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 Bearing storage

Most rolling bearings are coated with a rust prevent oil before being packed and shipped, and they should be stored at room temperature with a relative humidity of less than 60%.

15.2 Installation

When bearings are being installed on shafts or in housings, the bearing rings should never be struck directly with a hammer or a drift, as shown in **Fig. 15.1**, because 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, as shown in **Fig. 15.2**, should be avoided because indentations in the raceway surface may be caused by the rolling elements, or other internal damage may result.

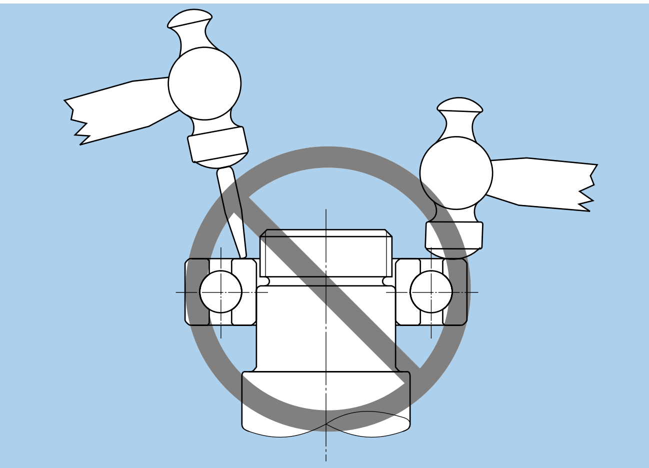


Fig. 15.1

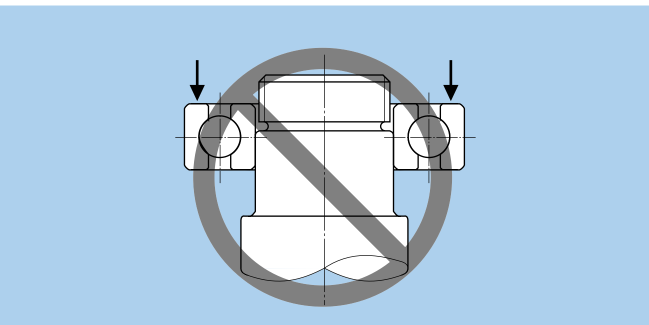


Fig. 15.2

15.2.1 Installation preparations

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

All dirt, burrs or metal filings must be removed from the shaft, housing and tools used for mounting the bearings. Shaft and housing fitting surfaces should also be checked for roughness, dimensional and design accuracy, and to ensure that they are within allowable tolerance limits.

Bearings should not be unwrapped until just prior to installation. Normally, bearings to be used with grease lubricant can be installed as is, without removing the rust prevent oil. However, for bearings which will use oil lubricant, or in cases where mixing the grease and rust prevent oil would result in loss of lubrication efficiency, the rust prevent oil should be removed by washing with benzene or petroleum solvent and dried before installation. Bearings should also be washed and dried before installation if the package has been damaged or there are other chances that the bearings have been contaminated. **Double shielded bearings and sealed bearings should never be washed.**

15.2.2 Installing cylindrical bore bearings

For bearings with relatively small interference, the entire circumference of the raceway can be uniformly press-fit at room temperature as shown in **Fig. 15.3**. Usually, bearings are installed by striking the sleeve with a hammer; however, when installing a large number of bearings, a mechanical or hydraulic press should be used.

When installing non-separable bearings on a shaft and in a housing simultaneously, a pad which distributes the fitting pressure evenly over the inner and outer rings is used as shown in **Fig. 15.4**. If the fitting is too tight or bearing size is large, a considerable amount of force is required to install the bearing at room temperature. Installation can be facilitated by heating and expanding the inner ring beforehand. The required relative temperature difference between the inner ring and the shaft depends on the amount of interference and the shaft fitting surface diameter. **FIg. 15.5** shows the relation between the bearing inner bore diameter temperature differential and the amount of thermal expansion. **In any**

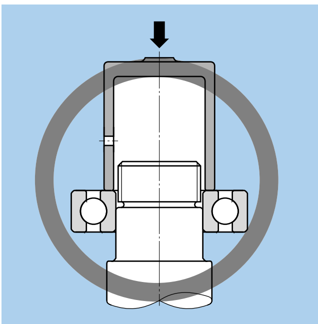


Fig. 15.3 Fitting sleeve pressure against inner ring

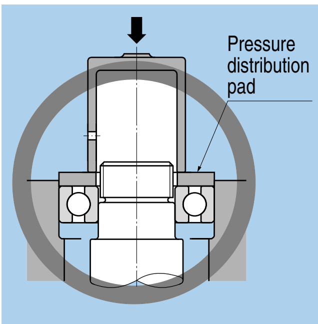


Fig. 15.4 Fitting sleeve pressure against inner /outer ring simultaneously

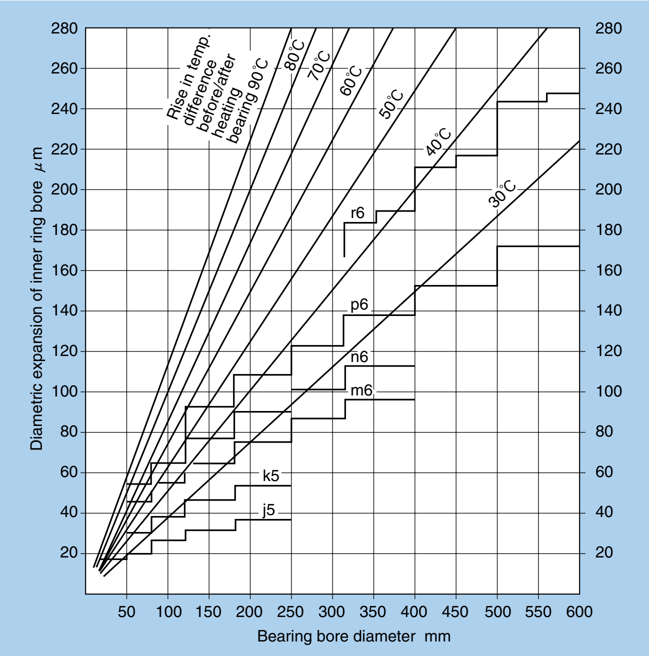


Fig. 15.5 Temperature required for heat-fitting inner ring

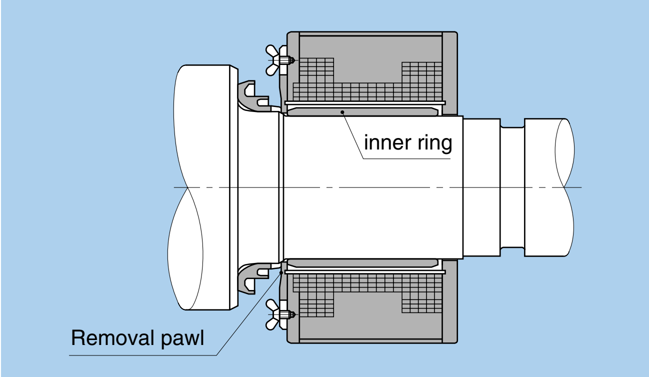
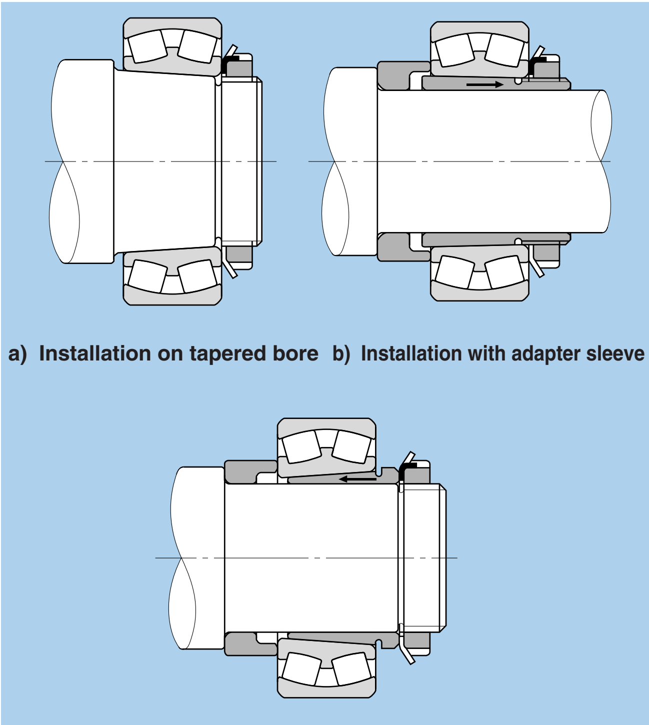


Fig. 15.6 Removal of inner ring using an induction heater



a) Installation on tapered bore b) Installation with adapter sleeve

c) Installation using withdrawal sleeve

Fig. 15.7 Installation methods using locknuts

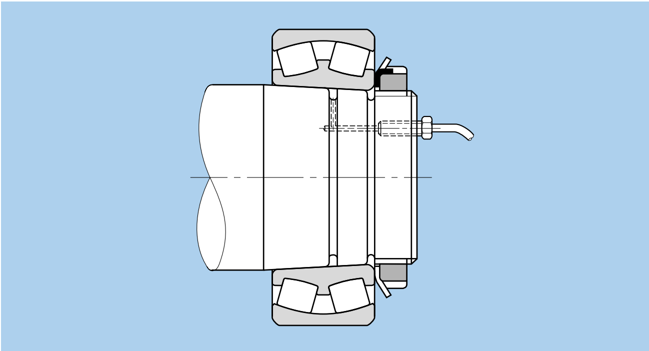


Fig. 15.8 Installation utilizing oil injection

event, bearings should never be heated above 120˚C.

The most commonly used method of heating bearings is to immerse them in hot oil. This method must not be used for sealed bearings or shield bearings with grease sealed inside.

To avoid overheating parts of the bearings they should never be brought into direct contact with the heat source, but instead should be suspended inside the heating tank or placed on a wire grid.

If heating the bearing with air in a device such as a thermostatic chamber, the bearing can be handled while dry.

For heating the inner rings of NU, NJ or NUP cylindrical and similar type bearings without any ribs or with only a single rib, an induction heater can be used to quickly heat bearings in a dry state **(must demagnetize).**

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

As shown in **Fig. 15.6**, a removal pawl, or tool, can also be used to dismount the inner ring when using the induction heating method described above.

15.2.3 Installation of tapered bore bearings

Small type bearings with tapered bores are installed over a tapered shaft, withdrawal sleeves, or adapter sleeves by driving the bearing into place using a locknut. The locknut is tightened using a hammer or impact wrench. (**Fig. 15.7**)

Large size bearings require considerable fitting force and must be installed hydraulically.

In **Fig. 15.8** the fitting surface friction and nut tightening torque needed to install bearings with tapered bores directly onto tapered shafts are decreased by injecting

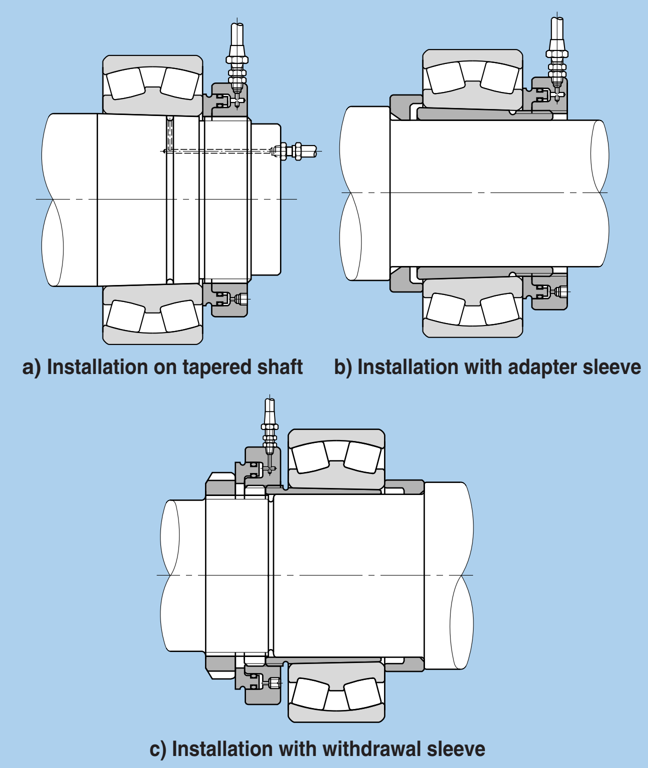


Fig. 15.9 Installation using hydraulic nut

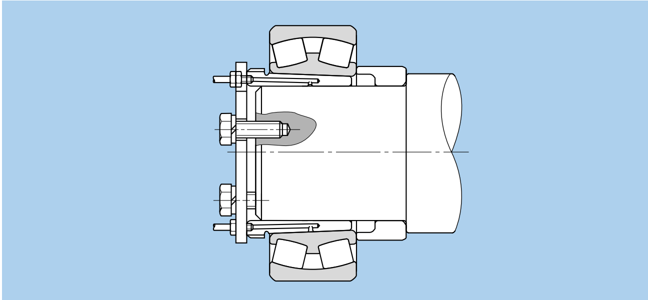


Fig. 15.10 Installation using hydraulic withdrawal sleeve

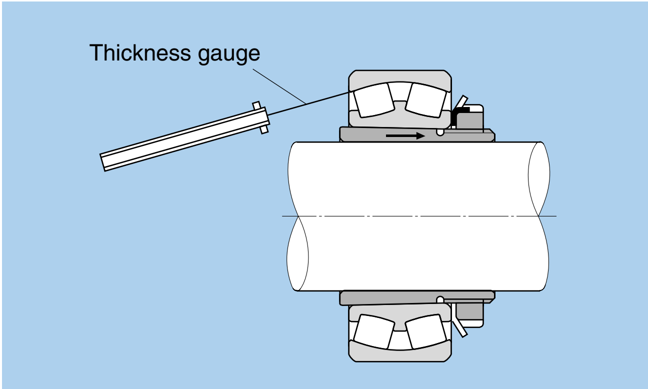


Fig. 15.11 Internal clearance measurement method for spherical roller bearings

high pressure oil between the fitting surfaces.

Fig. 15.9 a) shows one method of installation where a hydraulic nut is used to drive the bearing onto a tapered shaft.

Fig. 15.9 b) and **c**) show installation using a hydraulic nut with adapter sleeves and withdrawal sleeves.

Fig. 15.10 shows an installation method using a hydraulic withdrawal sleeve.

With tapered bore bearings, as the inner ring is driven axially onto the shaft or adapter or withdrawal sleeve, the interference will increase and the bearing internal radial clearance will decrease. Interference can be estimated by measuring decrease in internal radial clearance. As shown in **Fig. 15.11**, the internal radial clearance between the rollers and outer ring of spherical roller bearings should be measured with a thickness gauge under no load while the rollers are held in the correct position. Instead of using the decrease in amount of internal radial clearance to estimate the interference, it is possible to estimate by measuring the distance the bearing has been driven onto the shaft.

For spherical roller bearings, **Table 15.1** indicates the appropriate interference which will be achieved as a result of the internal radial clearance decrease, or the distance the bearing has been driven onto the shaft.

For conditions such as heavy loads, high speeds, or when there is a large temperature differential 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. **Table 15.1** lists the maximum values for internal radial clearance decrease and axial displacement. For these applications, the remaining clearance must be greater than the minimum allowable residual clearance listed in **Table 15.1**.

15.2.4 Installation of outer ring

Even for tight interference fits, the outer rings of small type bearings can be installed by driving them into housings at room temperature. For large interference type bearings, the housing can be heated before installing the bearing, or the bearing's outer ring can be cooled with dry ice, etc. before installing. If dry ice or other cooling agent is used, atmospheric moisture will condense on bearing surfaces, and therefore appropriate rust preventative measures are necessary.

15.3 Internal clearance adjustment

As shown in **Fig. 15.12**, for angular contact ball bearings and tapered roller bearings the desired amount of axial internal clearance can be set at the time of installation by tightening or loosening the adjustment nut.

To adjust the suitable axial internal clearance or amount of bearing preload, the internal clearance can be measured while tightening the adjusting nut as shown in **Fig. 15.13**. Other methods are to check rotation torque by rotating the shaft or housing while adjusting the nut, or to insert shims of the proper thickness as shown in **Fig. 15.14**.

Table 15.1 Installation of tapered bore spherical roller bearings

Units mm

Nominal bearing bore diameter *d*		Reduction of radial internal clearance		Axial displacement drive up				Minimum allowable residual clearance		
				Taper, 1:12		Taper, 1:30				
over	incl.	Min	Max	Min	Max	Min	Max	CN	C3	C4
30	40	0.02	0.025	0.35	0.4	—	—	0.015	0.025	0.04
40	50	0.025	0.03	0.4	0.45	—	—	0.02	0.03	0.05
50	65	0.03	0.035	0.45	0.6	—	—	0.025	0.035	0.055
65	80	0.04	0.045	0.6	0.7	—	—	0.025	0.04	0.07
80	100	0.045	0.055	0.7	0.8	1.75	2.25	0.035	0.05	0.08
100	120	0.05	0.06	0.75	0.9	1.9	2.25	0.05	0.065	0.1
120	140	0.065	0.075	1.1	1.2	2.75	3	0.055	0.08	0.11
140	160	0.075	0.09	1.2	1.4	3	3.75	0.055	0.09	0.13
160	180	0.08	0.1	1.3	1.6	3.25	4	0.06	0.1	0.15
180	200	0.09	0.11	1.4	1.7	3.5	4.25	0.07	0.1	0.16
200	225	0.1	0.12	1.6	1.9	4	4.75	0.08	0.12	0.18
225	250	0.11	0.13	1.7	2	4.25	5	0.09	0.13	0.2
250	280	0.12	0.15	1.9	2.4	4.75	6	0.1	0.14	0.22
280	315	0.13	0.16	2	2.5	5	6.25	0.11	0.15	0.24
315	355	0.15	0.18	2.4	2.8	6	7	0.12	0.17	0.26
355	400	0.17	0.21	2.6	3.3	6.5	8.25	0.13	0.19	0.29
400	450	0.2	0.24	3.1	3.7	7.75	9.25	0.13	0.2	0.31
450	500	0.21	0.26	3.3	4	8.25	10	0.16	0.23	0.35
500	560	0.24	0.3	3.7	4.6	9.25	11.5	0.17	0.25	0.36
560	630	0.26	0.33	4	5.1	10	12.5	0.2	0.29	0.41
630	710	0.3	0.37	4.6	5.7	11.5	14.5	0.21	0.31	0.45
710	800	0.34	0.43	5.3	6.7	13.3	16.5	0.23	0.35	0.51
800	900	0.37	0.47	5.7	7.3	14.3	18.5	0.27	0.39	0.57
900	1,000	0.41	0.53	6.3	8.2	15.8	20.5	0.3	0.43	0.64
1,000	1,120	0.45	0.58	6.8	8.7	17	22.5	0.32	0.48	0.7
1,120	1,250	0.49	0.63	7.4	9.4	18.5	24.5	0.34	0.54	0.77

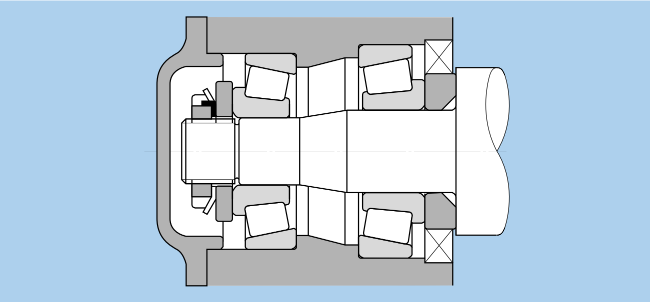


Fig. 15.12 Axial internal clearance adjustment

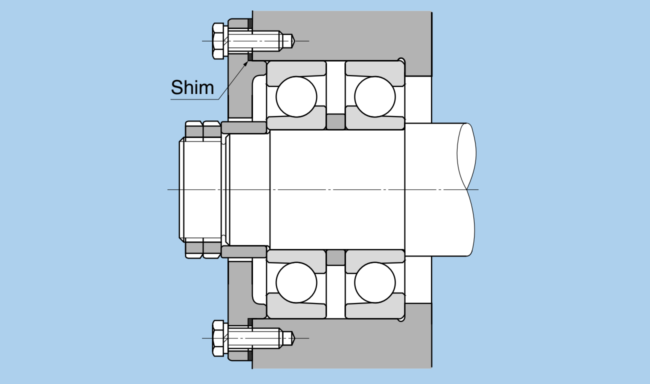


Fig. 15.14 Internal clearance adjustment using shims

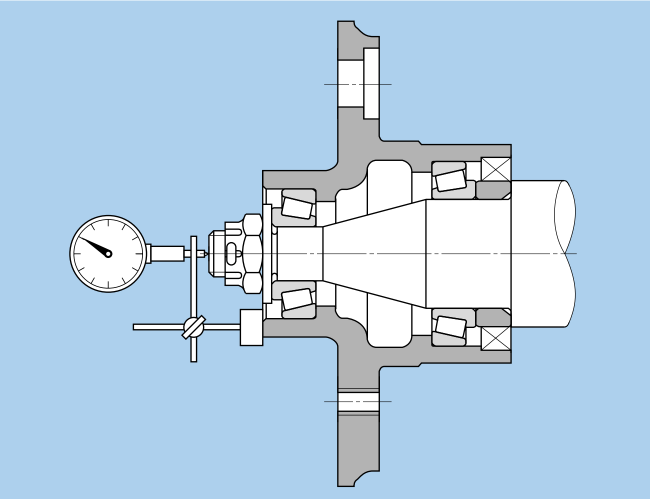


Fig. 15.13 Measurement of axial internal clearance adjustment

15.4 Post installation running test

To insure that the bearing has been properly installed, a running test is performed after installation is completed. The shaft or housing is first rotated by hand and if no problems are observed low speed, no load power test is performed. If no abnormalities are observed, **the load and speed are gradually increased to operating conditions**. **During the test if any unusual noise, vibration, or temperature rise is observed the test should be stopped and examine the equipment. If necessary, the bearing should be disassembled 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 and continuous running sound is normal. A high, metallic or irregular sound indicates some error in function. Vibration can be accurately checked with a vibration measuring instrument, and the amplitude and frequency characteristics measured guantitatively.

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

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

15.5 Bearing disassembly

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 more than a few cases the bearings themselves are reused. These bearings, shafts, housings, and other related parts must be designed to prevent damage during disassembly procedures, and the proper disassembly tools must be employed. When removing raceways with interference, pulling force should be applied to the raceway only. **Do not remove the raceway through the rolling elements.**

15.5.1 Disassembly of bearings with cylindrical bores

For small type bearings, the pullers shown in **Fig. 15.15 a**) and **b**) or the press method shown in **Fig. 15.16** can be used for disassembly. When used properly, these methods can improve disassembly efficiency and prevent damage to bearings.

To facilitate disassembly procedures, attention should be given to planning the designs of shafts and housings, such as providing extraction grooves on the shaft and housing for puller claws as shown **Figs. 15.17** and **15.18**. Threaded bolt holes should also be provided in housings to facilitate the pressing out of outer rings as shown in **Fig. 15.19**.

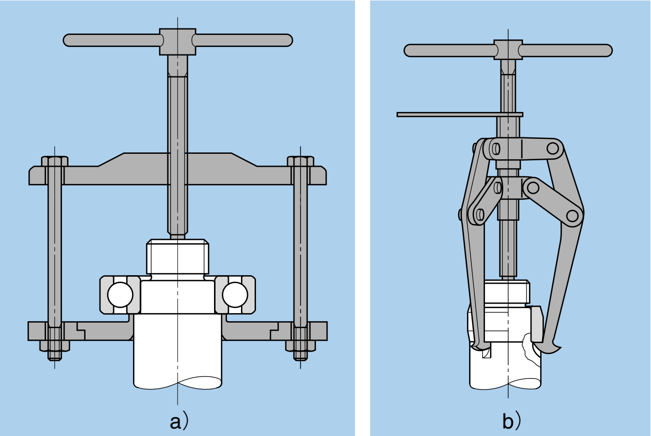


Fig. 15.15 Puller disassembly

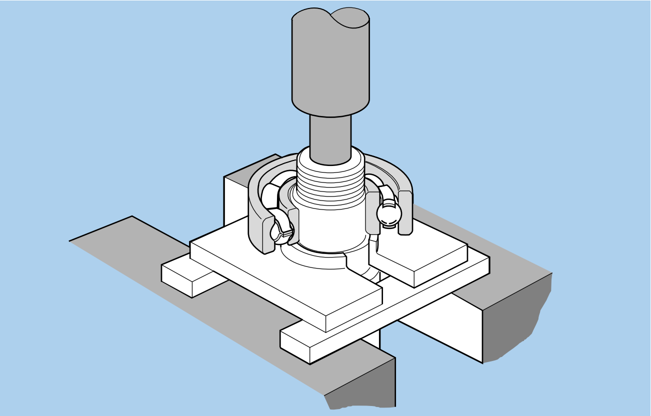


Fig. 15.16 Press disassembly

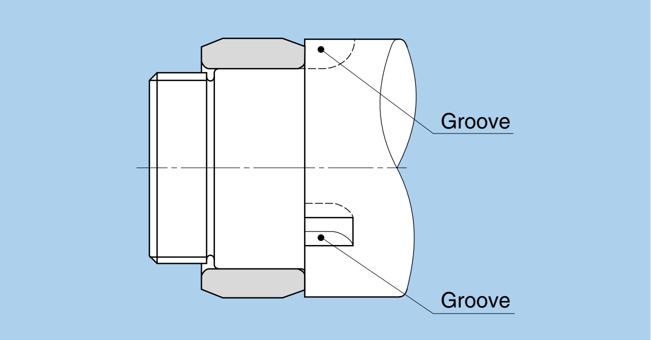


Fig. 15.17 Extracting grooves

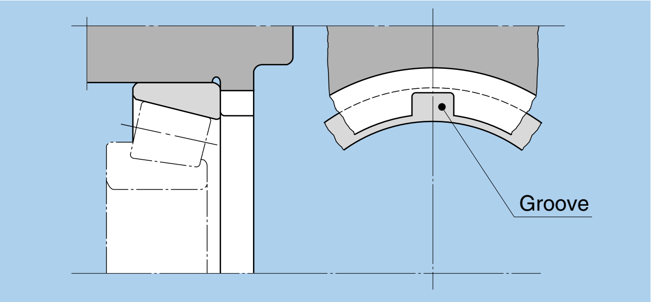


Fig. 15.18 Extraction groove for outer ring disassembly

Large bearings, installed with tight fits, and having been in service for a long period of time, will likely have developed fretting corrosion on fitting surfaces and will require considerable dismounting force. In such instances, dismounting friction can be reduced by injecting oil under high pressure between the shaft and inner ring surfaces as shown in **Fig. 15.20**.

For NU, NJ and NUP type cylindrical roller bearings, the induction heating unit shown in **Fig. 15.6** can be used to facilitate removal of the inner ring by means of thermal expansion. This method is highly efficient for frequent disassembly of bearings with identical dimensions.

15.5.2 Disassembly of bearings with tapered bores

Small bearings installed using an adapter are removed by loosening the locknut, placing a block on the edge of the inner ring as shown in **Fig. 15.21**, and tapping with a hammer. Bearings which have been installed with withdrawal sleeves can be disassembled by tightening down the lock nut as shown in **Fig. 15.22**.

For large type bearings on tapered shafts, adapters, or withdrawal sleeves, disassembly is greatly facilitated by hydraulic methods. **Fig. 15.23** shows the case where the bearing is removed by applying hydraulic pressure on the fitting surface of a bearing installed on a tapered shaft.

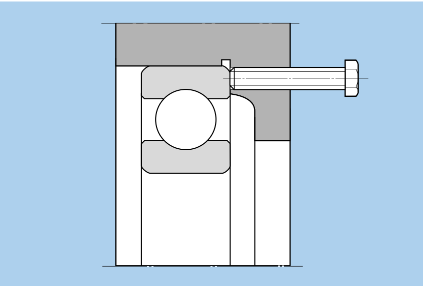


Fig. 15.19 Outer ring disassembly bolt

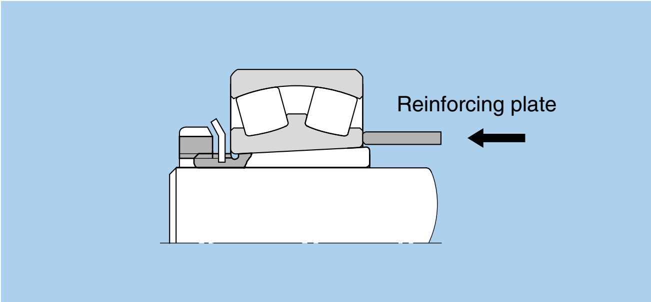


Fig. 15.21 Disassembly of bearing with adapter

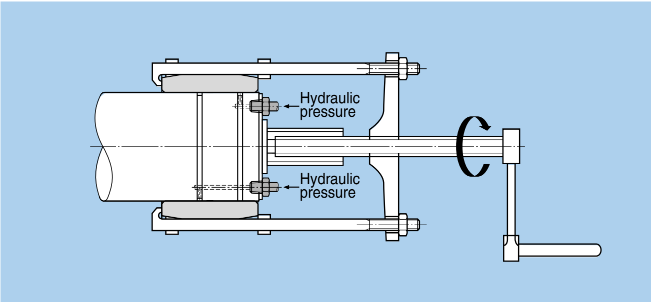


Fig. 15.20 Removal by hydraulic pressure

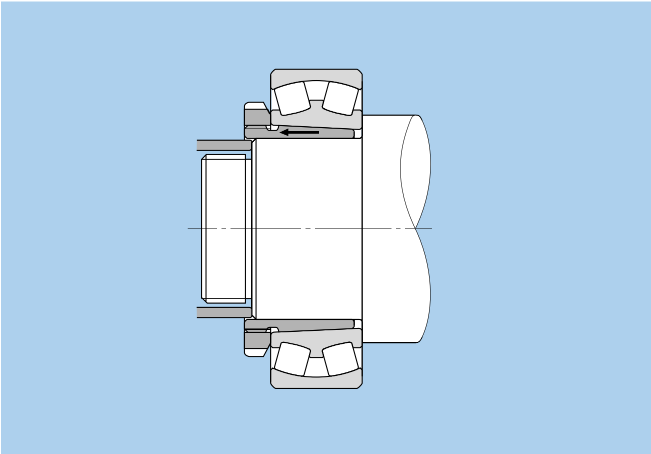


Fig. 15.22 Disassembly of bearing with withdrawal sleeve

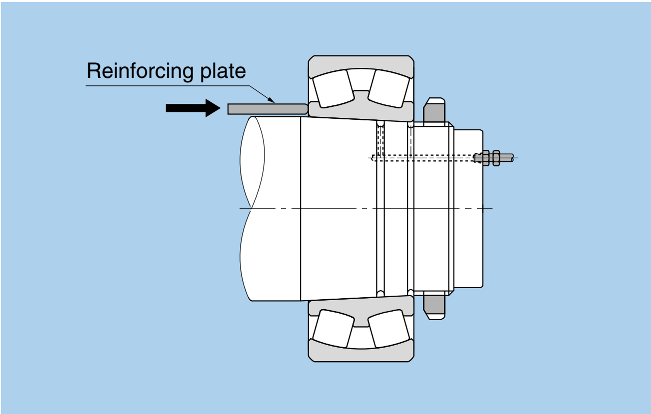
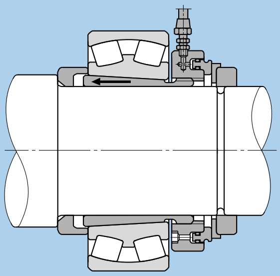
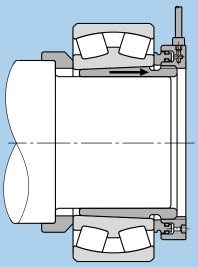


Fig. 15.23 Removal of bearing by hydraulic pressure

Fig. 15.24 shows two methods of disassembling bearings with adapters or withdrawal sleeves using a hydraulic nut. **Fig. 15.25** shows a disassembly method using a hydraulic withdrawal sleeve where high pressure oil is injected between fitting surfaces and a nut is then employed to remove the sleeve.



a) Disassembly of adapter sleeve



b) Disassembly of withdrawal sleeve

Fig. 15.24 Disassembly using hydraulic nut

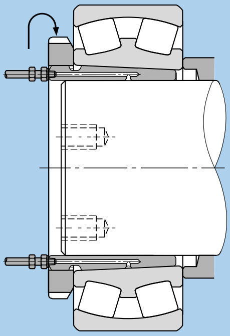


Fig. 15.25 Disassembly using hydraulic withdrawal sleeve

15.6 Bearing maintenance and inspection

In order to get the use the bearing to its full potential and keep it in good working condition as long as possible, maintenance and inspections should be performed. Doing so will enable early detection of any problems with the bearing.

This will enable you to prevent bearing failure before it happens, and will enhance productivity and cost performance.

The following measures are often taken as a general method of maintaining and managing bearings.

Maintenance management requires inspection items and frequency for performing routine inspections be determined according to the importance of the device or machine.

15.6.1 Inspection of machine while running

The interval for replenishing and replacing lubricant is determined by a study of lubricant nature and checking the bearing temperature, noise and vibration.

15.6.2 Observation of bearing after use

Take note of any problem that may appear after the bearing is used or when performing routine inspections, and take measures for preventing reoccurrence of any damage discovered. For types of bearing damage and countermeasures for preventing damage, see section 16.