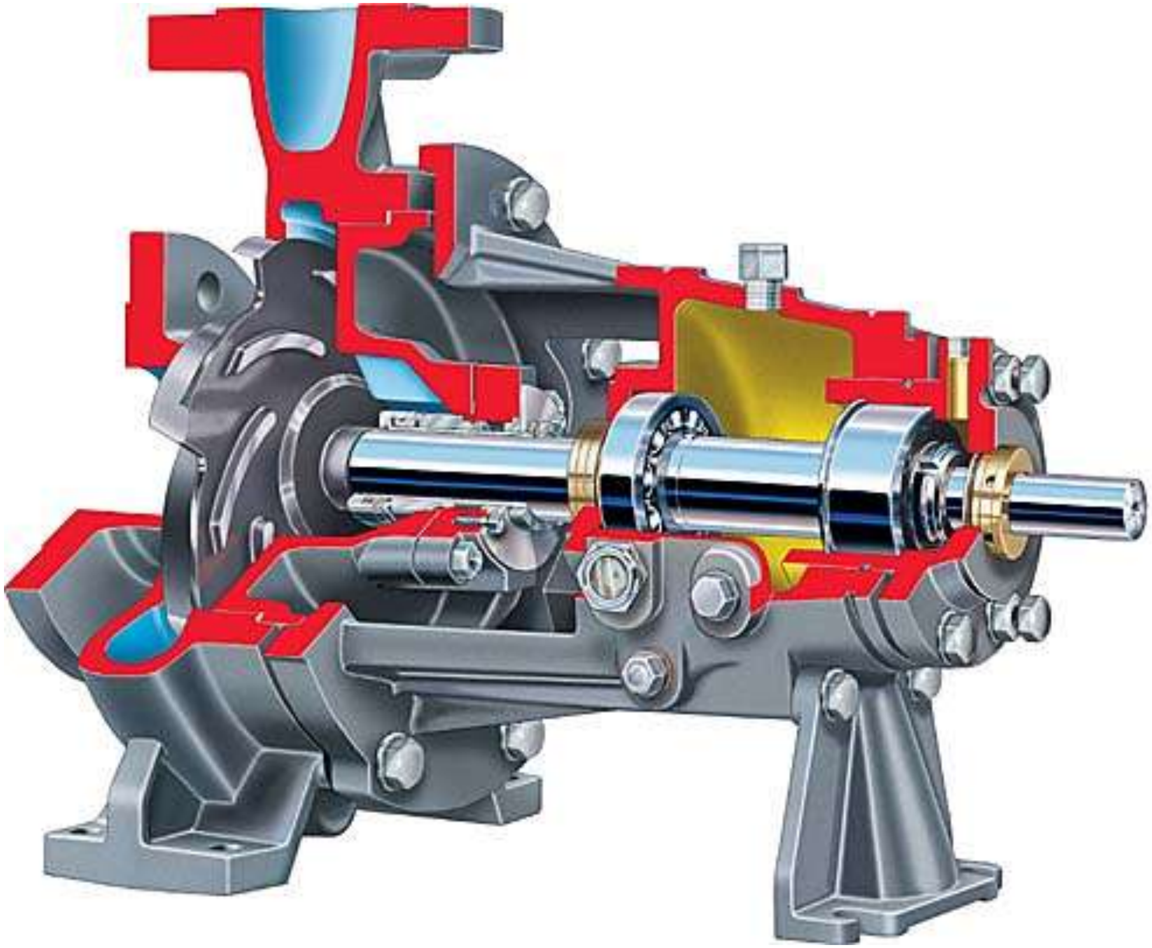
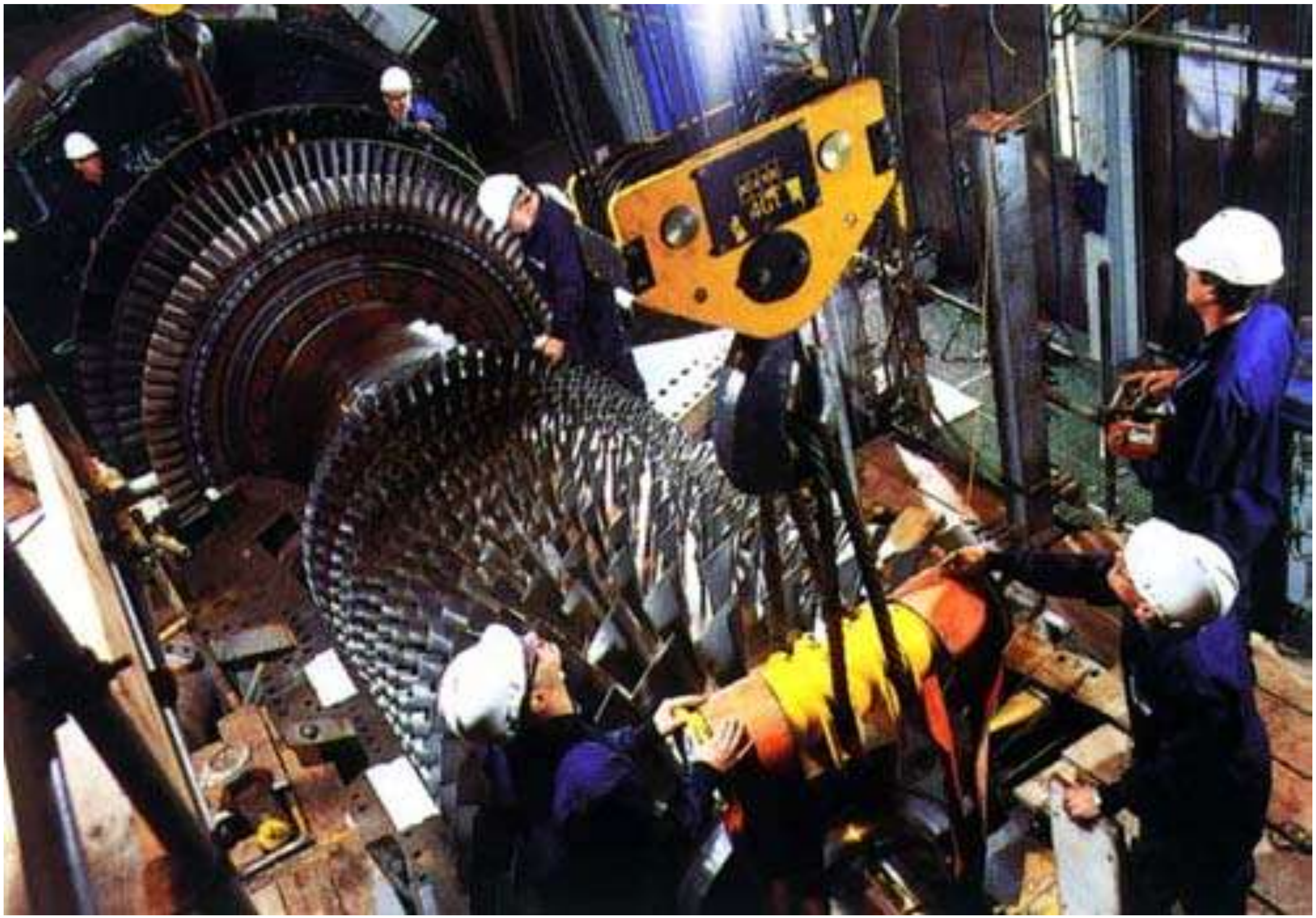
Bearings & Bushes

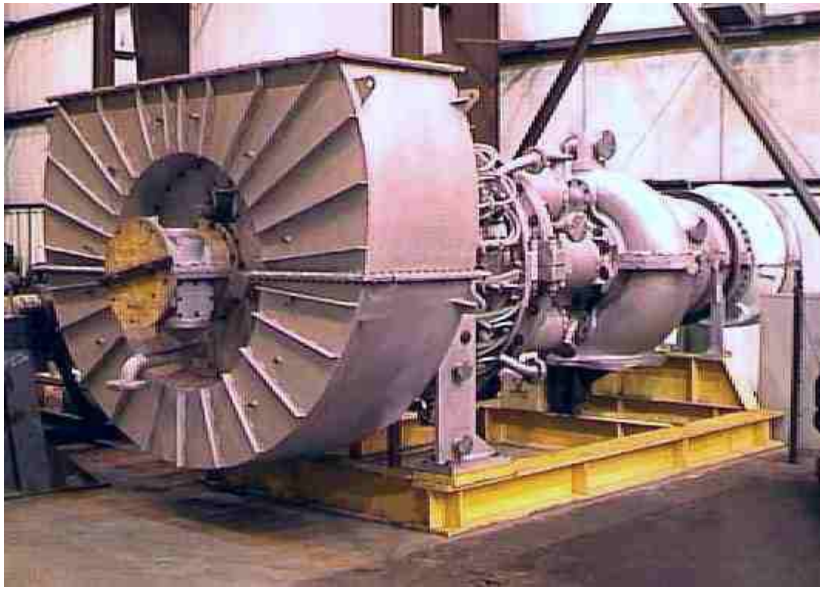
Part One General and Plain Bearing

Website: www.ttetraining.ltd.uk

ROTATING EQUIPMENT







BEARINGS

Any drive which includes a rotating or reciprocating shaft uses bearings to support and locate the shaft while still allowing movement with minimum friction

DEFINITION:

The medium of contact in between the rigid frame and movable parts in a machine is called bearing.

Bearings are common machine components.

Two types of bearings

- Plain or sleeve bearing.
- Anti-friction or rolling element bearings.

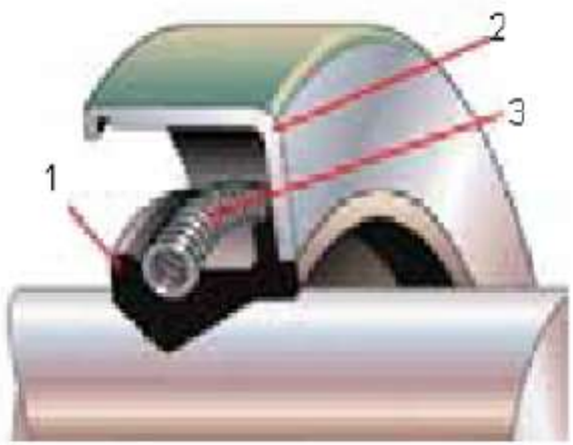
Oil lubrication system

A clean and adequate supply of lubricating oil of the correct type is essential to maintain all bearing condition.

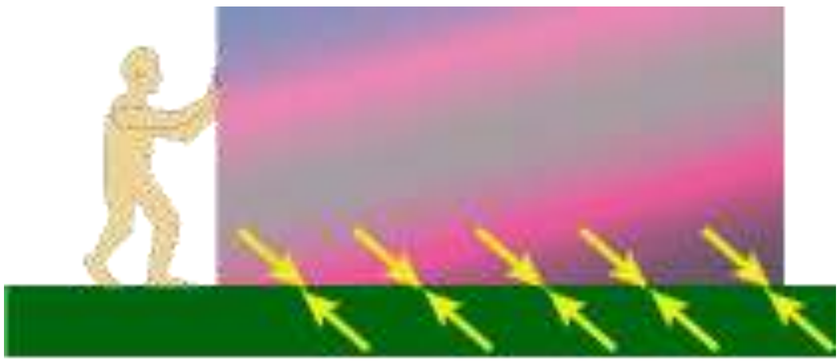
Oil lubrication Sealing

Normally shaft bearing are protected by an oil-seal (or lip-seal) arrangement that keep the oil in and the dirt out.

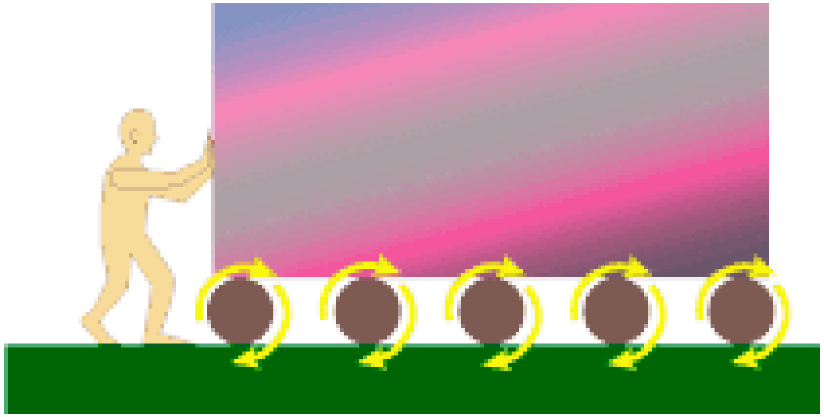
1. Sealing lip (varied material)
2. Metal or rubber casing
3. Contact spring



Sliding friction



Rolling friction



Types of Bearings

Sliding Rotary Motion

Sliding Plane Motion

Rolling Element

Sliding Rotary Motion, is a shell type bearing that usually has a white metal surface supporting a steel shaft on a journal.

<u>Sliding Plane Motion</u>, is a linear type bearing that may have a white metal half and would be similar to a cross-head bearing or a shaping machine action.

White Meal Plain Bearing

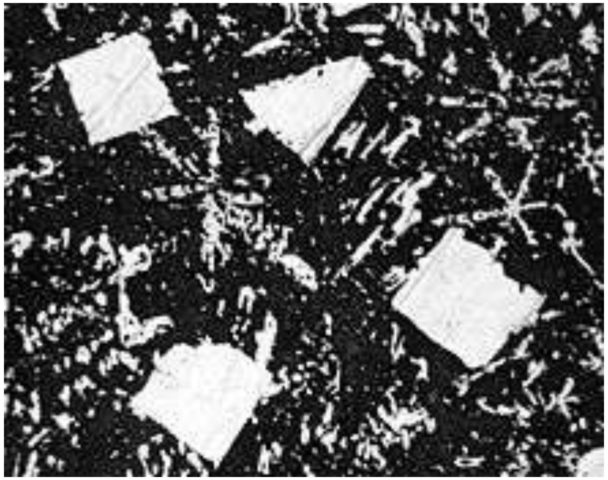
(Sliding Plane Motion & Sliding Rotary Motion)

White metal or Babbitt Metal is metal alloy originally used as a cast-in place metal bearing material. Amongst it properties is a resistance to galling along with good heat transfer. It is soft and easily damaged, which suggests that it might be unsuitable for a bearing surface.

There are the most common compositions that make up the white metal alloy.

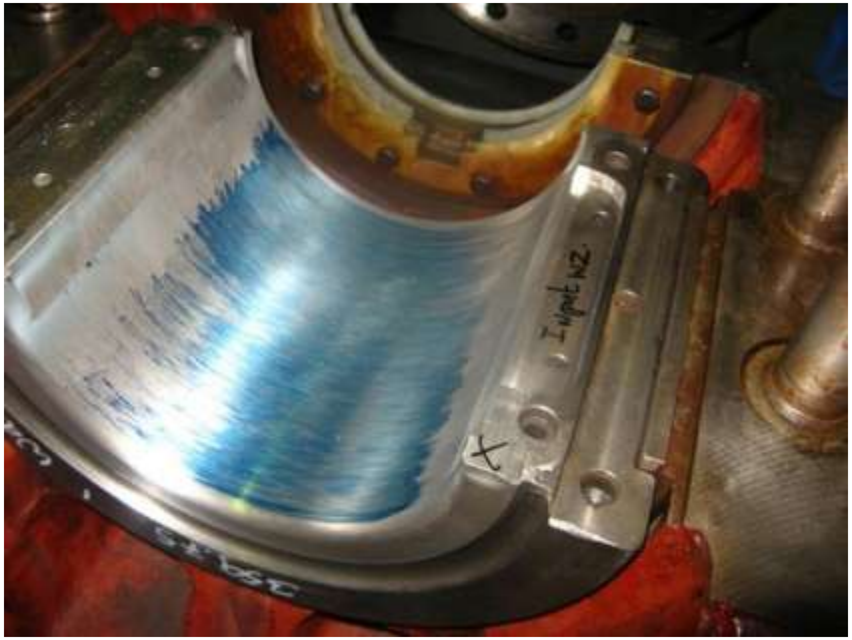
- 90% tin, 10% copper
- 89% tin, 7% antimony, 4% copper
- 80% lead, 15% antimony, 5% tin
- 76% copper, 24% lead
- 75% lead, 10% tin
- 67% copper, 28% tin, 5% lead

However, in its structure is small hard crystals dispersed in a softer metal, which makes it a metal matrix composite.



Because of it makeup it is particularly suited to hand finishing for preparing a bearing surface. It can be very accurately shaped using special bearing scrappers to produce the ideal bearing tolerance while ensuring a good support fit.

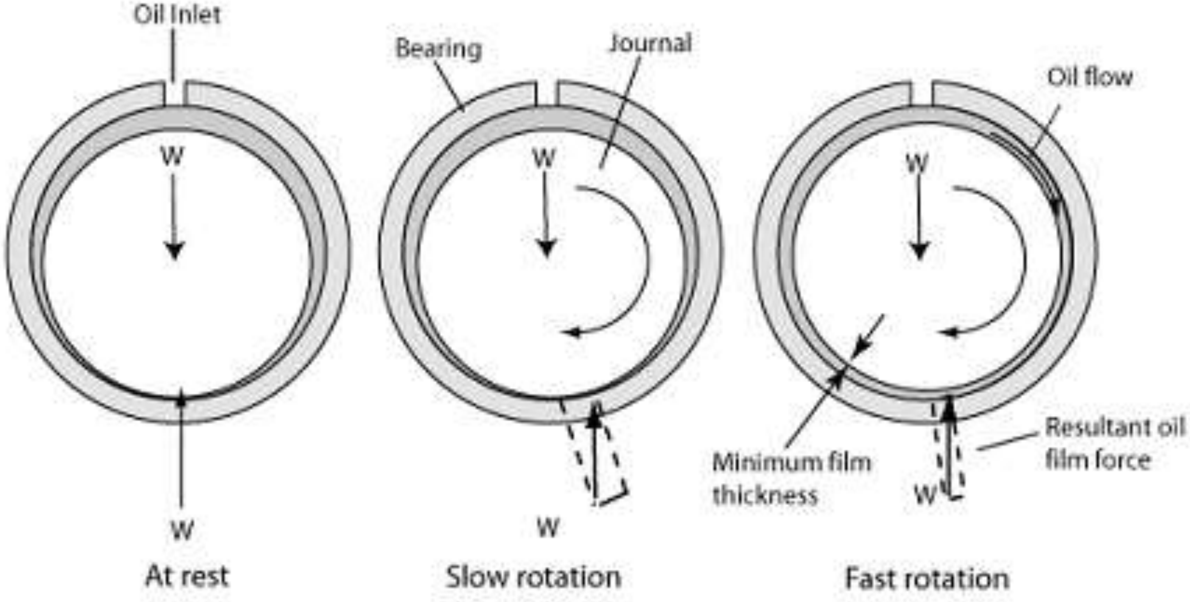
Through the process known as “Scrapping In” the half bearing and bearing journal are brought together and marked with engineers blue. Then using the bearing scrapers the “High Spots” are removed, this process is then repeated until a large contact area achieved. The overall clearance in the bearing is set using the same process



As well as sizing the bearing using scrappers, oil channels or oil grooves can also be cut into the bearing. Depending on the bearing style these grooves will channel the oil to area of shaft support, normally only see on gravity oil feed systems.

Journal Bearings Load is transferred through a lubricant in sliding contact

Load is transferred through a thin film of lubricant (oil).

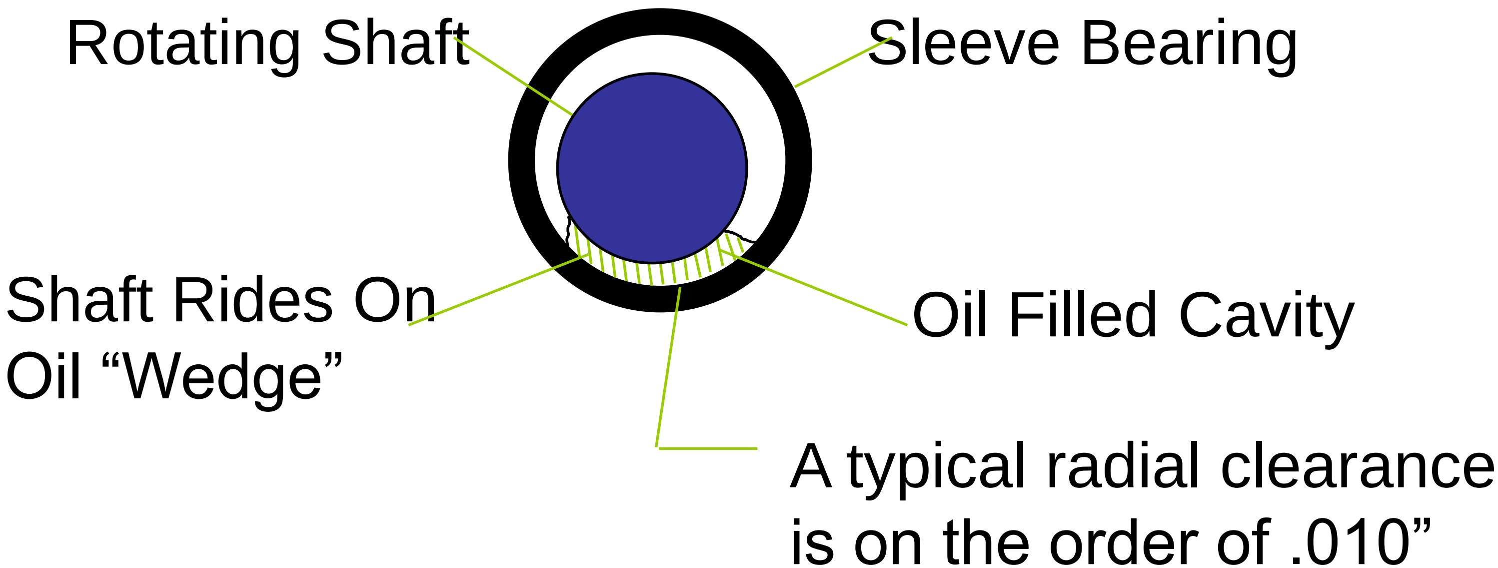


Plain and tilting pad bearings

The shaft supported in a plain journal bearing, will as it rotates, carry oil to its underside and develop a film of pressure. The pressure build up is related to speed of rotation. Thus oil delivered as the shaft turns at normal speed, will separate shaft and bearing, so preventing metal to metal contact.

Hydrodynamic oil fed bearing theoretically no wear takes place, radial or thrust.

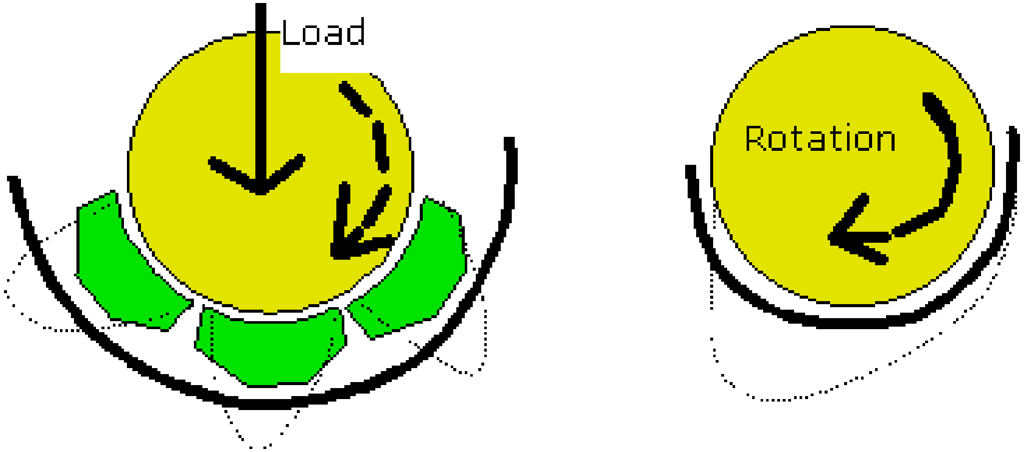
Oil support wedge produced as the shaft rotates in the bearing.



Pressure generated in the oil film, is effective over about one third of the bearing area because of oil loss at the bearing ends and peripherally. Load is supported and transmitted to the journal, by the area where the film is generated. The remaining two thirds area does not carry load

Tilting Pad Arrangement

The three pressure wedges give a larger total support area than that obtained with a plain bearing. The tilt of the pads automatically adjusts to suit load, speed and oil viscosity. The wedge of oil gives a greater separation between shaft and bearing than does the oil film in a plain journal. The enhanced load capacity of a tilting pad design permits the use of shorter length or less bearings



Replacement of the passive side portions of the plain bearing journal by tilting pads capable of carrying load will considerably increase its support capacity of the bearing.

Tilting pads bearings based on those developed by Mitchell for thrust blocks are used for the purpose.

Each pad tilts as oil is delivered to it so that a wedge of oil is formed.

Tilting pads

To adjust the overall bearing running clearance once the pad faces have been scrapped-in to the shape of the shaft journal. The radial ridge (fulcrum point) can be carefully filled and sized and checked using a D.T.I. to ensure they are all the same, this then allow the overall bearing clearance to be adjusted.

Thrust tilting pad bearings (Mitchell Bearings)

Thrust and Radial Tilting pad bearings

An essential component for the buildup of the oil wedge is a good radius on the leading edge of the pad; with out this the pads would act as a scraper removing the oil.

The radial ridge set at the back of the pad which becomes the fulcrum for the tilting action is normally positioned just off-center.

Tilting pads

When the thrust pads are viewed from the top the tilting point is away from the centre moving in the direction of rotation of the collar. This way it is shown that the pad tilts easily to form the wedge.

The thrust collar is sometimes forged integral as part of the shaft. In normal operation only one set of pads are in contact with thrust collar (active pads) the other set of pads are set with the thrust running clearance (passive pads) this then sets the total shaft axial displacement.

This builds up an oil pressure between the pad and the collar due to an oil wedge when supplied with oil and the collar revolves. The pad tilts the angle and self adjusts to the shape of the wedge which is a function of the speed too.

Temperature of the bearing is a good indication of the of the condition. A rise in temperature is an indication of low oil flow or a bearing defect and the shaft should be checked for abnormal thrust clearance. (Normal 0.015 to 0.025”).

Normally a thrust bearing operates for many years trouble free so long as the lubricated properly. The reason for this is that there is no metal to metal contact between the moving parts.

Factors which adversely affect bearings

Boundary lubrication e.g starting conditions

Surface discontinuities

Concentration of electrolyte e.g. fresh or salt water or other contamination

Oil temperature

Stresses in the bearing metal

How to Measure Bearing Clearances

A running clearance is necessary between the shaft and the bearing to allow a film of lubrication to 'cushion' the shaft. If there is too little clearance then metal to metal contact will occur causing excessive wear. Too great a clearance will cause a breakdown of the lubrication barrier and also cause metal to metal contact and subsequent failure of the bearing.

A correctly fitted rolling element bearing, the running clearance is set by the manufacturer and can only be checked by and compared to their standards. In plain bearings (white metal) very often you can adjust the clearance in the fitting and scrapper process, but again you should always refer to the makers standards. A rough guide is 0.0015” clearance per inch of diameter of the shaft journal up to 4” and 0.001” after that.

Checking Clearances

The shaft would first be assembled into the bearing and a overall pattern of contact areas established using internal scrapers and engineers blue. The correct clearance would then be checked, by one of the following methods:

Measuring the inside diameter of the bearing and comparing it to the outside diameter of the shaft – the difference is the clearance.

Placing 'plastigage' or lead wire between the bearing and the shaft during assembly. This is then crushed to the exact size of the clearance when the bearing cap is fully tightened. The thickness of the plastigage or lead wire after torquing will indicate the bearing clearance.

You can also used lead wire and measure the thickness after compressing it, but be carful not to compress the wire more that 1/3 of its diameter or it will hold off the bearing cap and give a false reading and maybe damage the bearing

Positioning a dial test indicator on the shaft and measuring any movement available between shaft and bearing. Lift clearance or Bump clearance.

The End

Any Questions ?