



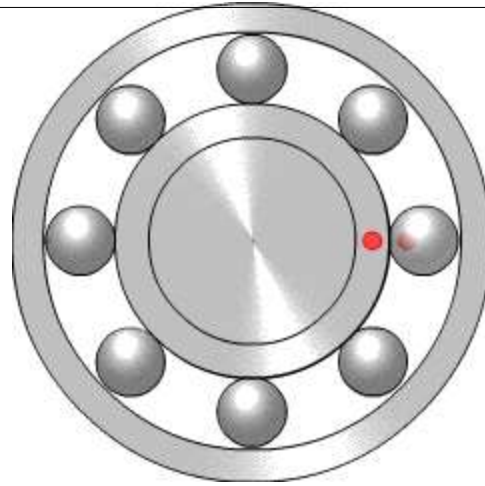
**IPS ACADEMY,
INSTITUTE OF ENGINEERING & SCIENCE, INDORE
DEPARTMENT OF MECHANICAL ENGINEERING**

1

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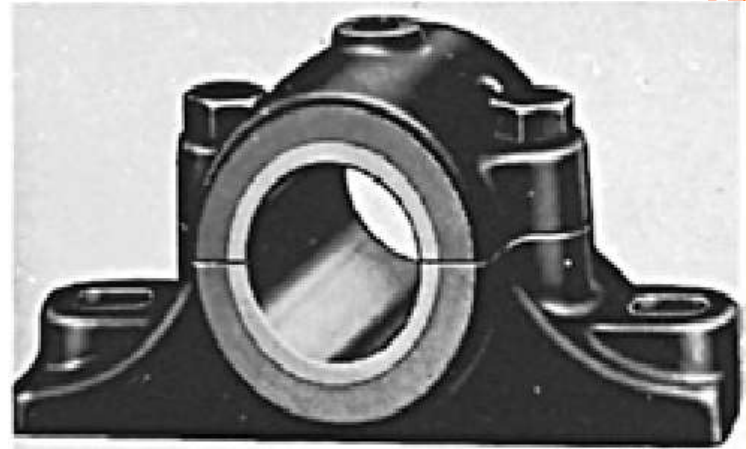
BEARING

FUNCTION OF A BEARING

- The main function of a rotating shaft is to transmit power from one end of the line to the other.
 - It needs a good support to ensure stability and frictionless rotation. The support for the shaft is known as “**bearing**”.
- The shaft has a “**running fit**” in a bearing. All bearing are provided some lubrication arrangement to reduced friction between shaft and bearing.

BEARINGS ARE CLASSIFIED UNDER TWO MAIN CATEGORIES:

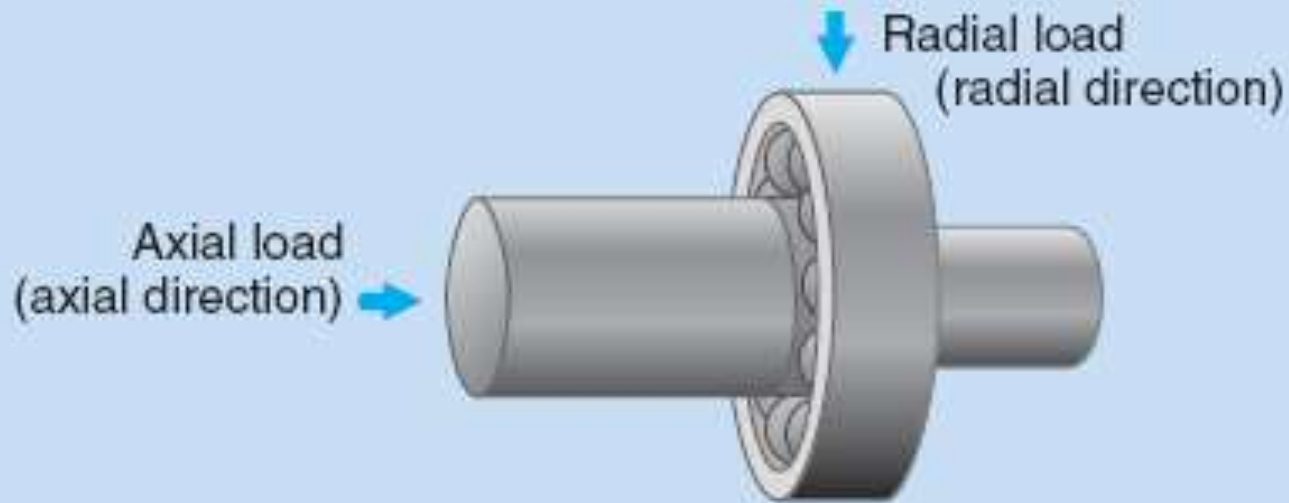
- **Plain or slider bearing :** -
 - In which the rotating shaft has a sliding contact with the bearing which is held stationary . Due to large contact area friction between mating parts is high requiring greater lubrication.
- **Rolling or anti-friction bearing :** -
 - Due to less contact area rolling friction is much lesser than the sliding friction , hence these bearings are also known as **antifriction bearing**.





Rolling or anti-friction bearing

Load Direction and Name



BALL AND ROLLER BEARINGS

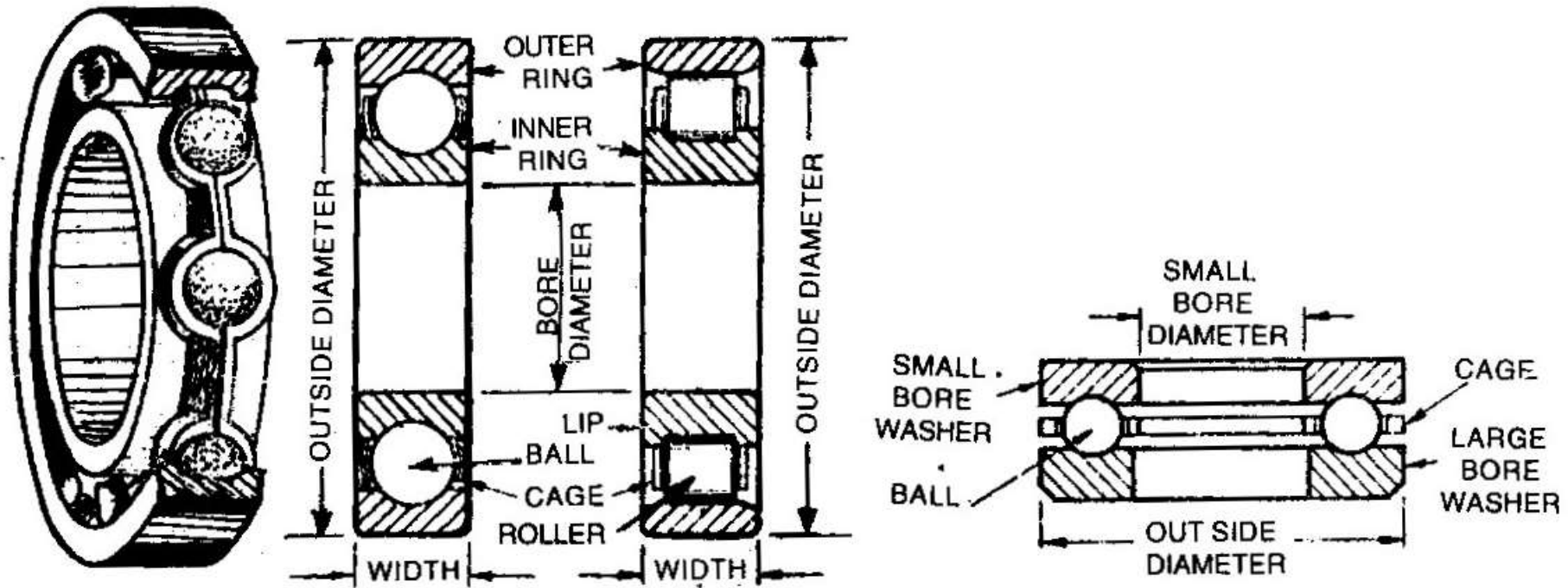
DUE TO LOW ROLLING FRICTION THESE BEARINGS ARE APTLY CALLED
“ANTIFRICTION” BEARING.

- Frictional resistance considerably less than in plain bearings
- Rotating – non-rotating pairs separated by balls or rollers
- Ball or rollers has rolling contact and sliding friction is eliminated and replaced by much lower rolling friction.
- In plain bearing the starting resistance is much larger than the running resistance due to absence of oil film.
- In ball and rolling bearings the initial resistance to motion is only slightly more than their resistance to continuous running.
- Hence ball and rolling bearing are more suitable to drives subject to frequent starting and stopping as they save power.
- Owing to the low starting torque, a low power motor can be used for a line shaft running in ball bearing.

TYPES OF ROLLING BEARING

- Single row deep-groove ball bearing:
 - Incorporating a deep hardened raceway which makes them suitable for radial and axial loads in either direction, provided the radial loads are greater than the axial loads.
- Single row roller bearing:
 - Roller bearing have a greater load-carrying capacity than ball bearing of equivalent size as they make line contact rather than point contact with their rings.
 - Not suitable for axial loading, cheaper to manufacture, used for heavy and sudden loading, high speed and continuous service.

BALL AND ROLLER BEARING



(a) Ball bearing

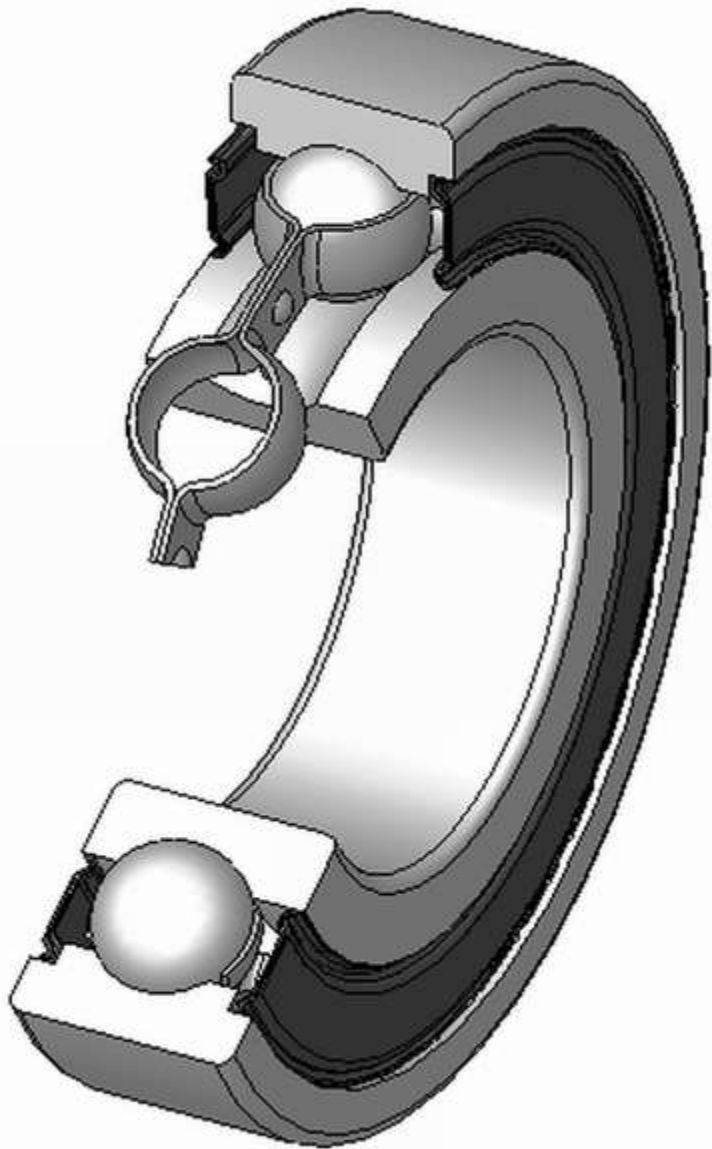
(b) Roller bearing

(c) Thrust ball bearing

Ball and roller bearing

Races and balls are high carbon chrome steel (to provide resistance to wear) machined and ground to fine limits of 0.0025 mm, highly polished and hardened.

The cages are made of low-carbon steel, bronzes or brasses, though for high temperature application case-hardened and stainless steels are used.

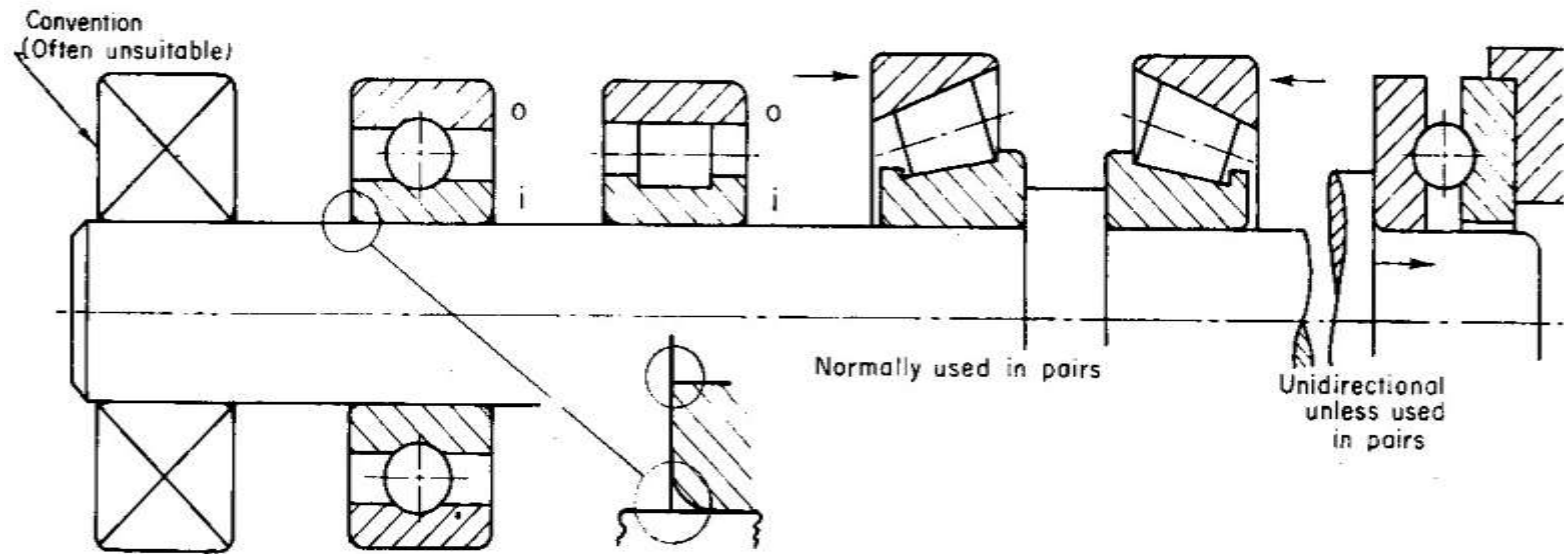


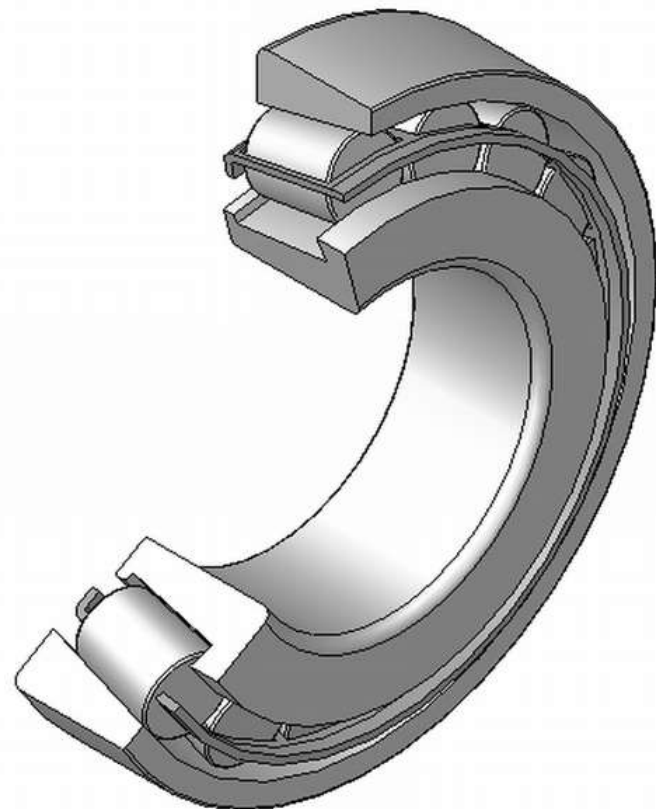
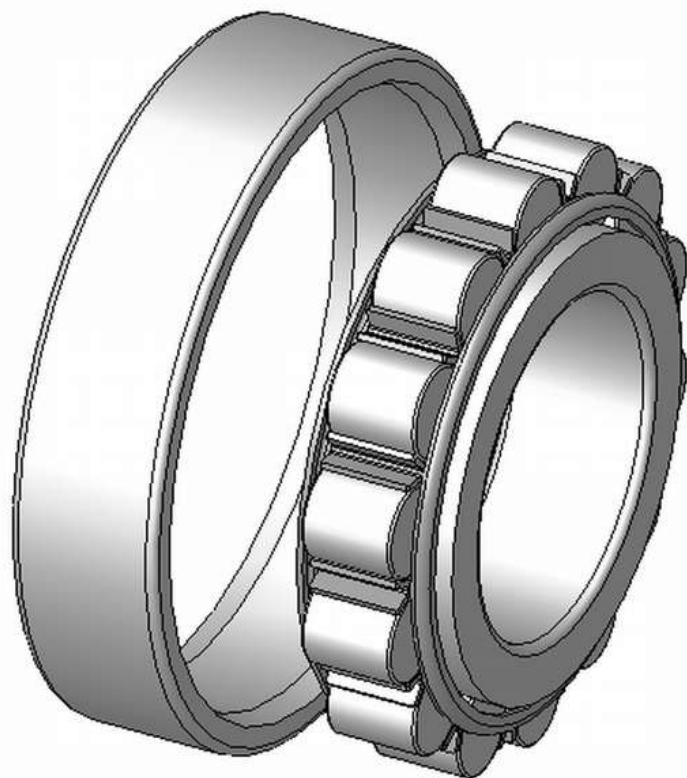
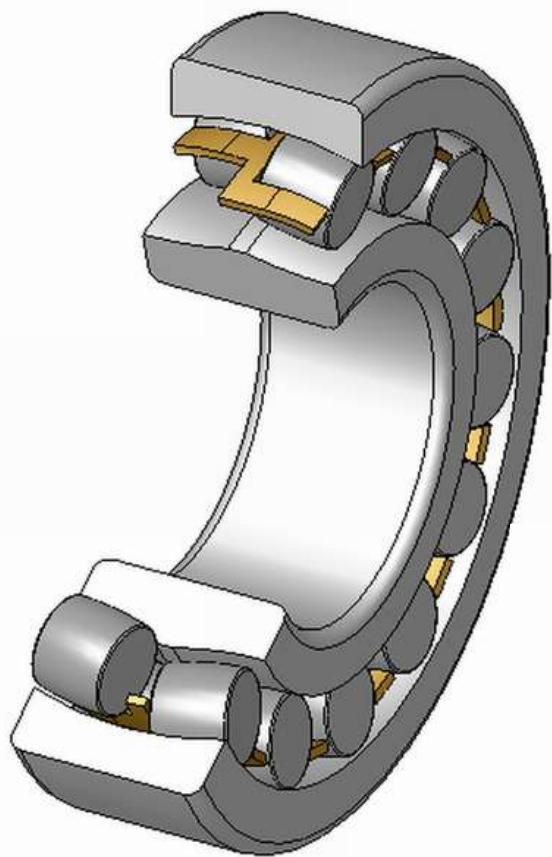
The ball and roller bearing consists of following parts:

- Inner ring or race which fits on the shaft.
- Outer ring or race which fits inside the housing.
- Ball and roller arranged between the surfaces of two races. These provide rolling action between the races.
 - the radius of the track for balls is slightly greater 5 to 10 % than that of the ball themselves.
 - Note that the rotating surfaces rotate in opposite directions.
- Cage which separates the balls or rollers from one another.

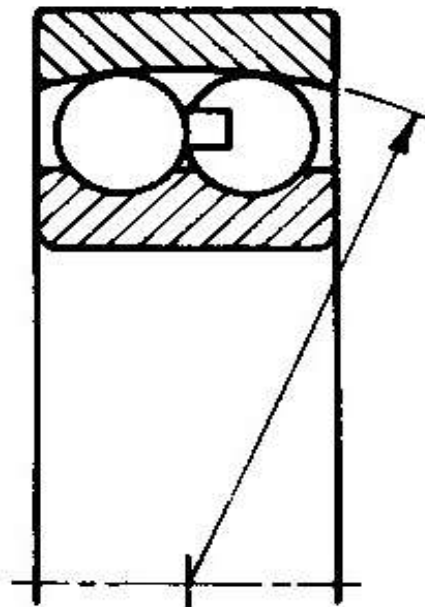
The **disadvantage** of the ball and roller bearings are high cost, they cannot be used in half, and greater noise.

TYPES OF BEARING

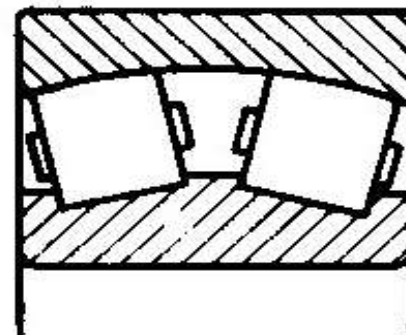
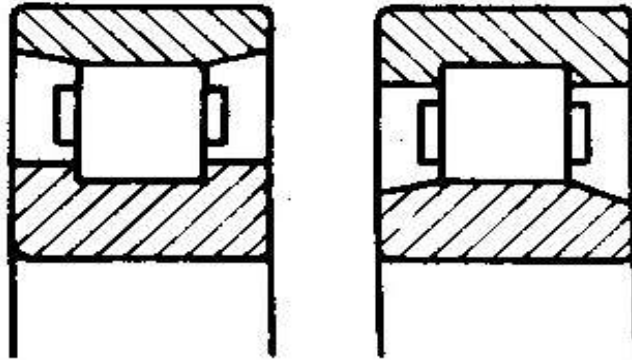




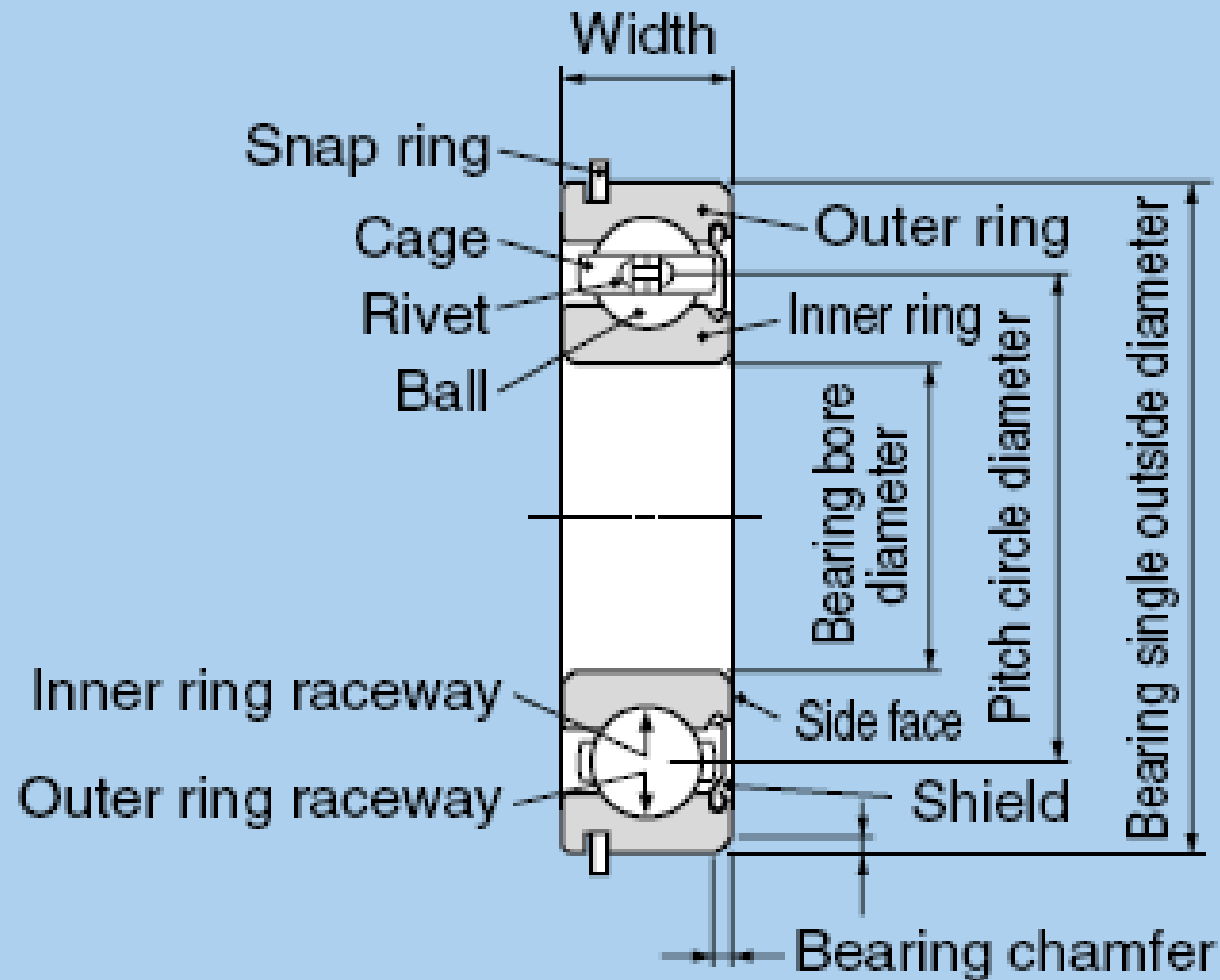
TYPES OF BALL BEARINGS



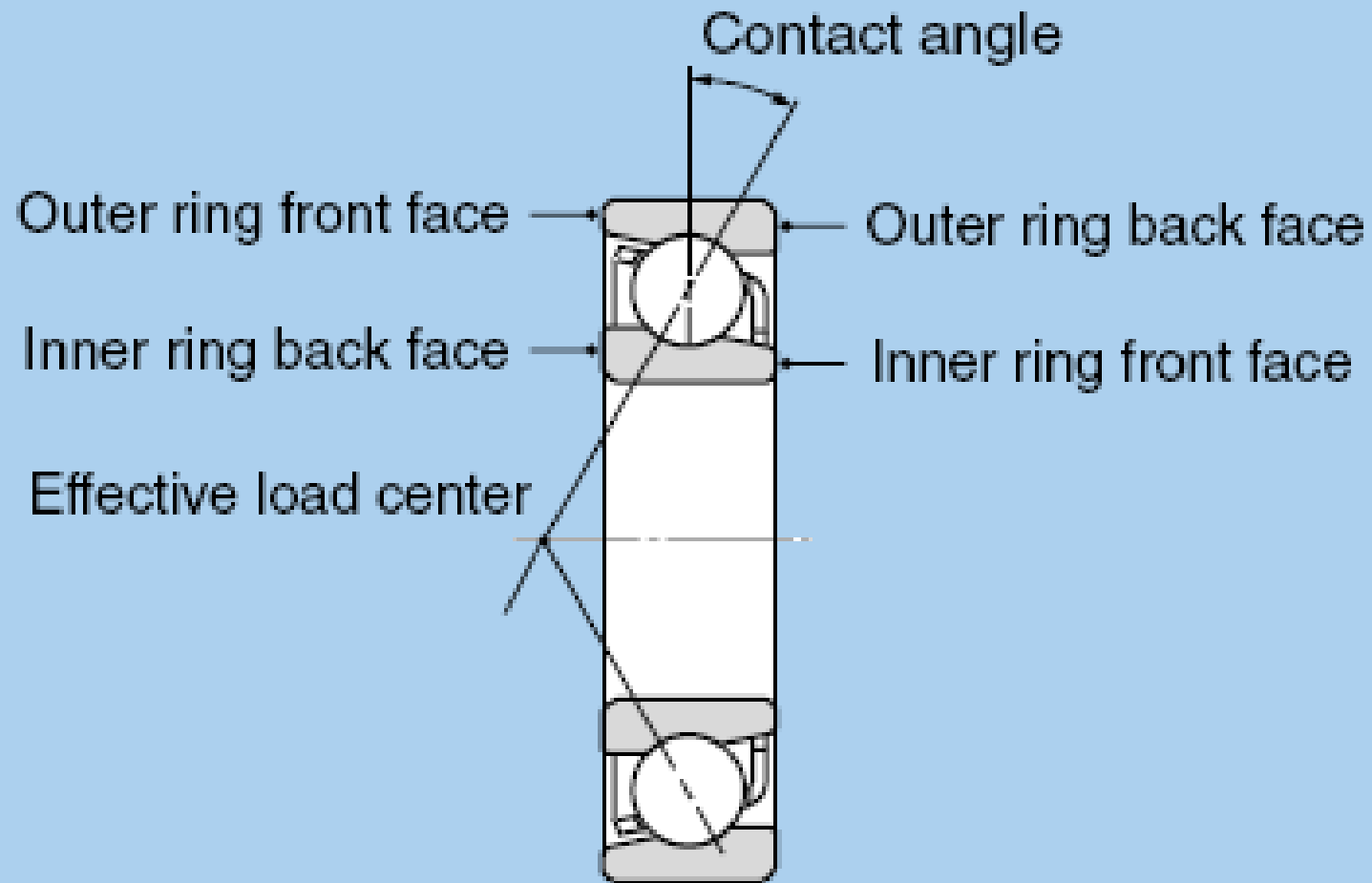
(a) Double-row self-aligning ball bearing



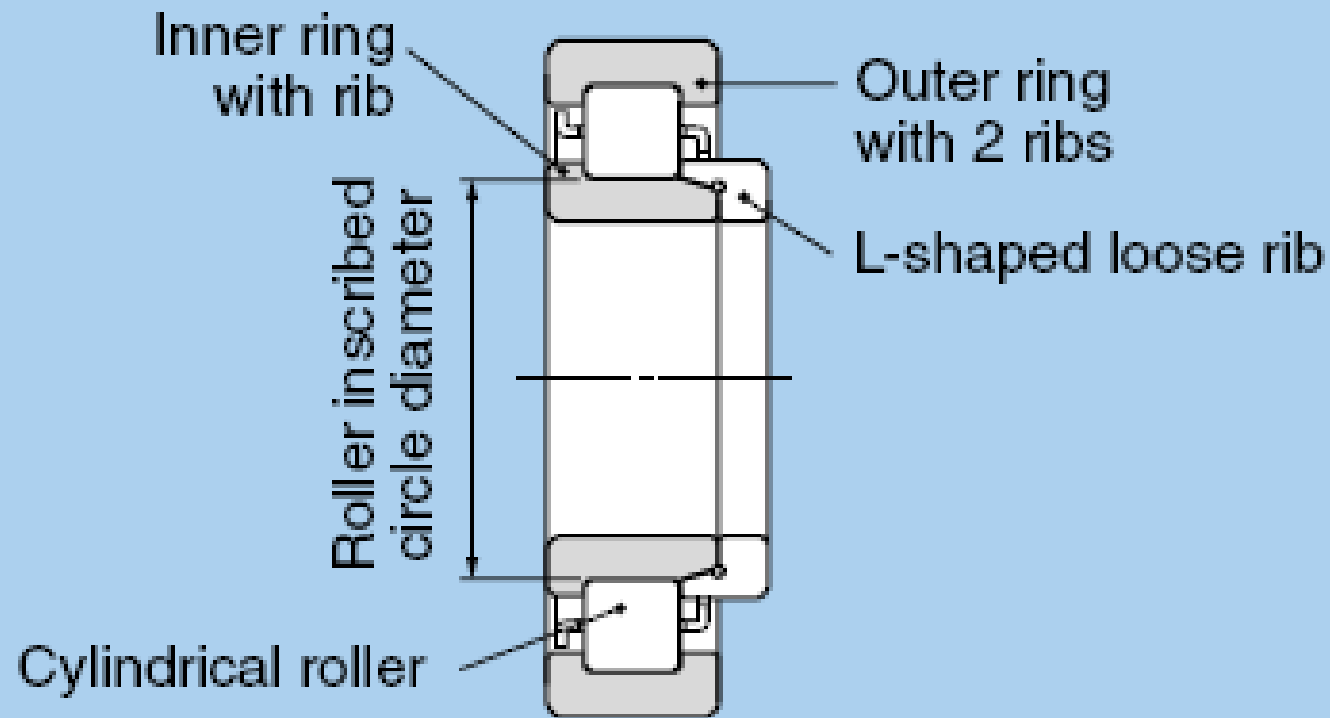
(b) Single and double-row roller bearing



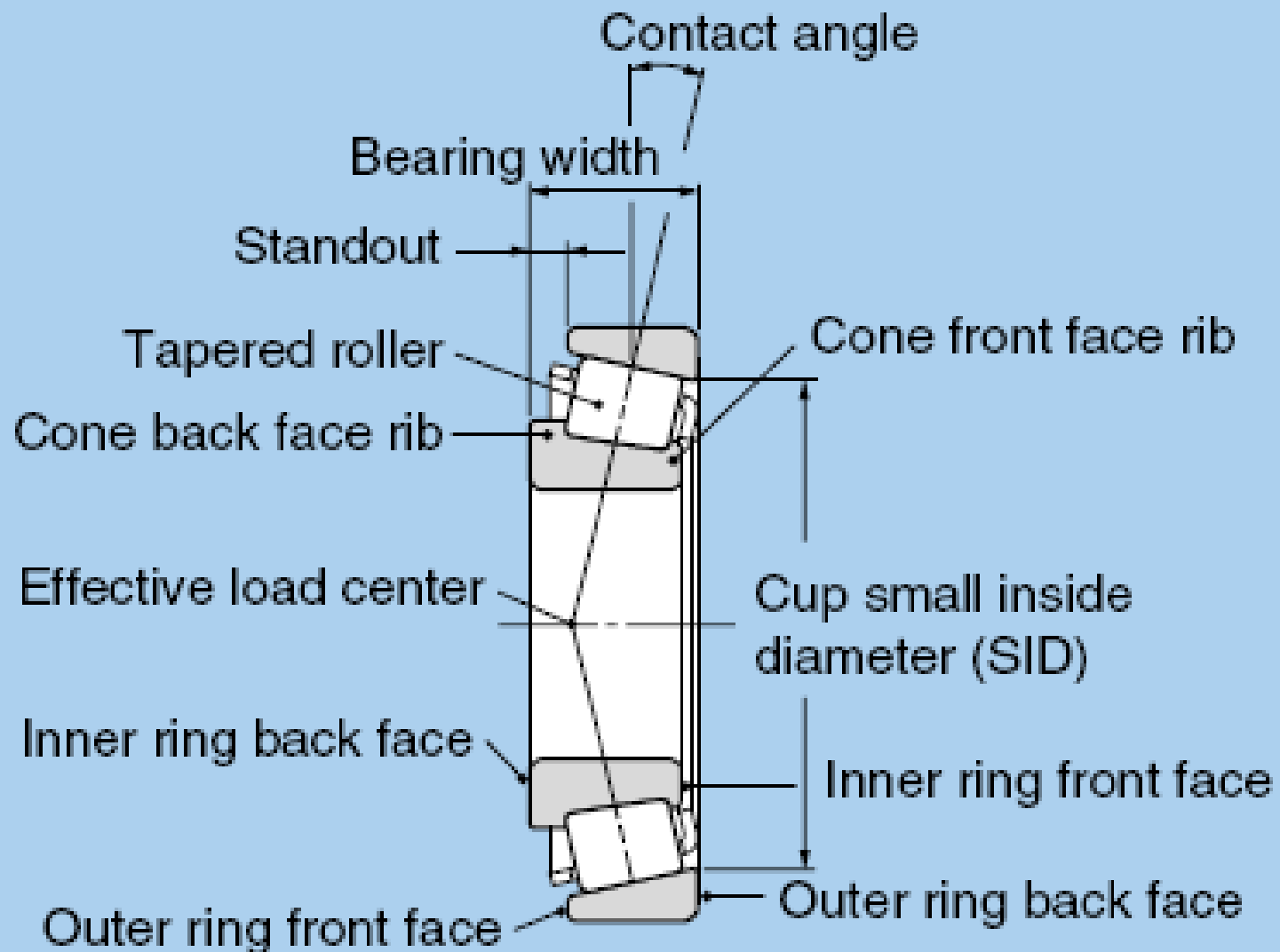
Deep groove ball bearing



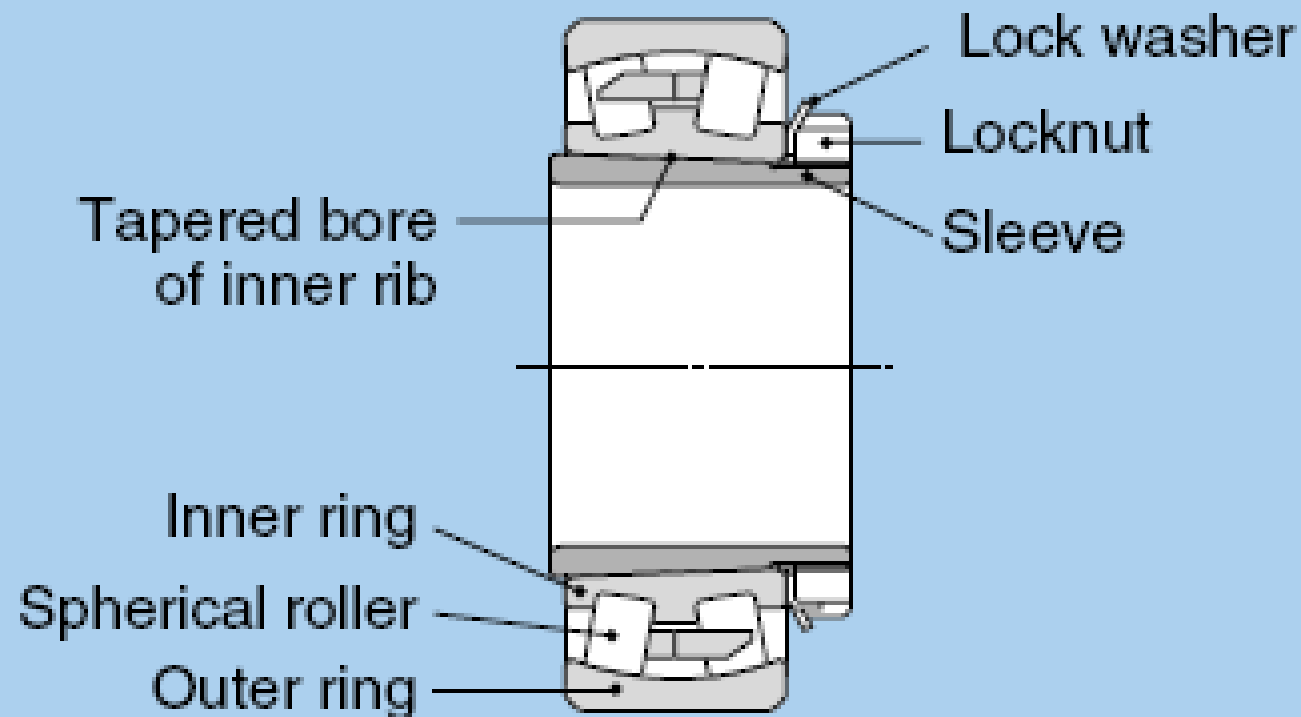
Angular contact ball bearing



Cylindrical roller bearing



Tapered roller bearing



Self-aligning roller bearing

PRELUBRICATED SEALED BALL BEARING



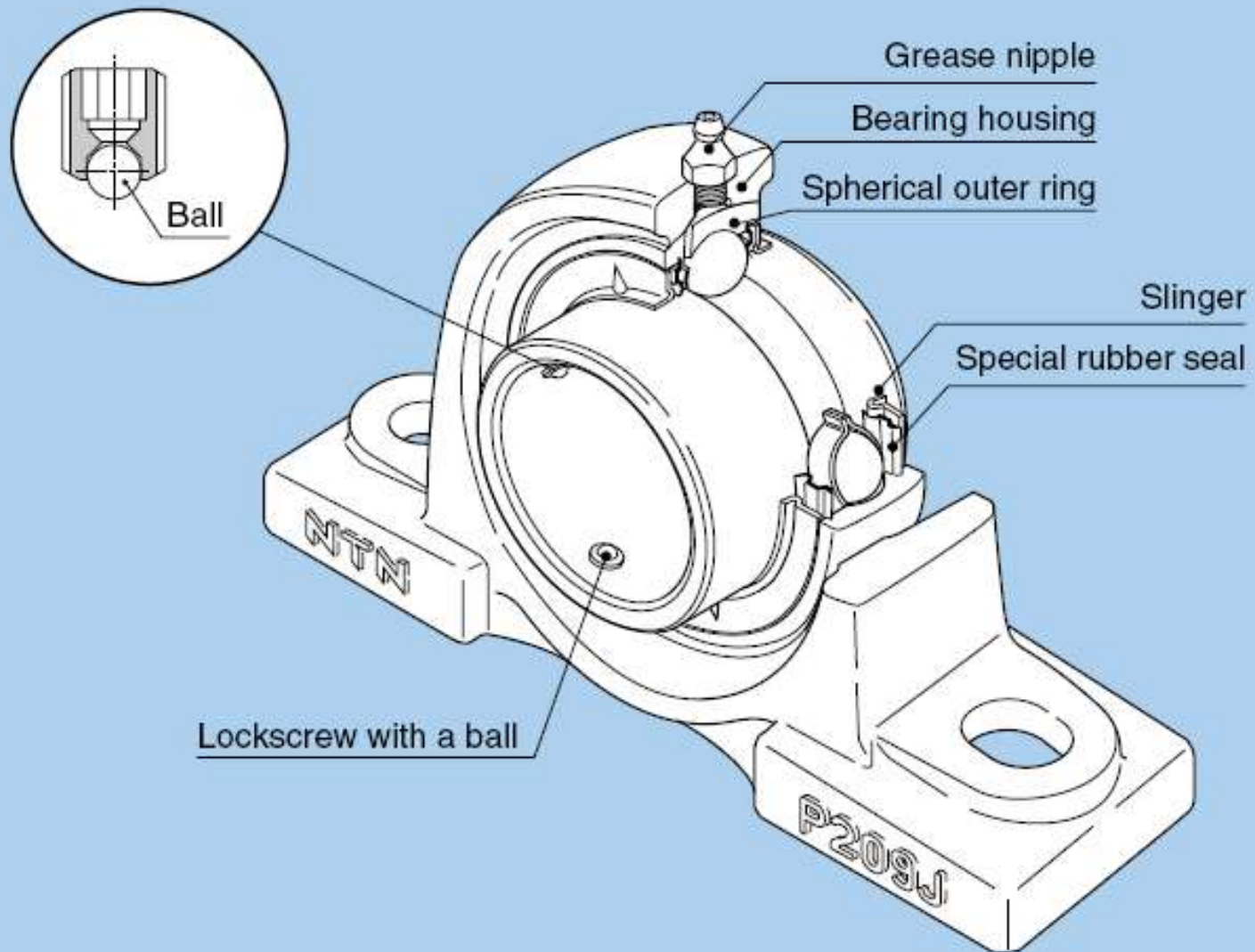

















Fig. 2.7 Oiling Type Bearing Unit

Table 3.1 Types and Performance of Rolling Bearings

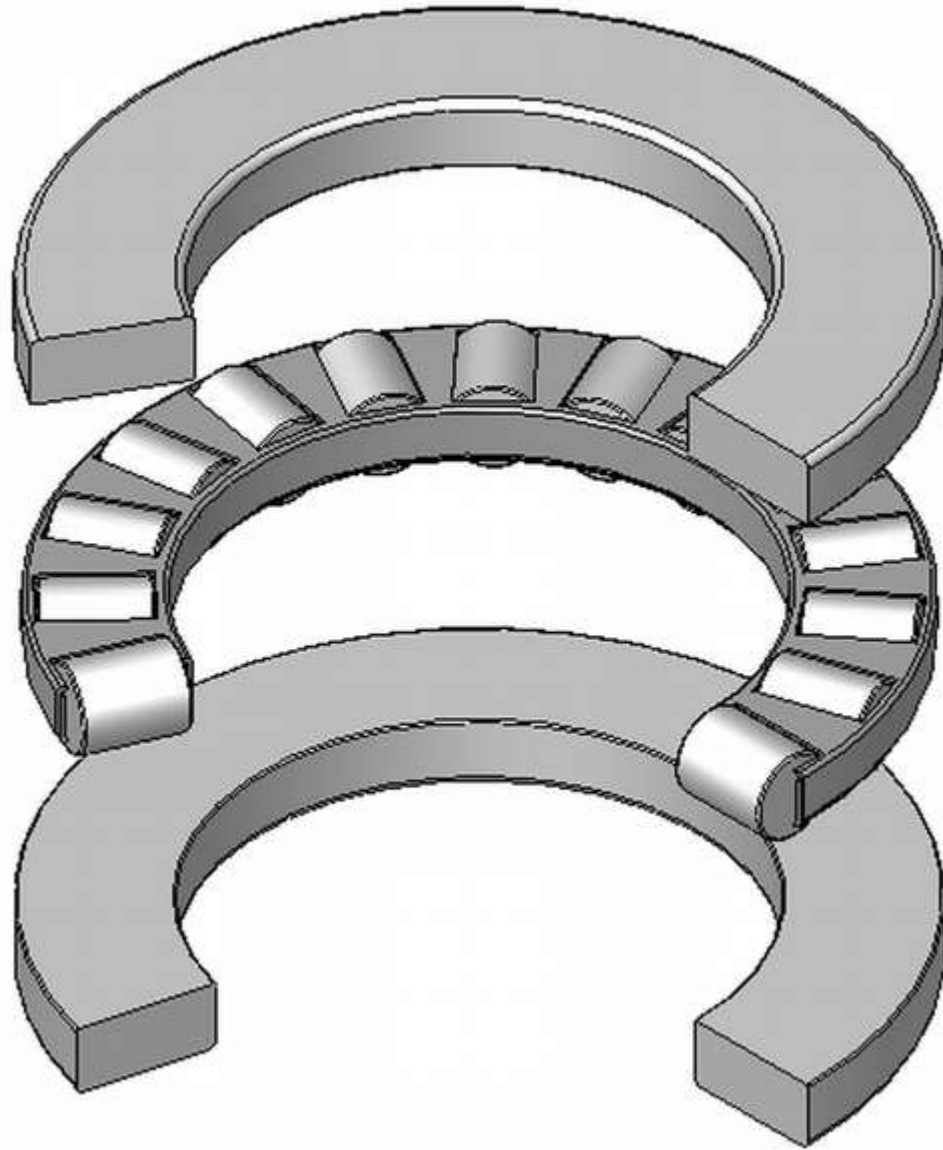
Bearings types Characteristics	Deep groove ball bearings	Angular contact ball bearings	Cylindrical roller bearings	Needle roller bearings	Tapered roller bearings	Self-aligning roller bearings	Thrust ball bearings
							
Load carrying capacity 							
High speed rotation ^①	☆☆☆☆	☆☆☆☆	☆☆☆☆	☆☆☆	☆☆☆	☆☆	☆
Low noise/vibration ^①	☆☆☆☆	☆☆☆	☆	☆			☆
Low friction torque ^①	☆☆☆☆	☆☆☆	☆				
High rigidity ^①			☆☆	☆☆	☆☆	☆☆☆	
Allowable misalignment for inner/outer rings ^①	☆					☆☆☆	★
Non-separable or separable ^②			○	○	○		○

① ☆ The number of stars indicates the degree to which that bearing type displays that particular characteristic.

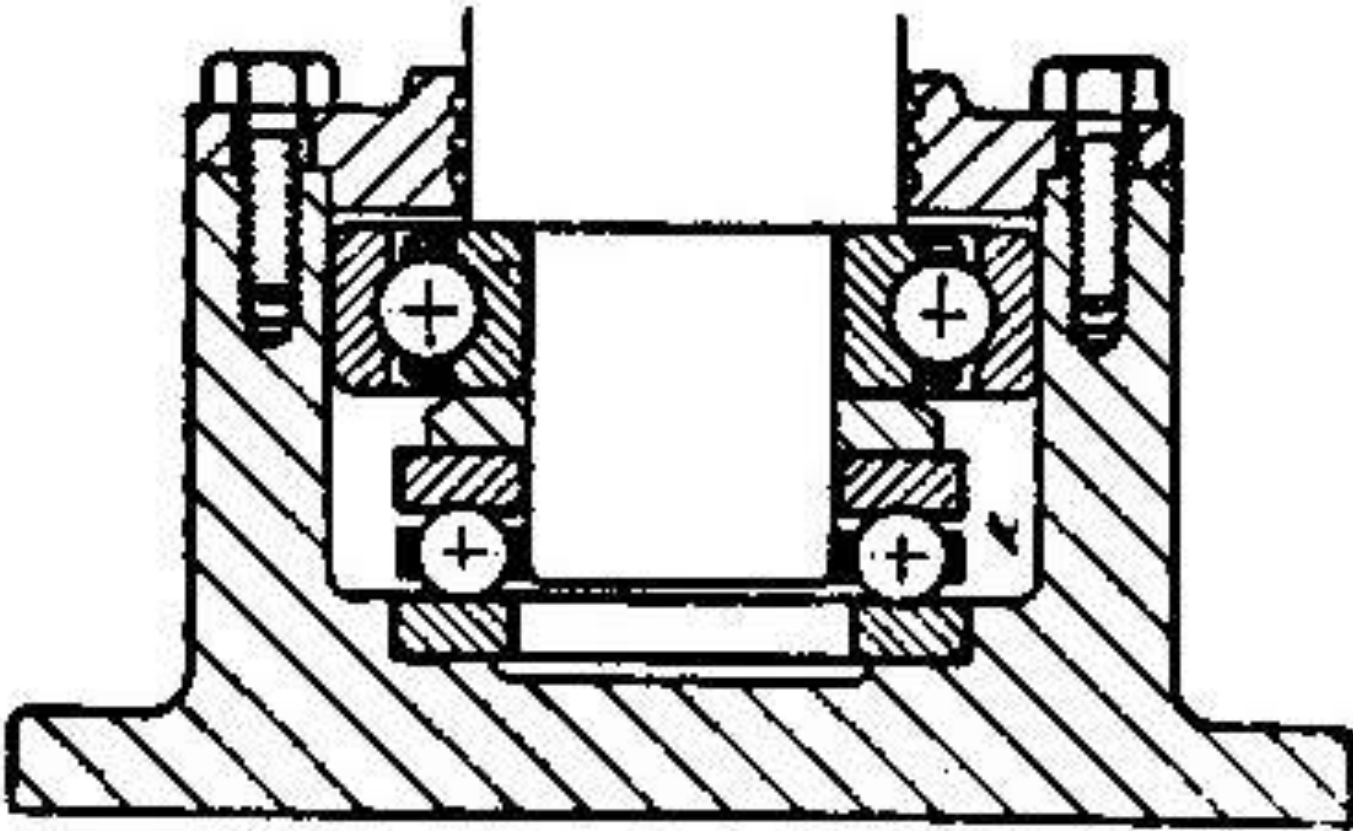
★ Not applicable to that bearing type.

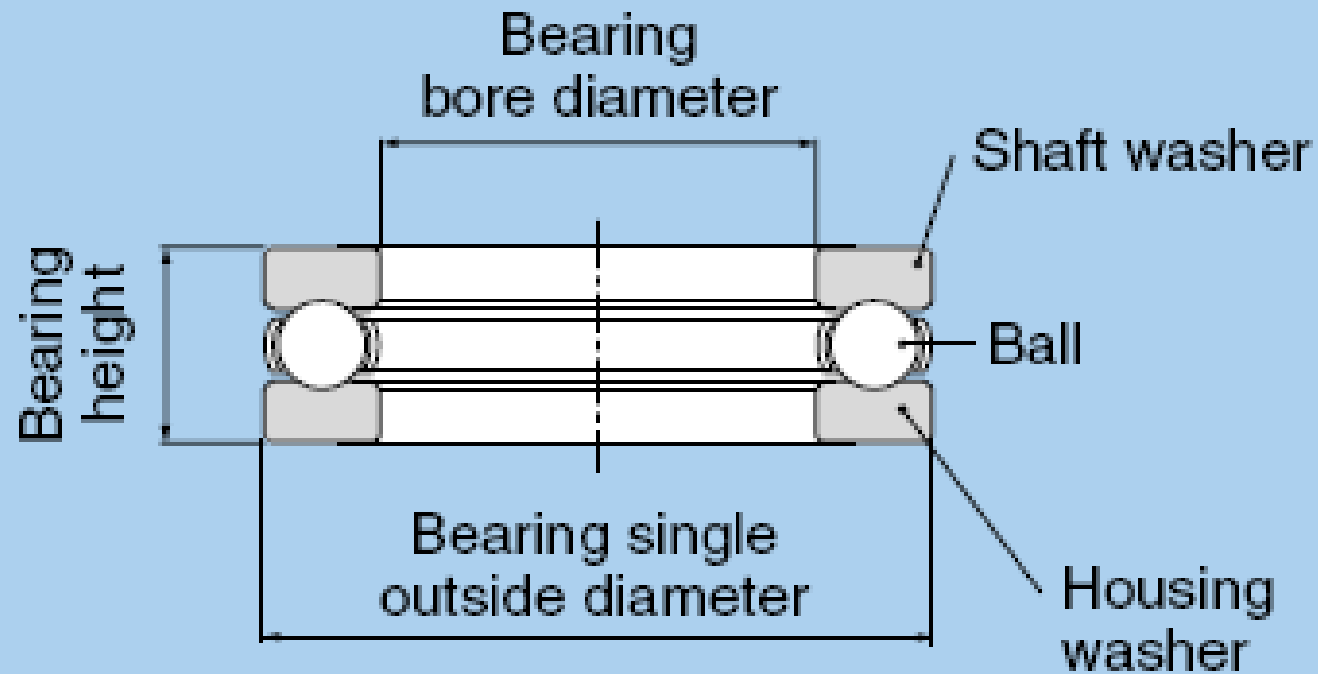
② ○ Indicates both inner ring and outer ring are detachable.

③ Some cylindrical roller bearings with rib can bear an axial load.



THRUST BALL BEARINGS



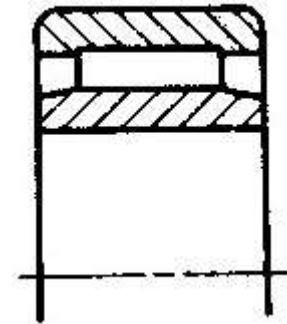


Thrust ball bearing

APPLICATIONS OF ROLLER BEARINGS

- Tapered roller bearing (TRB):
 - TRB can take both radial and axial loads and used for gear boxes for heavy trucks, bevel-gear transmission, lathe spindles, etc.
- Thrust ball bearing:
 - It can take only thrust loads.
 - Thrust ball bearing are used for heavy axial loads and low speeds.
- Needle roller bearing:
 - It use small diameter of rollers. They are used for radial load at slow speed and oscillating motion.
 - They have the advantage of light weight and occupy small space.
 - They are used in aircraft industry, live tail stock centers, bench-drill spindles, etc.

NEEDLE BALL BEARING



BEARING ARRANGEMENT

- Shafts are generally supported by two bearings in the radial and axial directions.
- The side that fixes relative movement of the shaft and housing in the axial direction is called the "fixed side bearing," and the side that allows movement is called the "floating side bearing."
- The floating side bearing is needed to absorb mounting error and avoid stress caused by expansion and contraction of the shaft due to temperature change.

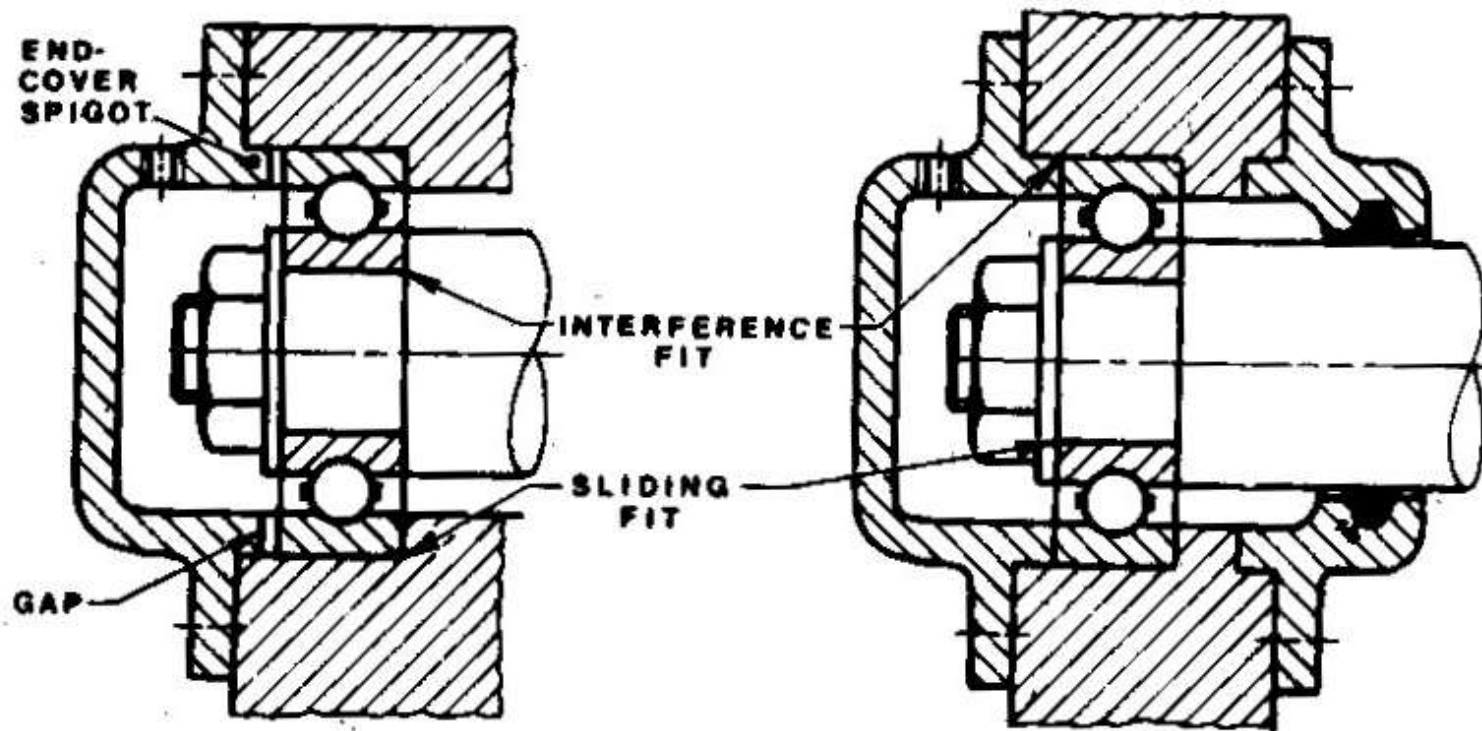
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In the case of bearings with detachable inner and outer rings such as cylindrical and needle roller bearings, relative movement is accomplished by the raceway surface.

Bearings with non-detachable inner and outer rings, such as deep groove ball bearings and self-aligning roller bearings, are designed so that the fitting surface moves in the axial direction.

If bearing clearance is short, the bearings can be used without differentiating between the fixed and floating sides. In this case, the method of having the bearings face each other, such as with angular contact ball bearings and tapered roller bearings, is frequently used.

POSITIONS OF BEARING



BEARING FITS:

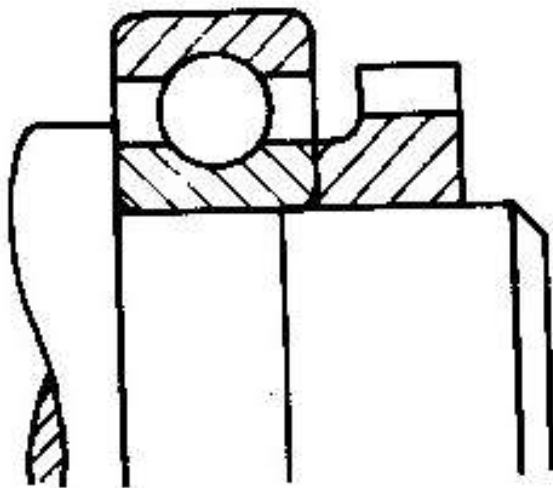
- Extreme fits, whether loose or tight, are not recommended. The effect of press fits on contact angle or radial play must be considered. As a rule of thumb, mounted radial play (and hence contact angle) will be reduced by approximately 75% of the press fit. This is important where precise control on deflection rates is required or where low-radial-play bearings are used.
- Size tolerance of the shaft and housing should be equal to those of the bearing bore and OD. Roundness and taper should be held to one-half of size tolerance. Surface finish should be held as close as possible.
- Extreme fits will depend upon tolerances on the bearings, shaft, and housing. Upon request, the bearing manufacturer will code the bearing bores and OD into increments within the size tolerance. These increments are normally 0.0001 in., but can be supplied as low as 0.00005 in.
- When operating at a temperature considerably different from room temperature, material expansion differences must be considered.

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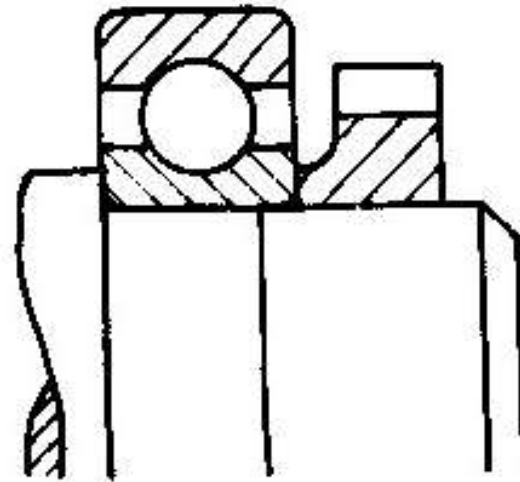
- Adhesives offer several advantages in producing proper fits:
- End play can be removed by applying a light external thrust load during curing time.
- Extreme fits can be eliminated, since the adhesive will fill up any reasonable clearance.
- Rotational accuracy can be improved by driving the shaft at slow speed during cure time.
- Disadvantages to using adhesives include:
- Certain adhesives are attacked by lubricants or solvents.
- To ensure a good bond, bearing surface, shaft, and housing must be thoroughly clean of oil and dirt.
- Adhesives may get into the bearing and cause damage.
- To ensure a good bond without rotational inaccuracies, clearance should be held reasonably close. The tolerances on the shaft and housing should be of the same magnitude as standard-fits practice. Actual clearance depends upon the specific adhesive.
- Under vibration, some adhesives may break loose.

ASSEMBLY OF BALL BEARING

Correct assembly



WRONG



CORRECT

BEARING MOUNTING

- For instrument bearings, certain special considerations should be emphasized:
- Heavy press fits should be avoided.
- Accuracy of mounting surfaces should be equal to accuracy of mating bearing surface.
- Misalignment for low torque and running accuracy should not exceed $1/4^\circ$. Loading across the bearing during assembly should be avoided.

AXIAL POSITIONING:

- Accurate axial positioning of the shaft relative to the housing requires shoulders, snap rings, or bearing flanges.
- *Shaft and housing shoulders:* Diameter of a shaft or housing shoulder must be sufficient to ensure solid seating and support for applied thrust loads, yet small enough to avoid interference with other parts of the bearing. Most manufacturers provide recommended shoulder dimensions for each bearing size. Fit accuracy between shoulder and mounting diameter should be as good as bearing accuracy.
- The corner between the shoulder and mounting diameter should be undercut because undercutting provides a more accurate machining of the shoulder surface. However, a radius is permissible if proper clearance is allowed.

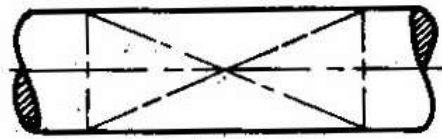
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- *Retaining rings*: Certain cautions must be observed with this method:
- Recommendations as to the groove dimensions should be followed.
- Locating grooves machined into the shaft or housing must be controlled for squareness of groove face to bearing mounting diameter. Recommended value is 0.0002-in. TIR max.
- Parallelism of the faces of the ring should be held to 0.0002-in. TIR max.
- Lug dimensions should be checked to ensure there is no interference with the bearing. (Extended inner-ring bearings may offer an advantage here.)
- Avoid a snap ring that locates directly on the shaft or housing diameter (no groove) if heavy thrust loads are involved.
- *Flanges*: Squareness of face-to-bore of the housing is critical and should be maintained to within 0.0003-in. TIR. Corners may be broken or left sharp because the flange is undercut and flush seating is ensured.

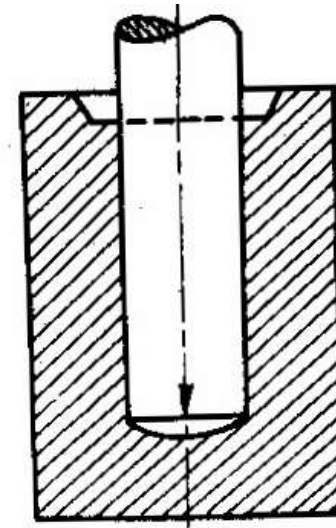
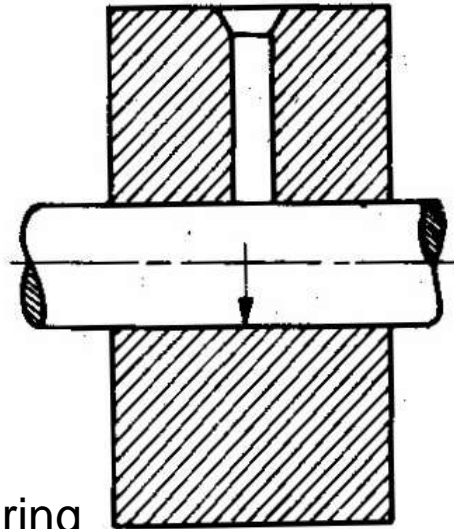
SLIDING CONTACT BEARING



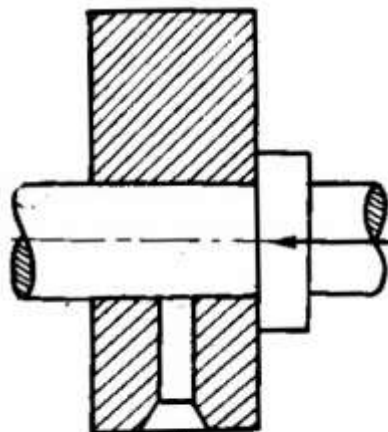
CLASSIFICATION OF THE SLIDING CONTACT BEARING



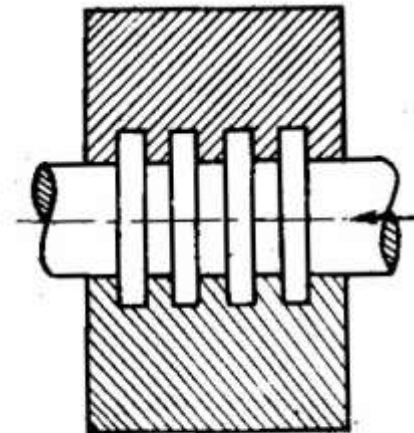
● Journal bearing



● Footstep bearing



● Collar thrust bearing

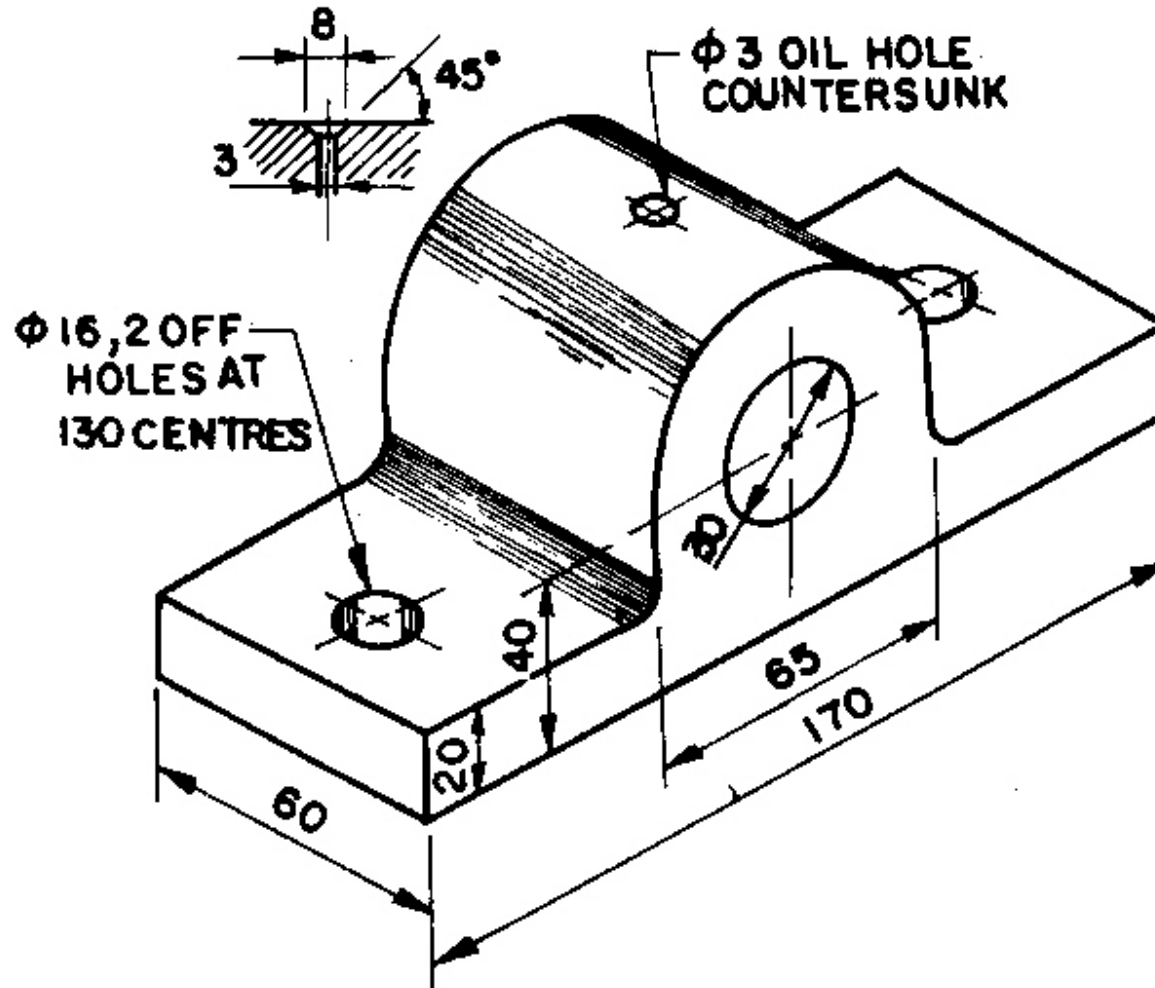


- **Journal bearing** – in this the bearing pressure is exerted at right angles to the axis of the shaft. The portion of the shaft lying within the bearing is known as journal. Shafts are generally made of mild steel.
- **Foot step or pivot bearing** – in this bearing the bearing pressure is exerted parallel to the shaft whose axis is vertical. Note that in this case the end of the shaft rests within the bearing.
- **Thrust bearing** – in this bearing supporting pressure is parallel to the axis of the shaft having end thrust. Thrust bearings are used in bevel mountings, propeller drives, turbines, etc. Note here the shaft, unlike foot-step bearing, passes through and beyond the bearing.
 - Thrust bearings also known as “**collar bearing**”.

JOURNAL BEARING

- Simple journal or solid bearing
 - It is simply a block of cast iron with a hole for the shaft providing running fit. An oil hole is drilled at the top for lubrication.
 - The main disadvantage of this type of bearing are
 - There is no provision for wear and adjustment on account of wear.
 - The shaft must be passed into the bearing axially, i.e. endwise.
 - Limited load on shaft and speed of shaft is low.

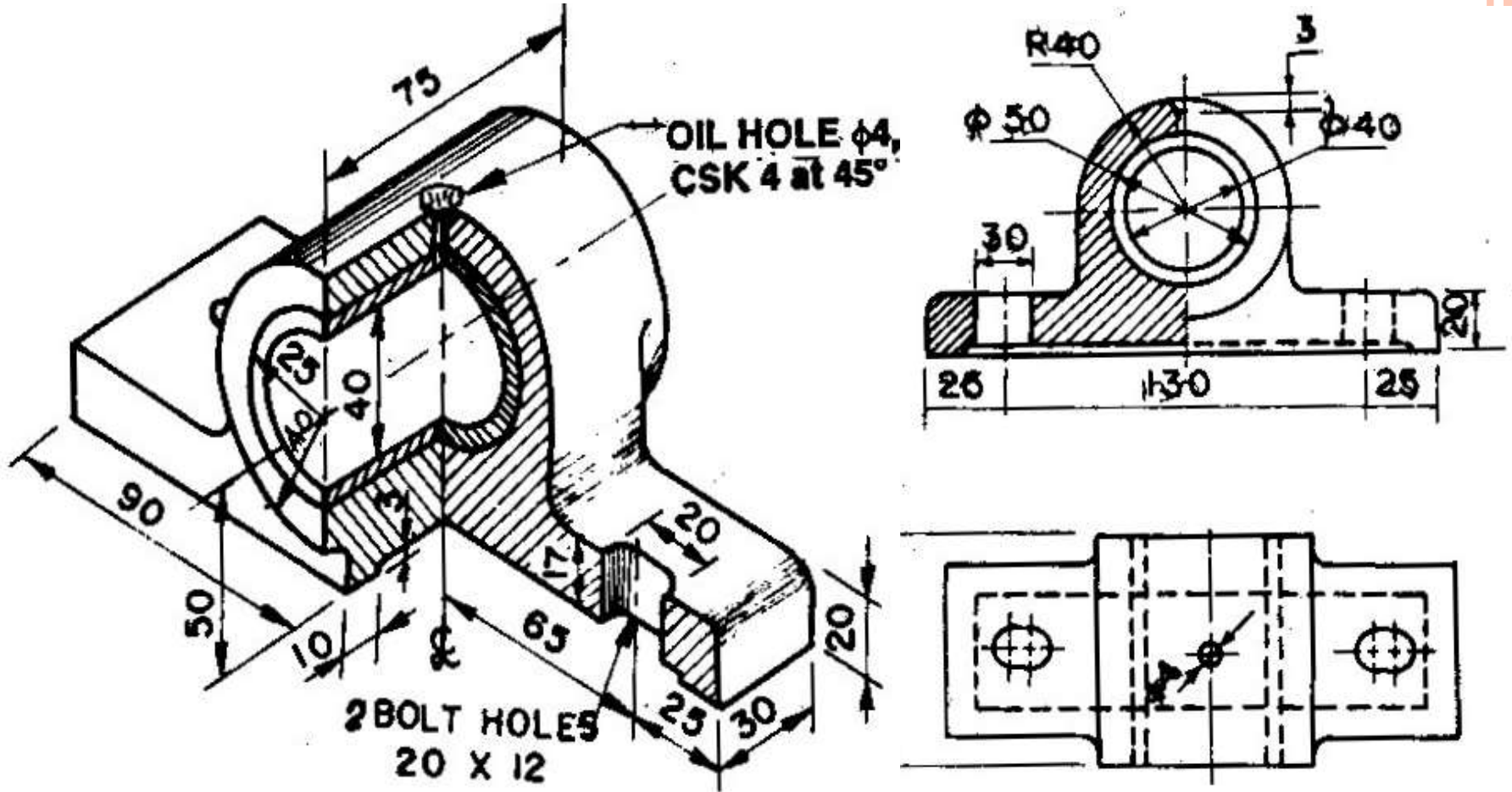
SOLID BEARING



○ Bush bearing

- In this the bush of soft material like brass or gun metal is provided and the body or main block is made of cast iron. Bush is hollow cylindrical piece which is fitted in a housing to accommodate the mating part. When the bush gets worn out it can be easily replaced.

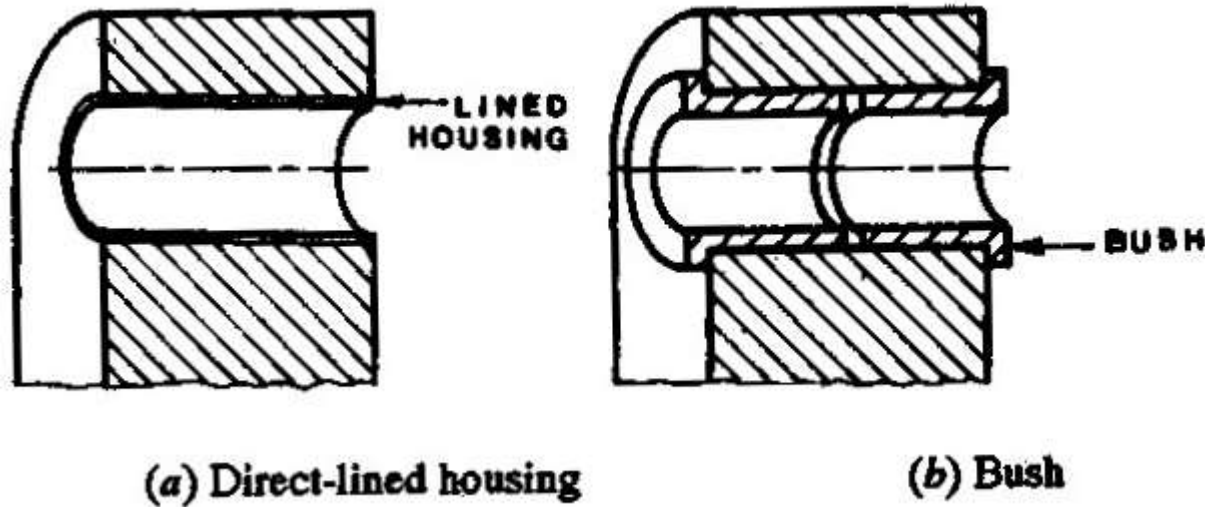
BUSHED BEARING



Note that the insertion of the shaft in this bearing is endwise.

- The outside of the bush is a driving fit (interference fit) in the hole of the casting whereas the inside is a running fit for the shaft.
- The bearing material used may be white metal (Babbitt – Tin/Cu/Lead/antimony) , copper alloy (brass, gunmetal) or aluminum alloy.
- Solid bushes are entirely made of bearing material and find the general application. In lined bush as the bearing material is applied as a lining to a backing material .
- Applications: turbines, large diesel engines etc

BUSH AND DIRECT-LINED HOUSING



- Direct lined housings
- In this type of the housing is lined directly by means of metallurgical bonding.
- Low-melting point white metal is used as a lining on the cast iron housing

PLUMMER BLOCK OR PEDESTAL BEARING

- It is a split type of bearing. This type of bearing is used for higher speeds, heavy loads and large sizes.
- The component of the bearing:
 - Cast iron pedestal or block with a sole
 - Brass or gun-metal or phosphorus-bronze “Brasses”, bushes or steps made in two halves.
 - Cast iron cap.
 - Two mild steel bolts and nuts.

Care is taken that the brasses do not move axially nor are allowed to rotate. For preventing this rotation, usually a snug at the bottom fitting inside a recess at the bottom of the pedestal is provided.

This bearing facilitates the placements and removal of the of the shaft from the bearing. Unlike the solid bearing which are to be inserted end-wise and hence are kept near the ends of the shaft, these can be placed anywhere. This bearing ensures a perfect adjustment for wear in the brasses by screwing the cap.

FOOTSTEP OR PIVOT BEARING

- suitable for supporting a vertical shaft with axial loads.
- In a footstep bearing a gun metal bush having a collar on top is placed inside the C.I. sole. The end of the shaft rests on a gun metal disc placed at the bottom in the bush. The disc is prevented from rotation with the help of a pin or screw fitted in the sole. The disc act as a thrust bearing whereas the bush fitted in the casting supports the shaft in position. The bush can take radial loads, if any, on the shaft.
- The disadvantage of footstep bearing is that it cannot be efficiently lubricated and there is unequal wear on the bottom disc.

ADVANTAGES AND DISADVANTAGES OF THE PLAIN BEARING

- Plain bearing are cheap to produce and have noiseless operation. They can be easily machined, occupy small radial space and have vibration damping properties. Also they can cope with tapped foreign matter.
- **Disadvantages** are they require large supply of lubricating oil, they are suitable only for relative low temperature and speed; and starting resistance is much greater than running resistance due to slow build up of lubricant film around the bearing surface.