20°.

**4. Pitch point**

It is a common point of contact between two pitch circles.

**5. Pitch surface**

It is the surface of the imaginary rolling cylinder that the toothed gear may be considered to replace.

# Gear Nomenclature

**6. Addendum**

The addendum is the radial distance of a tooth from the pitch circle to the top of the tooth.

**7. Dedendum**

Dedendum is the circle drawn through the bottom of the teeth. It is also called “root circle”.

**8. Addendum circle**

It is the circle drawn through the top of the teeth and it is concentric with the pitch circle.

**9. Dedendum circle**

It is the circle drawn through the bottom of the tooth. It is also called “root circle”.

**10. Base Circle**

The base circle of involute gear is the circle from which involute tooth profiles are determined.

# Gear Nomenclature

**11. Circular pitch**

The circular pitch is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth. It is denoted by Pc.

**$Pc = \pi d/T$**

D = diameter of the circle

T = No. of teeth on the wheel

**12. Diametral Pitch**

It is the ratio of a number of teeth to the pitch circle diameter. It is indicated by Pd.

**$Pd = T/d = \pi/Pc$**

**$Pc = \pi d/T$**

Where,

T= No. of teeth,

d= Pitch circle diameter.

**13. Module**

A module is the ratio of pitch circle diameter by m. $m= d/T$

**14. Clearance**

Clearance is the difference between the dedendum of one gear and the addendum of the mating gear.

# Gear Nomenclature

**15. Total Depth**

Total depth is the radial distance between the addendum and the dedendum of a gear. It is equal to the sum of addendum and dedendum.

**16. Working Depth**

It is the radial distance from the addendum circle to the clearance circle. It is equal to the sum of the addendum of the two meshing gears.

**17. Tooth thickness**

Tooth thickness is the width of the tooth measured along the pitch circle.

**18. Tooth space**

Tooth space is the width of space between the two adjacent teeth measured along the pitch circle.

**19. Face of the tooth**

It is the surface of the tooth above the pitch surface.

**20. Flank of the tooth**

The flank of the tooth is the surface of the tooth below the pitch surface.

# Gear Nomenclature

**21. Top land**

The top land is the surface of the top of the tooth.

**22. Face width**

Face width is the width of the gear tooth measured parallel to its axis.

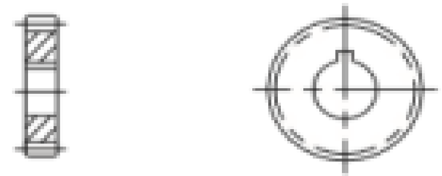
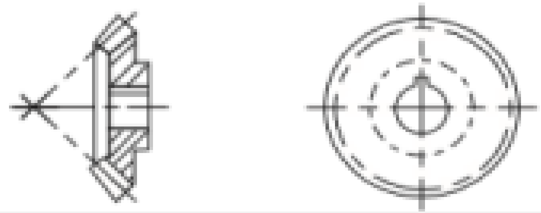
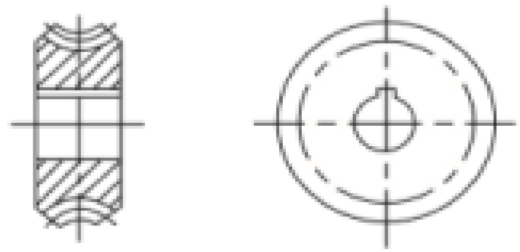
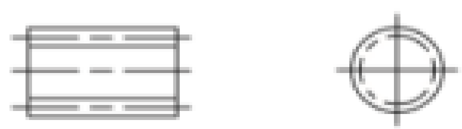
**23. Profile**

It is the curve formed by the face and flank of the tooth.

**24. Backlash**

Backlash is the difference between the thickness of a tooth and the width of a tooth space on which it meshes.

# Convention of Gears

| Title | Convention |
|---|---|
| Spur gear |  |
| Bevel gear |  |
| Worm wheel |  |
| Worm |  |

# Draw the actual profile of involutes teeth of spur gear by different methods

There are two methods given of construction of Spur gear profile

- Tracing Paper Method
- Base Circle Method

# Draw the actual profile of involutes teeth of spur gear by different methods

**Problem 13.1. Draw the profile of involute teeth for a gear having 22 teeth and diametral pitch 0.1 tooth/mm. Assume pressure angle = 20°. Use tracing paper method.**

Solution. Given, $T = 22,\ P_d = 0.1$ tooth/mm, $\phi = 20°$

$$\text{Module, } m = \frac{1}{P_d} = \frac{1}{0.1} = 10 \text{ mm}$$

Pitch circle diameter, $d = m \times T$

$= 10 \times 22 = 220$ mm

Circular pitch, $P_c = \pi \times m$

$= \pi \times 10 = 31.4$ mm

Addendum $= 1\text{ m} = 10$ mm

Addendum circle diameter $= d + 2 \times \text{Addendum}$

$= 220 + 2 \times 20 = 240$ mm

Clearance $= 0.157\text{ m} = 0.157 \times 10 = 1.57$ mm

Dedendum $= \text{Addendum} + \text{Clearance} = 10 + 1.57 = 11.57$ mm

Dedendum circle diameter $= d - 2 \times \text{Dedendum} = 220 - 2 \times 11.57 = 196.86$ mm

$$\text{Tooth thickness} = \frac{P_c}{2} = \frac{31.4}{2} = 15.7 \text{ mm}$$

$$\text{Fillet radius} = \frac{P_c}{8} = \frac{31.4}{8} = 3.9 \text{ mm}$$

# Draw the actual profile of involutes teeth of spur gear by different methods

**Problem 13.1. Draw the profile of involute teeth for a gear having 22 teeth and diametral pitch 0.1 tooth/mm. Assume pressure angle = 20°. Use tracing paper method.**