15. Bearing Handling

Bearings are precision parts, and in order to preserve their accuracy and reliability, care must be exercised in their handling. In particular, bearing cleanliness must be maintained, sharp impacts avoided and rust prevented.

15.1 Storage

Most all rolling bearings are coated with a rust preventative before being packed and shipped, and they should be stored at room temperature with a relatively humidity of less than 60%. Under optimum storage conditions, and if the package remains intact, bearings can be stored for many years.

15.2 Fitting

When bearings are being mounted on shafts or in housings, the bearing rings should never be struck directly with a hammer or drift as damage to the bearing may result. Any force applied to the bearing should always be evenly distributed over the entire bearing ring face. Also, when fitting both rings simultaneously, applying pressure to one ring only should be avoided as indentations in the raceway surface may be caused by the rolling elements, or other internal damage may result.

15.2.1 Fitting preparation

Bearings should be fitted in a clean, dry work area. Especially for small and miniature bearings, a “clean room” should be provided as any dust in the bearing will greatly affect bearing efficiency.

Before installation, all fitting tools, shaft, housings and related parts should be cleaned and any burrs or cutting chips removed if necessary.

Shaft and housing fitting surfaces should also be checked for roughness, dimensional and design accuracy, and ensure that they are within allowable tolerance limits.

Bearings should be unwrapped just prior to installation. Normally, bearings to be used with grease lubrication can be installed as is, without removing the rust preventative. However, for bearings to be oil lubricated, or in cases where mixing the grease and rust preventative would result in loss of lubrication efficiency, the rust preventative should be removed by washing with benzene or petroleum solvent and drying before installation. Bearings should also be washed and dried before installation if the package has been damaged or there are other chances that the bearing has been contaminated. Double shielded bearings and sealed bearings should never be washed.

15.2.2 Fitting cylindrical bore bearings

Bearings with relatively small interference fits can be press fit at room temperature by using a sleeve against the ring face as shown in Fig. 15.1. By applying the fitting pressure to the center of the bearing, even pressure on the entire ring circumference can be attained. Usually, bearings are mounted by striking the sleeve with a hammer; however, when installing a large number of bearings, a mechanical or hydraulic press should be used.

When mounting a non-separable bearing on a shaft and in a housing at the same time, a pad which distributes the fitting pressure evenly over the inner and outer rings is used as shown in Fig. 15.2.

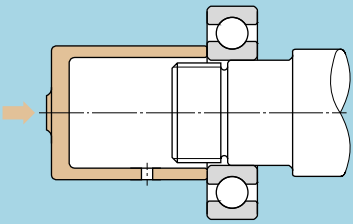


Fig. 15.1 Press mounting of inner ring

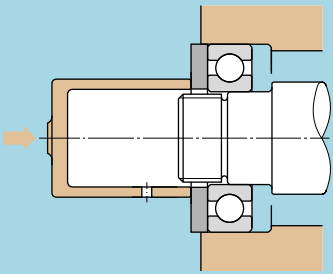


Fig. 15.2 Press mounting of inner and outer rings simultaneously

When fitting bearings having a large inner ring interference fit, or when fitting bearings on shafts that have a large diameter, a considerable amount of force is required to mount the bearing at room temperature. Mounting can be facilitated by heating and expanding the inner ring before hand. The required relative temperature difference between the inner ring and the fitting surface depends on the amount of interference and the shaft fitting surface diameter. Fig. 15.3 shows the relation between the bearing inner ring bore diameter temperature differential and the amount of thermal expansion. In any event, bearings should never be heated above 120°C.

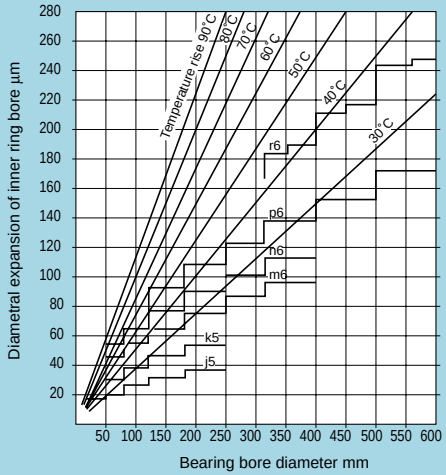


Fig. 15.3 Temperature differential required for shrinkage fit of inner ring

The most commonly used method of heating bearings is to immerse them in hot oil. However, to avoid overheating parts of the bearings, they should never be brought in direct contact with the heating element or bottom of the oil tank.

Bearings should be suspended inside the heating tank or placed on a wire grid.

If the bearings are dry heated with a heating cabinet or hot plate, they can be mounted without drying.

This method can also be used for prelubricated shielded and sealed bearings.

For heating the inner rings of NU, NJ or NUP cylindrical roller and similar type bearings without any ribs or with only a single rib, an induction heater can be used as shown in Fig. 15.4. With this method, bearings can be quickly installed while in a dry state.

When heated bearings are installed on shafts, the inner ring must be held against the shaft abutment until the bearings has been cooled in order to prevent gaps from occurring between the ring and the abutment face.

The same induction heating method described above can also be used for dismounting the inner ring with the use of a pawl.

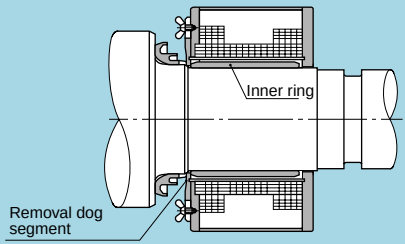


Fig. 15.4 Removal of inner ring using an induction heater

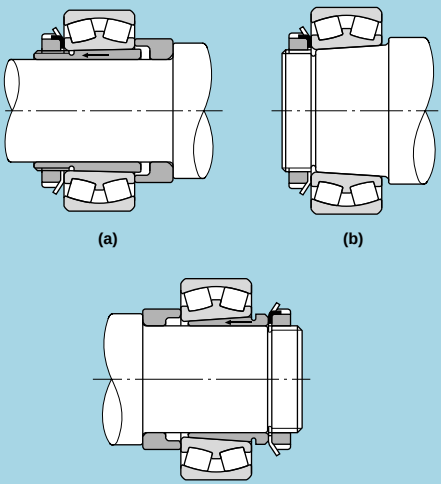


Fig. 15.5 Mounting with nuts

15.2.3 Mounting bearings with tapered bore

Small bearings with a tapered bore are driven on to the tapered seating; i.e. tapered shaft, withdrawal sleeves or adapter sleeves; with tightening a nut. This nut is tightened by using a hammer or impact wrench (Fig. 15.5).

Large bearings are mounted by hydraulic method because the fitting force is considerably large.

In Fig. 15.6 the fitting surface friction and nut tightening torque needed to mount bearings with tapered bore directly on tapered shafts are lessened by injecting high pressure oil between the fitting surfaces.

In Fig. 15.7 (a) a hydraulic nut method of pressing the bearing on a tapered shaft is shown.

Use of a hydraulic nut with adapters and withdrawal sleeves is shown in Fig. 15.7 (b) and (c).

A mounting method using a hydraulic withdrawal sleeve is shown in Fig. 15.8.

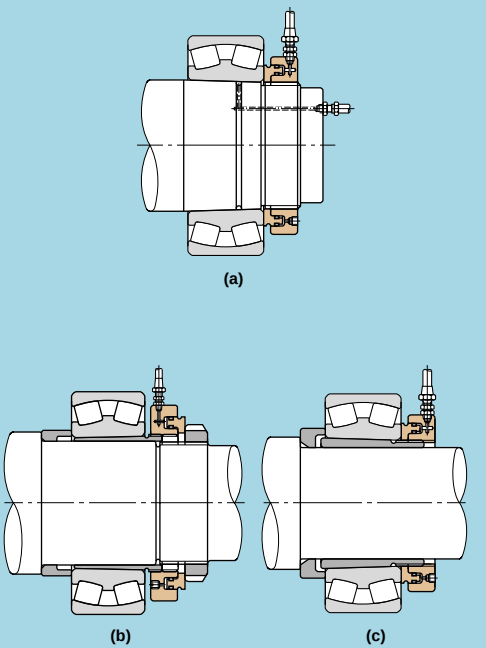


Fig. 15.7 Mounting using hydraulic nut

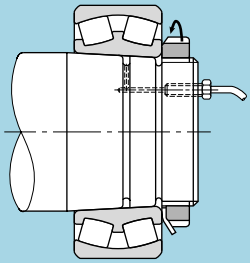


Fig. 15.6 Mounting using oil injection

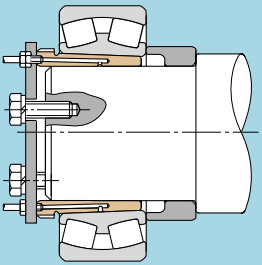


Fig. 15.8 Hydraulic sleeve mounting

In tapered bore bearings, as the inner ring is pressed axially onto the shaft or adapter or withdrawal sleeve, the interference will increase and the bearing internal radial clearance will decrease. The amount of interference can be estimated by measuring the amount of radial clearance decrease.

The internal radial clearance between the rollers and the outer ring should be measured with a thickness gauge under no load and the rollers held in the correct position. The measured clearance should be the same at both rows. In place of using the decrease in the amount of internal radial clearance to estimate the interference, it is possible to estimate it by measuring the distance the bearing has been driven onto the shaft.

Table 15.1 indicates the interference which will be given as a result of the internal radial clearance decrease, or the distance the bearing has been driven onto the shaft for tapered bore spherical roller bearings.

For conditions such as heavy loads, high speeds, and large temperature differentials between the inner and outer rings, etc. which require large interference fits, bearings which have a minimum internal radial clearance of C3 or greater should be used.

When using Table 15.1, the maximum values for clearance and axial displacement driven up should be used. For these applications, the remaining clearance must be greater than the minimum remaining clearance listed in Table 15.1.

15.2.4 Installation of Outer ring

For tight interference fits, the outer rings of small type bearings can be installed by pressing into housings at room temperature. For large interference fits, the housing can be heated before installing the bearing, or the bearing outer ring can be cooled with dry ice, etc. before installation.

15.3 Clearance adjustment

As shown in Fig. 15.9, for angular contact ball bearings or tapered roller bearings, the desired amount of axial internal clearance can be set at the time of mounting by tightening or loosening the adjusting nut. These bearings can also be preloaded by turning the adjusting nut until a minus axial internal clearance is reached.

There are three basic methods to ascertain if negative clearance is adjusted. One method is to actually measure the

Table 15.1 Mounting spherical roller bearings with tapered bore bearings — Unit mm

Bearing bore diameter *d*		Reduction in radial internal clearance		Axial displacement drive up				Minimum permisible residual clearance		
				Taper:1:12		Taper:1:30				
over	incl.	min	max	min	max	min	max	Normal	C3	C4
30	40	0.020	0.025	0.35	0.4	—	—	0.015	0.025	0.040
40	50	0.025	0.030	0.4	0.45	—	—	0.020	0.030	0.050
50	65	0.030	0.040	0.45	0.6	—	—	0.025	0.035	0.055
65	80	0.040	0.050	0.6	0.75	—	—	0.025	0.040	0.070
80	100	0.045	0.060	0.7	0.9	1.75	2.25	0.035	0.050	0.080
100	120	0.050	0.070	0.75	1.1	1.9	2.75	0.050	0.065	0.100
120	140	0.065	0.090	1.1	1.4	2.75	3.5	0.055	0.080	0.110
140	160	0.075	0.100	1.2	1.6	3.0	4.0	0.055	0.090	0.130
160	180	0.080	0.110	1.3	1.7	3.25	4.25	0.060	0.100	0.150
180	200	0.090	0.130	1.4	2.0	3.5	5.0	0.070	0.100	0.160
200	225	0.100	0.140	1.6	2.2	4.0	5.5	0.080	0.120	0.180
225	250	0.110	0.150	1.7	2.4	4.25	6.0	0.090	0.130	0.200
250	280	0.120	0.170	1.9	2.7	4.75	6.75	0.100	0.140	0.220
280	315	0.130	0.190	2.0	3.0	5.0	7.5	0.110	0.150	0.240
315	355	0.150	0.210	2.4	3.3	6.0	8.25	0.120	0.170	0.260
355	400	0.170	0.230	2.6	3.6	6.5	9.0	0.130	0.190	0.290
400	450	0.200	0.260	3.1	4.0	7.75	10	0.130	0.200	0.310
450	500	0.210	0.280	3.3	4.4	8.25	11	0.160	0.230	0.350
500	560	0.240	0.320	3.7	5.0	9.25	12.5	0.170	0.250	0.360
560	630	0.260	0.350	4.0	5.4	10	13.5	0.200	0.290	0.410
630	710	0.300	0.400	4.6	6.2	11.5	15.5	0.210	0.310	0.450
710	800	0.340	0.450	5.3	7.0	13.3	17.5	0.230	0.350	0.510
800	900	0.370	0.500	5.7	7.8	14.3	19.5	0.270	0.390	0.570
900	1000	0.410	0.550	6.3	8.5	15.8	21	0.300	0.430	0.640
1000	1120	0.450	0.600	6.8	9.0	17	23	0.320	0.480	0.700
1120	1250	0.490	0.650	7.4	9.8	18.5	25	0.340	0.540	0.770

axial internal clearance while tightening the adjusting nut (Fig. 15.10). Another method is to check rotation torque by rotating the shaft or housing while adjusting the nut. Still another method (Fig. 15.11) is to insert shims of the proper thickness.

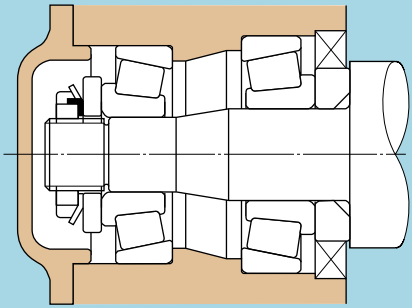


Fig. 15.9 Axial internal clearance adjustment

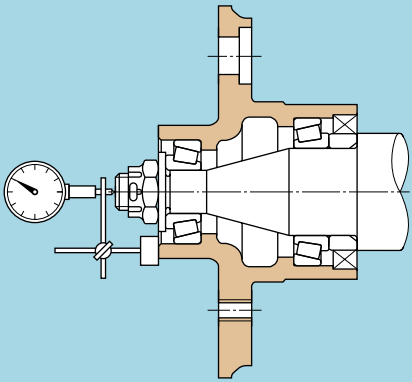


Fig. 15.10 Axial internal clearance measuring

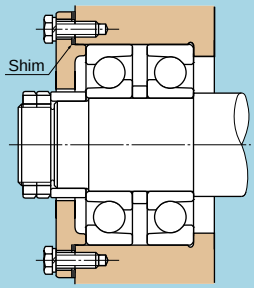


Fig. 15.11 Clearance adjustment with shims

15.4 Running test

To ensure that the bearing has been properly installed, a running test is performed after mounting. The shaft or housing is first rotated by hand, and if no problems are observed, a low speed, no load power test is performed. If no abnormalities are observed, the load and speed are gradually increased to operating conditions. During a test, if any unusual noise, vibration or temperature rise is observed, the test should be stopped and the equipment examined. If necessary, the bearing should be dismounted for inspection.

To check bearing running noise, the sound can be amplified and the type of noise ascertained with a listening instrument placed against the housing. A clear, smooth, continuous running sound is normal.

A high metallic or irregular sound indicates some error on function. Vibration can be accurately checked with a vibration measuring instrument, and the amplitude and frequency characteristics measured against a fixed standard.

Usually the bearing temperature can be estimated from the housing surface temperature. However, if the bearing outer ring is accessible through oil holes, etc. the temperature can be more accurately measured.

Under normal conditions, bearing temperature rises with rotation and then reaches a stable operating temperature after a certain period of time. If the temperature does not level off and continues to rise, or if there is a sudden temperature rise, or if the temperature is unusually high, the bearing must be inspected.

15.5 Dismounting

Bearings are often removed as part of periodic inspection procedures or during the replacement of other parts. However, the shaft and housing are almost always reinstalled, and in some cases the bearings themselves are reused. These bearings, shafts, housings and other related parts must be designed to prevent damage during the dismounting procedures, and the proper dismounting tools must be employed. When removing inner or outer rings which have been installed with interference fits, the dismounting force should be applied to that ring only and not applied to other parts of the bearing, as this may cause internal damage to the bearings' raceway or rolling elements.

15.5.1 Dismounting of bearing with cylindrical bore

For small bearings, the pullers shown in Fig. 15.12 or the press method shown in Fig. 15.13 can be used for dismounting. When used properly these methods can improve dismounting efficiency and can prevent damage from occurring to the bearings. To facilitate dismounting procedures, care should be given to planning design of shafts and housings, such as providing extraction grooves on the shaft and housing for puller claws as shown in Figs. 15.14 and 15.15.

Threaded bolt holes should also be provided in housings for pressing out outer rings (Fig. 15.16).

Large bearings, having been in for a long service period and installed with shrink fits, require considerable dismounting force, and fretting corrosion is likely to have occurred on the seating surface. In these instances, the dismounting friction can be relieved by injecting oil under high pressure between the shaft and inner ring surfaces (Fig. 15.17).

For NU, NJ and NUP type cylindrical roller bearings, the induction heating method shown in Fig. 15.4 can also be used for easier dismounting of the inner ring. This method is highly efficient for dismounting the same dimension bearings frequently.

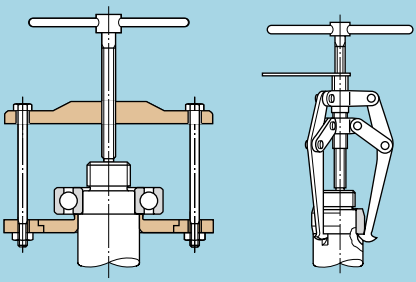


Fig. 15.12 Puller dismounting

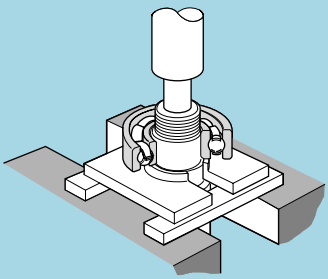


Fig. 15.13 Press dismounting

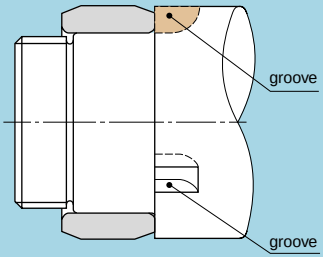


Fig. 15.14 Extracting grooves

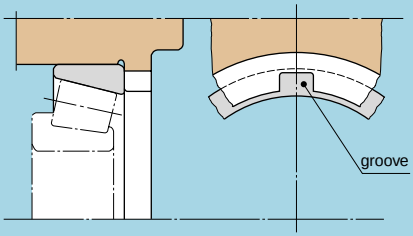


Fig. 15.15 Extraction groove for outer ring removal

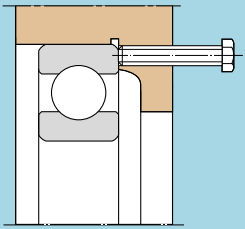


Fig. 15.16 Outer ring dismounting bolt

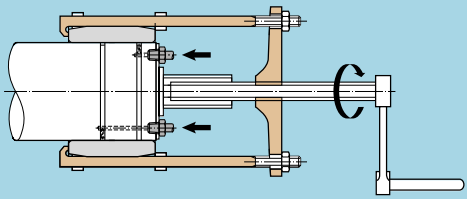


Fig. 15.17 Hydraulic dismounting

15.5.2 Dismounting of bearings with tapered bore

Small bearings with adapters can be easily dismounted by loosening the lock-nut and driving the inner ring off with a metal block (Fig. 15.18). Those bearings which have been installed with withdrawal sleeves can be extracted by tightening the nut (Fig. 15.19).

For large bearings on tapered shafts, adapters, or withdrawal sleeves; dismounting is greatly facilitated with hydraulic methods. Fig. 15.20 shows a hydraulic injection dismounting method. High pressure oil is injected between the fitting surface of the conical shaft and bearing.

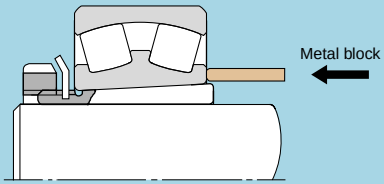


Fig. 15.18 Adapter dismounting

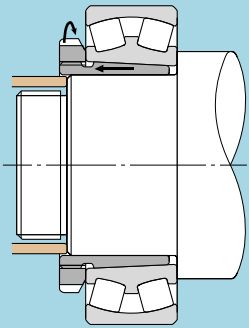


Fig. 15.19 Withdrawal sleeve extraction

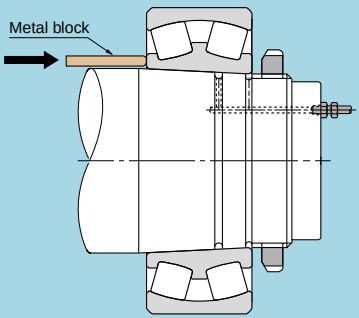
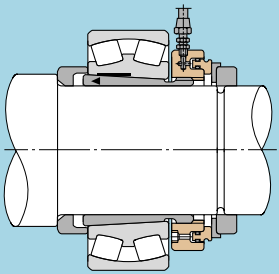
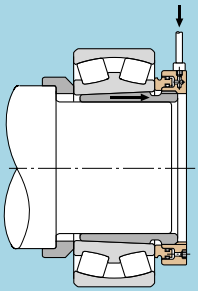


Fig. 15.20 Hydraulic injection dismounting

The metal block is used for protection of sudden movement of the bearing which occurs during injection. In Fig. 15.21 hydraulic nuts are used with adapters or withdrawal sleeves for dismounting, and a hydraulic withdrawal sleeve extraction method is shown in Fig. 15.22.



(a) Adapter sleeve



(b) Withdrawal sleeve

Fig. 15.21 Hydraulic nut dismounting

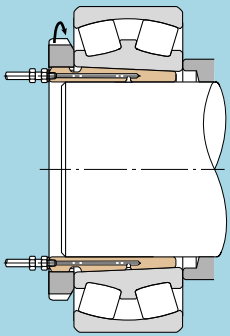


Fig. 15.22 Hydraulic withdrawal sleeve