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History, Working and Application of Different Types of Bearing

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ABSTRACT

The major goal of this study is to determine the different types, how they work, and how they can be used. Mineral oil refined from petroleum is typically used to separate the journal and bearing, but vegetable oils, silicon oils, greases, and other lubricants may also be employed. A coating of fluid (known as lubricant) may be applied to reduce frictional resistance and wear, as well as to take away the heat created in some instances. By incorporating interfaces such as balls or rollers that rotate or roll in instead of sliding, rolling bearings try to decrease friction and sliding between surfaces in a junction. Rolling bearings and sliding bearings are the two types of bearings. A little thought will reveal that a certain amount of power is spent in overcoming frictional resistance owing to relative motion between the contact surfaces, and that if the rubbing surfaces are in direct contact, fast wear will occur. It allows relative motion between the parts' contact surfaces while carrying the load. A bearing is a machine component that supports another machine component in motion (known as journal). Axial ball and roller bearings are examples of this type of bearing.

Keywords: Machine element, Relative motion, Frictional resistance, Rubbing surfaces, Lubricant, Rolling bearing, Sliding bearing.

1. INTRODUCTION

Bearings are categorized in broad terms based on the type of operation, the motions that are permitted, or the directions of the loads (forces) applied to the parts. Within mechanical systems, rotary bearings hold rotating components such as shafts or axles in place and transfer axial and radial loads from the load source to the structure supporting it. A bearing is a mechanical component that decreases friction between moving parts by restricting relative motion to only the desired motion. To reduce sliding friction, rolling elements such as rollers or balls with a circular cross-section are inserted between the races or journals of the bearing assembly in ball bearings and roller bearings. Friction is reduced by lubrication. The bearing's design may allow for free linear movement of the moving part or free rotation around a fixed axis, or it may inhibit motion by controlling the vectors of normal forces acting on the moving parts. By reducing friction, most bearings make it easier to achieve the desired motion. There are many different bearing designs available to meet the demands of the application for maximum efficiency, reliability, durability, and performance. The plain bearing is the most basic type of bearing, consisting of a shaft rotating in a hole.

As mentioned, new surface profiles (cycloidal, catenoidal, exponential, polynomial) are found to offer a large increase in load-carrying capacity as well as a significant reduction in coefficient of friction when compared to typical taper fluid film form. Many thrust pad bearings were theoretically examined in the 1950s by investigators for design and development of good performing bearings due to early industrial demand for bearings. The stepped pad thrust bearing has a better load carrying capability than the standard plane inclined thrust bearing, according to Charnes. Many academics have studied thrust bearings with varying surface patterns on the pads in the past. The impact of pad curvatures on thrust bearing performance were investigated by Abramovitz. According to Bagci, Singh, and Gethin, the film forms have a significant impact on bearing performance. Anant Pal Singh looked into the implications of continuous circumferential surface profiles on a sector-type thrust bearing's performance. The pressure distributions for an optimum inclination of a sector pad are determined using a computer-aided finite difference numerical solution of the Reynolds equation in polar form. The authors conducted an adiabatic analysis and found that stepped pad thrust bearings have a lower temperature than plane thrust bearings. The verb "to bear" is the source of the phrase "bearing." A bearing is a machine component that permits one part to support (bear) another. Bearing surfaces, cut or moulded into a part, with variable degrees of control over the form, size, roughness, and position of the surface, are the simplest bearings. Other bearings are devices that

are mounted separately in a machine or machine part. The most sophisticated bearings for the most demanding applications are extremely precise devices, requiring some of the most advanced technological standards now available.



Figure: 1.1 Ball Bearing.

2. BEARING AND ITS TYPES

A bearing is a machine component that supports another moving machine component by allowing relative motion between the members' contact surfaces while sustaining the load. A little thought will reveal that a certain amount of power is spent in overcoming frictional resistance owing to relative motion between the contact surfaces, and that if the rubbing surfaces are in direct contact, fast wear will occur. A coating of fluid (known as lubricant) may be applied to reduce frictional resistance and wear, as well as to take away the heat created in some instances. Mineral oil refined from petroleum is typically used to separate the journal and bearing, but vegetable oils, silicon oils, greases, and other lubricants may also be employed. Rolling bearings and sliding bearings are the two types of bearings. By incorporating interfaces such as balls or rollers that rotate or roll in instead of sliding, rolling bearings try to decrease friction and sliding between surfaces in a junction. Axial ball and roller bearings are examples of this type of bearing.

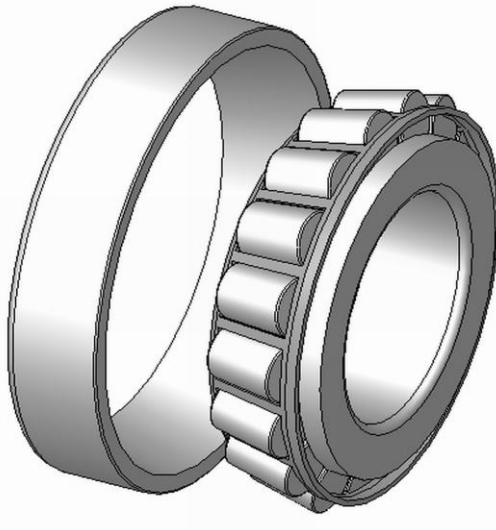


Figure: 2.1 Roller Bearing

Reduced friction in bearings is typically necessary for efficiency, reduced wear, and extended use at high speeds, as well as to avoid overheating and early bearing failure. In essence, a bearing can minimize friction by virtue of its shape, material, or introduction and containment of a fluid between surfaces, or

separation of the surfaces with an electromagnetic field.

Gains an advantage by the use of spheres or rollers, or the formation of flexure bearings.

- By material, it takes advantage of the bearing material's properties. (Using plastics with minimal surface friction is one example.)
- By fluid, exploits the low viscosity of a layer of fluid, such as a lubricant or a pressured medium, to keep the two solid pieces from touching each other, or by lowering the normal force between them.
- By fields, uses electromagnetic fields, such as magnetic fields, to keep solid parts apart;
- By air pressure, uses air pressure to keep solid parts apart.
- Even within the same bearing, a combination of these can be used. The cage, which is constructed of plastic and isolates the rollers/balls, which reduce friction due to their form and quality, is an example of this.

2.1 Loads

Bearings are designed differently based on the size and direction of the forces they must support. Radial, axial (thrust bearing), or bending moments perpendicular to the main axis are the most common forces.

3.3 Speeds

The operating speed restrictions of various bearing types vary. Maximum relative surface speeds are commonly indicated in feet per second (ft/s) or meters per second (m/s). The product DN is used to describe the performance of rotational bearings, where D is the bearing's mean diameter (commonly in mm) and N is the rotation rate in revolutions per minute. In general, the speed ranges of different bearing types overlap quite a little

2.2 Play

Some applications apply bearing loads in a variety of directions and only allow for a certain amount of play or "slop" as the applied load changes. Gaps or "play" in the bearing are one source of motion. A 10 mm shaft in a 12 mm hole, for example, has 2 mm of play. The amount of time you're allowed to play varies a lot depending on how you're going to use it. A wheelbarrow wheel, for example, can withstand both radial and axial weights. Axial loads can reach hundreds of newtons to the left or right, and it's normal for the wheel to wobble by up to 10 mm under changing loads. A lathe, on the other hand, can position a cutting tool to 0.002 mm utilizing a ball lead screw that is held in place by revolving bearings. The bearings must withstand axial stresses of thousands of newtons in either direction while holding the ball lead screw to a tolerance of 0.002 mm.

2.3 Stiffness

The flexibility of the bearing itself is a second source of motion. The balls in a ball bearing, for example, are firm rubber and deform from spherical to a somewhat flattened shape when loaded. The race is also elastic, and when the ball presses against it, it forms a little dent.

The stiffness of a bearing is defined as the variation in distance between the sections separated by the bearing as a function of applied load. This is due to the strain on the ball and race in rolling element bearings. It's because of how the fluid's pressure varies with the gap using fluid bearings (when correctly loaded, fluid bearings are typically stiffer than rolling element bearings).

2.4 Types

There are at least six different types of bearings, each with its own set of principles:

- A plain bearing is made out of a shaft that rotates in a hole. Bushing, journal bearing, sleeve bearing, rifle bearing, and composite bearing are some of the several types.
- A rolling element bearing prevents sliding friction by placing rolling elements between the rotating and stationary races. There are two major categories:
 - A ball bearing has spherical balls as the rolling components.
 - Roller Bearings, which have cylindrical, taper, or spherical rollers as rolling elements.
 - Jewel Bearing, a plain bearing with an ultra-hard glassy jewel material such as sapphire on one of the bearing surfaces to reduce friction and wear.
 - A fluid bearing is a noncontact bearing that supports the load with a gas or liquid (i.e. air bearing).
 - Magnetic Bearing, which uses a magnetic field to sustain the load.
 - Flexure Bearing: In this type of bearing, the motion is supported by a bending load element.

3. MATERIALS OF BEARING

The majority of ball bearings are manufactured of high carbon chromium steel, sometimes known as chrome still. This is utilized for cost and durability considerations. Other materials used to make bearings include stainless steel, ceramics, and plastic.

Because chrome steel corrodes when exposed to moisture, bearings manufactured of 440 grade stainless steel are frequently utilized when corrosion resistance is required. This is a hard, magnetic steel with excellent corrosion resistance, but it is not appropriate for use with sea water or many chemicals. 316 grade stainless steel is utilized for more corrosive applications, but because it is much softer, it can only be used in applications with low loads and speeds.

Ceramics (zirconia and silicon nitride) are useful for very corrosive or extreme temperature applications, whereas various types of plastics have good to

excellent corrosion resistance but are only suitable for low load and low speed applications. Non-magnetic bearings include 316 stainless steel bearings, ceramic bearings, and plastic bearings.

3.1 Manufacturing Process:

The inner and outer rings of a ball bearing are manufactured in nearly identical ways.

Tube stock is used to make the rings. Cutting tools are used to cut the ring to the basic shape, leaving additional material for machining, in automatic machines comparable to lathes, such as screw machines.

The bearing number and manufacturer information are stamped on the outer ring faces.

The hardening process is the next phase in the ring-making process. The rings are heated to 1565 degrees Fahrenheit for 15-20 minutes, then quenched in oil at 375 degrees Fahrenheit for 15-20 minutes before being tempered at 340 degrees Fahrenheit for 2 hours.

The next phase in the process for both the inner and outer rings is to grind them to their final dimensions using specialized grinding equipment.

- Grinding the face of the bearing to produce the required bearing width
- Race grinding for optimum radius, race position, and geometry
- OD grinding for outer rings and bore grinding for inner rings

Honing the races for correct surface polish and shape is the final production step. Some bearings may necessitate additional processes. When a thrust force is applied to an angular contact bearing, for example, further face grinding may be required to guarantee that the inner and outer rings have the same width. Even if the inner and outer rings start out the same width, differences in race radius, race position, race geometry, and ball diameter might cause them to misalign when the bearing is assembled and loaded. Bearing balls, like bearing rings, are made in a multi-step process. Balls begin as a wire or rod slug holding the correct quantity of material for the finished product. After that, the slugs are cold headed to form an almost net spherical shape. To remove flash and burrs, the balls are filed or tumbled. To make uniformly sized balls, soft grinding is used. A method similar to that used to harden bearing rings is utilized to harden balls. To meet finished size and roundness criteria, the hardened balls are finished ground. Finally, the balls are lapped to meet final tolerances and surface polish specifications.

Depending on the material and size, a variety of procedures are used to create bearing retainers. Stamping and forming, molding, forging, and machining are all examples of manufacturing processes.

4. Conclusion

These papers concentrate on the significance of bearings and the many types of bearings. We focused on four different types of bearings because each has its own set of characteristics and applications in the mechanical area. The Michell concept demonstrates the thrust bearing's tilting basics, which leads to proper pressure and lubrication wedge distribution. Thrust bearings are not widely used, yet they are extremely beneficial in heavy-duty applications.

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