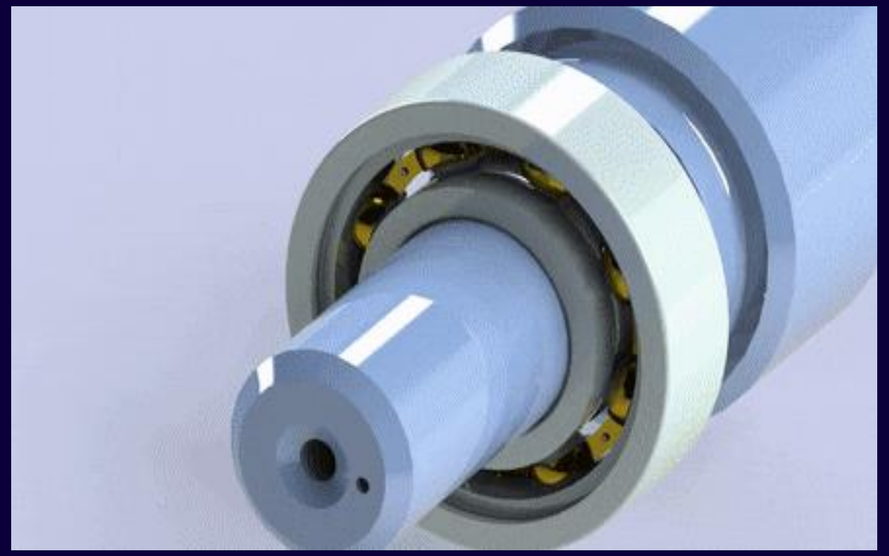
Bearings



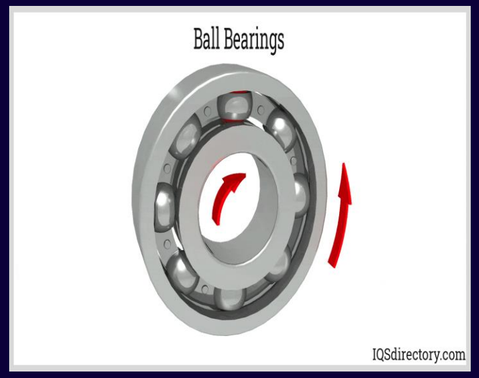
RK RANA

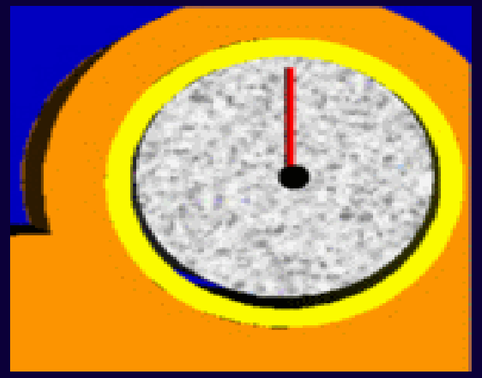
Table of Contents

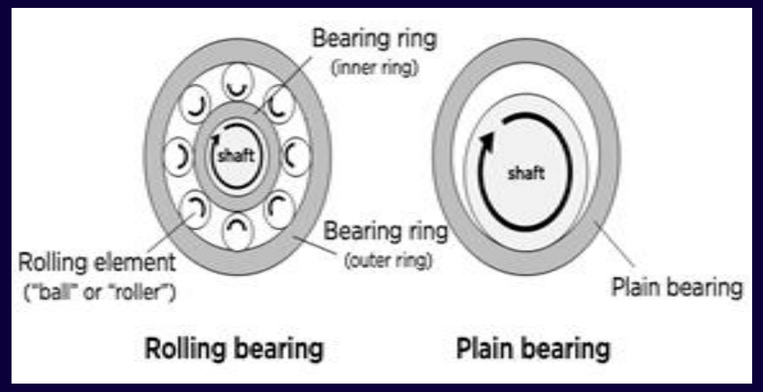
Bearings

- ***Bearings Introduction (Types of bearings and functions)***
- A Bearing is a device that support load and reduces the friction of motion between moving machine parts.
- Bearing is very important element in any machine.

1) Plain, Sliding contact OR Frictional bearings
2) Rolling contact OR Anti-frictional bearings



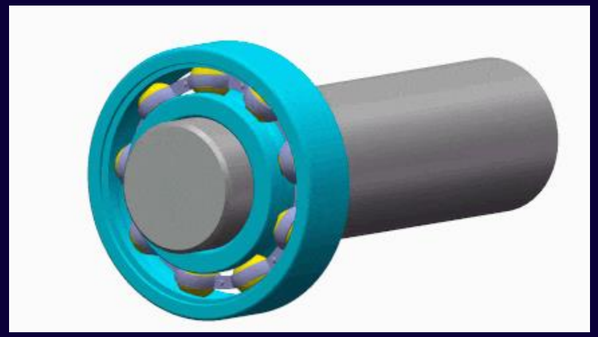


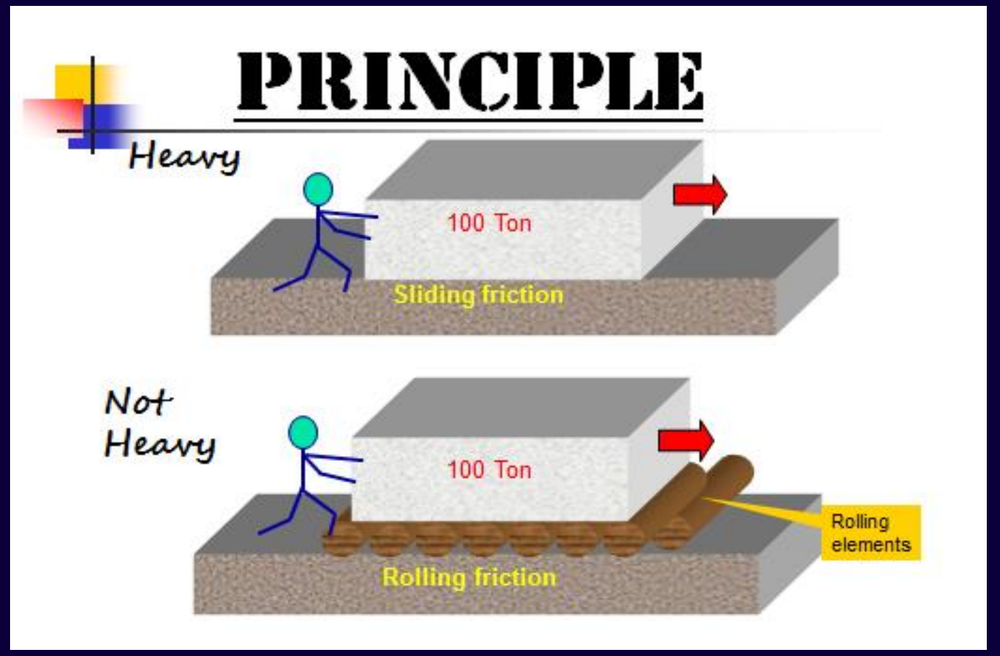


Bearings (Friction)

Bearings Introduction

- Friction is defined as "the resistance to motion between two surfaces in contact

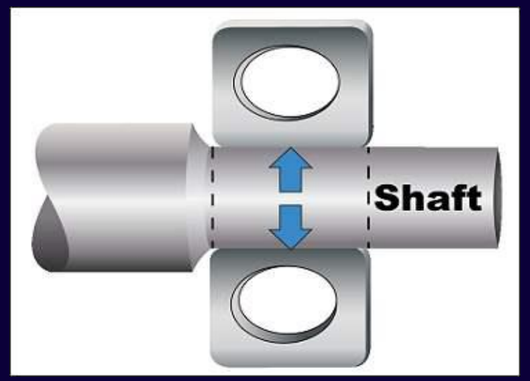


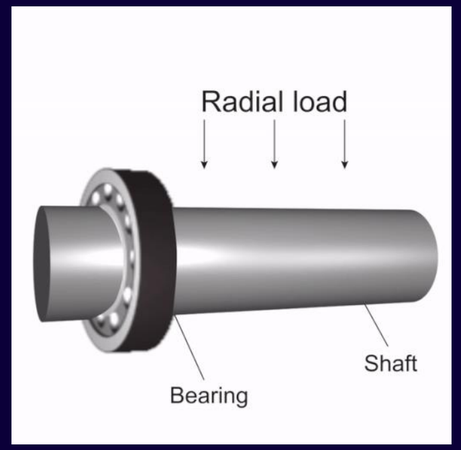


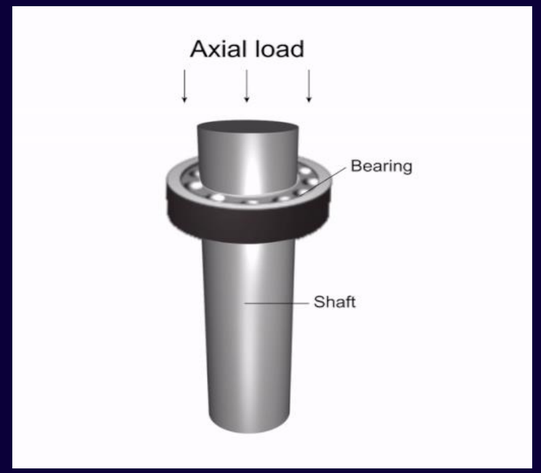
Bearings (Friction)

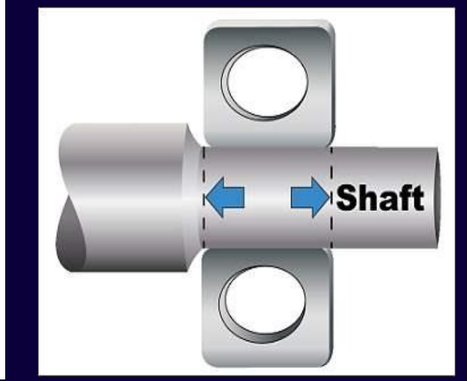
- ***Bearings Introduction (Based on the Direction of Load)***
- **Radial Load:** Load acting perpendicular to the direction of motion of moving element

  Radial loads – loads which are applied perpendicular (90 degrees) to the shaft.
- **Axial or Thrust Load:** Load acts along the axis of rotation. Axial loads which are applied parallel to the shaft; sometimes called thrust loads.





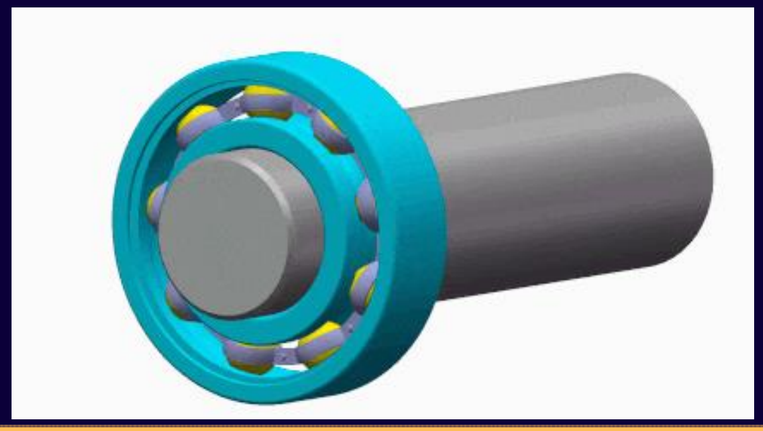


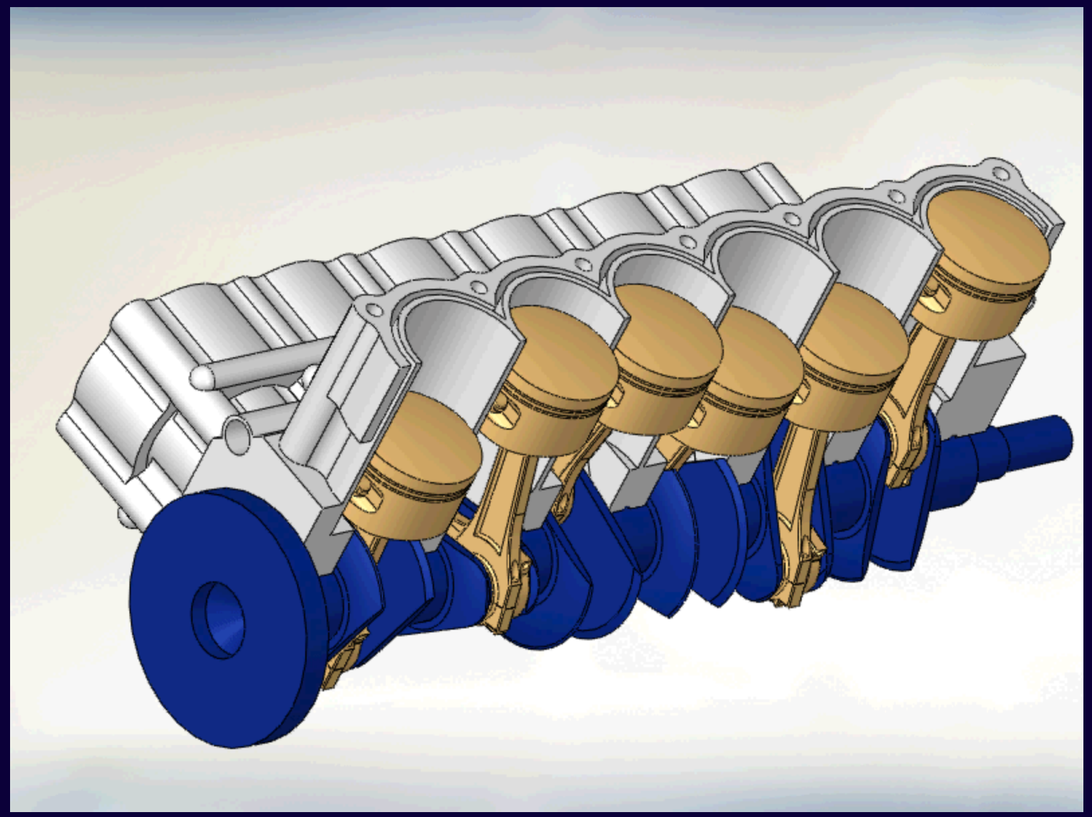


Bearings

Bearings Introduction (Bearings are used to…)

1) Reduce Friction
2) Minimize Wear
3) Reduce Power Losses
4) Load on the shaft





Bearings

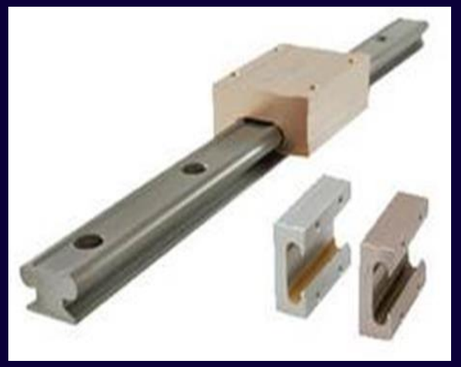
Bearings Introduction (Plain Bearing Types)

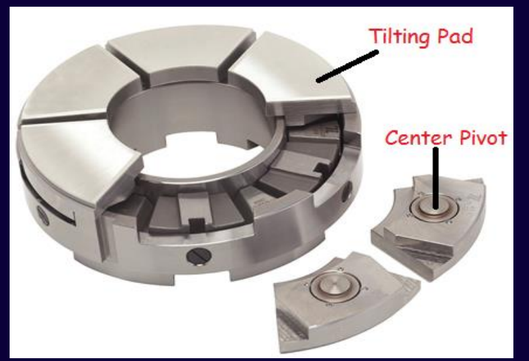
- Bearings can also be classified on the basis of function

Journal Bearing

Thrust Bearing

Guide Bearing

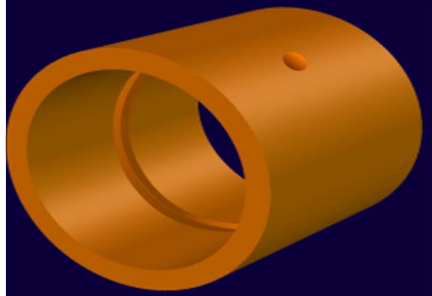


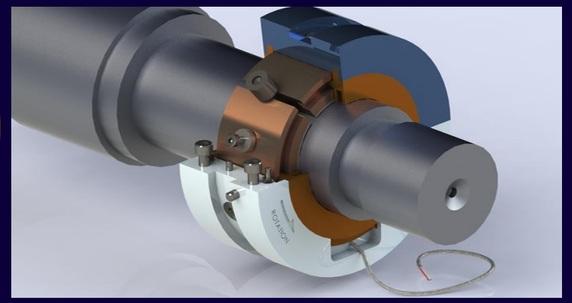


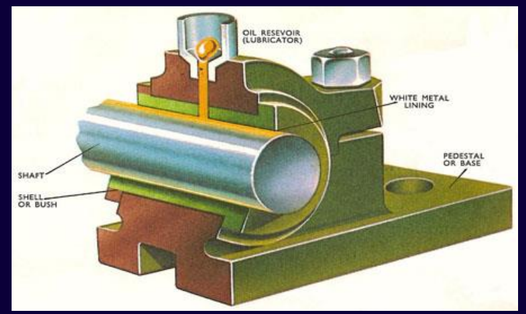
Plain Bearings

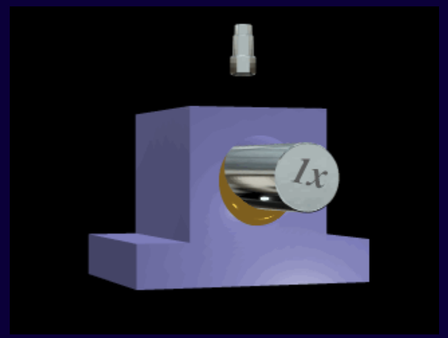
Plain Bearings

- Plain bearing is a simple cylinder, whole or in pieces, made to fit around the journal of a shaft.
- Lubricant film separates the bearing surface from the journal.
- Plain bearings are usually made of relatively soft material and therefore it does not scratch the shaft.
- Plain bearings are used mainly to support shafts carrying heavy loads.









Bearings

Plain bearings advantages

- Small size
- Low cost
- Quiet operation
- Easy installation
- Long self life without damage.

Plain bearings Materials

- Bronze
- Babbitt metal (Tin Alloy)
- Cast iron
- Graphite Teflon
- Plastic
- Aluminum alloys






Plain Bearings

Babbitt

- The addition of the layer of Babbitt metal to the inside of a bearing. Babbitt metal, also called white metal.
- It is a soft metal
- It a good material to use in a plain bearing

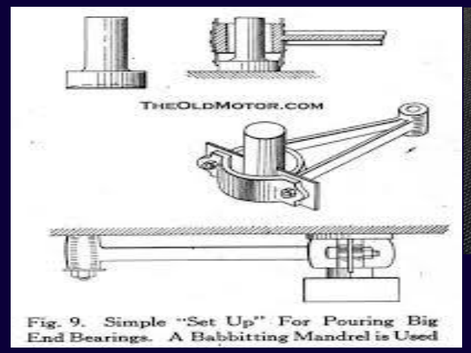


Fig. 9. Simple "Set Up" For Pouring Big End Bearings. A Babbitting Mandrel is Used

Tin base white metal:

- Babbitt is composed of **(89%Tin,7.5% Lead and 3.5% copper)**
- It is used for high speed and light load application.
- Thickness of Babbitt metal layer of plain bearings from **(0.010 to 0.015 inches)**

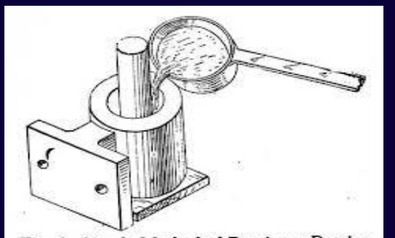
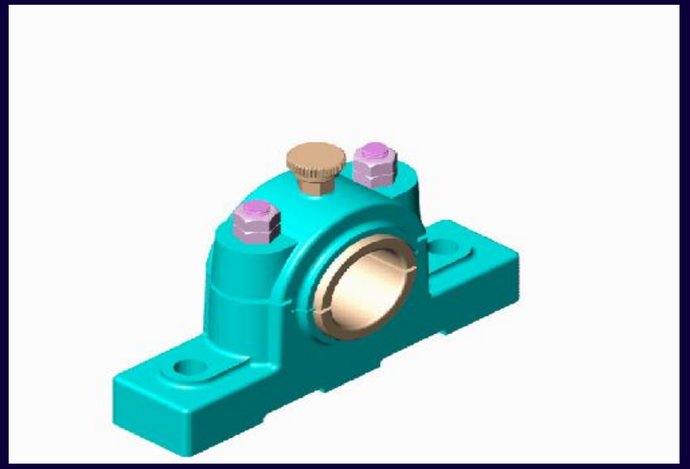


Fig. 4. Simple Method of Pouring a Bearing in Vertical Position

Plain Bearings

Plain Bearing Lubrication

- Bearings cannot be discussed without considering lubrication.
- Lubricant film separates the shaft journal from bearing and reduces friction and prevents the shaft and the bearing from overheating.
- When the shaft begins to rotate, a wedge of oil is forced under the journal, lifts it away from the bearings.
- Both Oil and grease can be used as a lubricant.



Plain Bearings

Journal or plain bearings

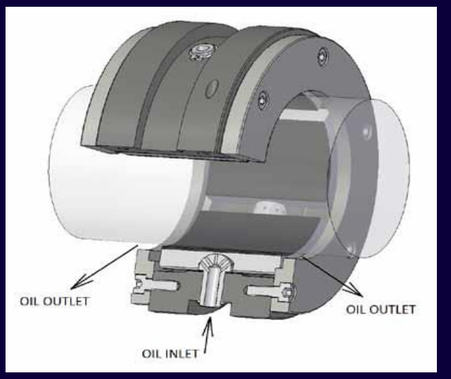
- Journal bearings provide radial load support to keep shafts centered and eliminate vibration, often in high performance applications.

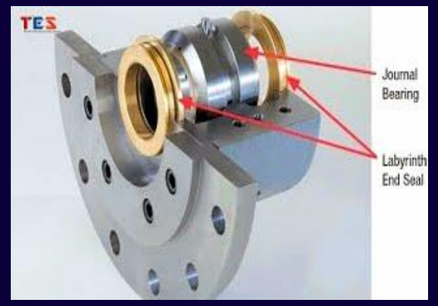
Direct Lubrication design

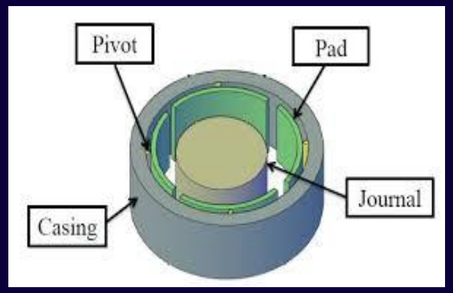
- Oil flow controlled by nozzles between each pad

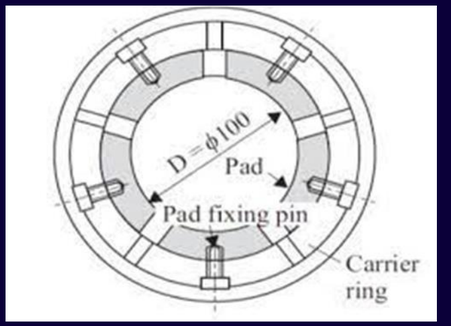
Temperature Sensors

- Temperature sensors are used for measuring of bearing temperature.





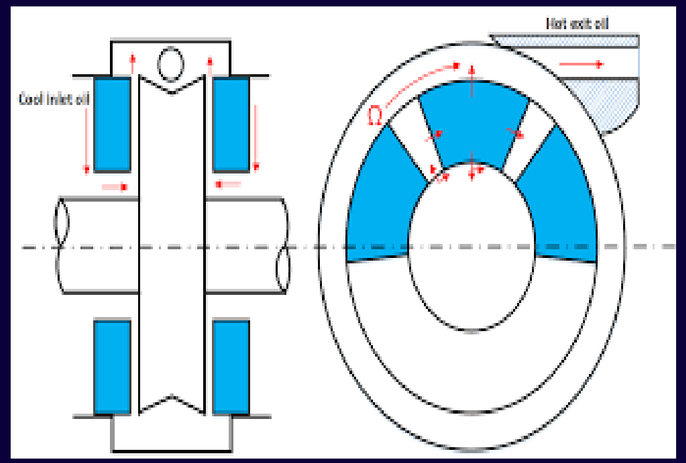


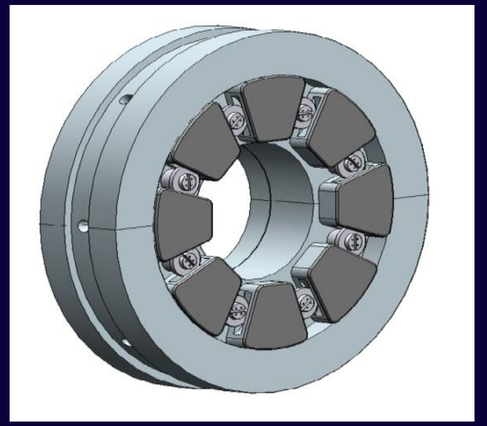


Plain Bearings

Tilting pad thrust

- Thrust bearing support axial loads in vertical or horizontal shafts, often ones in high load and high speed applications.
- A self-leveling tilt pad thrust bearing can accommodate misalignment.
- Spray nozzles are located between pads which improves oil flow and oil film thickness.





Plain Bearings

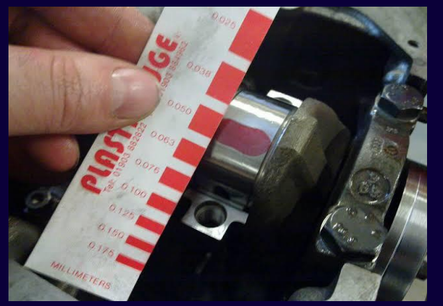
Bearings clearances

1- Bearing clearance by I.D and Shaft O.D.

2- Bearing clearance by Mandrel method.

3- Bearing clearance by plastic gauge.

4- Dial Indicator Method



Plain Bearings

Bearings clearances

1- Bearing clearance by I.D and Shaft O.D.

- Total clearance inside a bearing in the radial direction

Plain Bearings

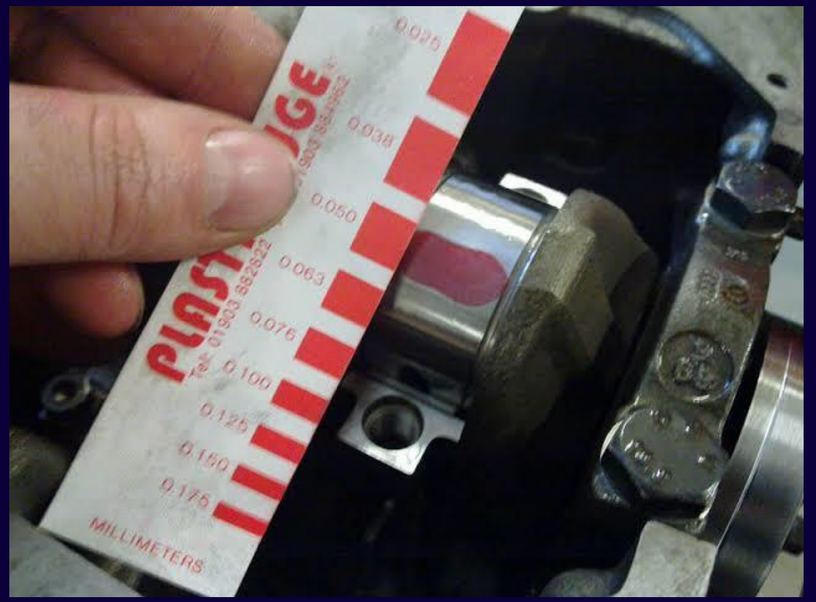
Bearings clearances

2- Bearing clearance by Mandrel method.

Plain Bearings

Bearings clearances

3- Bearing clearance by plastic gauge.

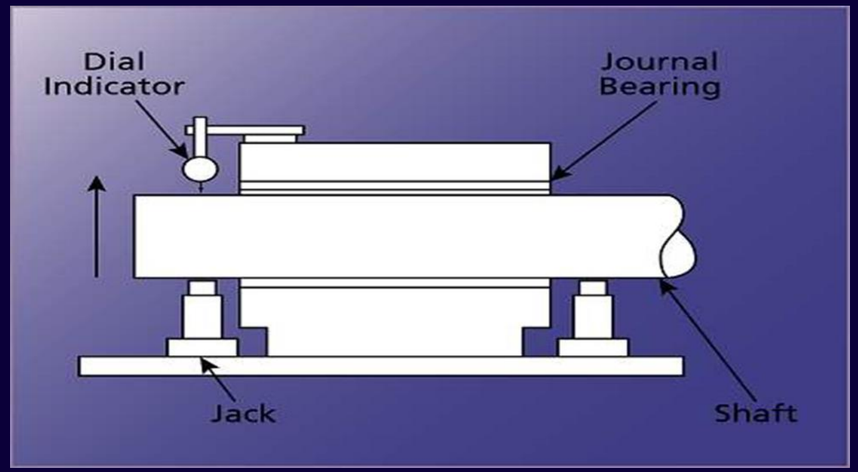


Plain Bearings

Bearings clearances

4- Dial Indicator Method

- A dial reading will indicate the total clearance in the bearing but will not identify the high and low spots.
- Any wear checks must be performed visually.

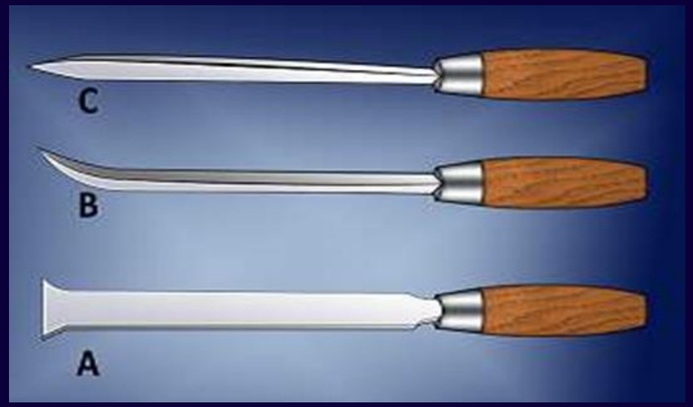


Plain Bearings

Bearings clearances

Bearing Scraper

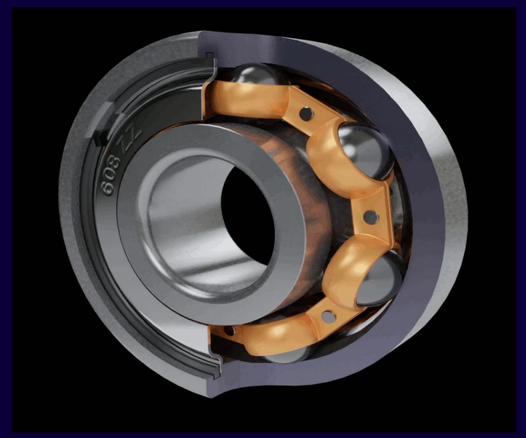
- Bearing Scraper Suitable for removing high spots from bearings.
- Scrapers are made of hardened carbon steel and are shaped to suit different scraping and fitting operations.

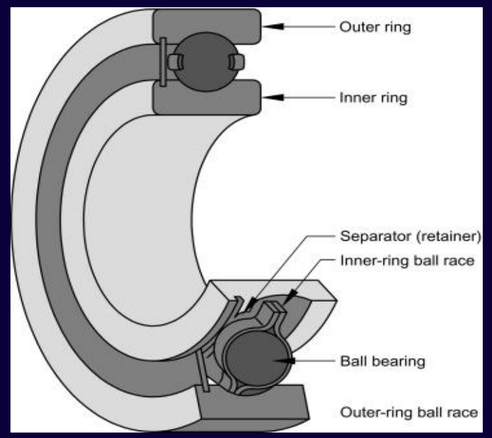


Anti-friction Bearings

Anti-friction Bearings

- An antifriction bearing is a bearing that contains moving elements to provide a low friction.
- Total effective contact area is much less in antifriction bearings as compared to plain bearings.
- Antifriction bearings are commonly made with hardened rolling elements (balls and rollers) and races.

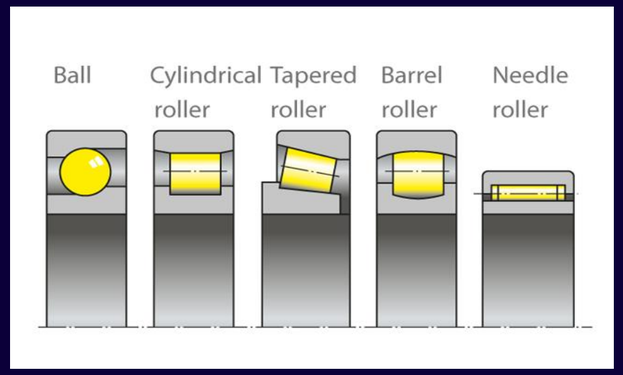


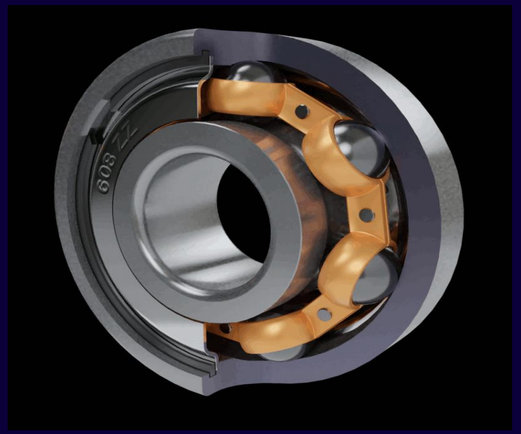


Anti-friction Bearings

Classification of rolling bearings elements

- 1- Ball Bearing
- 2- Roller Bearing





Anti-friction Bearings

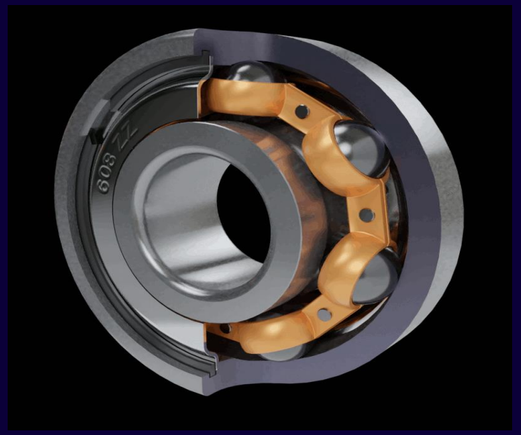
Difference between Ball and Roller bearings

- **1- Ball Bearings**

1) Point Contact
2) Less area of contact
3) Less friction
4) More speed
5) Less load

1- Roller Bearings

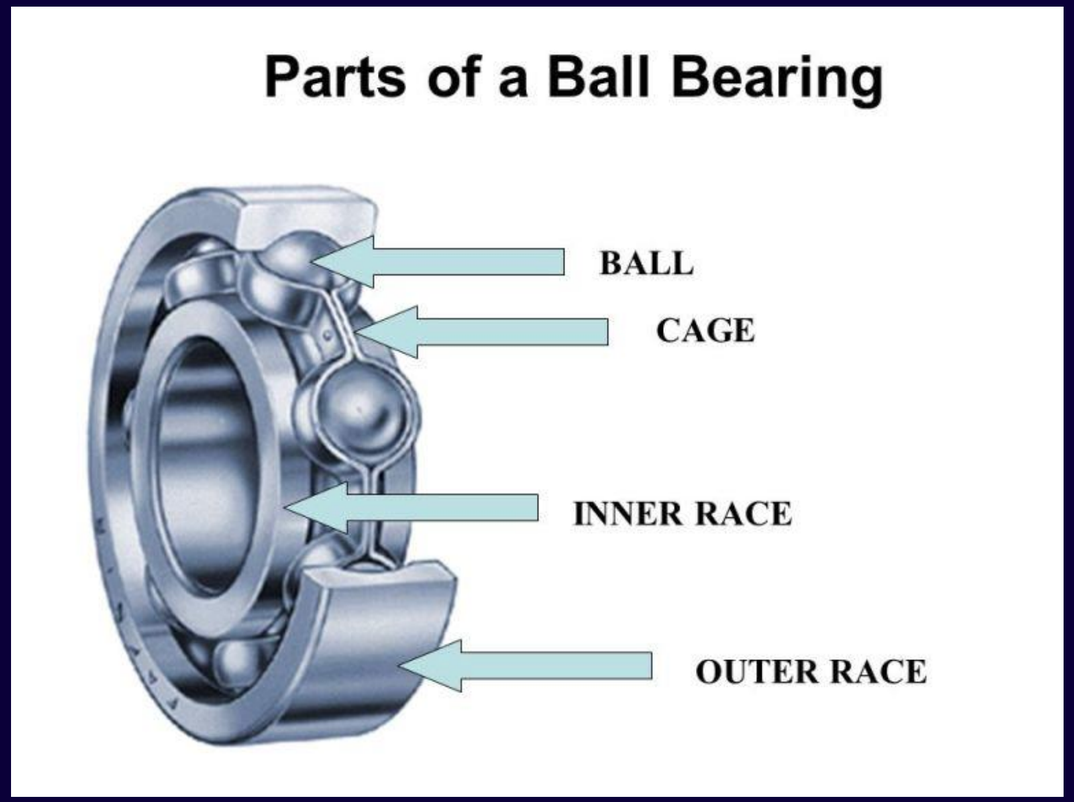
1) Line contact
2) More area contact
3) More friction
4) Less speed
5) More load

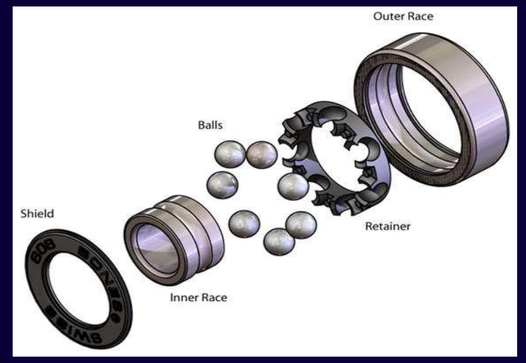


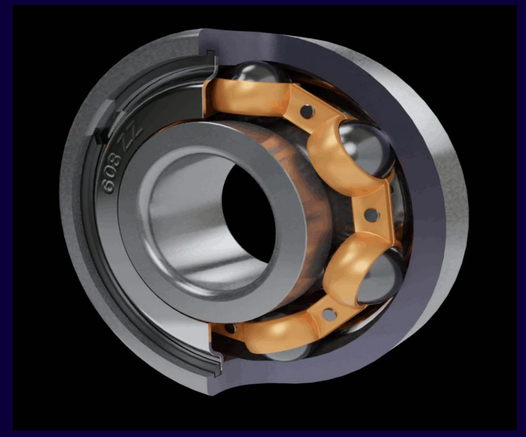
Anti-friction Bearings

Construction of anti-friction bearing

1) Outer race
2) Inner race
3) Rolling elements
4) Retainer



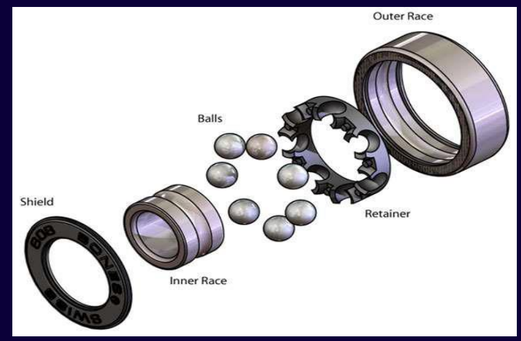




Anti-friction Bearings

Bearing Material

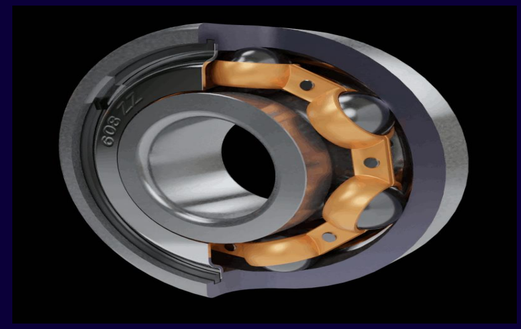
- High carbon chromium bearing steel is mainly used for bearing rings and rolling elements.
- Bearing steel can be easily heat treated.
- It has a long life and is resistant to wear.
- Cages made of low carbon steel or brass.
- Cages for high speed bearings are sometime made of plastic.



Bearing Running temperature

1-Anti-friction bearing temperature (50C -85C) (120 – 185F)

2-Plain bearing temperature (38C- 66C)



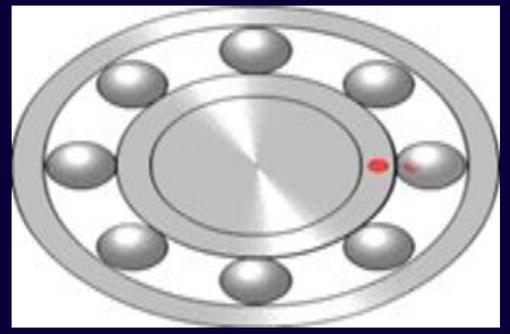
Anti-friction Bearings

Function of the cage and material

- Separates the rolling elements.
- Maintains same distance between rolling elements.
- Prevents the rolling elements falling out.

CAGE MATERIALS:

- STEEL
- BRASS
- POLYAMID



Anti-friction Bearings

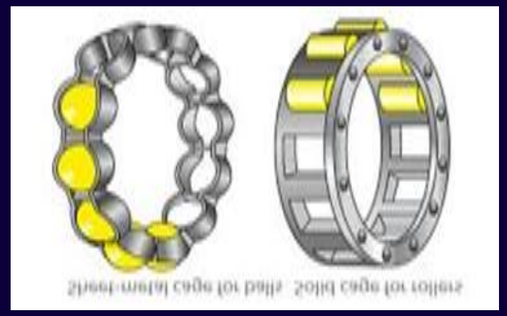
Types of Anti- friction Bearings

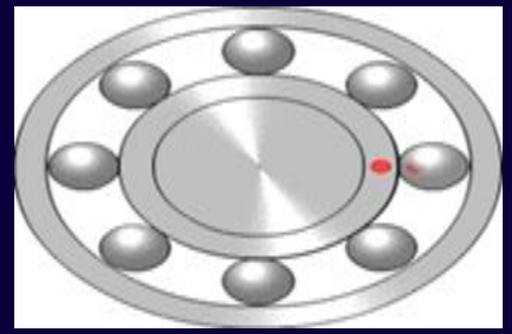
1) Ball Bearings

2) Roller Bearings

1-Ball Bearings (Types)

- Single Row Radial Ball Bearing.
- Single Row Angular Contact Ball Bearing.
- Double Row Angular Contact Ball Bearing.
- Ball Thrust Bearing.





Anti-friction Bearings

Types of Anti- friction Bearings

1-Ball Bearings

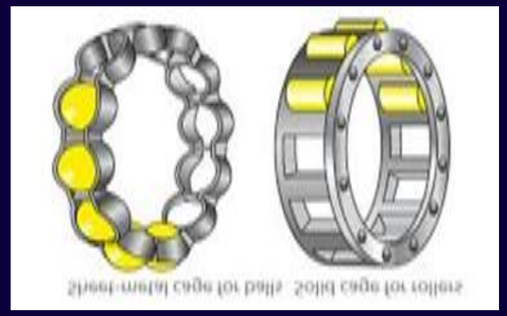
Deep Groove Ball Bearings

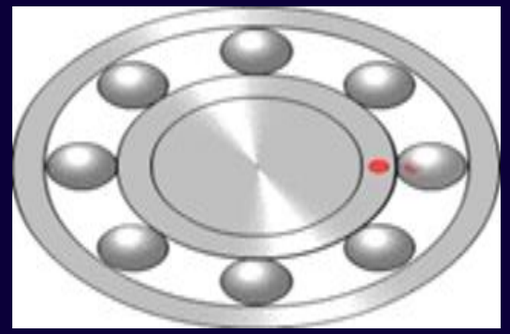
- Carries Radial & axial loads.
- Operating at high speed.

TYPES- 1-Single row for medium load.

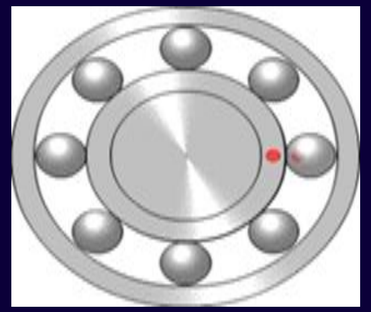
- 2-Double row for high load.

GENERALLY USED IN: Motors, Pump, Gear boxes.





Anti-friction Bearings



Single row deep groove Ball Bearings

- Single row deep groove ball bearings come in three numerical series.

1-6000 Series -Extra Light Ball Bearings.

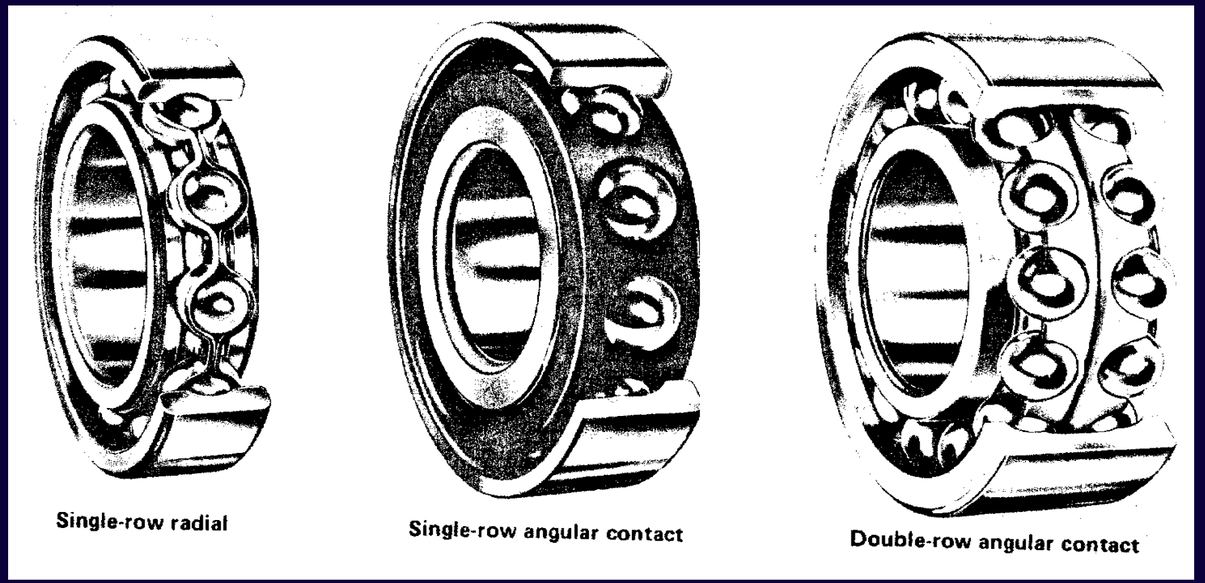
Ideal for limited space applications

2-6200 Series - Light Series Ball Bearings.

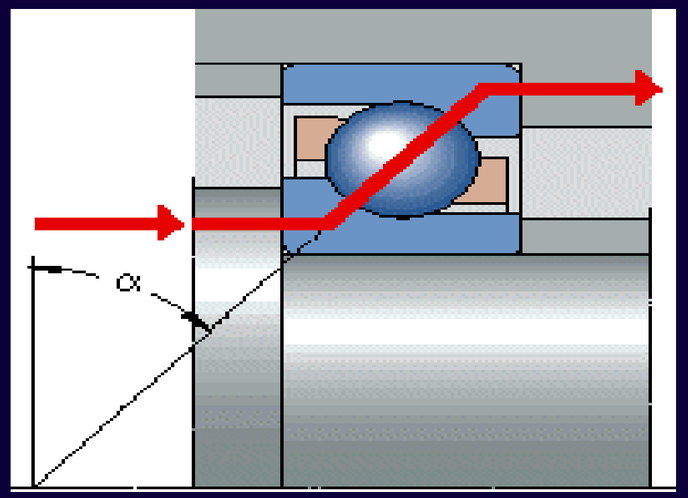
Balanced between space and load capacity

3-6300 Series - Medium Series Ball Bearings.

Ideal for heavier load capacity applications



Anti-friction Bearings



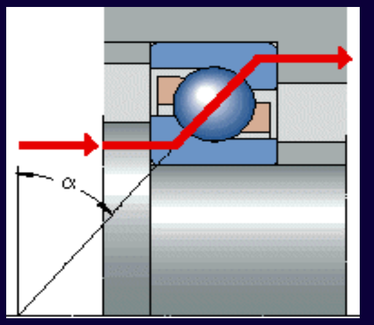
Angular contact ball bearing

- Angular contact bearings can carry both radial and axial loads.
- The contact of balls & races is on angle. (30,40)

CAPABLE FOR

- Angular load
- Compensate for misalignment.
- High running accuracy.
- Suitable for combined loads(axial, radial)
- Single row angular contact ball bearing accommodate axial load in one direction only in addition to radial load.

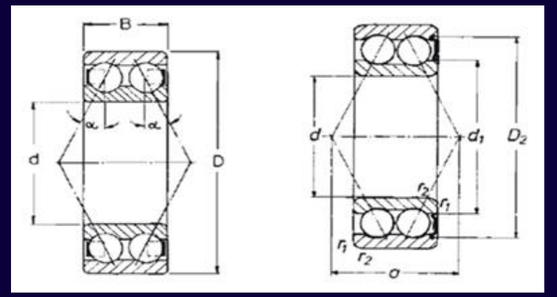
Anti-friction Bearings



Angular contact ball bearing

Double row Angular contact ball bearing

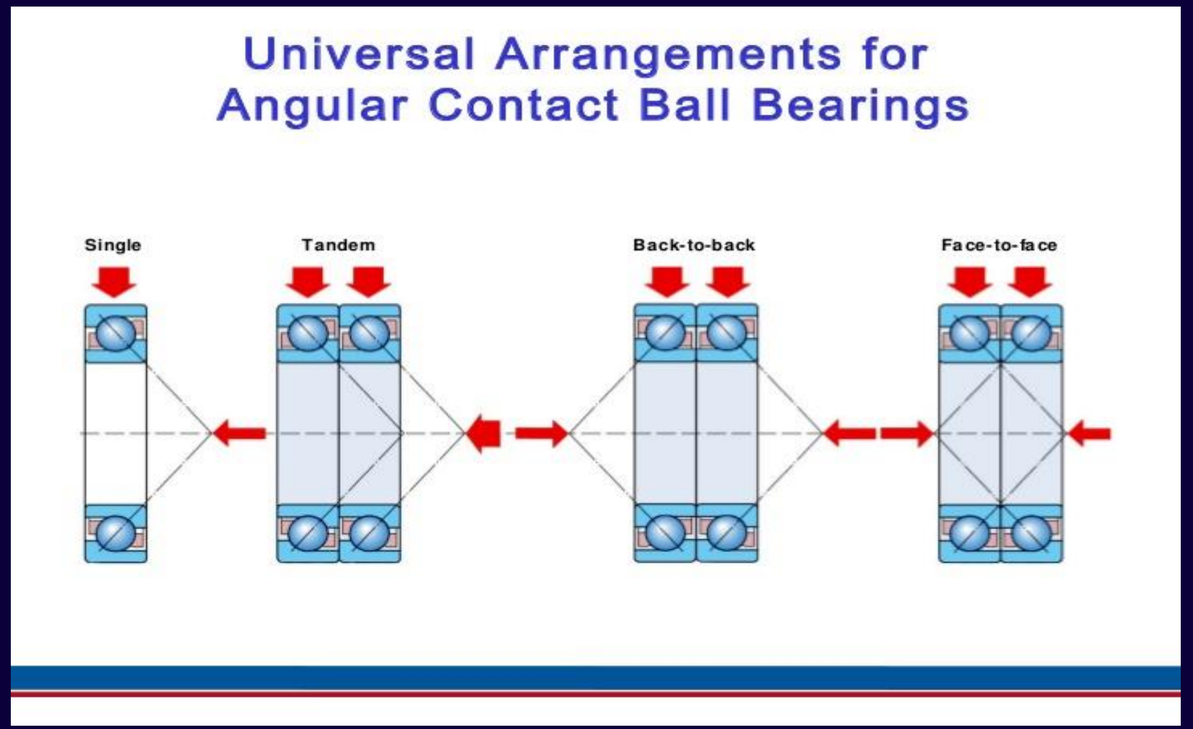
- Double row angular ball bearings are designed in double rows to accommodate thrust loads on both directions in addition to radial load.
- These are resemble a single row bearing arranged back to back.



Anti-friction Bearings

Angular contact ball bearing Arrangement

1) Back to back
2) Face to face
3) Tandem



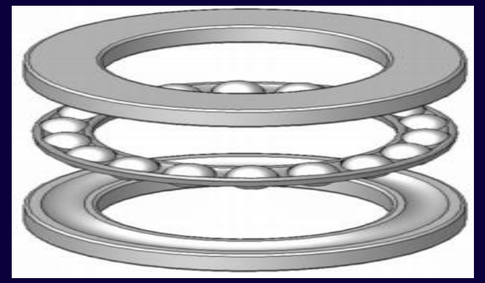
Anti-friction Bearings

Ball Thrust Bearings

- Thrust ball bearing have no outer or inner race.
- Rolling elements rotates between two discs called washer.

CAPABLE FOR:

- Heavy thrust loads.
- Designed for pure axial loading
- High running accuracy



Anti-friction Bearings

Thrust Ball Bearings Types

1-Single direction bearings

2-Double direction bearings

1- Axial loads in one direction only.

2-Axial loads in both direction

Anti-friction Bearings

Self Aligning ball Bearings

- Self-aligning bearings are designed for applications where bearing alignment is difficult to achieve and maintain.
- These bearing are used in vibrators, shakers, conveyors and heavy duty equipment.

Anti-friction Bearings

2-Roller Bearings

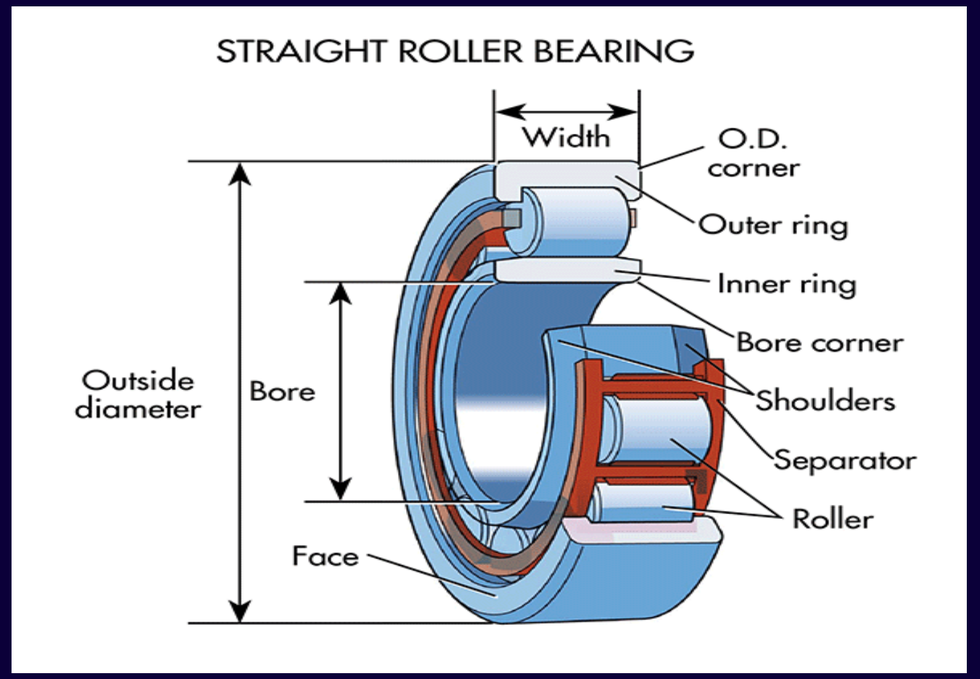
- Cylinder Roller Bearing
- Barrel or Spherical Roller Bearing.
- Tapered Roller Bearing
- Needle Roller Bearing
- Roller Thrust Bearing
- They are having greater area of contact with the race ways

Anti-friction Bearings

2-Roller Bearings

Straight Roller Bearing or cylindrical roller bearing

- Carrying high radial load.
- Assembly is separable



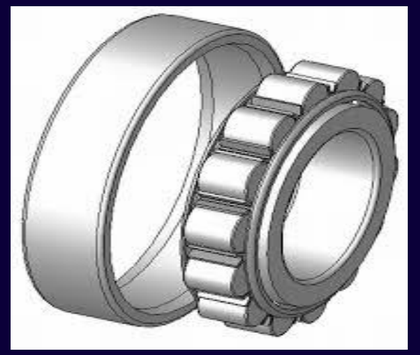
Anti-friction Bearings

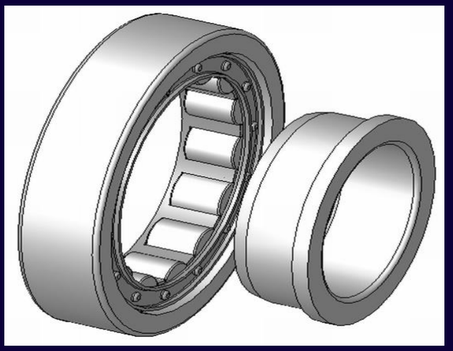
2-Roller Bearings

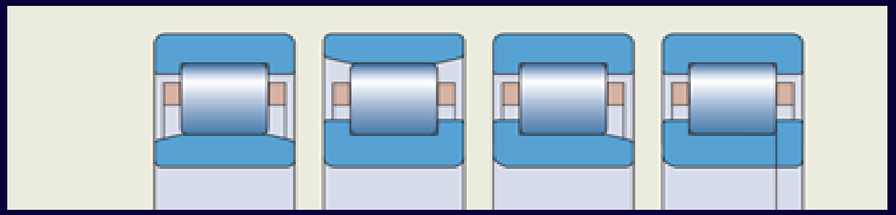
Cylindrical roller bearing

- It is used for heavy radial loads.

Three types 1-NU , 2- N , 3- NJ





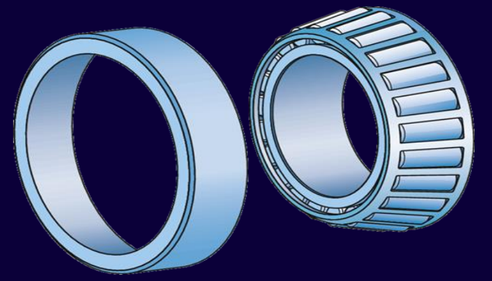


1-NU type bearing inner ring separated in any direction.

2-N type outer ring with out cage and rolling element can be separated in any direction.

3-NJ type roller bearing has a caller on one end of its inner ring, so inner ring of this bearing can be removed in one direction only.

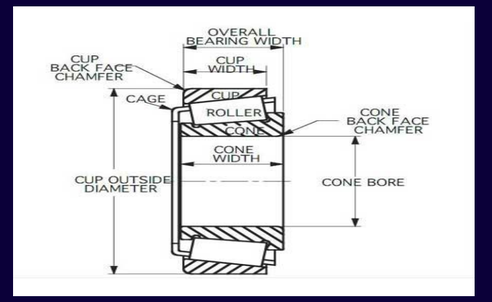
Anti-friction Bearings



2-Roller Bearings

Tapered Roller Bearings

- Taper roller bearings are designed to take up combined loads radial & axial .
- Its inner & outer raceways are tapered with tapered rollers in between .
- Inner race is called cone & outer race is called cup.

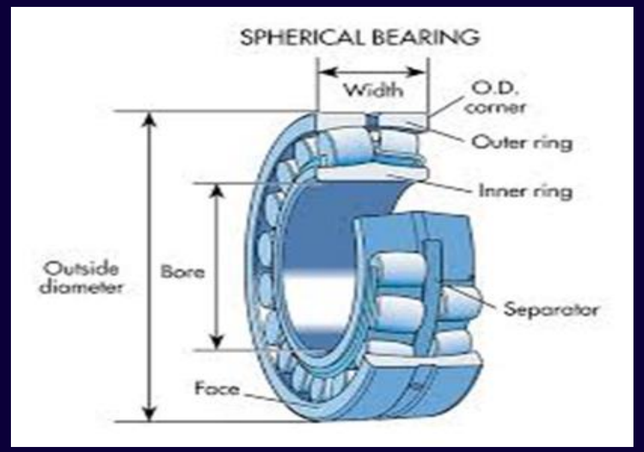


Anti-friction Bearings

2-Roller Bearings

Spherical (Barrel)Roller Bearing

- **CAPABLE FOR**
- Accommodate heavy radial & axial load
- Spherical raceway makes it self align.

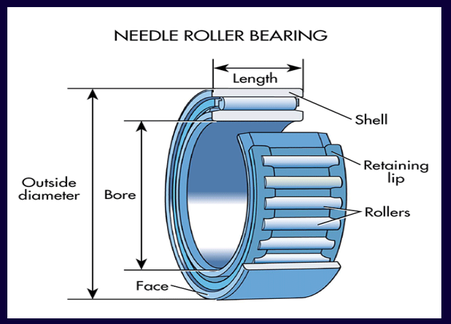


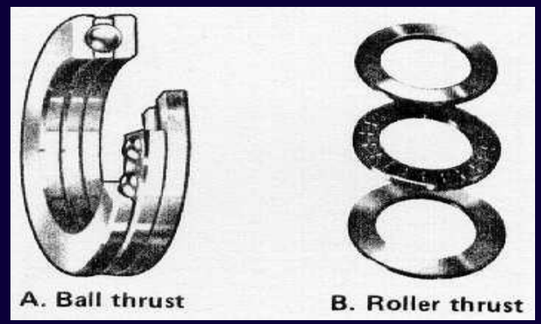
Anti-friction Bearings

2-Roller Bearings

Needle Roller Bearing

- The bearings with 5mm or less than 5mm of rollers.
- High load carrying capacity.
- Used for radial load & thrust load.

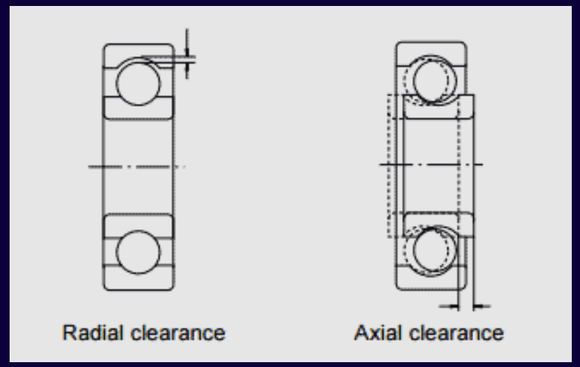


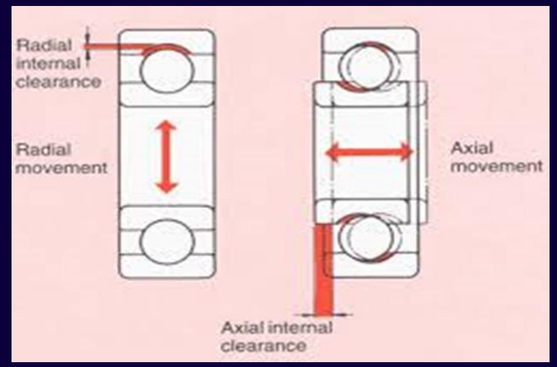


Anti-friction Bearings

Internal Clearance

- The bearing internal clearance means the distance between the rolling elements and the bearing rings.
- The movement in the radial direction is defined as "radial bearing clearance", while the movement in the axial direction is defined as "axial bearing clearance".

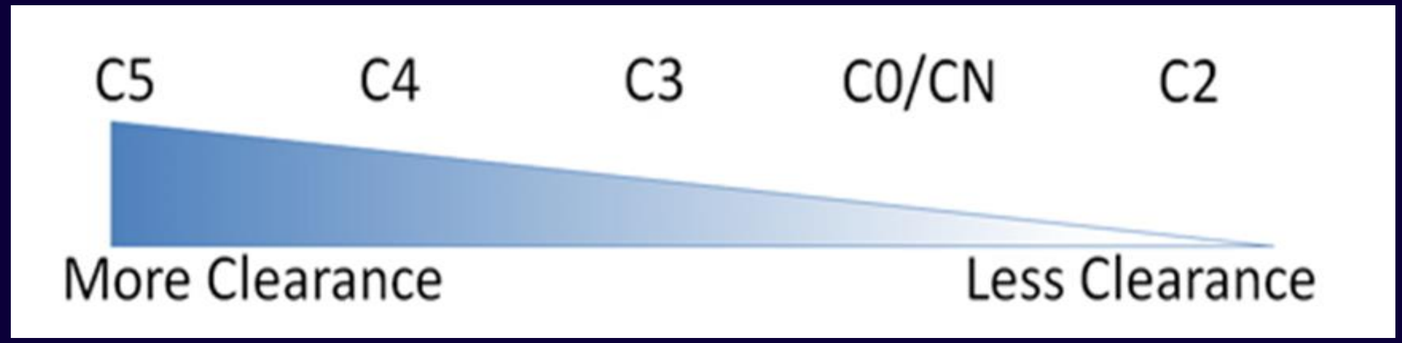




Anti-friction Bearings

Internal Clearance

- **BEARING INTERNAL CLEARANCE**
- C2 - Less than normal
- CN or C0 - Normal clearance
- C3 - More than normal
- C4 - More than C3
- C5 - More than C4



Anti-friction Bearings

GENERAL INFORMATION

- There are three important dimensions of an antifriction bearing, inside diameter, outside diameter and width diameter, may be calculated by multiplying the last two digits with five of the bearing number but **00 to 03 digit** of the number shows the **inside dia. 10,12,15 and 17mm** respectively.
- If the number of the bearing is in three digits then the ID of the bearing will be less than **10mm** and that will be the **last digit of the number.**

Anti-friction Bearings

GENERAL INFORMATION

- Internal diameters of bearing: Internal diameter (I.D) of the antifriction bearings may be determined by the manufacturers number given on the bearing.
- In a series the last two digits of the manufacturers number **multiplied by five(5)** will give the I.D of that particular bearing e.g.
- Manufacturer no. ---------- I.D -MM

6008	40
6205	25
6409	45
3310	50
7304	20

Anti-friction Bearings

General :Anti friction Bearings

- If in a series the last two digits are less than 04,then the I.D of the bearing will be:

Manufacture number	ID
6000	10MM
6201	12 MM
6402	15MM
7303	17MM

Anti-friction Bearings

General :Anti friction Bearings

- But if in a series, there are only three digits in the manufacturer number ,the last digit of the number will be the I.D of that bearing e.g.

Manufacture number	ID
803	03MM
604	04 MM
906	06MM
839	09MM

Anti-friction Bearings

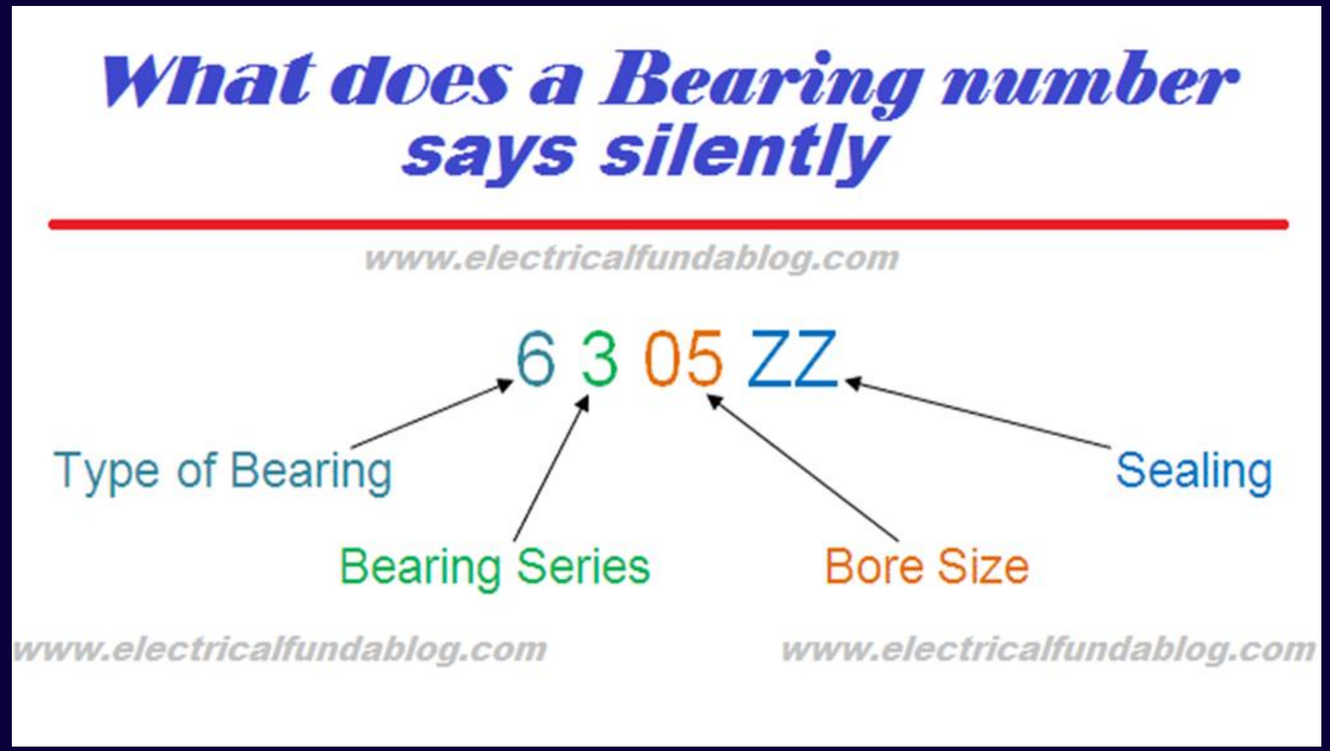
Bearings Serial codes:

- 0 Double row angular contact ball bearing
- 1 Self aligning ball bearing
- 2- Spherical roller bearing .Spherical roller thrust bearing
- 3 Taper roller bearing
- 4 Double row deep groove ball bearing
- 5 Thrust ball bearing
- 6 Single row deep groove ball bearing
- 7 Single row angular contact ball
- 8 Cylindrical roller thrust bearing
- C CARB toroidal roller bearing
- N Cylindrical roller bearing
- QJ Four point contact ball bearing
- T Taper roller bearings according to ISO355-1997

Anti-friction Bearings

How to Identify Bearings by Bearing Number

A Bearing number contains many hidden information about the bearing in itself.



Anti-friction Bearings

Bearing Series and Their Code in Bearing Number

- The second digit of a bearing patter number indicates the bearing series.
- Series of a bearing denotes the toughness of the bearing.
- We can identify now that in case of bearing **6305ZZ**, the second digit ‘3‘ means the bearing is of medium toughness.

Series Code	Series Description
0	Extra light
1	Extra light thrust
2	Light
3	Medium
4	Heavy
8	Extra thin section
9	Very thin section

Anti-friction Bearings

Shielding/Sealing/Specialty of Bearing in Bearing Number

- The last letters of the bearing indicates the availability/unavailability/type of shielding or sealing and other specialty in the bearing.

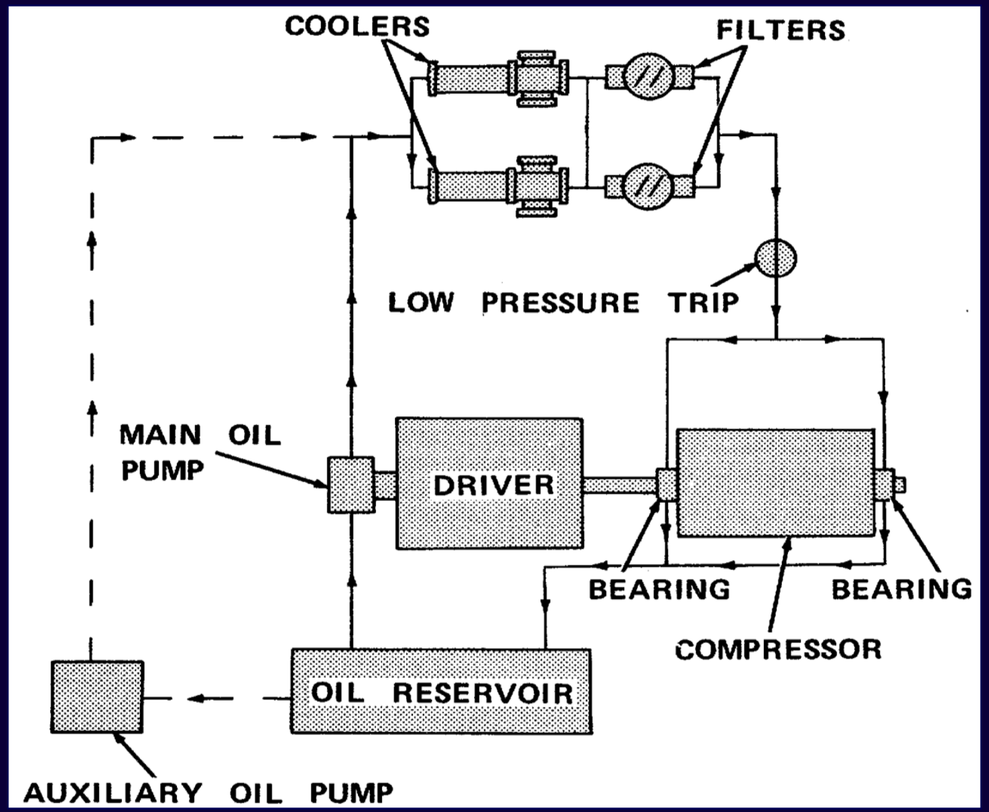
Code (last letters)	Description
Z	One side shielded
ZZ	Both sides shielded
RS	One side sealed
2RS	Both sides sealed
V	One side non contact seal
VV	Both sides non contact seal
DDU	Both sides contact seals
NR	Snap ring and groove
M	Brass cage

Anti-friction Bearings

LUBRICATION OF BEARINGS

The purpose of lubrication is:

- To reduce friction between the rolling members.
- To protect bearing from corrosion.
- To reduce the running noise.
- To reduce heat.



Anti-friction Bearings

Inspection and Surface Preparation before Mounting

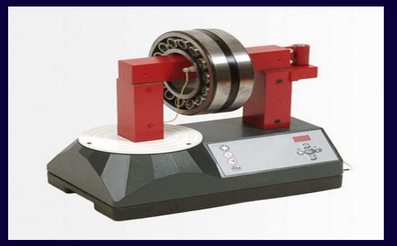
- Shaft size should be measured with outside micrometer and the bearing housing bore with inside micrometer.
- Make sure that the fitting surfaces of the shaft and the bearing housing are free from scratches, burrs, dirt.
- Remove scratches and burrs with polish paper for proper fitting.

Anti-friction Bearings

Bearings Mounting Method

- Depending on the bearing type, and size, mechanical, thermal and hydraulic methods are used for mounting.

1. **Cold Mounting Method.**
2. **Hot Mounting Method.**



Anti-friction Bearings

Bearings Mounting Method

- Depending on the bearing type, and size, mechanical, thermal and hydraulic methods are used for mounting.

1. **Cold Mounting Method.**
2. **Hot Mounting Method.**

Anti-friction Bearings

Tools requirement

1.Plastic hammer
2. Outside micrometer
3. Inside micrometer
4. Mounting sleeve
5. Mounting plate
6. Induction heater
7. Temperature gun
8. Emery paper
9. Spanner wrench
10. Bearing puller
11. Screw driver.
12. Leather gloves

Anti-friction Bearings

Mechanical removal, Installation method

- Pullers and presses designed for that purpose are the best options for three reasons:

1-safety

2-saving time

3-Minimizing the damage.

- Two and three jaw mechanical pullers pull evenly on the outer ring.

Anti-friction Bearings

Arbor press

- An arbor press is a safe method for removal and installation.
- The press should be bolted to a work bench.
- Apply pressure slowly.

Anti-friction Bearings

Hydraulic press

- Hydraulic press is a useful and efficient machine to remove and mount bearings.
- keep your hands clear, identify the start/ stop button and PPEs.
- Do not exceed the working load limit of the press.

Anti-friction Bearings

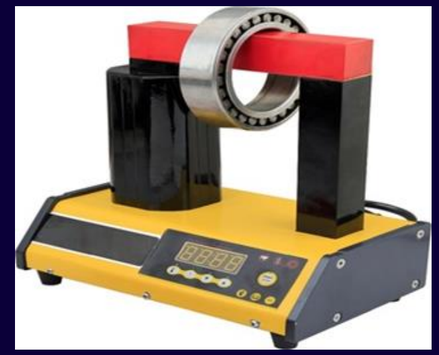
Driving tools

- Bearing less than **50 millimeter (mm)** in diameter may be mounted by using a bearing driver if the rings are installed with a light interference fit.
- Driving tools consist of a metallic tube, and dead blow hammer.

Anti-friction Bearings

Induction heater

- Bearing induction heaters produce a strong, alternating, magnetic field to induce eddy currents in the metal.
- Remember, the temperature probe should be placed on the inner ring for expansion to accommodate a press fit to shaft.
- The recommended temperature setting is **110C or 230F**
- The operator has complete control of the settings.

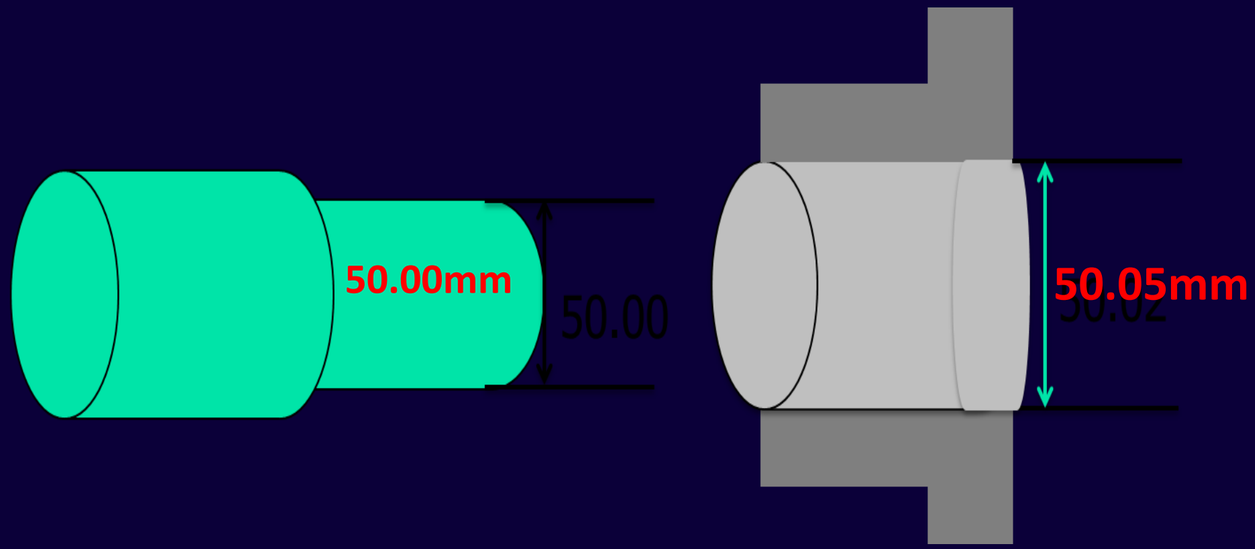


Anti-friction Bearings

Clearance and interference

Clearance

- Inner diameter of the bore greater than the outer diameter of the shaft.

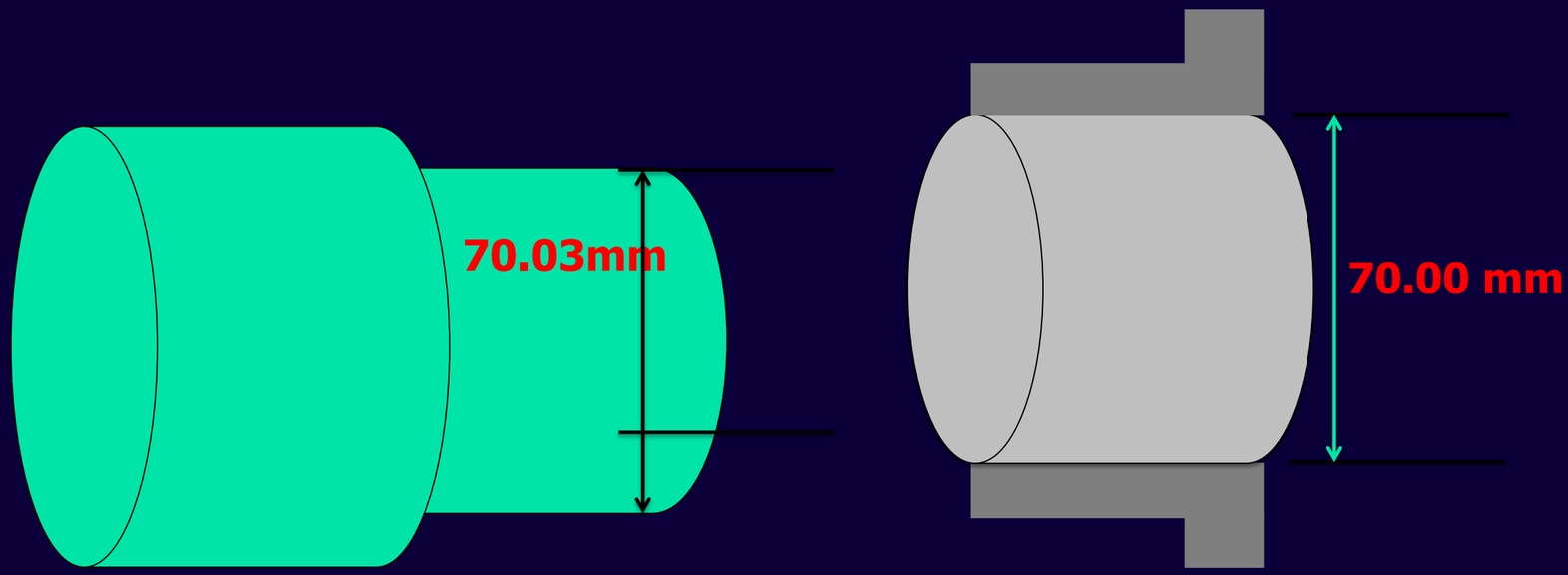


Anti-friction Bearings

Clearance and interference

Interference

- Outer diameter of the shaft greater than the inner diameter of the bore.

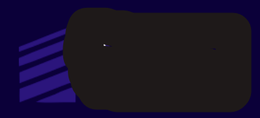


Anti-friction Bearings

Bearing crush

- Interference between journal bearing to bearing housing is called bearing crush.
- A mean of ensuring that a plain bearing is a secure interference fit in its housing.
- The outer surface of the bearing does not slip against the housing.

Anti-friction Bearings



Safety Precautions

- Bearing should be kept clean in ware house and properly wrapped.
- Use tools made of wood or light metal like brass bar or plastic hammer to install the bearing.
- Bearing should be avoid from falling if dropped it will cause dimensional imperfections in bearing.
- Apply force for removal to the inner ring when removing the bearing from the shaft, and to the outer ring when removing it from the housing.
- Use leather gloves when installing bearing by hot mounting method.
- Use hammer carefully in order to avoid pinching of fingers.

THANK YOU

RK RANA

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