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Spherical Plain Bearings

A radial spherical plain bearing, or SPB, consists of two components; an inner ring with a spherical race or convex outside diameter and an outer ring with a spherical race or concave inside diameter. Spherical plain bearings are thought to have originated as replacements for plain cylindrical sleeve bearings or bushings. In fact, spherical plain bearings are still occasionally referred to as ball bushings. Radial spherical plain bearings are designed to support heavy radial loads under misalignment. This feature allows the bearing to accommodate misalignments between the shaft and housing as well as oscillating movements at slow speeds.

Spherical plain bearings are primarily used in the following markets:

- Mining
- Off-Highway Equipment
- Construction
- Agriculture
- Material Handling

In the following applications:

- Hydraulic cylinders
- Vehicle suspensions
- Articulated joints
- Heavy duty linkage pivots
- High load hitch assemblies



Figure 1

The first modern spherical plain bearing had a one piece outer ring that was slightly wider than the inner ring and contained a loading slot for assembly purposes. (figure 1). Because these loading slots reduce the effective contact area, the radial and thrust capacities in the direction of the slots are affected. This design also creates a condition where the bearing is sensitive to the orientation of the loading slots with respect to the direction of loading.

The loading slot bearing eventually evolved into a bearing with a fractured outer ring. Initially, outer rings were double fractured (figure 2), followed later by a single-fracture design (figure 3). Both designs are insensitive to the orientation of the fracture plane with respect to the load direction as long as the outer ring maintains a press fit inside a sufficiently rigid housing bore.



Figure 2

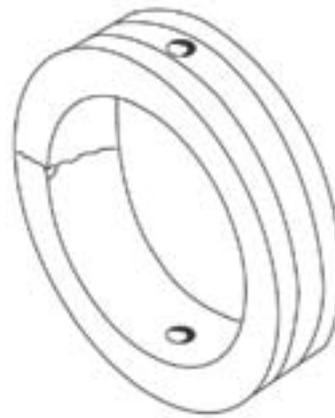


Figure 3

A double fractured outer ring consists of two segments of approximately equal size and a means of holding the bearing assembly together such as a snap ring or other form of tie such as a plastic strap (figure 2). After pressing the bearing into a suitable housing bore, the fractured surfaces of the two outer ring halves interlock making the fracture line virtually invisible. Outer ring halves can not be interchanged among bearings and must not be inadvertently rotated 180 degrees out of position.

In the single fractured design, the outer ring is fractured at a single point on its circumference; the outer ring is still a single piece (figure 3). To assemble the inner ring, the outer ring must be spread open far enough to let the inner ring pass through.

Typically spherical plain bearings are manufactured from through hardened high quality bearing steels. For applications with high shock loads, spherical plain bearings manufactured from case-hardened high quality bearing steels are also available.

There are basically two types of spherical plain bearings: Steel-on-Steel (Maintenance required spherical plain bearings), and Steel/PTFE composite (Maintenance-Free).

Steel-on-Steel spherical plain bearings require regular lubrication. These Steel-on-Steel bearings are suitable for applications where heavy loads of alternating direction, shock loads or heavy static loads need to be accommodated. Maintenance-Free spherical plain bearings consist of a low friction composite material bonded to the race of the outer ring. These bearings can be operated without maintenance and are ideal for applications where providing lubrication is not possible. Maintenance-free spherical plain bearings are designed primarily to accept heavy loads in a constant direction.

Spherical plain bearings can be divided into three groups:

1. Radial spherical plain bearings
2. Angular contact spherical plain bearings
3. Thrust spherical plain bearings

The direction of the load that is acting on the bearing will determine which type of spherical plain bearing is right for the application.

Radial spherical plain bearings should be used in applications where the load is predominately radial, although a small amount of axial load can be accommodated as well. Radial spherical plain bearings can be supplied with seals which serve two functions: to retain lubricant inside the bearing and to slow the ingress of contaminants. Seals can

have a significant impact on the overall service life of the bearing. There are many different seal variations available; factors such as tilting angle, environmental conditions, available space and cost have to be considered when determining an appropriate sealing arrangement.

If the load is predominately axial, then a thrust spherical plain bearing is the bearing of choice. Although this bearing is designed to handle primarily thrust loads, a small amount of radial load can also be accommodated.

Angular contact spherical plain bearings are intended for applications with thrust loads exceeding the axial load capabilities of a radial spherical plain bearing. Angular contact bearings can support both radial and thrust loads. Single acting angular contact bearings are separable. These bearings support thrust loads in only one direction (figure 9), and as such are usually mounted against another single acting angular contact bearing in either an “X” or “O” configuration, see figure 10.

Another option is combining two single acting angular contact bearings into a single unit; this yields a double acting bearing with a heavy section inner ring. The double acting bearing has the same configuration as mounting two single acting angular contact bearings in an “X” configuration, except the double acting bearing has one inner ring (figure 11).

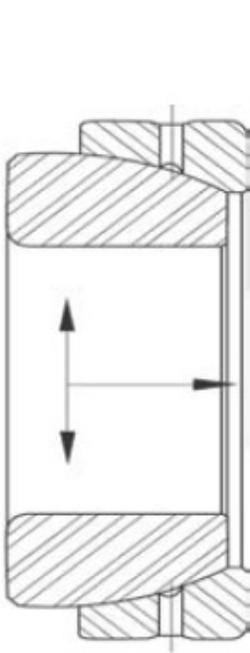


Figure 9

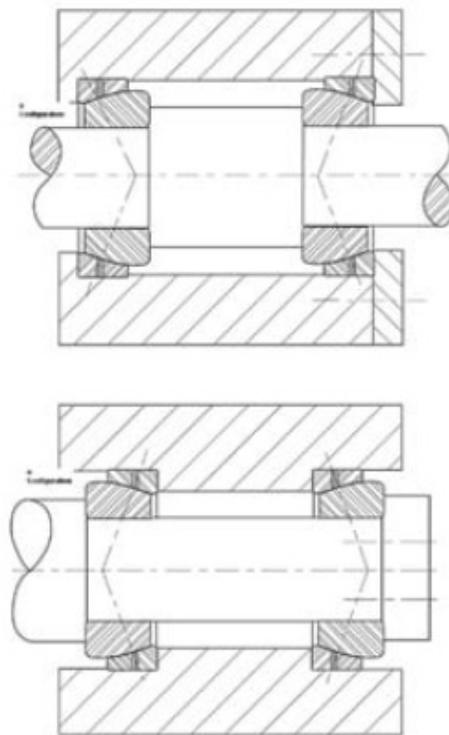


Figure 10

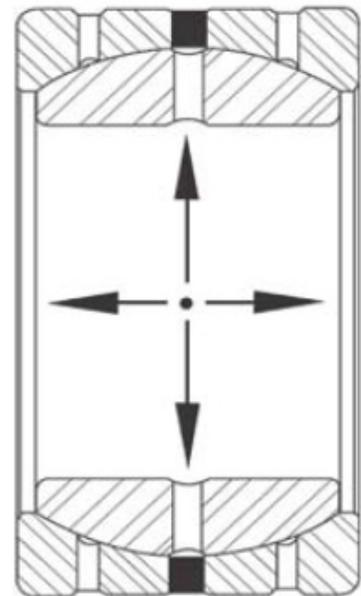


Figure 11

The table below provides information on the pertinent criteria used in the spherical plain bearing selection process.

Spherical Plain Bearing Selection Guide					
	Standard Radial	Extended Inner Ring Radial	High Misalignment Radial	Maintenance-Free Radial	Angular Contact
Radial load Reversing radial load Uni-directional load	Excellent Excellent Good	Excellent Excellent Good	Excellent Excellent Good	Excellent Good Excellent	Good Excellent Good
Thrust load Reversing thrust load Capability of misalignment	Good Good Good	Good Good Good	Good Good Excellent	Good Poor Good	Excellent None Good
Max. operating temp. (open)* Max. operating temp. (sealed) Sensitivity to contamination	500 250 Low	500 250 Low	500 250 Low	n/a 250 High	500 n/a Low
Re-lubrication Corrosion protection Adjustable clearance	Yes Good No	Yes Good No	Yes Good No	No Excellent No	Yes Good Yes
*Operating temperature above 300 F requires a special heat treatment.					

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