PEERLESS PUMP • HYDRODYNAMICS DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

PEERLESS PUMPS

TECHNICAL INFORMATION Bulletin

NUMBER SIX

COMMENTS ON BALL BEARINGS USED IN CENTRIFUGAL PUMPS

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Ball bearings are used on practically every pump which Peerless manufactures. Although the basic concept of a ball bearing is quite simple, the practical application can be rather complicated. In order to better understand why we use different types of ball bearings in different applications and do *not* use certain ball bearing arrangements, the following comments in relation to them are given.

The ball bearing industry has done an excellent job of standardizing the bore and outside dimensions of ball bearings so that different types and sizes of bearings can be interchanged and the same tooling can be used in producing bearing bores and shaft diameters. However, there may be extreme variations in the internal construction, load handling and operating characteristics of ball bearings with the same external dimensions. Just because a ball bearing is physically interchangeable with another, by no means indicates that it is designed to perform the same function. Therefore great care must be taken to make certain that replacement bearings are exactly equivalent in design and operating characteristics as well as physical dimensions.

It can be assumed that the material of the balls and races of bearings are essentially the same regardless of the manufacturer. It can also be reasonably assumed that the accuracy of manufacture of the various components is approximately the same, regardless of the make.

The radial load carrying capacity of a ball bearing is a function of the number of balls and the size of balls utilized in a given bearing. Bearings with the same external dimensions may have different size and/or a different number of balls and thus differ in load carrying capacity.

Bearings vary in the type of retainers that space the ball within the bearing. Retainers may be made of steel, solid bronze, or plastic. Various constructions of steel retainers are used by the various manufacturers. A well designed and constructed retainer is vital to the proper operation of a ball bearing.

Bearings commonly used by Peerless may be classed as a deep groove or Conrad type, maximum-capacity or notched type, double row angular contact, and angular contact bearings used singly, duplex back-to-back, face-to-face, or tandem.

DEEP GROOVE BEARINGS:

The simple deep groove bearing is commonly used to carry radial loads in horizontal pumps and motors and vertical motors. (Fig. 1). In addition to carrying radial thrust, these bearings will carry an axial thrust up to the amount of the radial thrust. If both axial and radial thrust are present, then the bearing sizes must be evaluated by combined thrust formulas. This type of bearing is used in virtually every type of pump which Peerless manufactures, in addition to their Moturbo construction, and vertical hollowshaft motors and gear heads.

MAXIMUM-TYPE BEARINGS:

There is a limit to how many balls can be installed in a deep groove bearing. Thus, when very high radial loads are present and small or a minimum axial thrust load, a maximum type bearing is used. This bearing has filling notches at one point in each race to permit the insertion of the balls so that

more and/or larger balls can be accommodated to increase its radial capacity. (Fig. 2). We use this type of bearing in a few applications where no axial thrust is present and high radial loads can be experienced. It should be noted that this type of bearing can have exactly the same dimensions as a deep groove bearing, but definitely has more radial thrust capacity and less axial thrust capacity.

DOUBLE ROW BEARINGS:

A double row bearing is a bearing which has two rows of balls running in a dual track inner race and outer race. This bearing is completely assembled at the factory and is simply a wide ball bearing having two rows of balls. Double row bearings are made in three styles:

1. MRC and New Departure make an angular contact double row bearing where lines drawn through the center of contact of the balls with the races intersect in the inner race. (Fig. 3). Such a bearing will carry relatively heavy radial loads, relatively heavy thrust loads in either direction, or relatively heavy combined thrust and radial loads. This type of bearing will permit some misalignment, although it is appreciably more sensitive to misalignment than a single row bearing.

2. New Departure also makes a double row bearing where the angle of contact of the bearings with the races is such that the line drawn through the centers of contact would meet in the outer race of the bearing. (Fig. 4). This bearing is an efficient dual purpose bearing capable of resisting relatively heavy radial thrust loads and axial thrust loads from either direction with equal facility. This is a rigid bearing which will hold an assembly in axial position with virtually no end-play. However, it is sensitive to misalignment.

Because of their inability to accept misalignment, we have virtually no designs in the Peerless line where 2 double row bearings are used on a single shaft. Regardless of the care that is taken to provide straight shafts and concentric bores and housings, and to prevent them from deflecting under load, no machine can be perfectly made nor assembled. Thus, we believe that an essential part of good design is to minimize its sensitivity to such features as misalignment. By avoiding the use of two double row bearings on a single shaft, we can accomplish this objective. Quoting from the New Departure handbook on this subject: "The use of two double row bearings on the same shaft either free or clamped, should not be undertaken unless the application has received the approval of New Departure engineers."

When replacing double row bearings, great care should be taken that an exactly equivalent type of bearing is used to replace the original. Because the bearing has a double row and has the same dimensions does not mean that it is equivalent. It is important to see whether the bearing is of the angular contact type and also which direction the contact takes so that a bearing identical to the original design is used. In their anxiety to sell their own make of bearings, some bearing interchangeability charts do not honestly point out these differences and *it is always safer to replace a bearing of the same make and number to be sure you are getting the same type of double row bearing.*

SINGLE VS. DOUBLE ROW BEARINGS:

Many people have the mistaken idea that a double row bearing is always superior to a single row bearing in pump design applications. Such a general assumption is incorrect.

Double row bearings are much more sensitive to misalignment than single row bearings and when they are used, special care must be taken in the machining of all parts and in their assembly to avoid their early failure because of misalignment. Double row bearings are more expensive to replace, are more difficult to lubricate, and have a greater tendency to heat up than single row bearings. They are excellent bearings when they are properly used and if they are needed, *but they should not be used if not required.*

Some users will look at a picture of a pump showing a double row bearing and automatically assume that such a unit has better bearing life than one which utilizes only a single row bearing. Until the type and size of bearing used is known, the relative load carrying capacities cannot be determined. It is true that a double row bearing has a greater capacity than a single row bearing that has the same shaft bore and same housing bore. However, this information can generally not be determined from a cross-section view of a pump. A slightly larger single row bearing, particularly of the heavy series and the maximum type, can well have more load carrying capacity than a smaller double row bearing. Frequently, a shaft size must be large in order to minimize deflection and the single row bearing which will fit the shaft has ample capacity to carry any of the radial and thrust loads involved. If this is the case, a single row bearing is the very best choice for the application. Thus, you should never conclude that a single row bearing design is inferior to that of a double row bearing design unless a detailed analysis of the forces and bearing ratings is available.

On most applications it is poor practice to use two double row bearings on the same shaft. If misalignment is present, even to a small degree, two double row bearings on a single shaft could easily have much less life than two single row bearings or a double row used in conjunction with a single row on the same shaft. The forces that can be set up between two double row bearings that are not perfectly aligned can be very great and can easily cause premature failure of the bearings themselves. Thus, as indicated in the previous section, Peerless has virtually no designs using two double row or two pairs of angular contact bearings on the same shaft.

ANGULAR CONTACT THRUST BEARINGS:

Most Peerless representatives are very familiar with angular contact thrust bearings because of their wide use in vertical hollowshaft motors to carry the very high axial thrust loads which are present in vertical turbine pumps. These bearings are designed primarily to take high thrust loads and when loaded to take thrust, will also take some radial load. However, unless there is a thrust load on an angular contact bearing, it will be loose and is not satisfactory to take a radial load. (Fig. 5). Thus, on a vertical motor where upthrust is present, special precautions must be taken.

Where high axial loads are present on horizontal pumps, duplex angular contact bearings have been frequently used. (Fig. 6). These bearings are precision ground so that their eccentricities are minimized and the faces are ground so that the bearings are preloaded when clamped to the shaft by a lock nut. Bearings such as these are frequently used in machine tools where zero end-play is required. The necessity of this class of bearing on a horizontal double suction pump which has a minimum of axial thrust is questionable. In many cases, a single row bearing would take all of the radial and axial thrust required by a double suction pump, would be much less sensitive to misalignment, would heat less, and would have a lower replacement cost. On some of our newer "A" pump designs, the loads have been carefully evaluated and duplex bearings have been replaced by single row bearings which do a very adequate job, are less sensitive to handling by maintenance personnel, and are appreciably less expensive. Bearing heating, which is often a cause of customer complaint, is invariably less with single row bearings.

An additional problem with duplex angular contact bearings is the lack of knowledge by some users that precision ground duplex angular contact bearings are required to be assembled together. Ordinary angular contact bearings are slightly cheaper and two such bearings are sometimes assembled together rather than purchasing a duplex type bearing. There is a good chance that trouble can result from such a procedure as the concentricity of the bearings could "fight," causing excessively high bearing loads, heating, and early failure. Always use bearings ground and selected for duplex use when used in pairs.

Where greater radial and/or thrust loads are required than can be carried on a shaft of a given size by a single row bearing, a double row bearing appears to us to be a better selection than duplex angular contact bearings. Such a bearing can be better handled by maintenance personnel and normally has sufficient capacity for any horizontal pump application. We have found these bearings highly successful for this type of service on PR pumps.

CONCLUSIONS:

1. Identical outside dimensions do not mean that a bearing is interchangeable and great care should be taken to be certain that equivalent bearings are used for replacement purposes.

2. Single row deep groove bearings are the best all around bearings within the range of their capacity.

3. The use of two double row or two sets of duplex bearings on a single shaft can lead to serious trouble if the machining and assembly work is not near perfect.

4. All double row bearings are not the same and great care should be taken to make sure that equivalent bearings are used for replacement applications.

5. When replacing angular contact bearings, used in duplex, make certain that duplex quality bearings are used and that they are assembled in the same direction as in the original assembly.

REPRESENTATIVE BALL BEARING TYPES AND CONFIGURATIONS USED IN PEERLESS PUMPS

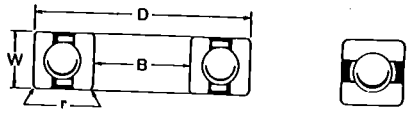

Fig. 1.
SINGLE ROW-DEEP GROOVE

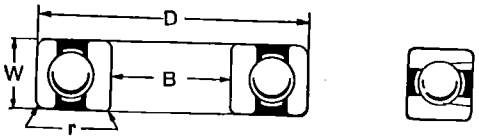

Fig. 2.
SINGLE ROW-MAX.:

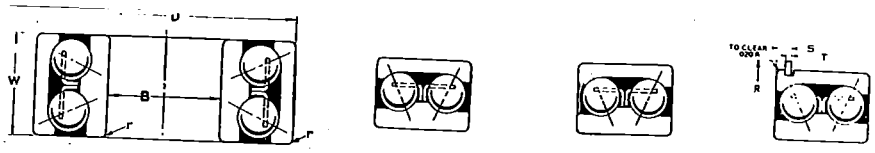

Fig. 3.
DOUBLE ROW ANGULAR CONTACT:
Angle Contact Converges at *Inner* Race . . .

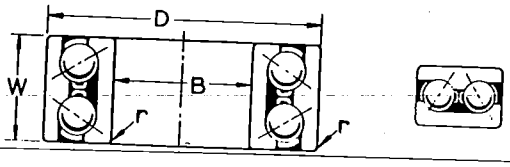

Fig. 4.
DOUBLE ROW-ANGULAR CONTACT
Angle Contact Converges at *Outer* Race . . . .

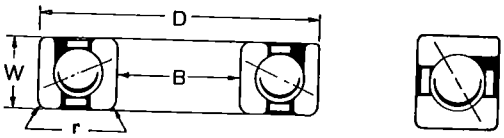

Fig. 5.
SINGLE ROW-ANGULAR CONTACT

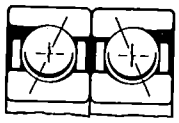

Fig. 6.
DUPLEX "DB" MOUNTING
Back-to-Back

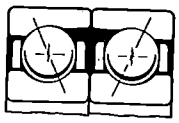

Fig. 7.
"DF"
Face-to-Face

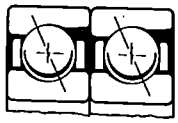

Fig. 8.
DUPLEX "DT" MOUNTING
Tandem

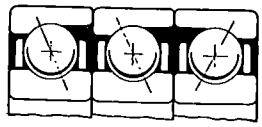

Fig. 9.
MULTIPLE MOUNTING

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