Bearing Installation

Spacers and Clamping Nuts

Opportunities for error increase with the number of separate parts used in a bearing application and it is always a good rule to employ as few spacers, washers and similar parts as possible.

All spacers, clamping nuts and washers should be faced square and true in relation to their bores, so that when the assembly is locked up, there is a minimum tendency toward misalignment or bending of the shaft. Where relatively long spacers are used to separate the bearings, they should be made heavy enough to properly resist the compression load imposed when the bearings are clamped tight. A spacer having walls thick enough to withstand the clamping load without serious distortion will also be thick enough to have ample clamping face for bearing location.

Clamping and Retaining Methods

Where ball bearing rings are properly press fitted, they will not creep excessively or turn on the shaft or in the housing under normal conditions. Therefore, where suitable shoulders can be provided in a mounting design to definitely locate the bearings against endwise movement, it is frequently unnecessary to employ clamping members.

However, in most applications where thrust is present, it is usually desirable to resist the axial load with a single bearing leaving the remaining bearing or bearings on the same shaft to perform radial duty only. Obviously, under such conditions, particularly where the thrust is subject to reversal of direction, it is necessary to clamp the thrust-resisting bearing in place.

Clamping Inner Rings

Where bearing rings must be clamped, the type of device employed is determined principally by me nature of the service to which the bearing will be subjected. Thus, where the loads are heavy or the mounting is to be operated under a steady pounding or vibration, the device used must be of a kind which can be securely locked in position after being tightly set up. Since the nut which can be positively locked is required to a greater extent than any other, the type shown in figure 3 has been standardized by the principal ball bearing manufacturers.

Here a lockwasher, interposed between the bearing and the nut, is keyed to a slot in the shaft. Six wings or ears on the washer are so spaced that one of the four slots in the nut will so nearly line up with a wing when the nut Is set up tightly that only a slight movement of the nut one way or the other Is necessary before the wing can be bent into the slot, thus interlocking the assembly. This device is quickly applied or removed and is positive, but requires the machining of a keyway In the shaft which, in some installations, is not convenient.

Under some conditions, sufficient shaft extension to allow threadIng for a standard locknut is not possible and yet a positive clamping device is necessary. A method frequently adopted In such cases is that shown in figure 4. In this, a heavy washer is clamped against the bearing face by means of two cap screws which are threaded into the shaft. The screws have holes drilled In their heads so that a wire passed through and twisted, as shown, prevents any possibility of loosening In service.

Another type which, though not positively locked when set up, is capable of being more securely held in place than Is possible with a plain nut, Is shown in figure 5. ThIs is the split nut using a screw to cramp the thIn split section against the shaft threads. To be most effective, this nut must be so cut that the slot extends past the center of the bore of the nut and near enough to one side so that the desired crampIng can be obtained with the size of screw used. A screw applied exactly as shown will lock more effectively than will one which forces the split portions apart and will also give a more uniform clamping pressure at all points on the bearing race, thus mInImiZIng the possibility of misalignment. It is advisable to use a screw of the largest diameter, consIstent with the nut size. This screw can be either as shown or a standard hexagon or fih1lter head.

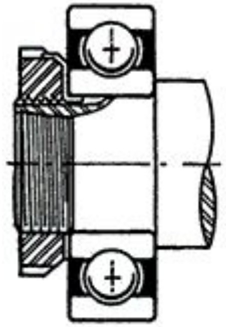

Figure 3.

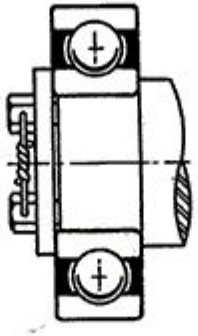

Figure 4.

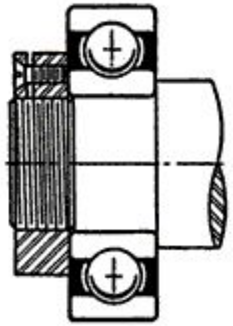

Figure 5.

(Clamping Inner Rings—Continued)

Another device in which the locking is obtained by means of a setscrew is shown in figure 6. Either a round nut with slots or spanner holes, or a standard hexagonal nut may be used, the setscrew being as large as can be introduced without seriously weakening the nut. The screw should fit tightly so as not to easily lose its locking pressure, and in order that the threads on the shaft may not be damaged, a small slug of soft metal should be placed between the screw and the shaft.

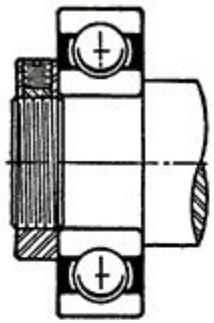

Figure 6.

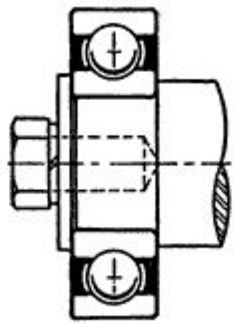

Figure 7.

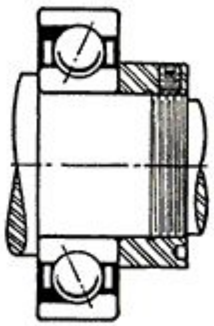

Figure 8.

The clamping method illustrated in figure 7 may be used in certain Instances where it is not desirable to thread the shaft, and a device as positive as that shown in figure 4 is not required. The washer should be of such thickness as not to spring too much at the center when the screw is set up tightly, since this would reduce the contact surface between the washer and the bearing race. A lock washer placed under the head of the screw will assist In keeping the assembly tight In such a mounting, if the direction of rotation remains constant, It Is an additional security against loosening if the clamping screw Is threaded against the direction of rotation; that Is, so as to tighten rather than loosen, should the bearing turn upon the shaft.

Where extreme precision is essential, the clamping face of the nut must be square with the axis of the shaft in such cases it is often advisable to utilize a nut of the type shown in figure 8. This nut should be an easy fit on the threads so as to prevent binding where the ground piloting bore of the nut fits over the shaft. The length of the piloting surface of the nut should at least equal the length devoted to the threads.

Locating Shoulders for Clamping Bearings

When a bearing inner ring is to be clamped, it is essential to provide a sufficiently high shoulder on the shaft to locate the bearing positively and with sufficient accuracy to meet the requirements of the Installation.

There are applications where the difference between the bearing bore and the maximum shaft diameter gives a low shoulder which would enter the corner radius of the bearing. To use such a shoulder would be very poor practice, and if the shaft diameter cannot be increased, it is best to use a shoulder ring, as in figure 9. This ring should be a tight fit and should extend well into the shaft corner, the shaft having the smallest corner radius, consistent with strength. This is very important, since the ring must receive support from all available shaft shoulder, if it is to present a firm locating face to the bearing.

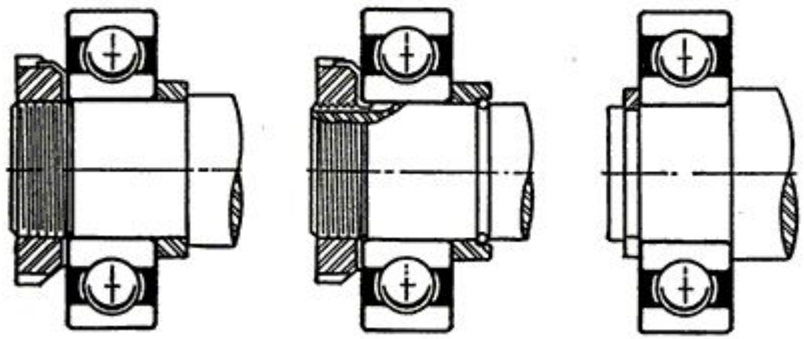

Figure 9. Figure 10. Figure 11.

In some instances It is desired to mount a ball bearing on a shaft, the diameter of which is either identical with the bore of the bearing, or so nearly the same as to admit of no Integral locating shoulder. Unless an extreme degree of accuracy is required, a shoulder ring may be applied to overcome this obstacle, as Illustrated in figure 10. This method requires that a groove be cut in the shaft to receive a snap wire. The shoulder ring should be tight on the shaft and should likewise be a snug fit over the wire, thus locking it firmly in place. This takes a special factory assembly, especially if the bearing is positively clamped against the ring. This would not, however, be recommended where loads are extremely heavy, since the snap ring groove, to a certain extent, weakens the shaft.

Use of Retaining Ring

Although the Inner ring of a bearing which has been properly press fitted on a shaft will not creep or move from Its seat under normal radial load, it is sometimes advisable to utilize some form of retaining member to prevent ion displacement of the bearing due to a possible change In load conditions.

The device most used is a snap ring fitted into a groove in the shaft, as in figure 11. Though not intended to exert any clamping

(Use of Retaining Ring—Continued)

Pressure against a bearing, such a ring should be located close against the bearing face so as to permit minimum end movement, should the bearing be forced away from its locating shoulder. This retainer ought not to be used at any point where a cut in the shaft surface can lead to fatigue failure of that member. It can best be used at the end of a shaft, as Illustrated.

Clamping Outer Rings

Where it is possible to machine a locating shoulder in a bearing housing, the clamping of the bearing is a relatively simple matter. The clamping member is best made with a narrow flange fitting into


Figure 12.

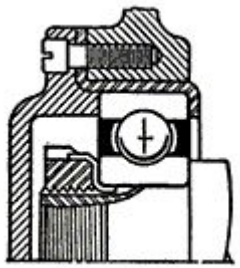
Figure 13.

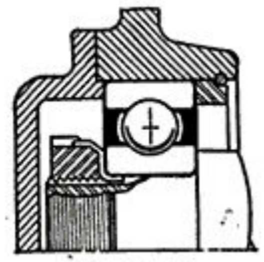
Figure 14.

The housing bore, as shown in figure 12. This flange Is of most Importance when the clamping piece must also act as a closure about the Shaft extension, for In such a case, It centers the closure with respect to the shaft and prevents possible rubbing or interference between the two.

In many housing designs where one bearing must be clamped, it is a decided advantage if the housing can be bored straight through without a shoulder. If this is done, it becomes necessary to incorporate some sort of separate shoulder against which the bearing outer race may be located. One method by which this is frequently accomplished is through the use of an adapter sleeve, as shown in figure 13. This sleeve may be either a relatively thin machined casting, or, in cases where a large number of parts are to be produced, may be a heavy sheet metal pressing. Whichever kind is employed, the fit of the sleeve in the housing should always be a light tap or press.

Where load conditions are not severe, and particularly where thrust loads are light, the shoulder ring in figure 14 may be satisfactorily employed.

This is simply an adaptation of the device illustrated in figure 10 and the same precautions should be observed if used in a housing design; that Is, the ring should fit tightly in the housing bore and should also fit very close over the snap wire to prevent any chance of its loosening In the groove.

Use of Adapter Sleeves on Shafts

It is desirable, wherever possible, to mount ball bearings directly upon the shaft; however, there are Instances more frequently encountered in changing machines already built than In new designs, where It is not feasible to adhere strictly to this rule. In certain cases this may necessitate the use of some form of adapter sleeve. Figure 15 Illustrates a mounting used where it is necessary to employ a bearing, the bore of which is too large to be fitted

directly upon the existing shaft. This type of sleeve mounting Is also used to some extent In new applications, the chief reason In such a case being the relative ease with which the bearing may be removed from the shaft without materially affecting the mounting fit. However used, the bearing should be applied to the sleeve with a firm press fit, and the sleeve to the shaft with a tap fit, a key being used to prevent rotation about the shaft.

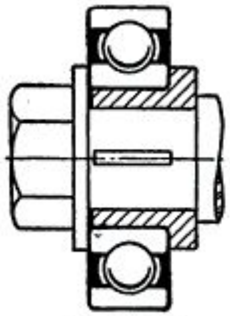

Figure 15.

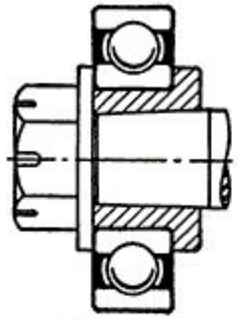

Figure 16.

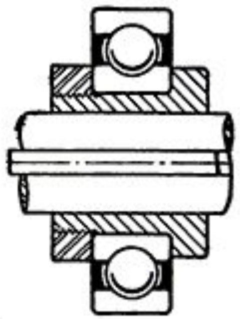

Figure 17.

A variation of this type of adapter is shown in figure 16, where the sleeve is mounted on a tapered shaft. In this Instance, the use of a key is not essential, since a moderate pressure exerted by the clamping nut would be sufficient to prevent movement between the sleeve and the shaft. It should be emphasized that wherever such a mounting Is used, the nut must not be set up tighter than is necessary to hold the sleeve securely In place; otherwise, excessive pressure Is quite apt to expand the sleeve and the bearing Inner race as well It is also very Important that the clamping nut used In such an Installation be provided with some form of positive locking device.

In certain Instances it is desired to apply a steadying bearing to a shaft which must be axially movable through the boring bore. While such an application is not recommended for heavy loads or more than ordinary accuracy, the bearing may be applied as in figure 17. Four points require especial observance:

The bearing should be a press fit on the sleeve; the sleeve should be not closer than .0003” loose on the shaft; the sleeve should be of sufficient length to give a relatively low unit pressure between shaft and sleeve, and the key should be of substantial cross section to minimize wear in restraining the sleeve against the natural creep due to the loose fit.

The mounting shown in figure 18 may be used for line shafting, where the speeds are not excessive. It consists of a tapered Inner sleeve, slotted lengthwise to allow for expansion or contractions, and a solid outer sleeve having a taper corresponding to that of the Inner member. An ear washer, with a key fitting into a slot In the Inner sleeve, locks the clamping nut when the assembly has been tightened. Such a mounting is not suitable where thrust loads are present which would tend to move the adapter from its original position.

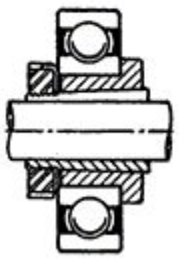

Figure 18.

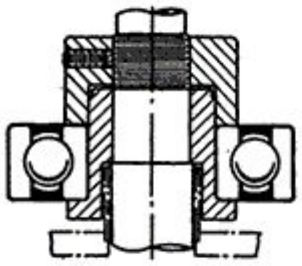

Figure 19.

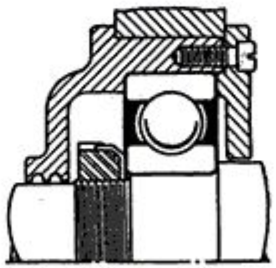

Figure 20.

The vertical mounting shown in figure 19 Is employed In varying forms, the use of the adapter here being directly due to the type of bearing closure desired. That is to say, the bearing is mounted upon the adapter sleeve only for the reason that it is in this way possible to introduce a stationary quill or tube between the bearing and the shaft, as indicated by the dotted lines. This is done so that the level of the lubricant may be brought up into the path of the balls.

The use of adapters for mounting ball bearings upon shafts is to be avoided, If possible, in the design of new machines, not only because of the extra machining and fitting involved, but because of the possible errors in alignment Introduced. Their use In any mechanism requires special attention to the accuracy obtained In machining or grinding the bore of the adapter In relation to the outside or bearing seat to ms1ce sure that these two surfaces are finished parallel and that the eccentricity Is held to as low a figure as possible.

Use of Adopter Sleeves in Housings

There are certain bearing applications where the use of an adapter sleeve in the housing not only justifies the somewhat greater expense of such construction, but is really essential to success of the design.

Two-Piece Housings

Where it is necessary to resort to a spilt housing, the bearings should always be fitted to a sleeve which may be located axially in the housing by means best suited to the particular case. In no Instance, however, should location be obtained by tight clamping of the sleeve between the housing halves, for the purpose of the adapter Is to prevent cramping or pinching of the bearing, and even where the sleeve Is of relatively thick section, an out-of-round condition of the housing may still affect the bearing If the fits are too tight.

Figures 20 and 21 Illustrate commonly used adapters, in either of which the bearing may be positively located or “floated,” as required,

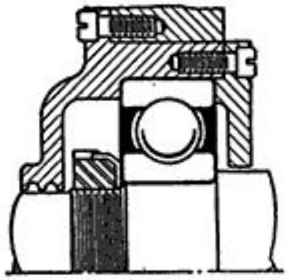
Figure 21.

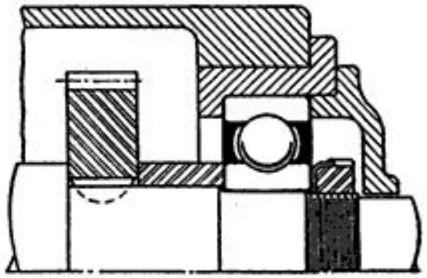
Figure 22.

Sleeves Required for Assembly Reasons

Instances are sometimes encountered where parts carried upon the shad must be assembled by passing through the bore of the bearing housing, but where the bore, to accommodate a bearing of adequate size, is too ma1l to allow of such assembly. In many such cases, a slight enlargement of the housing would solve the problem, and this may be accomplished by the use of a simple adapter sleeve applied as in figure 22. When an adapter is utilized for this purpose, it should be made a light tap fit in the main casting and should, of course, have the bore and O.D. finished as parallel and concentric as possible

Sleeves for Precision Mountings

Although the Initial cost of precision applications, such as machine tool spindles, is higher where sleeves are employed, their use may be such as to greatly facilitate assembly and their value from other standpoints usually outweighs the Item of expense. Where two bearings are mounted in sleeves at the front end of a precision spindle, figure 23, the bearing outer rings are press fitted with their eccentricity “high points” diametrically opposite similar points In the sleeves, so as to compensate for the eccentricity of both parts, thus mlnlmi7rng spindle run out. Where precision bearings must be so mounted In the housing as to permit a slight longitudinal movement due to spindle expansion, the use of a sleeve, as In figure 24, not only assures sufficient surface In contact with the housing to prevent excessive radial play, but it allows the bearing outer rings to be press fitted so as to maintain the original location of bearing and sleeve eccentricity high points.

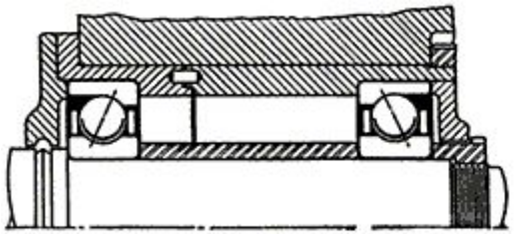
Figure 23.

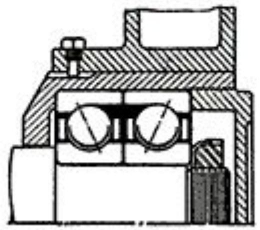
Figure 24.

Eccentric Sleeves

It Is occasionally necessary to so mount ball bearings as to allow a certain eccentric movement of the shaft, either as a means of adjustment for parts carried, belt tightening, or other reasons. This may be accomplished, where the shaft Is supported in one housing only, by means of a sleeve whose outside diameter Is sufficiently eccentric In relation to the bore to give the required movement, as In figure 25.

This type of sleeve is not practicable where separate housings and sleeves are desired at each end of a shaft, since unless the sleeves are adjusted very carefully and in unison, the shaft may be very badly misaligned.

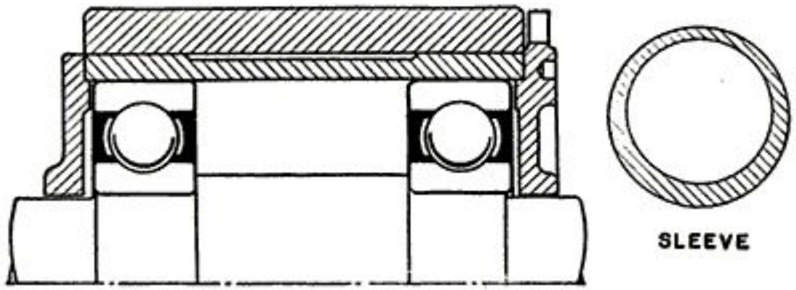

Figure 25.