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# HANDLING INSTRUCTIONS FOR SPHERICAL ROLLER BEARINGS

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NSK RHP bearings PPL neuweg

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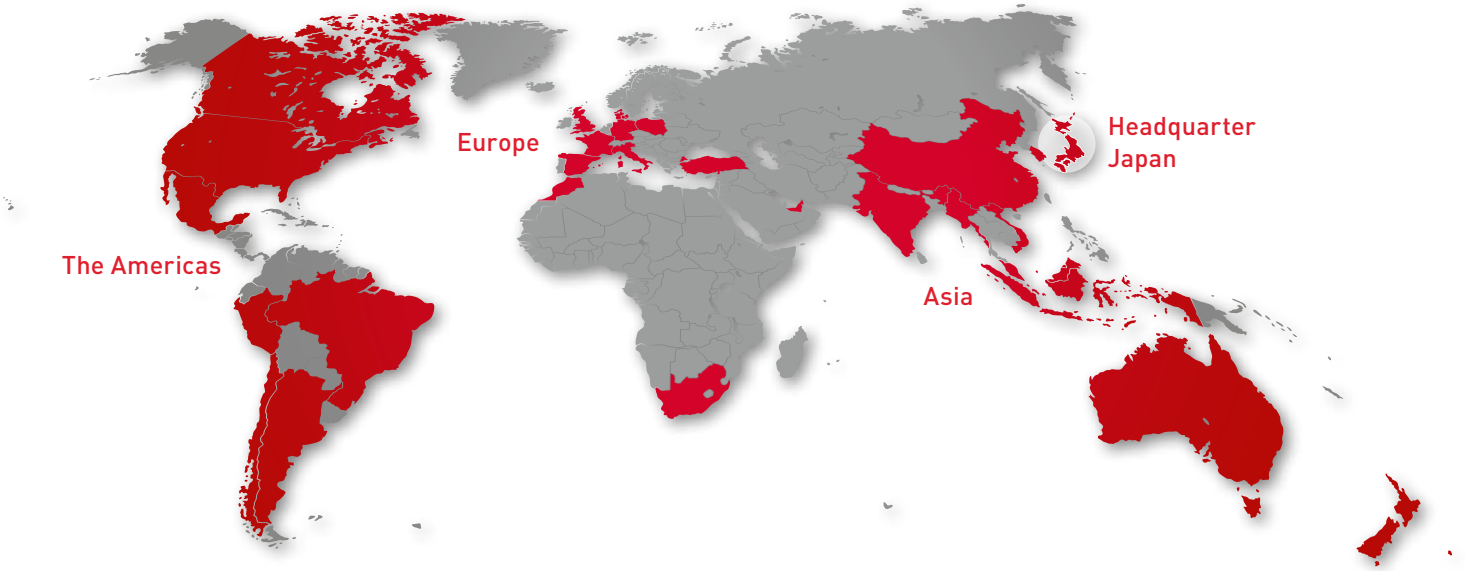
We are among the leading manufacturers for rolling bearings, linear technology components and steering systems worldwide. We can be found on almost every continent – with production facilities, sales offices and technology centres – because our customers appreciate short decision-making channels, prompt deliveries and local service.




## The NSK Company

NSK commenced operations as the first Japanese manufacturer of rolling bearings back in 1916. Ever since, we have been continuously expanding and improving not only our product portfolio but also our range of services for various industrial sectors. In this context our worlwide research and production facilities are linked together in a global network. Here we concentrate not only on the development of new technologies, but also on the continuous optimisation of quality – at every process stage. Among other things, our research activities include product design, simulation applications using a variety of analytical systems and the development of different steels and lubricants for rolling bearings.

# Our most important product: our customers' satisfaction

One thing keeps us moving: we want to help you increase the reliability of your vehicles and equipment, not only with excellent products, but above all with excellent service. Our experienced engineers have a deep understanding of systems – together with you, they work to optimise products and processes and develop solutions for the future. The goal that we are dedicated to every day is ensuring that you remain competitive over the long run.

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# Contents

# 1. Summary of Spherical Roller Bearings

Thank you for your purchase of NSK Spherical Roller Bearings. We are confident that NSK Spherical Roller Bearings will provide reliable service. Spherical Roller Bearings have been adopted in many mechanical devices because they offer self-aligning and heavy load-carrying capacity. Therefore, in handling of spherical roller bearings, it is necessary to consider both individually and collectively the various factors including bearing structure, shape of shaft, bearing mounting method, and housing.

To give you a more complete understanding of how to handle Spherical Roller Bearings, we have published this manual. We hope that you find it useful.

### 1.1 Name and Shape of Components of Spherical Roller Bearings

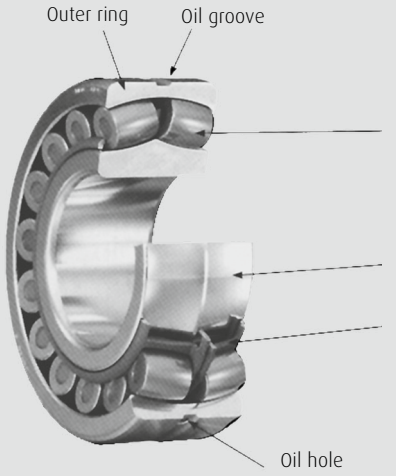



Fig. 1.1

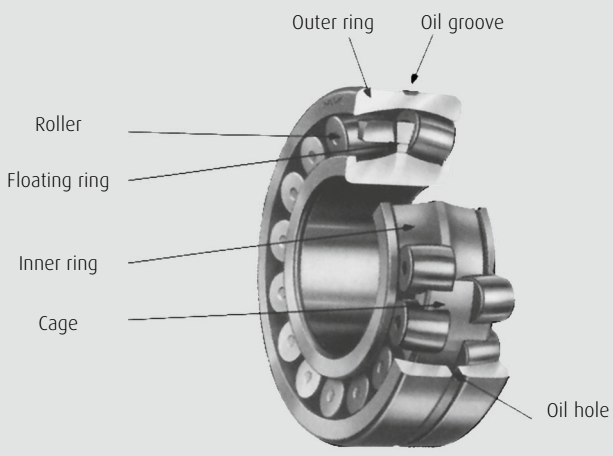



Fig. 1.2


## 1.2 Shape of Bearing Bore

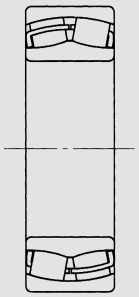


Fig. 1.3 Cylindrical Bore

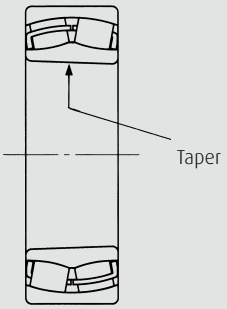



Fig. 1.4 Tapered Bore

## 1.3 Bearings with Self-Aligning Capability

As shown in Fig. 1.5, the spherical roller bearing has an outer ring whose raceway is spherical and the center of curvature matches that of the bearing. Thus, inner ring, rollers and cage can be inclined (self-aligning property) relative to the outer ring.
The permissible self-aligning angle of a Spherical Roller Bearing varies depending on the dimensional series, loading conditions, but with a usual load, it is approximately 1° to 2.5°.

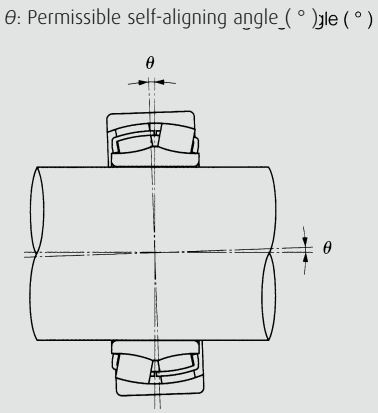



Fig. 1.5 Self-aligning

# 1. Summary of Spherical Roller Bearings

## 1.4 Bearing Mounting Conditions

**1.4.1 When shaft is cylindrical and bearing bore is cylindrical**



**1.4.2 When shaft is tapered and bearing bore is tapered**



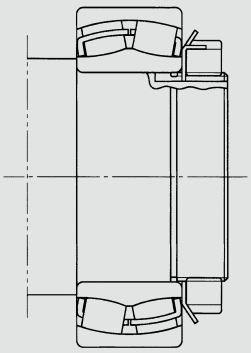


**Fig. 1.6 Cylindrical shaft, lock-washer**

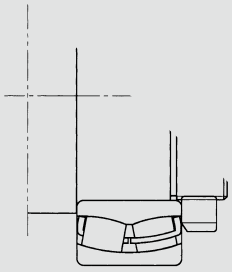


**Fig. 1.7 Cylindrical shaft, lock plate**

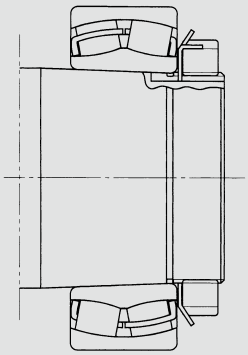


**Fig. 1.8 Tapered shaft, lock-washer**

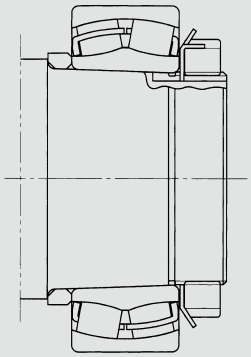


**Fig. 1.9 Tapered shaft, lock-washer (With spacer ring)**

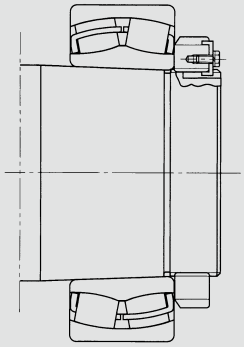


**Fig. 1.10 Tapered shaft, lock plate**

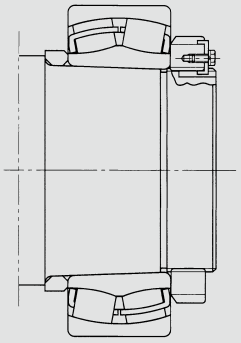


**Fig. 1.11 Tapered shaft, lock plate (With spacer ring)**

**1.4.3 When the shaft is cylindrical and sleeve (adapter or removable sleeve) is used**



**1.4.4 Bearing outer ring and housing**



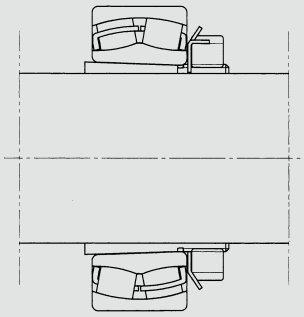


**Fig. 1.12 Cylindrical shaft, lock-washer (adapt sleeve)**

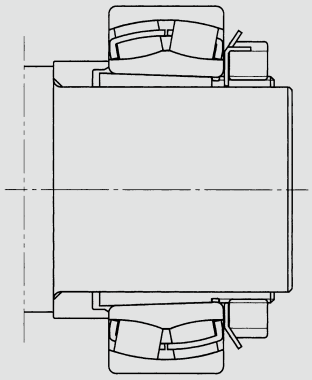


**Fig. 1.13 Cylindrical shaft, lock-washer (adapt sleeve with spacer ring)**

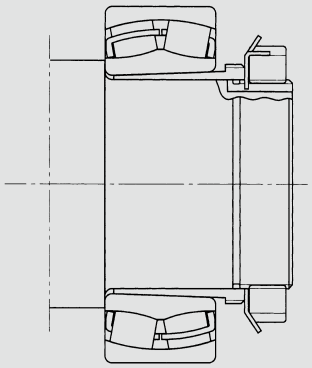


**Fig. 1.14 Cylindrical shaft, lock-washer (removable sleeve)**

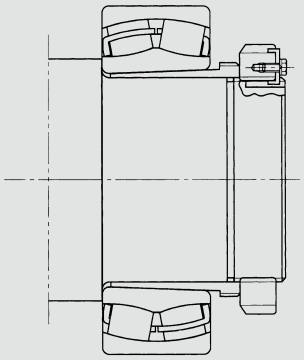


**Fig. 1.15 Cylindrical shaft lock plate (removable sleeve)**

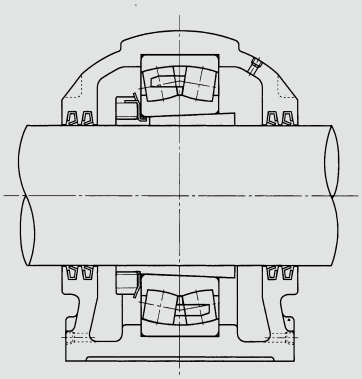


**Fig. 1.16 Fixed side**

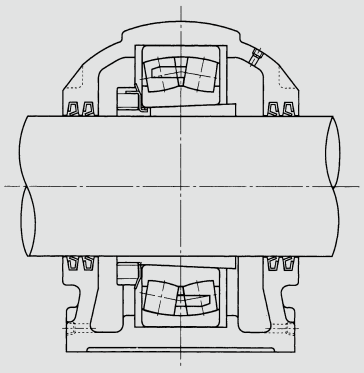


**Fig. 1.17 Free side**

# 2. Bearing Handling Precautions

## 2.1 Jigs, Tools, and Measuring Instruments

Jigs, tools and measuring instruments are necessary to handle bearings. Jigs are required to hoist and carry bearings, mounting/dismounting of lock nut, etc. Measuring instruments are required to measure the bearing clearance, temperature, etc. Let's give some examples of major jigs, tools and measuring instruments.

### 2.1.1 Jigs and Tools

Wire, belt for hoisting, hammer, chisel, screw driver, special wrench, special puller, 3-claw puller, hydraulic nut (see Section 14), oil injection pump, hydraulic press, bearing heater, immersion heater, etc. (**Fig. 2.1**)

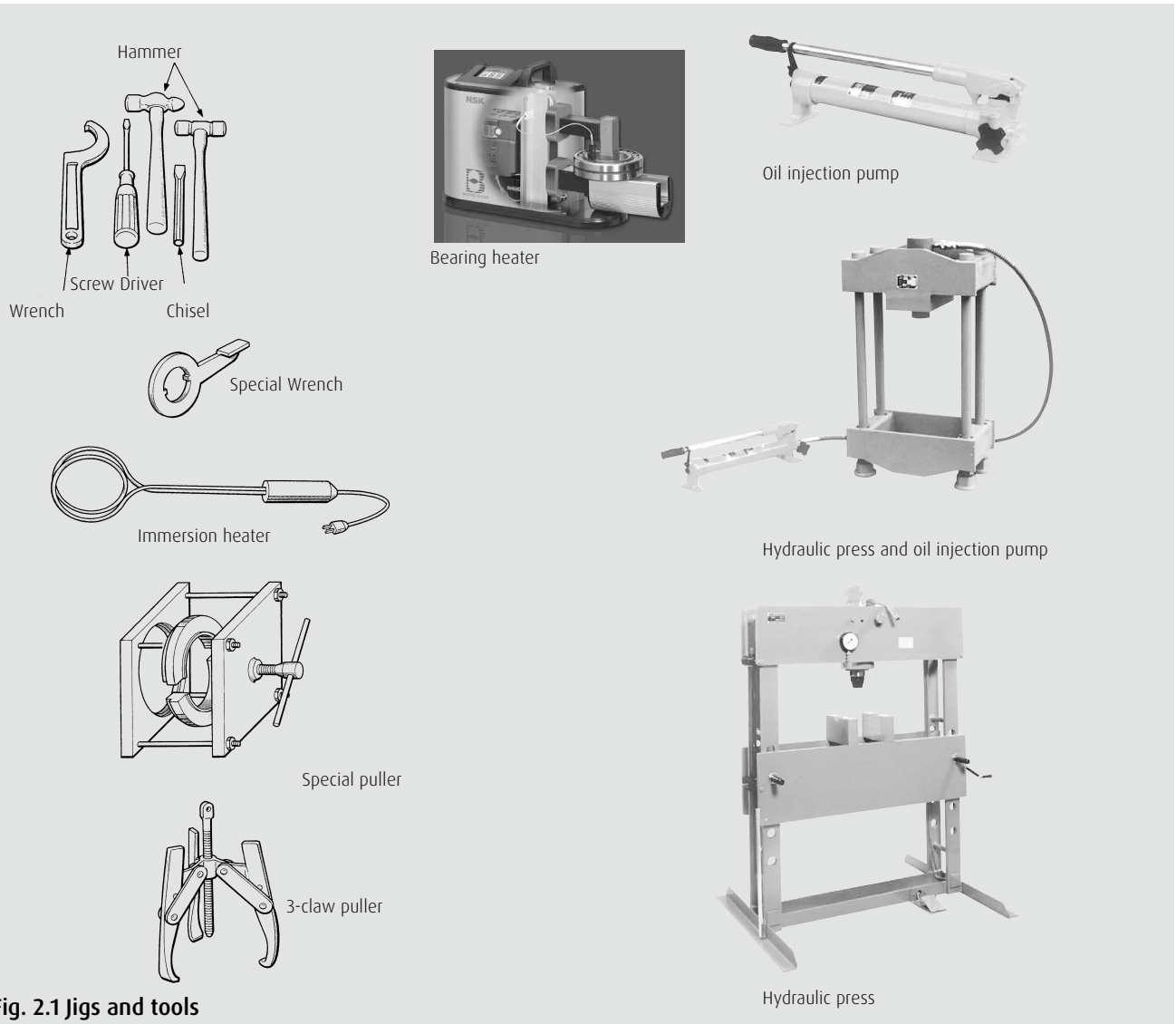



**Fig. 2.1 Jigs and tools**

### 2.1.2 Measuring Instruments

Surface plate, thickness gauge, vernier calipers, outside and inside measurement micrometers, thermometer, taper gauge, sine-bar type taper gauge, etc. (**Fig. 2.2**)

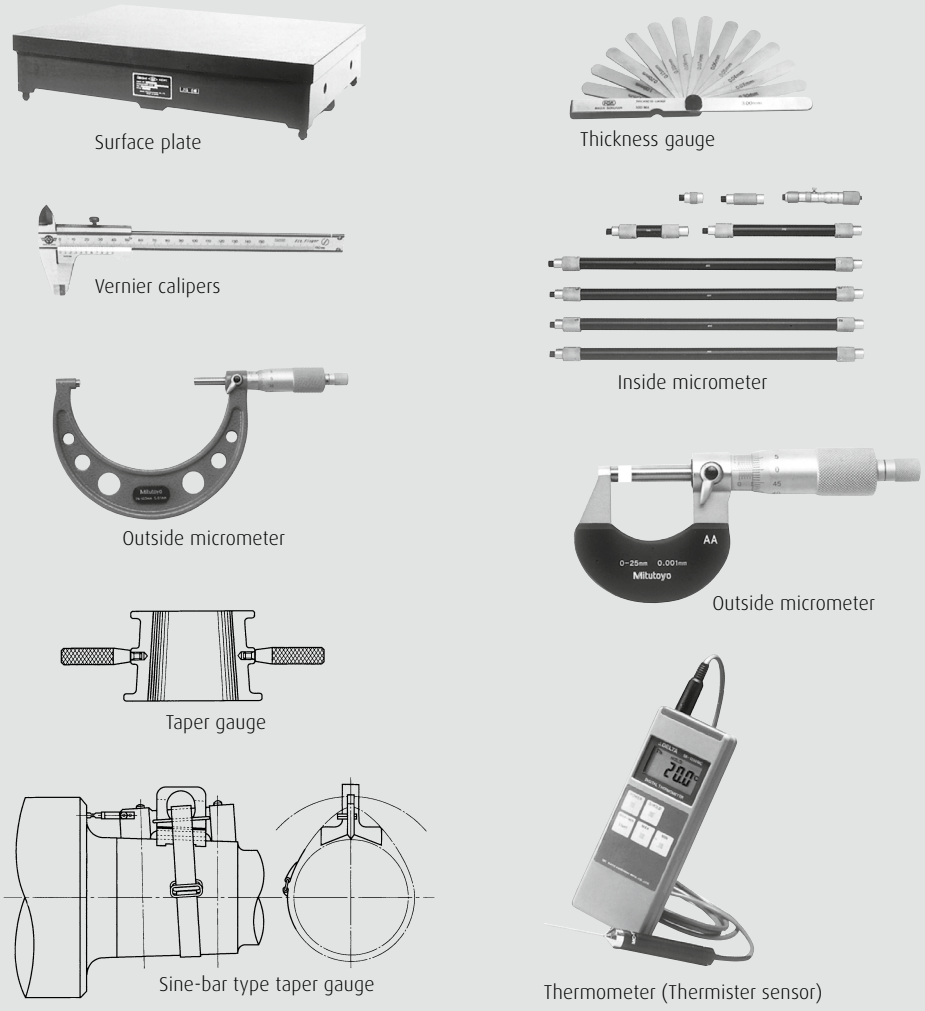



**Fig. 2.2 Measuring instruments**

# 2. Bearing Handling Precautions

## 2.2 Work Site

Select a work place that is as clean as possible.
There must be enough space so that bearing parts can be moved about freely. Bearing, bearing accessory, shaft, and handling jig needed to freely movable. Also, working table, surface plate, cleaning tank, bearing heater, oil heating tank, etc. shall be provided. Since jigs, tools and measuring instruments are frequently used, be sure to keep them clean and in order.

## 2.3 Precautions When Mounting Bearings

### 2.3.1 Packing of New Bearing

New bearings are packed with an anticorrosive agent.
Because if a bearing were to rust, it would prevent proper bearing rotation. As for their dimensional accuracy, bearings are manufactured precisely in units of 0.001 mm (micrometer). As a result, even powdery dust becomes a great obstacle to bearing running. Therefore, do not unpack bearings unless it is necessary.

### 2.3.2 Confirmation of Bearing Number

Before using a new bearing, confirm that its bearing number (Brg. No.), which consists of the basic number, appearance symbol and clearance symbol, matches or is equivalent to that of the bearing being removed from the equipment.
Confirmation example using 23136KE4C3

**a) Basic Number**

(Bearing Series Number + Bearing Bore Number)
The bearing series number is the first three digits, which are **231**.
The bore number is the fourth and fifth numbers, which are **36**.

**b) Appearance symbol**

The symbol consists of the following characters:
*KE4*,
where,

- *K*: Indicates that the shape of bore face of bearing inner ring has a tapered bore of 1/12 (K30: this indicates that the shape of bearing bore has a tapered bore of 1/30.)
- *E4*: Indicates that oil groove and oil holes are provided on the outer ring outside.

**c) Clearance symbol**

The clearance symbol consists of two characters *C3*.
The symbol *C3* represents the bearing clearance alone and indicates the "geometrical or real clearance". The geometrical clearance may change depending on the shaft and housing fitting, temperature difference, or its operational condition, after mounting.
Confirm that the basic number, appearance symbol, and clearance symbol of the new bearing are identical or equivalent to that of the removed bearing.

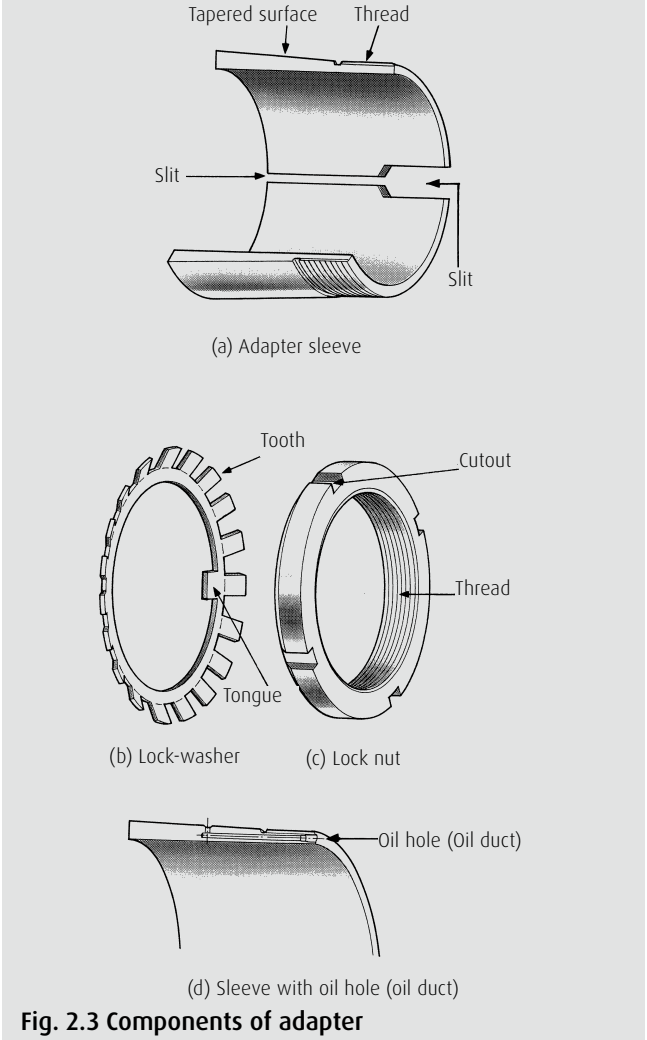



**Fig. 2.3 Components of adapter**

### 2.3.3 Measurement of Bearing Clearance

After mounting a bearing with tapered bore, the measurement of clearance is important. Bearing clearance and measurement method are described in Section 3, please refer to it.

### 2.3.4 Preparation of Jigs to Mount Bearing

Prior to the start of bearing mounting work, examine the steps involved in the mounting method by referring to the drawing and checking the jigs and tools necessary for mounting. Depending on the work, preparation of a special jig may be necessary, thus, preliminary examination must be done.

- Prepare jigs, tools, measuring instruments, working table, surface plate, cleaning tank, and bearing heater or oil heating tank. Also, prepare bearings sleeve, shaft, and parts.
- Select a clean work site where working table, surface plate, cleaning tank, and bearing heater or oil heating tank are provided and heavy material such as bearing, sleeve, shaft, etc. can be safely moved. Jigs, tools, measuring instruments and environment of work site shall be always kept clean to prevent entry of dust.

### 2.3.5 Parts to Be Used for Adapter, Removable Sleeve

**a) Adapter**

The adapter is used to mount the bearing and consists of adapter sleeve, lock nut, lock-washer, lock plate to prevent turning of adapter sleeve and lock nut. **(Fig. 2.3 and Fig. 2.4)** To mount and dismount the adapter sleeve, it becomes easier when slit is widened slightly with a chisel. **(Fig. 2.5)** To tighten the lock nut, use a special wrench. **(Fig. 2.6)**

**b) Removable sleeve (Fig. 2.4)**

The removable sleeve is used to mount the bearing. To fix the removable sleeve, the lock nut, end plate or end cap of shaft is used. To remove the bearing, the nut is mounted on the thread of the removable sleeve.

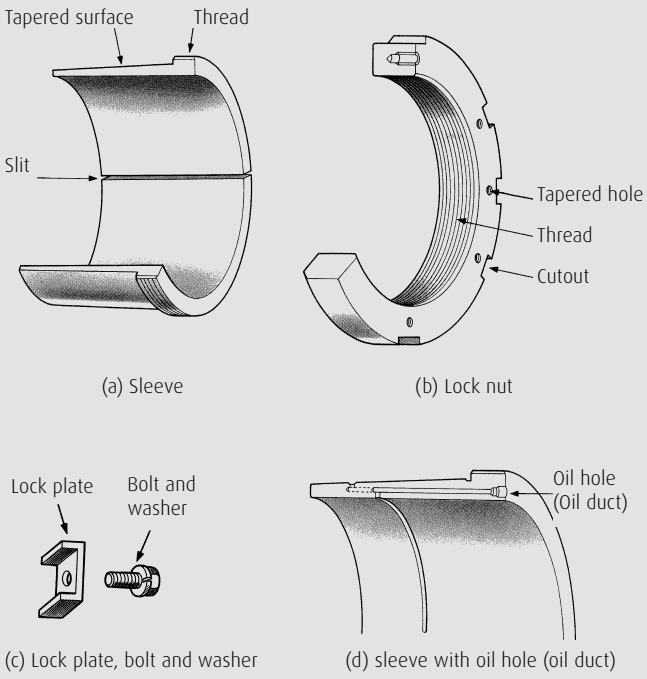



**Fig. 2. 4 removable sleeve**

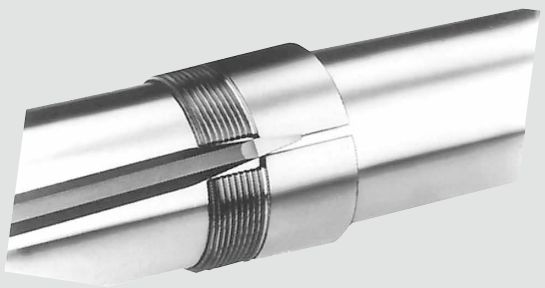


**Fig. 2.5 Sleeve slit widening method**

# 2. Bearing Handling Precautions

**c) Lock-washer, lock plate, and nut**

**(1) How to mount lock-washer and lock plate**

As a turning stopper of the lock nut, a lock-washer or lock plate is used.

**› Lock-washer**

Procedure

1. Mounting method: With inclined teeth of lock-washer facing away from the bearing side, mate the lock-washer tongue to the key groove or to the slit of the shaft sleeve, then, insert.
2. Mount the lock nut with its chamfered side facing the bearing's outer circumference side face.
3. To stop turning of the lock nut, mate one lock-washer tooth to the slit on outside of lock nut, then, bend that tooth with chisel. **(Fig. 2.7)**

Use a lock-washer as a standard for a nominal thread diameter that is smaller than 200 mm.

**› Lock plate**

Procedure

1. Mounting method: for a lock nut which fixes the bearing directly by mounting on the shaft, mate the cutout on outside diameter of lock nut to the key groove of shaft, then, insert the stopper for nut and fix with washer and bolt.
2. For the lock nut of an adapter sleeve, mate its cutout on outside to the slit of sleeve, then, insert the lock plate and fix with washer and bolt.
3. For the lock nut fixing removable sleeve, mate its cutout on outside to the key groove of sleeve, then, insert the lock plate and fix with washer and bolt.

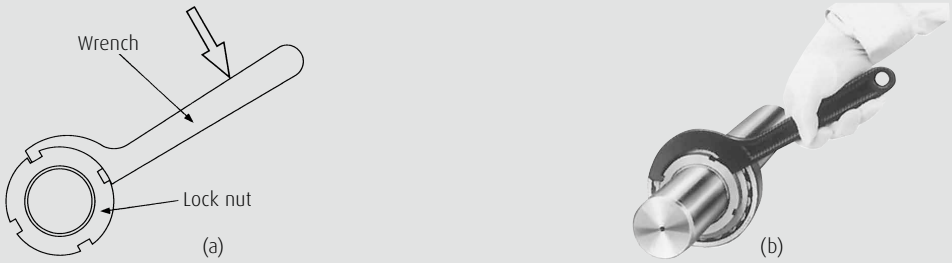



**Fig. 2.6 Lock nut tightening method**

**Fig. 2.7 Bending method for lock-washer tooth**

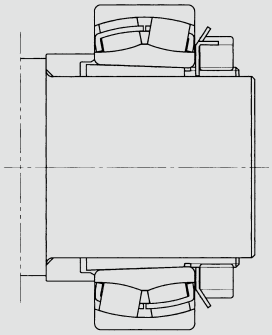


**Fig. 2.8 Assembly view**

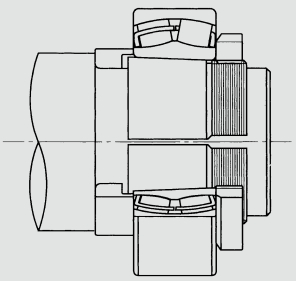


**Fig. 2.9 Clearance adjustment**

To mount a Spherical Roller Bearing having a tapered bore inner ring, after adjusting the bearing clearance **(Fig. 2.9)**, remove the lock nut temporarily, then, insert lock-washer, when a washer is used. **(Fig. 2.10)** Then, remount the lock nut. **(Fig. 2.8)** However, when a lock plate is used, after adjustment of bearing clearance, mate the key groove of shaft or slit of sleeve with the cutout on outside diameter of lock nut, then, insert the stopper for nut. Stopper for nut method is simpler than the lock-washer method. Therefore, the stopper for nut method is used for a large sized sleeves. (**Fig. 2.11 and Fig. 2.12)**

A lock plate is a standard part for applications with a nominal thread diameter larger than 220 mm.

› **Nut**

On the outside of a lock nut with a nominal thread diameter smaller than 200 mm, there are 4 equidistant cutouts. These are used to stop the turning of the lock nut with lock-washer. On the outside of a lock nut with a nominal thread diameter larger than 220 mm, there are 8 equidistant cutouts. And on the seat face of the lock nut corresponding to the cutouts, tapped holes to mount stopper for nut fixing bolts to prevent turning of lock nut are provided. The nut to be used to dismount bearing, being mounted on thread of removable sleeve has 4 equidistant cutouts on outside of nut.
The claws of the special wrench fit into the cutouts on outside of each nut when mounting or dismounting the nut. **(Fig. 2.6)**

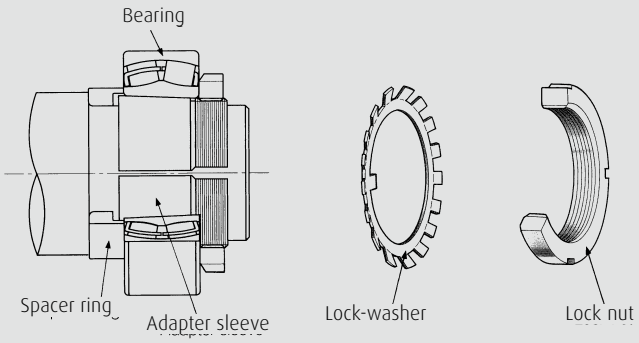



**Fig. 2.10 Mounting of lock-washer after clearance adjustment completion**

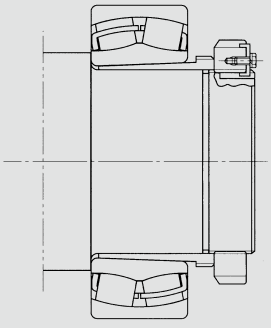


**Fig. 2.11 Assembly view**

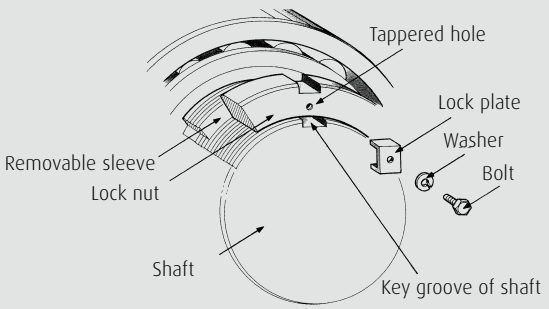



**Fig. 2.12 Mounting of lock plate after clearance adjustment completion**

**(2) Method to use lock-washer when mounting bearing**

To mount Spherical Roller Bearings having inner ring of tapered bore either on the tapered shaft or the cylindrical shaft using the adapter and when using the lock-washer as the turning stopper of lock nut, the lock-washer shall be inserted between the lock nut and bearing. While working to mount bearing, when the inner ring is pushed in by the lock nut, do it without insertion of lock-washer and mount the lock-washer finally as turning stopper of lock nut. The reason is to avoid breakage of the lock-washer tongue which is subject to big force by the transmission of large torque from nut to seat face of lock-washer if lock nut is turned while lock-washer remains inserted by push-in of inner ring to realize a middle value between minimum and maximum radial internal clearance reduction (specified clearance).

By this reason, after adjustment of the specified clearance using directly the lock nut, remove once the lock nut, then, insert the lock-washer and remount the lock nut. At that time, mount position of lock nut displaces by the portion of plate thickness of lock-washer, as the confirming method of correct push-in of inner ring, even under lock-washer inserted state, the method to affix matching marks on lock nut and sleeve or method to measure distance between sleeve end face and nut seat face with vernier calipers is adopted. With those methods, by the portion of plate thickness of lock-washer, matching mark position or measured value varies, it is necessary to devise to correct such variation amount.

**(a) Method to mark matching marks**

Matching mark may be affixed on any place of lock nut and adapter sleeve. Adopt themethod to anticipate variation amount of matching mark position by mounting of the lock-washer while referring to the center angle of the shaft. The variation amount is calculated by the following equation:

$q = (t/p) \times 360°$ **(Fig. 2.13)**

p : Thread pitch of lock nut, (mm)

t : Plate thickness of lock-washer, (mm)

q : Varied amount of matching mark depending on plate thickness of lock-washer, it is center angle on the mounting shaft, ( ° )

**(b) Method to measure distance between sleeve end face and nut seating face with vernier calipers**

Measure the distance between the sleeve end face and nut seating face with vernier calipers. The target value is the measured value less the plate thickness of the lock-washer.

$L = L_0 - t$ **(Fig. 2.14)**

$L_0$: Measured value of distance betweenthe sleeve end face and lock nut seating face, (mm)

t: Plate thickness of lock-washer, (mm)

L: Target value, (mm)

When the above method is used, you must confirm that the clearance is the specified one by measuring the bearing clearance and using the calculation equation.

## 2.4 Precautions When Removing Bearings

Removal of a bearing is done as part of the regular maintenance schedule or when replacement becomes necessary due to an abnormality. When the bearing is replaced based on the maintenance schedule, there is no special caution but when replacement becomes necessary due to occurrence of an abnormality during operation, it is recommended that you record and collect the following data items as a minimum. [This information is necessary for a thorough investigation into the causes of the problem and to develop effective countermeasures to prevent reoccurrence of the failure.]

1. Collect a sample of the used lubricant (about 200 $cm^3$) and keep it.
2. Keep the damaged bearing.
3. Describe any unusual phenomena during the operation.
4. Describe any symptoms when the abnormality occurred during operation (photos and sketch).

**Preparation of removing jigs and tools**

Prior to starting the bearing removal operation, check the drawing of the machine to examine dismounting method and its steps and prepare the jigs and tools necessary to do the removal procedure. In some case, the preparation of special tools may become necessary, therefore, a preliminary examination should always be done.

## 2.5 Bearing Storage

To prevent rusting, each bearing is treated and packed with an anticorrosive agent, but depending on the environment of the storing place, the effectiveness of the corrosion countermeasures varies greatly.
Careful attention is necessary to select a suitable place to keep and stock replacement bearings.

### 2.5.1 Bearing Storage Location

Bearings shall be stocked indoors in a place that is not exposed to wind or rain. Also, an indoor environment where temperature and/or humidity is high would be unsuitable for storage, because such a place would deteriorate the anticorrosion effect. Be sure to stock the bearings in a place where environmental temperature variation is small.

### 2.5.2 How to Store Bearings

After considering the size and weight of bearing to be stocked, secure enough space and proper carrying equipment to transport the bearing safely. It is recommended to provide proper storing shelves to stock bearings. The lowest tray of the storing shelves shall be at least 30 cm above the floor. Please avoid putting bearings directly on the floor.
The anticorrosive effectiveness of the package varies depending on the storing environment, but it is generally effective for about one to three years. Due to some special reason, if storing of the bearing for a longer time, or even up to nearly ten years is necessary, then a special storage method must be used. One such method is to immerse the bearing in a turbine oil which prevents corrosion.

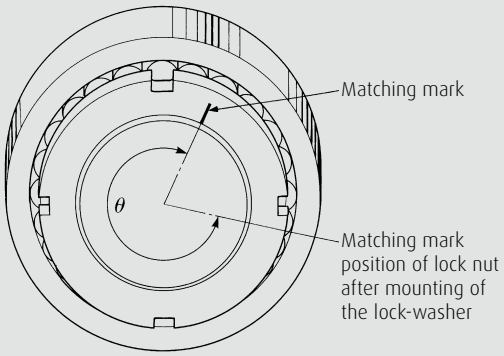



Fig. 2.13 Method to make matching marks

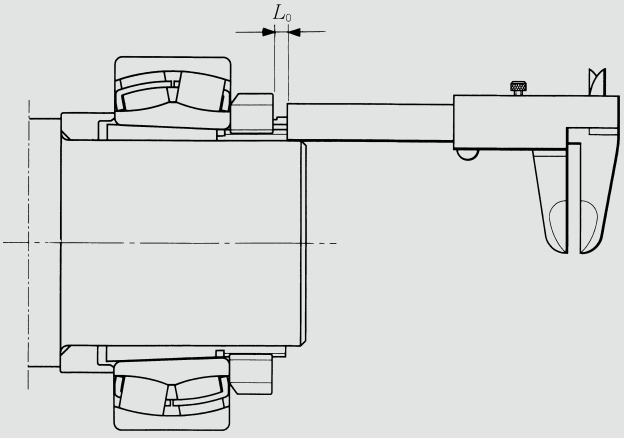



Fig. 2.14 Measurement with vernier calipers

# 3. Measurement of Bearing Clearance

For the bearing mounting, the measurement of internal bearing clearance is a most important task. Before handling the bearing and measuring the internal bearing clearance, be sure to wear thin rubber gloves. (If a bearing is touched by a bare hand, the touched part may rust.)
When measuring the internal bearing clearance, pay careful attention so that the rollers are positioned correctly.

## 3.1 Measurement of Bearing Clearance

To measure only internal bearing clearance, set the bearing standing upright (vertically) on a flat surface, while holding its outer ring with one hand. While paying attention not to incline the inner and outer rings, stabilize the rollers by turning the inner ring to the right and left by about one half to one full rotation. Adjust rollers until one randomly chosen roller of the double rows is positioned to be exactly at the top. Now, the internal clearance is measured with a thickness gauge. The measurement position and measured point vary slightly depending on the size of the outer ring outside diameter.

### 3.1.1 Bearing Outside Diameter Is Smaller Than 200 mm

Insert the thickness gauge between rollers of 2 rows which have a roller positioned exactly at the top of the bearing and outer ring. Now, measure the internal clearance ($\Delta_r$). **(Fig. 3.1)**

### 3.1.2 Bearing Outside Diameter Is Larger Than 200 mm

Insert the thickness gauge between the rollers of the 2 rows, which each have been positioned to be exactly at the top, and outer ring and between 2 rows of bearing at symmetrical position relative to the bearing center, then measure the respective internal clearance of the bearing. **(Fig. 3.2)**
For the internal bearing clearance ($\Delta_r$), take that value measured between 2 rows of just top of bearing and outer ring as respectively $\Delta_{rT1}$ and $\Delta_{rT2}$ and that value measured just at top of the bearing as $\Delta_{rT}$.

$$\Delta_{rT} = 1/2\ (\Delta_{rT1} + \Delta_{rT2})$$

Among internal clearances between 2 rows of rollers that are symmetrical relative to the bearing center and outer ring, take that measurement between 2 rows of rollers of left side respectively as $\Delta_{rL1}$ and $\Delta_{rL2}$. The internal clearance on the left side of the bearing is $\Delta_{rL}$:

$$\Delta_{rL} = 1/2\ (\Delta_{rL1} + \Delta_{rL2})$$

Take that measurement between 2 rows of rollers of right side respectively as $\Delta_{rR1}$ and $\Delta_{rR2}$. The internal clearance of the right side of the bearing is $\Delta_{rR}$:

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

The internal bearing clearance ($\Delta_r$) is given by the following equation:

$$\Delta_r = 1/2\ (\Delta_{rT} + \Delta_{rL} + \Delta_{rR})$$

## 3.2 Measuring Bearing Clearance When Mounted on Shaft or Sleeve

Basically, the measurement of the clearance is taken when the outer ring of bearing hangs down from rollers. At first, while holding the bearing up right, rotate the outer ring in the clockwise and counter-clockwise directions by one half to one full rotation until both rows have a randomly chosen roller positioned exactly at the bottom. The clearance is measured with a thickness gauge but the measurement point varies slightly depending on the size of the outer ring outside diameter.

### 3.2.1 Bearing Outside Diameter Is Smaller Than 200 mm

Insert the thickness gauge between rollers of 2 rows of just at the bottom of the bearing and outer ring and measure the internal clearance ($\Delta_{rS}$).**(Fig. 3.3)**

### 3.2.2 Bearing Outside Diameter Is Larger Than 200 mm

Insert the thickness gauge between rollers of 2 rows that are positioned just at the bottom of bearing and outer ring and between 2 rows of bearing rollers symmetrical relative to the bearing center, then, measure the respective internal clearance of the bearing. **(Fig. 3.3)** For the internal bearing clearance ($\Delta_r$), take the measurement when the roller is positioned exactly at the bottom, since the bearing has 2 rows, two values must be measured. The bearing internal clearance is $\Delta_{rS1}$ and $\Delta_{rS2}$ while that value measured at the exact bottom of the bearing is $\Delta_{rS}$.

$$\Delta_{rS} = 1/2\ (\Delta_{rS1} + \Delta_{rS2})$$

Among internal clearances between 2 rows of rollers symmetrical relative to the bearing center and outer ring, take that value measured between 2 rows of rollers of left side respectively as $\Delta_{rL1}$ and $\Delta_{rL2}$ and the internal clearance of left side of bearing as $\Delta_{rL}$.

$$\Delta_{rL} = 1/2\ (\Delta_{rL1} + \Delta_{rL2})$$

The internal clearances measured between 2 rows of rollers on the right side respectively as $\Delta_{rR1}$ and $\Delta_{rR2}$. The internal clearance of right side of bearing is $\Delta_{rR}$.

$$\Delta_{rR} = 1/2\ (\Delta_{rR1} + \Delta_{rR2})$$

The internal bearing clearance ($\Delta_r$) is given by the following equation:

$$\Delta_r = 1/2\ (\Delta_{rS} + \Delta_{rL} + \Delta_{rR})$$

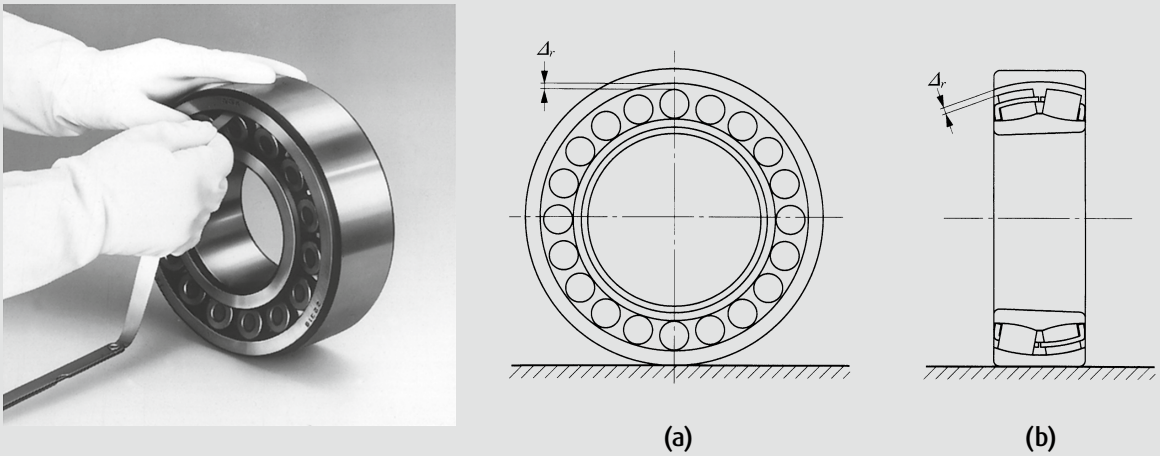



**Fig. 3.1 Clearance measurement point (Bearing outside diameter: less than 200mm**

# 3. Measurement of Bearing Clearance

### 3.3 Temperature Equilibrium When Taking Measurements

To ensure accurate bearing measurement of the internal clearance or dimensions, the temperature of the measurement instrument and that of the components to be measured must be brought to the same temperature. Especially, if the bearing is mounted by using an oil heating tank or induction heater, then measure the internal clearance only after a complete cool down. For example, if a bearing is brought from the warehouse to the measurement place, the temperature of the stored bearing may still be high, thus, if the clearance or dimension were measured wihtout confirming the bearing temperature, the measured value may be wrong.

For a large bearing with an outer ring outside diameter that is larger than 400 mm, if a clearance or dimension measurement is necessary, it is recommended to leave the unpacked bearing for about 24 hours on the surface plate, before making a clearance or dimension measurement. Put the end face of the bearing on a surface plate prior to measurement to ensure a measurement with both objects at the same temperature.

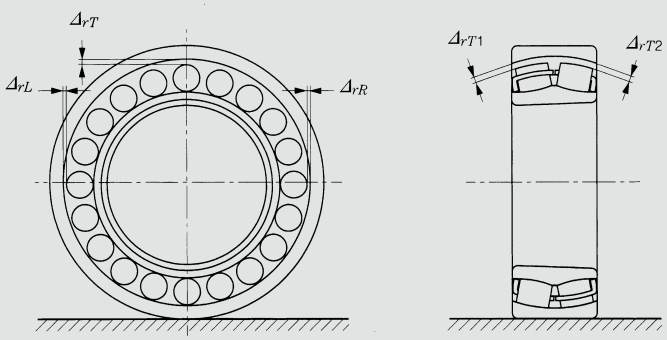



**Fig. 3.2 Clearance measurement point (Bearing outside diameter: larger than 200 mm)**

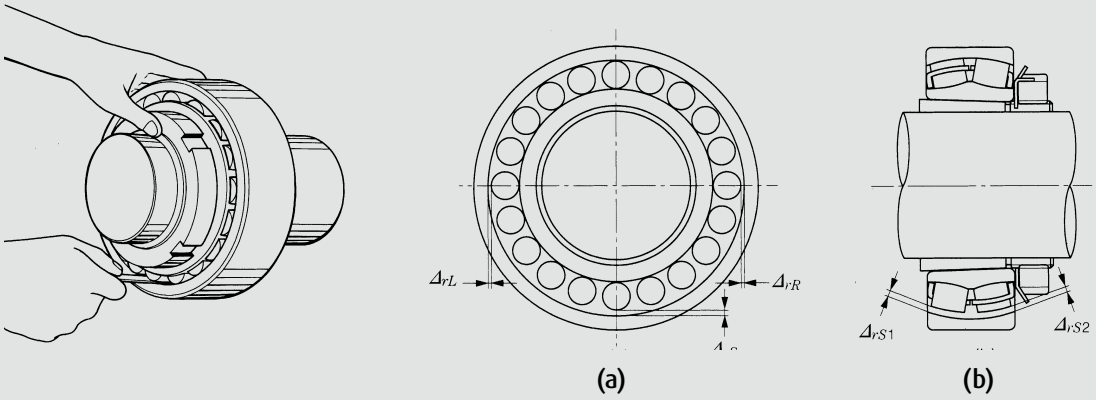



**Fig. 3.3 Clearance measurement point**

# 4. Clearance Adjustment When Mounting Bearing on a Tapered Shaft or Sleeve

Mount the bearing with its inner ring having a tapered bore to the tapered shaft or sleeve (adapter, removable sleeve). When pushing in the bearing to the tapered shaft or sleeve, the inner ring of bearing is widened resulting in increase of "interference" and reduction of internal clearance. It is important to give proper interference and internal clearance when mounting the bearing. Next, we show the reduction amount of the clearance to achieve the proper mounting.

Radial internal clearance of spherical roller bearings **Table 4.1**

Mounting of spherical roller bearings having tapered bore **Table 4.2**

When mounting a bearing, each time the bearing is pushed further onto the tapered shaft or sleeve, measure the variation of internal clearance and repeat the above procedure until the clearance reduction amount to the specified value listed in the Table 4.2 is attained. This procedure is called "Clearance adjustment" and when the clearance reduction amount is attained, the clearance necessary for bearing running is secured. The confirmation of the clearance reduction amount by measurement with a thickness gauge is very important. Depending on the method of clearance adjustment, the measured value obtained with the thickness gauge may not be correct. Therefore, the following corrective procedure must be executed.

**Table 4.1 Radial internal clearances in spherical roller bearings**

Units: μm

| Nominal Bore Dia. d (mm) | | Clearance in Bearings with Cylindrical Bores | | | | | | | | | | Clearance in Bearings with Tapered Bores | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C2 | | CN | | C3 | | C4 | | C5 | | C2 | | CN | | C3 | | C4 | | C5 | |
| over | incl. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. |
| 24 | 30 | 15 | 25 | 25 | 40 | 40 | 55 | 55 | 75 | 75 | 95 | 20 | 30 | 30 | 40 | 40 | 55 | 55 | 75 | 75 | 95 |
| 30 | 40 | 15 | 30 | 30 | 45 | 45 | 60 | 60 | 80 | 80 | 100 | 25 | 35 | 35 | 50 | 50 | 65 | 65 | 85 | 85 | 105 |
| 40 | 50 | 20 | 35 | 35 | 55 | 55 | 75 | 75 | 100 | 100 | 125 | 30 | 45 | 45 | 60 | 60 | 80 | 80 | 100 | 100 | 130 |
| 50 | 65 | 20 | 40 | 40 | 65 | 65 | 90 | 90 | 120 | 120 | 150 | 40 | 55 | 55 | 75 | 75 | 95 | 95 | 120 | 120 | 160 |
| 65 | 80 | 30 | 50 | 50 | 80 | 80 | 110 | 110 | 145 | 145 | 180 | 50 | 70 | 70 | 95 | 95 | 120 | 120 | 150 | 150 | 200 |
| 80 | 100 | 35 | 60 | 60 | 100 | 100 | 135 | 135 | 180 | 180 | 225 | 55 | 80 | 80 | 110 | 110 | 140 | 140 | 180 | 180 | 230 |
| 100 | 120 | 40 | 75 | 75 | 120 | 120 | 160 | 160 | 210 | 210 | 260 | 65 | 100 | 100 | 135 | 135 | 170 | 170 | 220 | 220 | 280 |
| 120 | 140 | 50 | 95 | 95 | 145 | 145 | 190 | 190 | 240 | 240 | 300 | 80 | 120 | 120 | 160 | 160 | 200 | 200 | 260 | 260 | 330 |
| 140 | 160 | 60 | 110 | 110 | 170 | 170 | 220 | 220 | 280 | 280 | 350 | 90 | 130 | 130 | 180 | 180 | 230 | 230 | 300 | 300 | 380 |
| 160 | 180 | 65 | 120 | 120 | 180 | 180 | 240 | 240 | 310 | 310 | 390 | 100 | 140 | 140 | 200 | 200 | 260 | 260 | 340 | 340 | 430 |
| 180 | 200 | 70 | 130 | 130 | 200 | 200 | 260 | 260 | 340 | 340 | 430 | 110 | 160 | 160 | 220 | 220 | 290 | 290 | 370 | 370 | 470 |
| 200 | 225 | 80 | 140 | 140 | 220 | 220 | 290 | 290 | 380 | 380 | 470 | 120 | 180 | 180 | 250 | 250 | 320 | 320 | 410 | 410 | 520 |
| 225 | 250 | 90 | 150 | 150 | 240 | 240 | 320 | 320 | 420 | 420 | 520 | 140 | 200 | 200 | 270 | 270 | 350 | 350 | 450 | 450 | 570 |
| 250 | 280 | 100 | 170 | 170 | 260 | 260 | 350 | 350 | 460 | 460 | 570 | 150 | 220 | 220 | 300 | 300 | 390 | 390 | 490 | 490 | 620 |
| 280 | 315 | 110 | 190 | 190 | 280 | 280 | 370 | 370 | 500 | 500 | 630 | 170 | 240 | 240 | 330 | 330 | 430 | 430 | 540 | 540 | 680 |
| 315 | 355 | 120 | 200 | 200 | 310 | 310 | 410 | 410 | 550 | 550 | 690 | 190 | 270 | 270 | 360 | 360 | 470 | 470 | 590 | 590 | 740 |
| 355 | 400 | 130 | 220 | 220 | 340 | 340 | 450 | 450 | 600 | 600 | 750 | 210 | 300 | 300 | 400 | 400 | 520 | 520 | 650 | 650 | 820 |
| 400 | 450 | 140 | 240 | 240 | 370 | 370 | 500 | 500 | 660 | 660 | 820 | 230 | 330 | 330 | 440 | 440 | 570 | 570 | 720 | 720 | 910 |
| 450 | 500 | 140 | 260 | 260 | 410 | 410 | 550 | 550 | 720 | 720 | 900 | 260 | 370 | 370 | 490 | 490 | 630 | 630 | 790 | 790 | 1000 |
| 500 | 560 | 150 | 280 | 280 | 440 | 440 | 600 | 600 | 780 | 780 | 1000 | 290 | 410 | 410 | 540 | 540 | 680 | 680 | 870 | 870 | 1100 |
| 560 | 630 | 170 | 310 | 310 | 480 | 480 | 650 | 650 | 850 | 850 | 1100 | 320 | 460 | 460 | 600 | 600 | 760 | 760 | 980 | 980 | 1230 |
| 630 | 710 | 190 | 350 | 350 | 530 | 530 | 700 | 700 | 920 | 920 | 1190 | 350 | 510 | 510 | 670 | 670 | 850 | 850 | 1090 | 1090 | 1360 |
| 710 | 800 | 210 | 390 | 390 | 580 | 580 | 770 | 770 | 1010 | 1010 | 1300 | 390 | 570 | 570 | 750 | 750 | 960 | 960 | 1220 | 1220 | 1500 |
| 800 | 900 | 230 | 430 | 430 | 650 | 650 | 860 | 860 | 1120 | 1120 | 1440 | 440 | 640 | 640 | 840 | 840 | 1070 | 1070 | 1370 | 1370 | 1690 |
| 900 | 1000 | 260 | 480 | 480 | 710 | 710 | 930 | 930 | 1220 | 1220 | 1570 | 490 | 710 | 710 | 930 | 930 | 1190 | 1190 | 1520 | 1520 | 1860 |
| 1000 | 1120 | 290 | 530 | 530 | 780 | 780 | 1020 | 1020 | 1330 | – | – | 530 | 770 | 770 | 1030 | 1030 | 1300 | 1300 | 1670 | – | – |
| 1120 | 1250 | 320 | 580 | 580 | 860 | 860 | 1120 | 1120 | 1460 | – | – | 570 | 830 | 830 | 1120 | 1120 | 1420 | 1420 | 1830 | – | – |
| 1250 | 1400 | 350 | 640 | 640 | 860 | 860 | 1240 | 1240 | 1620 | – | – | 620 | 910 | 910 | 1230 | 1230 | 1560 | 1560 | 2000 | – | – |

# 4. Clearance Adjustment When Mounting Bearing on a Tapered Shaft or Sleeve

1. In case to heat
   When the temperatures of bearing and shaft are both at the same room temperature, measure again the clearance with the thickness gauge to confirm that the specified value is secured.
2. In case that a lock-washer is used as a turning stopper of the lock nut.
   Prior to bending the tooth of the lock-washer into cutout of lock nut, measure again the clearance with the thickness gauge to confirm that the specified value is secured.
3. In case a hydraulic nut is used
   After removal of the hydraulic nut, mount the lock nut and measure the clearance again to confirm that the specified value remains constant prior to stopping the turning.
4. In case an oil injection pump is used
   Drop to zero the pressure of high pressure oil fed from the oil injection pump so that there is no pressure on bearing or sleeve fitted part. Next, measure the clearance with the thickness gauge to confirm that the specified value remains secured.

**Radial internal clearance and clearance reduction amount of the bearing to be mounted**

- When radial internal clearance is CN clearance (normal clearance). Perform the clearance adjustment while aiming at a middle value between minimum and maximum clearance reduction amount.
- When radial internal clearance is C3 or C4 clearance
  Perform the clearance adjustment aiming at the maximum clearance reduction amount.

**Internal clearance adjustment of tapered-bore bearings**

Perform the adjustment by measuring the clearance reduction amount with the thickness gauge.

1. For measurement position and measured point, refer to Section 3.2 of this manual.
2. To mount a bearing on a tapered shaft, perform each time when the bearing is pushed in by the lock nut, end plate, end cap or hydraulic nut.
3. When using an adapter sleeve, perform each time when the bearing is pushed in by the lock nut or hydraulic nut.
4. When using a removable sleeve, perform each time when the removable sleeve is pushed in by the lock nut or hydraulic nut.

When measuring the clearance during those operations, as the outer ring of bearing is hanging down from of rollers, turn the outer ring to right and left by one half to one full rotation while keeping the bearing in its correct posture. Position one randomly chosen roller from each row of rollers to the exact bottom position. Then, insert the thickness gauge to an appropriate place depending on size of the outer ring outside diameter to measure the internal clearance. For the clearance adjustment, the measured value of each clearance measurement shall be recorded.

## Table 4.2 Mounting of spherical roller bearings with tapered bores

Units: mm

| Bearing Bore Diameter d (mm) | | Reduction in Radial Clearance | | Axial Movement | | | | Minimum Permissible | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Taper 1 : 12 | | Taper 1 : 30 | | | | |
| over | incl. | min. | max. | min. | max. | min. | max. | CN | C3 | C4 |
| 30 | 40 | 0.025 | 0.030 | 0.40 | 0.45 | – | – | 0.010 | 0.025 | 0.035 |
| 40 | 50 | 0.030 | 0.035 | 0.45 | 0.55 | – | – | 0.015 | 0.030 | 0.045 |
| 50 | 65 | 0.030 | 0.035 | 0.45 | 0.55 | – | – | 0.025 | 0.035 | 0.060 |
| 65 | 80 | 0.040 | 0.045 | 0.60 | 0.70 | – | – | 0.030 | 0.040 | 0.075 |
| 80 | 100 | 0.045 | 0.055 | 0.70 | 0.85 | 1.75 | 2.15 | 0.035 | 0.050 | 0.085 |
| 100 | 120 | 0.050 | 0.060 | 0.75 | 0.90 | 1.9 | 2.25 | 0.045 | 0.065 | 0.110 |
| 120 | 140 | 0.060 | 0.070 | 0.90 | 1.1 | 2.25 | 2.75 | 0.055 | 0.080 | 0.130 |
| 140 | 160 | 0.065 | 0.080 | 1.0 | 1.3 | 2.5 | 3.25 | 0.060 | 0.100 | 0.150 |
| 160 | 180 | 0.070 | 0.090 | 1.1 | 1.4 | 2.75 | 3.5 | 0.070 | 0.110 | 0.170 |
| 180 | 200 | 0.080 | 0.100 | 1.3 | 1.6 | 3.25 | 4.0 | 0.070 | 0.110 | 0.190 |
| 200 | 225 | 0.090 | 0.110 | 1.4 | 1.7 | 3.5 | 4.25 | 0.080 | 0.130 | 0.210 |
| 225 | 250 | 0.100 | 0.120 | 1.6 | 1.9 | 4.0 | 4.75 | 0.090 | 0.140 | 0.230 |
| 250 | 280 | 0.110 | 0.140 | 1.7 | 2.2 | 4.25 | 5.5 | 0.100 | 0.150 | 0.250 |
| 280 | 315 | 0.120 | 0.150 | 1.9 | 2.4 | 4.75 | 6.0 | 0.110 | 0.160 | 0.280 |
| 315 | 355 | 0.140 | 0.170 | 2.2 | 2.7 | 5.5 | 6.75 | 0.120 | 0.180 | 0.300 |
| 355 | 400 | 0.150 | 0.190 | 2.4 | 3.0 | 6.0 | 7.5 | 0.130 | 0.200 | 0.330 |
| 400 | 450 | 0.170 | 0.210 | 2.7 | 3.3 | 6.75 | 8.25 | 0.140 | 0.220 | 0.360 |
| 450 | 500 | 0.190 | 0.240 | 3.0 | 3.7 | 7.5 | 9.25 | 0.160 | 0.240 | 0.390 |
| 500 | 560 | 0.210 | 0.270 | 3.4 | 4.3 | 8.5 | 11.0 | 0.170 | 0.270 | 0.410 |
| 560 | 630 | 0.230 | 0.300 | 3.7 | 4.8 | 9.25 | 12.0 | 0.200 | 0.310 | 0.460 |
| 630 | 710 | 0.260 | 0.330 | 4.2 | 5.3 | 10.5 | 13.0 | 0.220 | 0.330 | 0.520 |
| 710 | 800 | 0.280 | 0.370 | 4.5 | 5.9 | 11.5 | 15.0 | 0.240 | 0.390 | 0.590 |
| 800 | 900 | 0.310 | 0.410 | 5.0 | 6.6 | 12.5 | 16.5 | 0.280 | 0.430 | 0.660 |
| 900 | 1000 | 0.340 | 0.460 | 5.5 | 7.4 | 14.0 | 18.5 | 0.310 | 0.470 | 0.730 |
| 1000 | 1120 | 0.370 | 0.500 | 5.9 | 8.0 | 15.0 | 20.0 | 0.360 | 0.530 | 0.800 |

Remarks The values for reduction in radial internal clearance are for bearings with CN clearance.

For bearings with C3 or C4 Clearance, the maximum values listed should be used for the reduction in radial internal clearance.

# 5. Quick Reference for Bearing Mounting and Dismounting

Before mounting a bearing confirm that the bearing is still usable. When dismounting a bearing, confirm whether the bearing is still usable or is damabed. The bearing mounting operation is basically the method to fit bearing inner ring and shaft shape, but also there are numerous methods depending on size of bearing and shaft, and kind of mounting parts. For dismounting of a damaged bearing, there are even more methods available. Major mounting and dismounting operation methods are listed in **Tables 5.1 and 5.2.**

**Table 5.1 Bearing mounting method**

| Work | Bearing inner ring shape | | Shaft shape | | | Bearing mounting parts | | Major jig tools for handling | Working method | Describing Section |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cylindrical bore | Tapered bore | Cylindrical shaft | Tapered shaft | Added content | Part | Added content | | | |
| Bearing dismounting | ○ | – | ○ | – | Shaft with shoulder<br>With oil duct | With or without spacer ring | – | › Hammer<br>› Press<br>› Oil heating tank<br>› Bearing heater<br>› Lock nut | Method to use a hammer<br>Method to use press<br>Method to use oil heating tank<br>Method to use bearing heater | 6.2.1<br>6.2.2<br>6.2.3 (1)<br>6.2.3 (2) |
| | – | ○ | – | ○ | Shaft with shoulder<br>With oil duct | With or without spacer ringt | – | › Lock nut<br>› Hydraulic nut | Method to use lock nut<br>Method to use hydraulic nut | 6.2.6 (1)<br>6.2.6 (2) |
| | – | ○ | | – | Shaft with shoulder | Adapter<br>With or without spacer ring | With or without oil duct | › Lock nut<br>› Hydraulic nut<br>› O.I.P* | Method to use lock nut<br>Method to use hydraulic nut<br>Oil injection method | 6.2.4 (1)<br>6.2.4 (2)<br>6.2.4 (3) |
| | – | ○ | ○ | – | Shaft with shoulder | Removable sleeve | With or without oil duct | › Lock nut<br>› Hydraulic nut<br>› O.I.P.* | Method to use lock nut<br>Method to use hydraulic nut<br>Oil injection method | 6.2.5 (1)<br>6.2.5 (2)<br>6.2.5 (3) |

*O.I.P.: oil injection pump

# 6. Bearing Mounting

Spherical roller bearings are mounted by combining the shaft and bearing inner ring. For example, a cylindrical shaft or tapered shaft is combined with a cylindrical bore or tapered bore bearing. Mounting is made using a suitable method. We will explain major mounting methods (**Table 5.1**).

## 6.1 Required Preparation for Mounting the Bearing

To mount the bearing there are diverse methods listed in **Table 5.1.** Prior to the start of the bearing mounting operation, confirm the bearing mounted condition while referring to the machine structure drawing. Select a suitable method corresponding to your particular situation. Next, prepare the work site, jigs, tools, measurement instruments necessary to do the operation. If there are no suitable jigs or tools, prepare some beforehand.

## 6.2 Bearing Mounting Work

There are different methods to mount the bearing, but the post-mounting treatment is the same.
After the bearing mounting is completed, always apply lubricant to the inclined outer ring as a post-mounting treatment.

1) Application of lubricant
- In case of grease
  Apply grease to all the rollers no that their surface is covered by grease, then, reset the outer ring tots original position.
- In case of lubrication oil
  Apply lubrication oil to the surface of all the rollers, then, reset the outer ring to its original position.

2) After completion of lubricant application
Cover the bearing with a vinyl sheet etc. to prevent adhesion of powdery dust, etc.

**Table 5.2 Bearing dismounting method**

| Work | Bearing inner ring shape | | Shaft shape | | | Bearing mounting parts | | Major jig tools for handling | Working method | Describing Section |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cylindrical bore | Tapered bore | Cylindrical shaft | Tapered shaft | Added content | Part | Added content | | | |
| Bearing dismounting | ○ | – | ○ | – | Shaft with shoulder<br>With oil duct | With or without spacer ring | – | › Special puller<br>› Press<br>› O.I.P.* + special puller | Method to use special puller<br>Method to use press<br>Oil injection method | 7.2.1<br>7.2.4<br>7.2.6 |
| | – | ○ | – | ○ | Shaft with shoulder<br>With oil duct | With or without spacer ring | – | | | |
| | – | ○ | ○ | – | Shaft with shoulder | Adapter<br>With or without spacer ring | With or without oil duct | › Hammer<br>› Special puller<br>› Press<br>› O.I.P.* + special puller | Method to use hammer<br>Method to use special puller<br>Method to use press<br>Oil injection method | 7.2.2<br>7.2.1<br>7.2.4<br>7.2.6 |
| | | | | | Shaft with shoulder | Removable sleeve | With or without oil duct | › Nut<br>› Hydraulic nut<br>› O.I.P.* + removing nut | Method to use nut<br>Method to use hydraulic nut<br>Oil injection method | 7.2.3<br>7.2.5<br>7.2.6 |

*O.I.P.: oil injection pump

# 6. Bearing Mounting

**6.2.1 Hammer Method (Fig. 6.1)**
This method is used to mount small bearings when the interference of bearing with shaft is small.

Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore

Procedure
1. Clean the surface of the shaft on which the bearing will be mounted, then, apply machine oil.
2. Insert the bearing onto the shaft.
3. After inserting the bearing, make the contact as even as possible between the chamfered part of inner ring end face of bearing and the bearing mounting place of shaft. The aim is even contact between the flat face of the dolly plate and the end face of the inner ring on the shaft. (**Fig. 6.1 (a)**)
4. When the flat face of the dolly plate is perpendicular to the shaft center, use a hammer to tap the top of the dolly plate on the hammering side. (**Fig. 6.1 (b)**)
5. Tap with a hammer until the end face of the inner ring of the advancing direction approaches closely and touches the shoulder of the shaft.
6. When a lock-washer is used, insert it and mount the lock nut, then, fix it as a turning stopper.
7. After mounting the bearing, apply lubricant to the bearing and cover it with vinyl sheet to prevent entry of dust.

**6.2.2 Press Method (Fig. 6.2 and Fig. 6.3)**
Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore

Procedure
1. Set upright the shaft and place its lower end on the table of a hydraulic press so that the shaft center mates with that of the ram of hydraulic press. Adjust the height of the guide of hydraulic press and fix the shaft at the lower part of its shoulder. (**Fig. 6.2**)
2. Confirm that the moving stroke of hydraulic press ram is sufficient to push-in the bearing.
3. After making clean the shaft surface on which the bearing will be mounted, apply some machine oil.
4. Insert the bearing onto the shaft.
5. Insert the bearing so that the inner ring's chamfered part touches the dolly plate (**Fig. 6.3 (a)**) as evenly as possible in the advancing direction. The aim is to create even contact between the flat face of the dolly plate and the inner ring end face on the shaft. (**Fig. 6.3 (b)**)
   The top part of dolly plate on the hammering should be in contact with the flat face of the hydraulic ram. At that time, confirm again that the center of shaft mates with the hydraulic ram.
6. Activate the hydraulic ram to push-in the bearing. Continue until the inner ring end face touches closely the shoulder of shaft. (**Fig. 6.3 (c)**)
7. When a lock-washer is used, insert it and mount the lock nut and fix it as a turning stopper. When a lock plate is used, insert it adjusting its position to the key groove of shaft with cutout on lock nut outside and fix the lock plate with washer and bolt.
8. After mounting the bearing, apply lubricant to the bearing and cover it with vinyl sheet to prevent entry of dust.

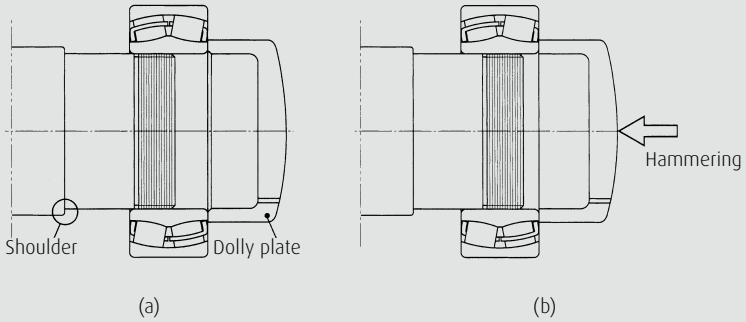



**Fig. 6.1 Hammer method**

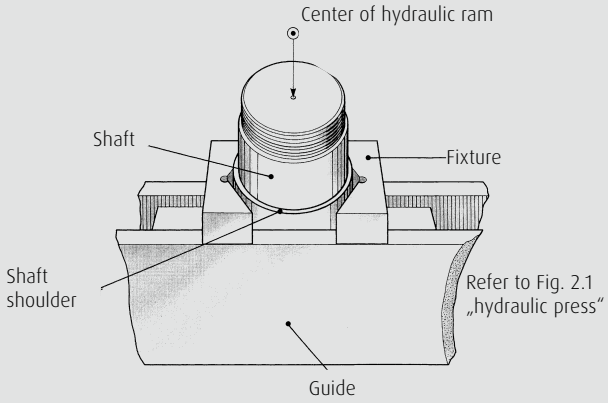



**Fig. 6.2 Press method (fixing of shaft on table of press)**

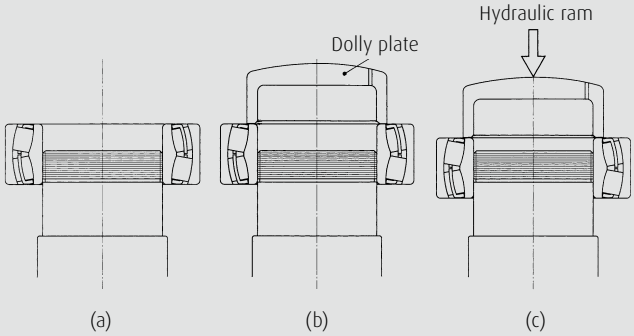



**Fig. 6.3 Push-in of bearing with press**

# 6. Bearing Mounting

### 6.2.3 Heat Method

**a) Oil heating tank method (Fig. 6.4 and Fig. 6.5 (a) (b))**

Shaft shape: Cylindrical shaft

Bearing inner ring bore shape: Cylindrical bore

Procedure

1. Heat the oil in the tank till 100°C to 110°C. The oil temperature shall be confirmed after sufficient agitation. (When heating the oil, do not raise the oil temperature over 120°C)
2. Immerse completely the bearing in the heated oil.
3. Keep the oil temperature in the tank to 100°C to 110°C and leave the bearing immersed till its temperature becomes the same as that of the oil.
4. The time necessary for temperature of bearing to rise to 100°C to 110°C varies depending on the size of bearing but usually it takes about 30 minutes.
5. Clean the surface of shaft with cleaning oil to remove dirt.
6. Take out the bearing from the oil tank and confirm that the bearing temperature is 100°C to 110°C.(To measure the bearing temperature, use a surface contact thermometer.) If the bearing temperature is not yet 100°C to 110°C, immerse again the bearing in the tank until it rises to 100°C to 110°C.
7. When the bearing temperature attains 100°C to 110°C, take the bearing out from the oil tank, while wearing heat insulating gloves. Next, insert and adjust the bearing to the center of the shaft. When inserting a bearing, if a caught feeling is felt, remove the bearing immediately and confirm the bearing temperature. If the bearing temperature is not yet 100°C to 110°C, immerse the bearing again in the oil tank until it rises to 100°C to 110°C. Then, insert and adjust the bearing to the center of the shaft. If insertion is forced beyond when the bearing is felt to be caught, then the bearing may get stuck on the shaft. Not only regular mounting becomes impossible but also removal becomes difficult.

**b) Bearing heater method (Fig. 6.6)**

Shaft shape: Cylindrical shaft

Bearing inner ring bore shape: Cylindrical bore

Procedure

1. For the heating method using a bearing heater, follow the instructions described in its Operation Manual for heating method and time.
2. For heating with a bearing heater too, the bearing temperature shall be within the range of 100°C to 110°C. However, the temperature to heat the bearing shall not exceed 120°C.
3. Clean the surface of shaft with cleaning oil to remove any dirt.
4. When the bearing temperature attains 100°C to 110°C, while wearing heat insulating gloves, take the bearing out from the bearing heater, then, insert and adjust the bearing to the center of the shaft. When inserting the bearing, if a caught feeling is felt, remove the bearing immediately and confirm the bearing temperature. If the bearing temperature is not yet 100°C to 110°C, heat it again with the bearing heater until it rises to 100°C to 110°C and then insert and adjust the bearing to the center of the shaft. (If insertion is forced beyond when a caught feeling is felt, the bearing may become stuck on the shaft. Thus, not only regular mounting becomes impossible but also removal becomes difficult.)
5. After mounting the bearing, apply lubricant to it and cover with vinyl sheet to prevent entry of dust.

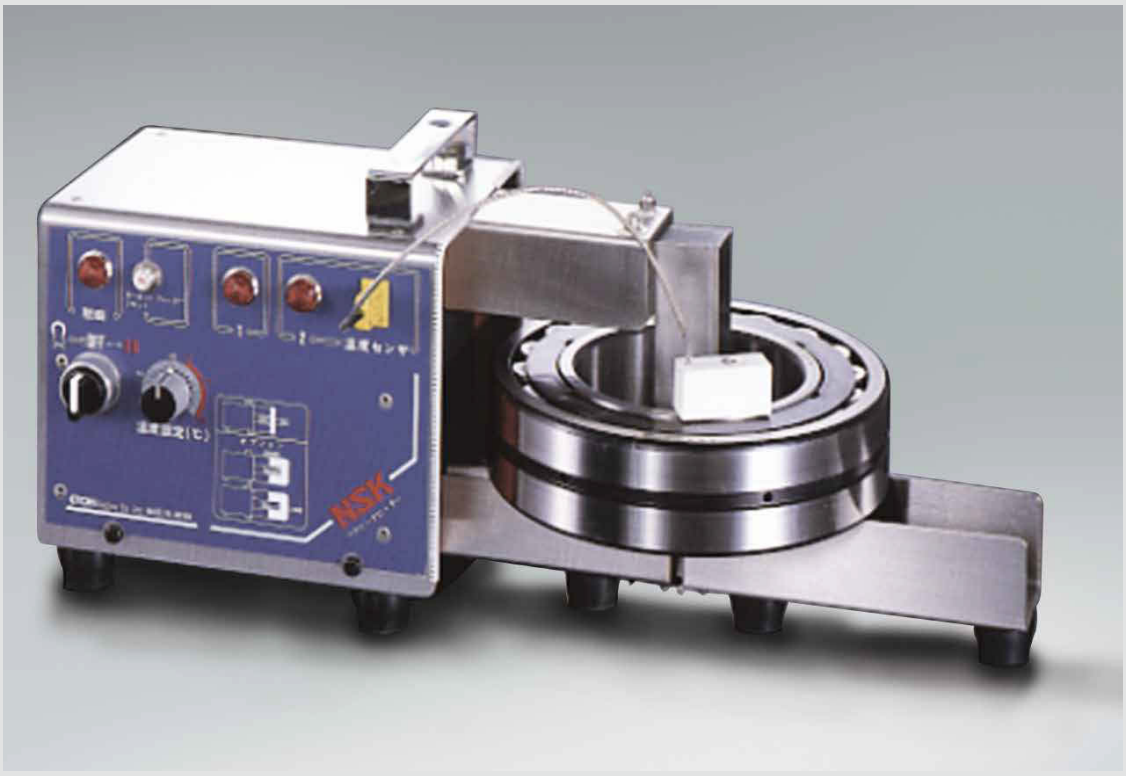



**Fig. 6.6 NSK Bearing Heater**

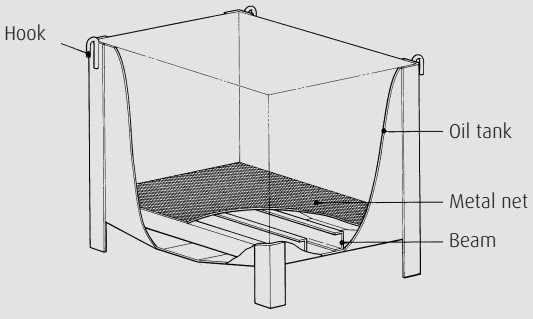



**Fig. 6.4 Structure of oil heating tank**

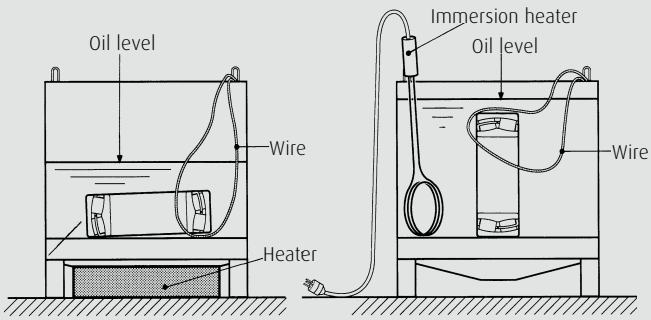



**Fig. 6.5 Heating method**

# 6. Bearing Mounting

### 6.2.4 When an Adapter Is Used

- As for shaft types, there are straight shafts without shoulder, shafts with shoulder on which a spacer ring is mounted or not mounted.
- As for adapter sleeves, there are sleeves with and without oil holes (oil duct).

**a) Lock nut method (Fig. 6.7 to Fig. 6.10)**

Shaft shape: Cylindrical shaft

Bearing inner ring bore shape: Tapered bore

Procedure

1. Unpack the adapter while wearing clean thin rubber gloves. Put it upright on the surface plate and remove the lock nut mounted on the adapter.
2. Clean the surface of shaft with clean cleaning oil to remove dirt.
3. For the shaft with shoulder (**Fig. 6.7 and Fig. 6.8**), if a spacer ring is needed, mount it.
4. Mount the adapter sleeve so that its thread comes to the shaft end side. When a spacer ring is needed, insert the adapter sleeve into a bore of shoulder of spacer ring, then, mount. For straight shaft without shoulder **(Fig. 6.9 and Fig. 6.10**), mount the adapter ring into the bearing mount span position so that its center is on top near the center of the bearing. To mount the adapter sleeve on the shaft, it is made easier by widening a little the slit of adapter sleeve by putting screw driver or chisel into the slit.
5. After mounting the adapter sleeve, adjust the direction of tapered bore of bearing inner ring to the taper of adapter sleeve and mount the bearing into the adapter sleeve. For a shaft with shoulder and equipped with a spacer ring, mount by letting the inner ring bore end face contact the spacer ring end face.
6. Mount the lock nut on the adapter sleeve. Advance the lock nut with the special wrench until it touches the bearing inner ring end face.
7. From the position where the lock nut touches the bearing inner ring end face, with the special wrench, turn further the lock nut and stop at once when the turning torque of special wrench increases.

For a straight shaft without shoulder, back off the lock nut a little, adjust the position by moving the adapter sleeve to the bearing mounting span position so that the bearing's center comes to it. After position adjustment, turn again the lock nut, and stop at once when the special wrench's turning torque increases. (From this point in time, the clearance adjustment to secure "clearance" necessary to run the bearing starts. Follow the instructions given in Section 4 "Clearance Adjustment When Mounting Bearing on Tapered Shaft or Sleeve".)

8. Measure the bearing internal clearance and record the measured clearance value. (The clearance measured at that time is called "Measured initial clearance").
9. Find the nominal bore and clearance symbol of the bearing being mounted, then confirm the radial internal clearance reduction amount (specified value) listed in **Table 4.2.**
   - When the bearing radial internal clearance is CN clearance (normal clearance) as the specified value, then aim for the middle value between the minimum and maximum clearance reduction amount.
   - When the bearing radial internal clearance is C3 or C4 as the specified value, then the maximum clearance reduction amount shall be aimed at.
10. Turn the lock nut, repeat the operation until the radial internal clearance varies. When the radial internal clearance value starts to vary, record the bearing internal clearance measured at that time. Here, calculate the difference between the measured initial value and this measured value. If the obtained difference is less than the specified value, repeat this operation until the specified value is obtained.

11. When the specified value is obtained, prevent turn of lock nut by using either a lock-washer or lock plate. When a lock-washer is used, follow the instructions given in Section 2.3.5 3) (2) "Method to use lock-washer when mounting bearing". When a stopper for nut is used, adjust the stopper for nut so that the cutout on outside of lock nut mates with the slit of adapter sleeve and insert, then, fix the stopper for nut with the washer and bolt.
12. Upon accomplishment of turning prevention, measure again the bearing internal clearance to confirm that the specified value remains secured.
13. After mounting the bearing, apply lubricant to it and cover with vinyl sheet to prevent entry of dust.

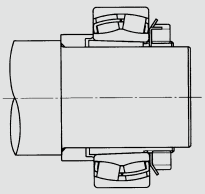


**Fig. 6.7 Assembly View**

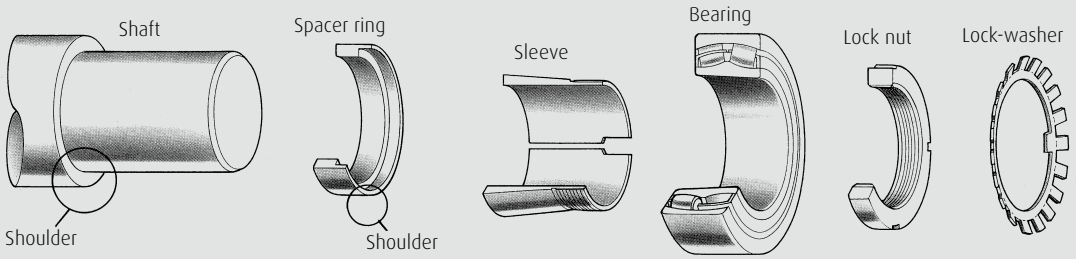



**Fig. 6.8 Method to use lock nut**

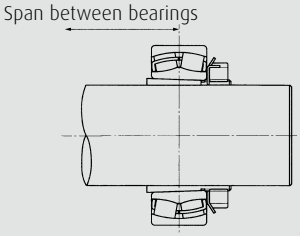



**Fig. 6.9 Assembly View**

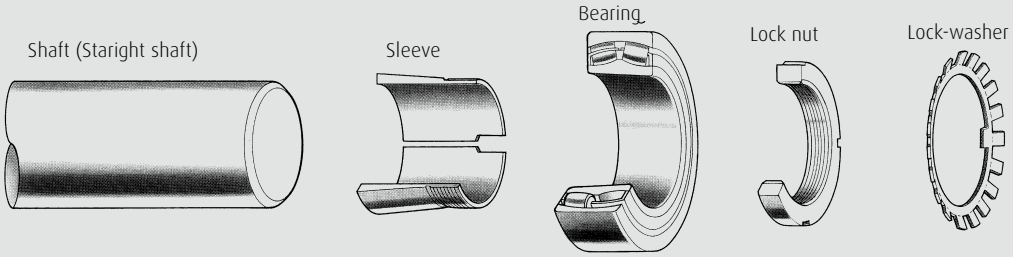



**Fig. 6.10 Method to use lock nut**

**b) Hydraulic nut method (Fig. 6.11 and Fig. 6.12)**
Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

After execution of Step 1 to 5 of the Procedure in Section 6.2.4 1) Lock nut method, follow the instruction given below.

Procedure

6. Mount the hydraulic nut to thread of adapter after adjusting the side face of piston side to the bearing inner ring end face. At that time, confirm that the piston is at position just prior to act.
7. Connect the hose of oil injection pump to the hydraulic nut.
8. Press down gently the oil injection pump lever to apply hydraulic oil pressure gradually. When change in the force to press the lever is felt (when an oil gauge is equipped, observe the value indicated by oil pressure gauge), stop at once the pressing and measure the bearing internal clearance ("Measured initial clearance") and record it.

(From this point in time, the clearance adjustment to secure the necessary "clearance" to run the bearing starts. Follow the instructions given in Section 4 "Clearance Adjustment When Mounting Bearing on Tapered Shaft or Sleeve".)

9. Find the nominal bore and clearance symbol of the bearing being mounted, then confirm the radial internal clearance reduction amount (specified value) listed in **Table 4.2**. When the bearing radial internal clearance is CN clearance (normal clearance) as the specified value, then aim for the middle value between the minimum and maximum clearance reduction amount. When the bearing radial internal clearance is C3 or C4 as the specified value, then aim for the maximum clearance reduction amount.
10. Press again gently the lever of oil injection pump, repeat the operation until the radial internal clearance varies. When the radial internal clearance value starts to vary, record the bearing internal clearance measured at that time, then, calculate the difference between the measured initial value and this measured value. If the obtained difference is less than the specified value, push the bearing into the sleeve with a hydraulic nut, stop at once the pump and measure the bearing internal clearance to confirm the clearance reduction amount, and repeat this operation until the specified value is obtained.

When the clearance reduction amount becomes close to its minimum or maximum value, feed the hydraulic nut a little to obtain the specified value. Pay attention not to exceed the specified value by excessive feed of the hydraulic nut.
(If the clearance reduction amount exceeds the specified value, it may cause too big an interference or too small a clearance which results in breakage of bearing inner ring and finally abnormal temperature rises or seizure may happen during bearing running.)

To measure the clearance for the confirmation of the specified value, at first drop the hydraulic oil pressure to zero, then, measure.

11. When the specified value is obtained, disconnect the oil injection pump hose and remove the hydraulic nut.
12. Mount the lock nut and fix its turning stopper. When a lock plate is used, adjust the lock plate so that the cutout on outside of lock nut mates with the slit of adapter ring and insert, then, fix the lock plate with the washer and bolt. When a washer is used, follow the instructions given in Section 2.3.5 3) (2) Method to use washer when mounting bearing".
13. Upon accomplishment of turning prevention, measure again the bearing internal clearance to confirm that the specified value remains secured.
14. After mounting the bearing, apply lubricant to it and cover with vinyl sheet to prevent entry of dust.

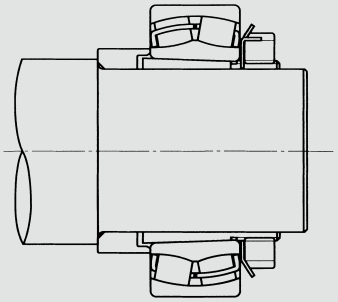


**Fig. 6.11 Assembly view**

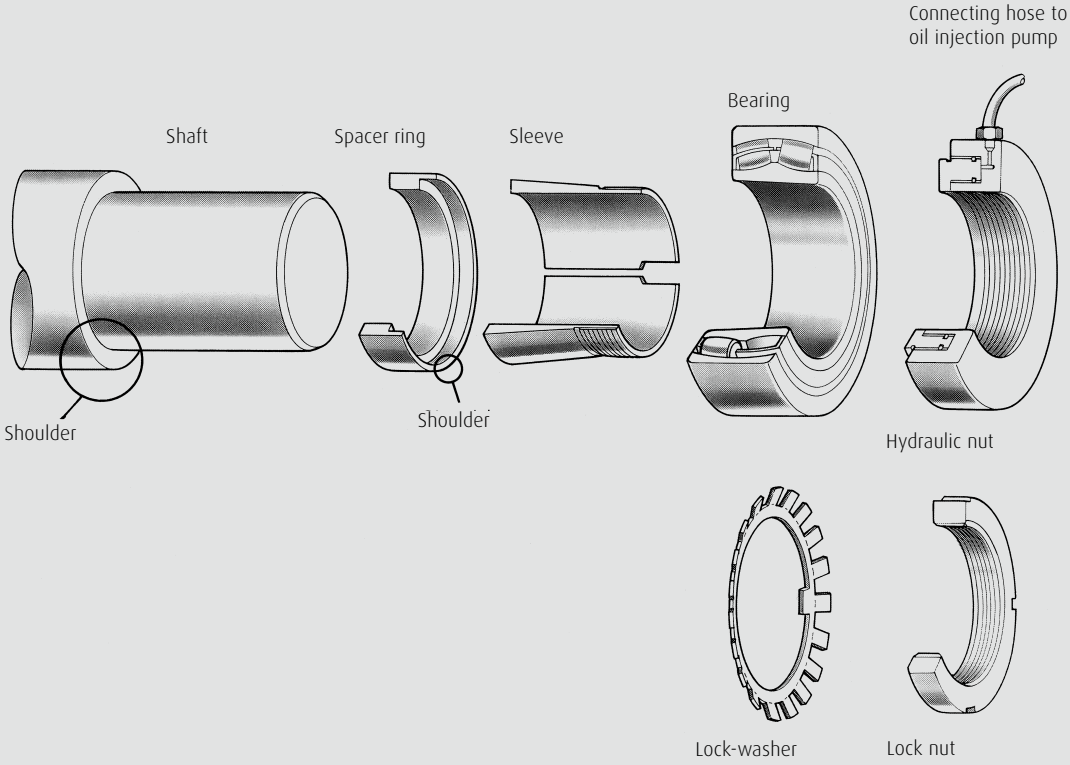



**Fig. 6.12 Hydraulic nut method**

**c) Oil injection method (Fig. 6.13 and Fig. 6.14)**
When oil hole (oil duct) is provided on adapter sleeve

Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

Among the adapter sleeves, there are some that have oil holes (oil duct). (**Fig. 2.3**) Their purpose is to make easier the bearing mounting/dismounting operation.
The method is to inject high pressure oil to the oil hole (oil duct) of adapter sleeve when mounting or dismounting the bearing. To execute large bearing mounting by the above said Section 6.2.4 1) "Lock nut method", insert the bearing into the adapter sleeve mounted on the shaft and push the bearing in with the lock nut. To adjust the clearance, when turning the lock nut, it is necessary to apply a big force by a special wrench.
To reduce the required turning torque, high pressure oil is fed between fitted face of adapter sleeve and bearing by connection of the oil injection pump hose to the oil hole (oil duct) of the adapter sleeve in order to reduce the torque necessary to turn the lock nut by reduction of friction at the fitted face and expansion of bearing inner ring.
As cautions for the bearing mounting operation, it is necessary to work with a closely fitted face between adapter sleeve and bearing. The reason is to prevent reduction in the effect of the high pressure oil due to leak from the fitted face.

Procedure
After execution of Step 1 to 10 of the Procedure in Section 6.2.4 1) Lock nut method, then execute the following steps.

1. Connect the oil injection pump hose to the oil hole (oil duct) of adapter sleeve. Start the pump, at the same time turn the lock nut with the special wrench and push the bearing into the adapter sleeve.
2. After insertion, measure the bearing internal clearance.
   When the radial internal clearance value varies, record that measured value and calculate the difference between the measured initial value and this value measured.
   If the obtained difference is less than the specified value, push the bearing into the sleeve by turning the lock nut with the special wrench while running the oil injection pump until the specified value is obtained. Then stop the pump and measure the bearing internal clearance to confirm the clearance reduction amount, and repeat this operation.
   As a caution for this operation, to measure the clearance for the confirmation of the specified value, at first drop the hydraulic oil pressure to zero, then, measure.
3. When the specified value is obtained, disconnect the oil injection pump hose from the hydraulic nut and stop turning of the lock nut.
   - When a lock plate is used.
     Adjust the lock plate so that the cutout on outside of the lock nut mates with the slit of adapter sleeve and insert the stopper for nut, then, fix the lock plate with the washer and bolt.
   - When a lock-washer is used
     (For more detail, follow the instructions given in Section 2.3.5 3) (2) "Method to use lock-washer when mounting bearing".)
     Remove at once the lock nut and place the lock-washer's tongue into the slit of the shaft key way to push in, then, place the lock nut and adjust the washer's tooth into the slit on outside of lock nut and bend the tooth of washer into it to stop turning.
4. Upon accomplishment of turning prevention, measure again the bearing internal clearance to confirm that the specified value remains secured.
5. After mounting the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

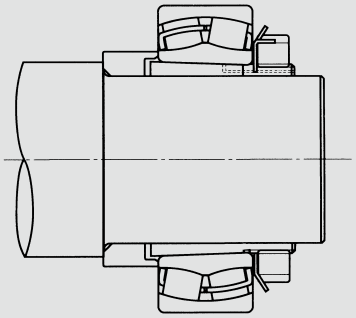


**Fig. 6.13 Assembly view**

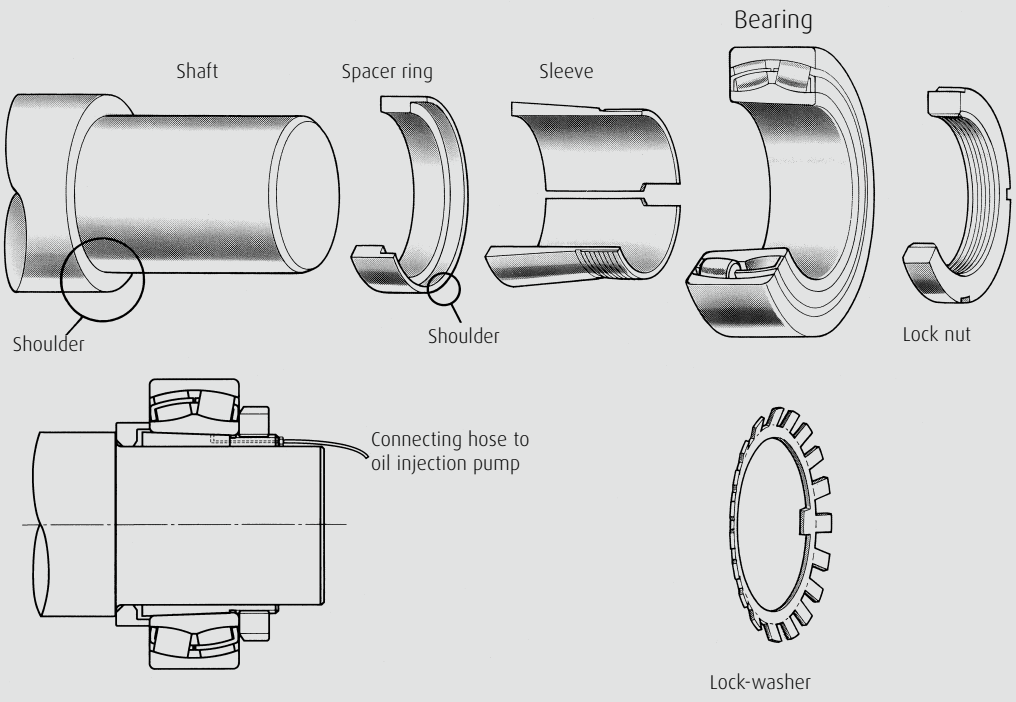



**Fig. 6.14 Oil injection pump method**

# 6. Bearing Mounting

**6.2.5 When Using Removable Sleeve**
**a) Lock nut method (Fig. 6.15 and Fig. 6.16)**
Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

Procedure
1. Unpack the removable sleeve, and while wearing clean thin rubber gloves, remove the anticorrosion oil applied onto the removable sleeve with clean cleaning oil.
2. Clean the surface of shaft with clean cleaning oil to remove dirt.
3. For the shaft with shoulder, if a spacer ring is needed, mount it.
4. Insert the bearing putting the larger diameter side of inner ring tapered bore to the shaft end side and push in until the inner ring end face touches the shaft shoulder or spacer ring end face.
5. Put the removable sleeve so that its thread comes to the shaft end side then insert it as close as possible to the bearing after adjusting it to the bearing inner ring tapered bore. When inserting the removable sleeve into the bearing, adjust the bearing side so that the top end of the removable sleeve does not hit too strongly against the bearing inner ring end face.
6. Mount the lock nut on the shaft and fix it to the place where the lock nut end face touches the removable sleeve end face.
7. Turn slowly the lock nut with a special wrench to insert the removable sleeve into the bearing. Immediately, stop the feeding of the lock nut when the special wrench's turning torque changes, and measure the bearing internal clearance ("Measured initial clearance") and record it. (From this point in time, follow the instructions in Section 4 "Clearance Adjustment When Mounting Bearing on Tapered Shaft or Sleeve".)
8. Find the nominal bore and clearance symbol of the bearing being mounted, then confirm the radial internal clearance reduction amount listed in **Table 4.2.**
   When the bearing radial internal clearance is CN clearance (normal clearance), aim the radial internal clearance reduction amount (specified value) for the middle value between minimum and maximum clearance reduction amount. When the bearing radial internal clearance is C3, C4, then aim the specified value for the maximum clearance reduction amount.
9. Turn again slowly the lock nut to push the removable sleeve into the bearing and measure the bearing clearance. Repeat this operation until the bearing clearance starts to vary. When the bearing clearance value starts to vary, record the bearing internal clearance measured at that time and calculate the difference between the measured initial value and this measured value.
10. If the obtained difference is less than the specified value, continue to perform clearance adjustment until the specified value is obtained.
11. When the specified value is obtained, prevent turning of the lock nut using either a washer or stopper for nut.
    - When a lock plate is used
      Adjust the lock plate so that the cutout on outside of lock nut mates with the key groove of shaft and insert, then, fix the lock plate with the washer and bolt.
    - When a washer is used
      (Follow the instructions given in Section 2.3.5 3) (2) "Method to use washer when mounting bearing".)
      Remove the lock nut, insert the washer's tongue into the shaft key groove, remount the lock nut, then, bend one tooth of the washer into the cutout on the outside of lock nut to stop turning.
12. Upon accomplishment of turning prevention, measure again the bearing internal clearance to confirm that the specified value remains secured.
13. After mounting the bearing, apply lubricant to it and cover with vinyl sheet to prevent entry of dust.

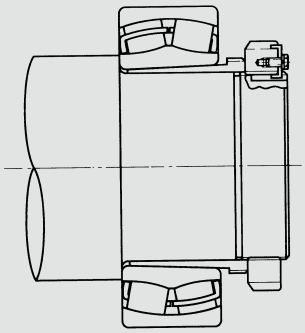


Fig. 6.15 Assembly view

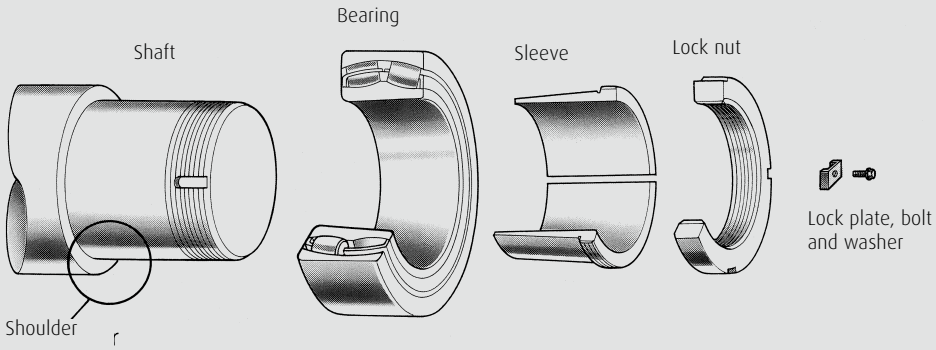



Fig. 6.16 Hydraulic nut method

**b) Hydraulic nut method (Fig. 6.17 and Fig. 6.18)**
Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

After execution of Steps 1 to 5 of the Procedure of the above Section 6.2.5 1) "Lock nut method" perform the following steps.

Procedure

1. Mount the hydraulic nut on the thread of shaft in placing the nut piston side end face to the sleeve end face. At that time, confirm that the piston is in the right position. (before operated)
2. Connect the oil injection pump hose to the hydraulic nut.
3. Press down gently the lever of oil injection pump to apply hydraulic oil pressure gradually. When there is a change in the force necessary to press the lever (when the oil gauge is equipped, observe the indicated oil pressure value), stop at once pressing and measure the bearing internal clearance ("Measured initial clearance") and record it. After recognizing the nominal bore and clearance symbol of the bearing being mounted, confirm the radial internal clearance reduction amount (specified value) listed in **Table 4.2.** When the bearing radial internal clearance is CN clearance (normal clearance), aim the radial internal clearance reduction amount (specified value) for the range between the minimum and maximum clearance reduction amount. When the bearing radial internal clearance is C3 or C4, aim the specified value for the maximum clearance reduction amount.
4. Press again gently the oil injection pump lever, repeat this operation until the radial internal clearance starts to vary. When the radial internal clearance value starts to vary, record the bearing internal clearance measured at that time. (From this point in time, follow the instructions of Section 4 "Clearance Adjustment When Mounting Bearing on Tapered Shaft or Sleeve".) Calculate the difference between the measured initial value and this measured value.
5. If the obtained difference is less than the specified value, repeat the clearance adjustment.
   When the clearance reduction amount becomes close to the specified value, feed the hydraulic nut a little to obtain the specified value. Pay attention not to exceed the specified value by excessive feed of the hydraulic nut.
   (If the clearance reduction amount exceeds the specified value, it may cause excess interference or too little clearance which results in breakage of the bearing inner ring and finally abnormal temperature rise or seizure may happen during bearing running.)
6. When the specified value is obtained, drop the hydraulic oil pressure to zero, then, after confirming again that the specified value remains constant, disconnect the hose of oil injection pump from the hydraulic nut and remove the lock nut.
7. Mount the lock nut on the thread of shaft and fix the removable sleeve, then, stop its turning.
   - When a lock plate is used
     After mounting the lock nut, insert the lock plate in the cutout on outside of lock nut and into the key groove of the shaft and fix the lock plate with the washer and bolt.
   - When a lock-washer is used
     Follow the instructions given in Section 2.3.5 3) (2) "Method to use washer when mounting bearing". Insert the washer's tongue into the shaft key groove, mount the lock nut, adjust the cutout on outside of lock nut to the tooth of washer, then, bend the tooth of washer to prevent turning.
8. Upon accomplishment of turning prevention, measure again the bearing internal clearance to confirm that the specified value remains constant.
9. After mounting the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

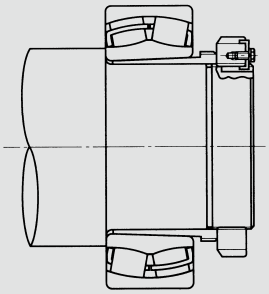


**Fig. 6.17 Assembly view**

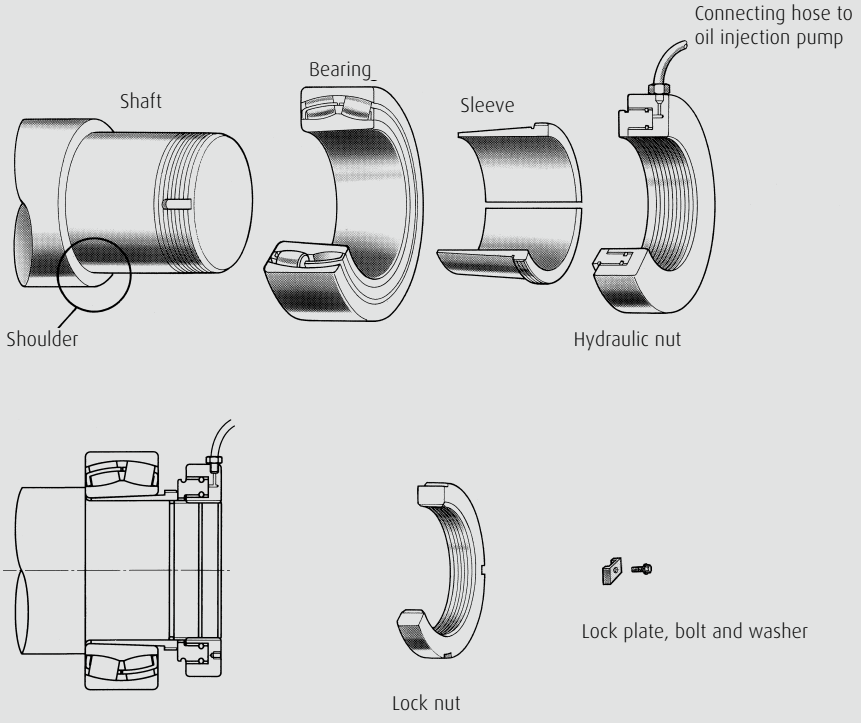



**Fig. 6.18 Hydraulic nut method**

**c) Oil injection method (Fig. 6.19 and Fig. 6.20)**
Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

On the end face of the removable sleeve, an oil hole (oil duct) is provided. The purpose is to make easier bearing mounting/dismounting by injecting high pressure oil to the oil hole (oil duct) of the removable sleeve when mounting or dismounting the bearing in reducing the friction on the fitted face of the bearing and shaft and expanding the bearing inner ring by high pressure oil. As for the method, high pressure oil is fed to the oil hole of the sleeve when mounting or dismounting the bearing.

As the method to fix the removable sleeve, use either an end plate or end cap. To fix this end plate or end cap, screw bolts into the screw holes that are provided on the shaft end. Therefore, mounting of washer or stopper for nut is not necessary. (When shaft nuts are mounted, direct mounting becomes impossible, since a lock nut covers the sleeve end face. For this reason, the use of an end plate or end cap is adopted to fix the sleeve.)

Clearance adjustment is performed by tightening mounting bolts to fix the end plate or end cap. When turning the mounting bolts, application of a big torque by the wrench is necessary.

To reduce the required turning torque, high pressure oil is fed between fitted faces of sleeve, bearing and shaft by connection of the oil injection pump hose to the oil hole (oil duct) of the removable sleeve (by reduction of friction on fitted faces and expansion of bearing inner ring with high pressure oil.)

Here we explain, as a representative example, about the removable sleeve. The side end face of the thread has an oil hole.

Procedure
Follow Steps 1 to 5 of the Procedure of the above Section 6.2.5 1) Lock nut method. Next, do the following steps.

1. To allow connection of the oil injection pump hose, adjust the cutout on external circumference of end plate or end cap to the oil hole on removable sleeve end face and mount the end plate or end cap on the shaft with fixing bolts.
   (If spring washers are used for fixing bolts, insert the spring washers.)
   To screw fixing bolts, it is important to tighten each bolt as equally as possible. At first, tighten provisionally and evenly all the fixing bolts. And choose a bolt at random and tighten it until turning torque of wrench becomes a little heavier, then, tighten another bolt opposite to it to the same degree of tightness. Upon tightening accomplishment of the opposite bolt, tighten other bolts at a nearly perpendicular position or nearly opposite to the same degree of tightness.
2. Upon accomplishment of even tightening of all the bolts, measure the bearing internal clearance and record the "Measured initial clearance".
3. Tighten again evenly all the bolts and push the removable sleeve into the bearing. Then, measure the bearing internal clearance. Repeat this operation until the bearing internal clearance starts to vary.
4. When the bearing internal clearance starts to vary, record the clearance value measured at that time.
5. Connect the oil injection pump hose to the oil hole (oil duct) on the sleeve.
6. Find the "nominal bore and clearance symbol" of the bearing, then confirm the radial internal clearance reduction amount (specified value) listed in **Table 4.2**. When the bearing radial internal clearance is CN clearance (normal clearance) as the specified value, then aim for the middle value between the minimum and maximum clearance reduction amount. When the bearing radial internal clearance is C3 of C4 as the specified value,

then aim for the maximum clearance reduction amount. Calculate the difference between the measured initial clearance and the clearance measured in Step 4. If the obtained difference is less than the specified value, while running the oil injection pump and at the same time, turn the fixing bolts, push the bearing and into the removable sleeve and measure the bearing internal clearance until the specified value is attained.

7. When the specified value is obtained, reduce the oil pressure of the oil injection pump to zero and measure again the clearance to confirm that the specified value is obtained, then, disconnect the oil injection pump hose.
8. If fixing bolt has a hole in its head to stop turning, pass the wire through this hole to stop bolt turning.
9. After mounting the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

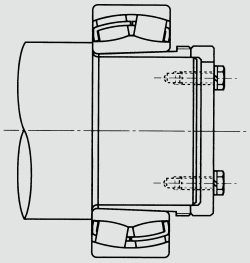


**Fig. 6.19 Assembly view**

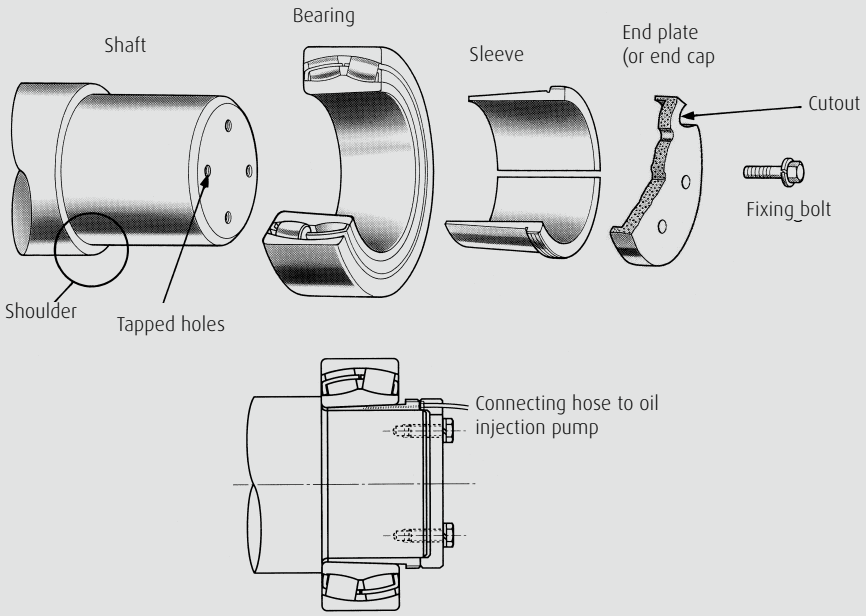



**Fig. 6.20 Oil injection method**

# 6. Bearing Mounting

**6.2.6 When Mounting a Bearing Directly on Tapered Shaft**
**a) Lock nut method (Fig. 6.21 and Fig. 6.22)**
Shaft shape: Tapered shaft
(including the case where the oil hole (oil duct)
is provided on the shaft)
Bearing inner ring bore shape: Tapered bore

Procedure
1. Clean the surface of shaft with clean cleaning oil to remove dirt.
2. Insert the bearing while adjusting its inner ring bore taper to the shaft and mount it so that the bearing is placed as close as possible against the shaft. (For shaft having shoulder and when it requires a spacer, at first mount the bearing without inserting the spacer.)
3. Mount the lock nut to the position where it touches the bearing inner ring end face.
4. Turn the lock nut with the special wrench, when increase in turning torque is felt, measure the bearing internal clearance and record the measured initial clearance. Turn again the special wrench then measure the bearing internal clearance. Repeat this operation until the measured initial clearance value starts to vary. When a change in clearance appears, measure that value and calculate the difference between the measured initial clearance value and that value measured. Read the corresponding bearing clearance reduction amount (specified value) from **Table 4.2.** If the corresponding bearing clearance reduction amount is not yet attained, turn further the lock nut and repeat the clearance adjustment until the specified value is obtained.
5. When the specified value is obtained

(a) In case of no spacer ring (**Fig. 6.21 and Fig. 6.22**)
- › To use stopper for nut as a turning stopper Adjust the cutout on outside of lock nut to the key groove of shaft. Insert the stopper for nut to this position and fix it with the washer and bolt.
- › To use the washer as turning stopper of lock nut (For more detail, follow the instructions given in Section 2.3.5 3) (2) "Method to use washer when mounting bearing".)

Remove the lock nut temporarily, and place the washer's tongue into the slit of the shaft key way to push in, then place the lock nut and adjust the washer's tooth into the slit on outside of lock nut and bend the tooth of washer into it to stop turning. Measure the bearing internal clearance and confirm the specified value.
After mounting of the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

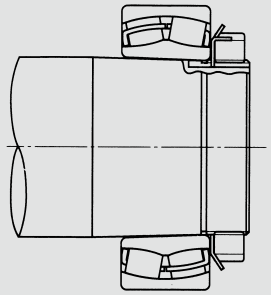


**Fig. 6.21 Assembly view (without spacer ring)**

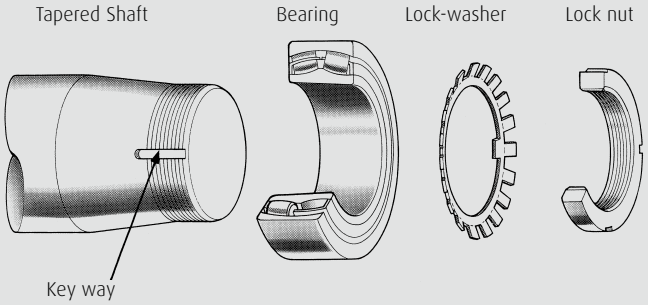



**Fig. 6.22 Method to use lock nut**

(b) When a spacer ring is used (**Fig. 6.23 and Fig. 6.24**)
Measure the distance ($L_0$) between the end face of shaft shoulder and bearing inner ring end face at each position on the circumference which is equally divided into 8 pitches. Next, calculate the mathematical mean value of the measured dimensions. Now, measure the width of the spacer ring at each of the same eight equal-pitch positions. Next, calculate the mathematical mean value of the spacer ring width. And compare the mathematical mean value of the above distance and that of spacer ring width. If the mathematical mean value of the measured spacer ring width is the same as that of the distance between the end face of shaft shoulder and bearing inner ring end face, use them as they are. If the mathematical mean value of measured spacer ring width is larger than that of distance between the end face of shaft shoulder and the bearing inner ring end face, at first machine the spacer ring to reduce its width till attaining the mean value, then, use the machined spacer ring. If the mathematical mean value of the measured spacer ring width is smaller than that of distance between the end face of shaft shoulder and bearing inner ring end face, such a spacer ring cannot be used. Prepare a new spacer ring with a size that is equal to the mean value of the distance.

After confirming the status of the spacer ring, perform the following steps.

6. Remove the lock nut.
7. After removal of the bearing, mount the spacer ring.
8. Here, perform the following operation regarding the method to stop turning of the lock nut.
   - When using a lock plate
     Mount the bearing, lock nut. Fix securely the bearing with the lock nut. At that time, adjust the cutout on lock nut outside to the key groove of shaft. Insert the lock plate to that position and fix it with the washer and bolt.
   - When using a lock-washer
     Mount the bearing, washer and lock nut. Insert the washer tongue into the key groove of shaft and mount the lock nut. At that time adjust the cutout on lock nut outside to any one of teeth of washer. Bend the tooth of washer into the cutout on lock nut outside to stop turning of lock nut.
9. After mounting of the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

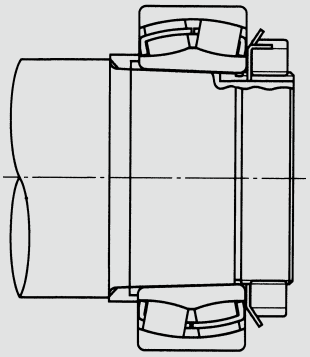


**Fig. 6.23 Assembly view (with spacer ring)**

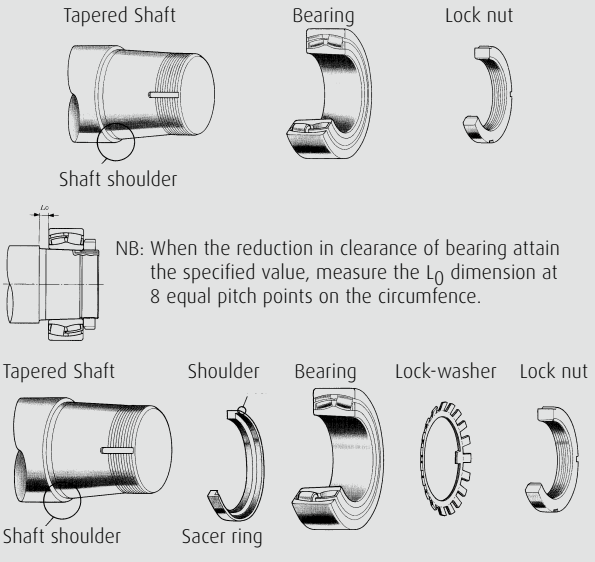



**Fig. 6.24 Cases with spacer ring**

# 6. Bearing Mounting

**b) Hydraulic nut method (Fig. 6.25 and Fig. 6.26)**
Shaft shape: Tapered shaft
(including the case where oil hole
(oil duct) is provided on the shaft)
Bearing inner ring bore shape: Tapered bore

Procedure

1. Clean the surface of shaft with clean cleaning oil to remove dirt.
2. Insert the bearing while adjusting its inner ring bore taper to the shaft and mount it so that the bearing is placed as close as possible against the shaft.
3. Mount the hydraulic nut to the thread of shaft so that its piston side contacts the bearing inner ring end face.
4. Connect the hose of the oil injection pump to the hydraulic nut.
5. Start the oil injection pump, and when a change in the force necessary to press the pump lever is felt (when the hydraulic oil pressure rises), stop it at once, and measure the bearing internal clearance ("Measured initial clearance") then, record it.
6. Repeat this operation until the measured initial clearance value starts to vary. When change of clearance appears, measure that value and record it.
7. Calculate this difference between the measured initial clearance value and this measured value. Then, confirm the corresponding reduction in clearance (specified value) referring to **Table 4.2**.
8. Repeat this operation until the specified value is obtained.
9. When the specified value is obtained, stop the oil injection pump to reduce hydraulic oil pressure to zero and confirm again that the clearance is at the specified value.
10. Disconnect oil injection pump hose, then, remove the hydraulic nut.
11. Mount the lock nut and stop its turning.
    - › When using a lock plate as a turning stopper of a lock nut Mount the lock nut and tighten the bearing with a lock nut. At that time adjust the cutout on outside of lock nut to the key groove of shaft. Insert the stopper for nut to this position and fix it with the washer and bolt.
    - › When using a lock-washer as a turning stopper of lock nut Insert the washer's tongue into the shaft key groove and mount the bearing with the lock nut. At that time, adjust the cutout on outside of lock nut to any one of teeth of washer. Bend the tooth of washer into the cutout on outside of lock nut in order to stop its turning.
12. After mounting of the bearing, apply lubricant to it and cover with a vinyl sheet to prevent entry of dust.

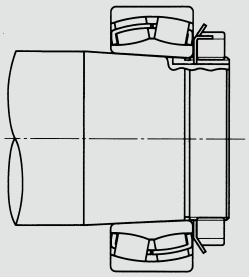


**Fig. 6.25 Assembly view**

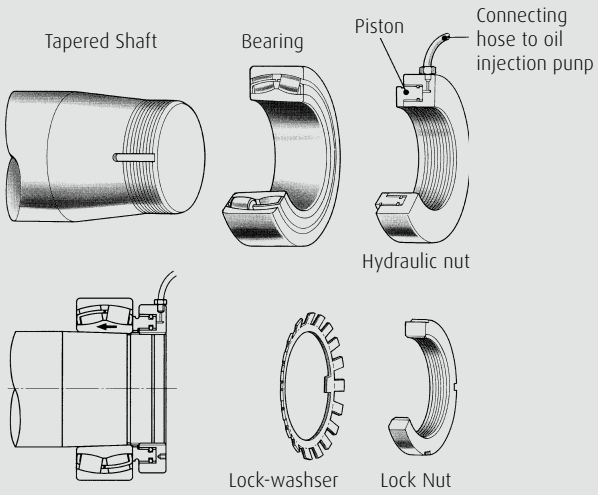



**Fig. 6.22 Method to use hydraulic nut**

# 7. Dismounting the Bearing

## 7.1 Procedure for Bearing Dismounting

The bearing dismounting operation is basically the reversed sequence of the mounting operation.
But compared to the mounting operation, due to changes that occur in the used bearing as a fitted part, a much bigger force is required to dismount it. For this reason, it is very important to examine beforehand the procedure and to prepare the necessary jigs and tools. It is also important to ask the machine manufacturer for advice on how to dismount the bearing from the machine.
As for the bearing dismounting operation, the dismount starts from the respective state listed in **Table 5.2** "Bearing mounting operation" of Section 5 "Quick Reference for Bearing Mounting/Dismounting Operation Method".

(a) Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore

(b) Shaft shape: Cylindrical shaft using sleeve (adapter, removable)
Bearing inner ring bore shape: Tapered bore

(c) Shaft shape: Tapered shaft
Bearing inner ring bore shape: Tapered bore

Comfirm the state of the bearing to be dismounted. Prepare the necessary jigs and tools. When ready, start the dismounting operation.

## 7.2 How to Disassemble the Bearing

For the method using the commonly used special puller (**Fig. 7.1**) among the dismounting jigs and tools, refer to **Fig. 7.2**. The structure of the special puller consists of * main face plate with push-in bolt, split face plates, mounting frame and 4 bolts and nuts as shown in the said Figure.
(* Sometimes the hydraulic jack driving force is used after mounting the hydraulic jack between the shaft and main face plate instead of using a push-in bolt.)

The basic procedure is as follows:

1. Insert the mounting frame after fixing 4 bolts to the back side of bearing (opposite side of shaft end).
   (To do so, the diameter of the part on which split face plates are mounted shall be larger than the outside diameter of the bearing to be dismounted.) (**Fig. 7.2 (a)**)
2. Mount each split face plate between mounting frame and bearing. At first apply the end face of protruded part on bore of split face plates to the bearing inner ring end face, connect the shaft with 2 split face plates. (**Fig. 7.2 (b), (c)**)
   For the bearing mounted with spacer ring, place the protruded part's end face on the split face plate's bore against the spacer ring end face that is opposite to the shaft end side, and connect the shaft with the 2-split face plates.
3. Mount the split face plates on the mounting frame. (**Fig. 7.2 (d)**)
4. Pass 4 bolts through the main face plate and mount nuts. (**Fig. 7.2 (e)**)
5. Set the push-in bolt of main face plate to the center of shaft, and turn gently the 4 nuts so that the main face plate becomes parallel with the mounting frame. (**Fig. 7.2 (e)**)
6. Turn the push-in bolt. When a big change in the turning torque is felt, the bearing starts to move, continue the operation to remove the bearing.
   (When the bearing is removed from the shaft, split face plates may fall, so pay attention to avoid this problem.)
7. Remove the special puller and remove the bearing.
8. Clean the surface of shaft from which the bearing is removed to remove dirt and apply anticorrosion oil to it.

# 7. Dismounting the Bearing

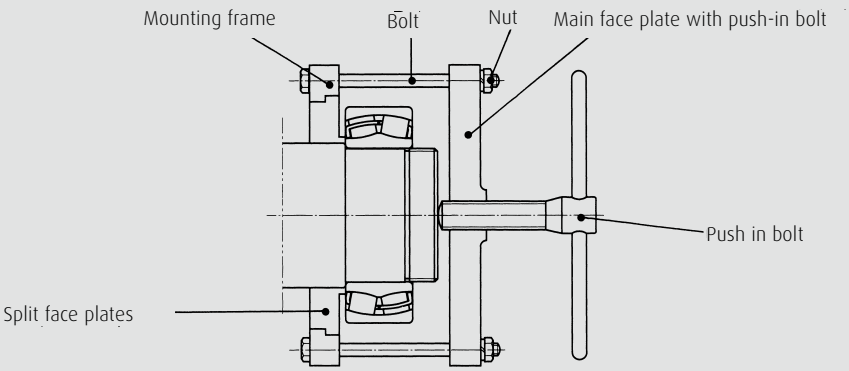
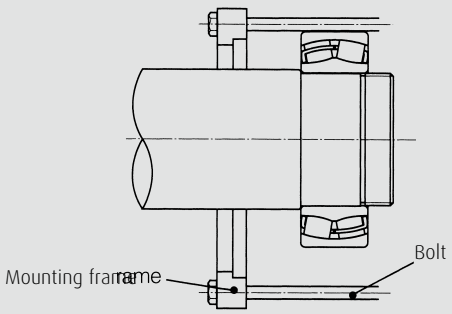
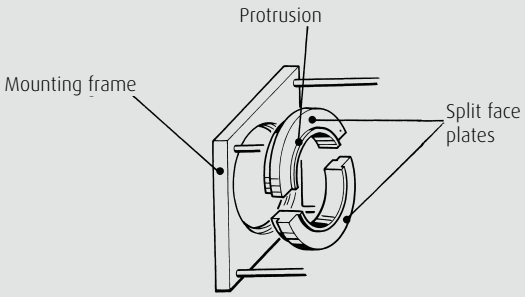


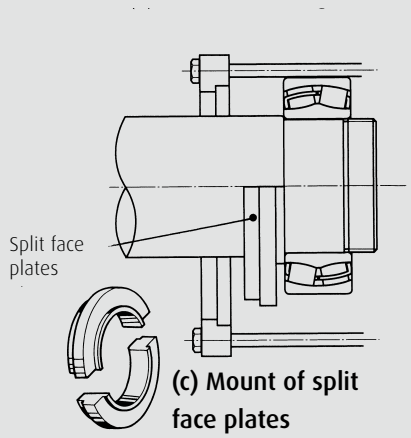

**Fig. 7.1 Setting of special puller**



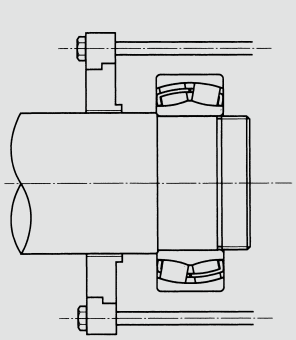

**(a) Mount of mounting frame and bolt**



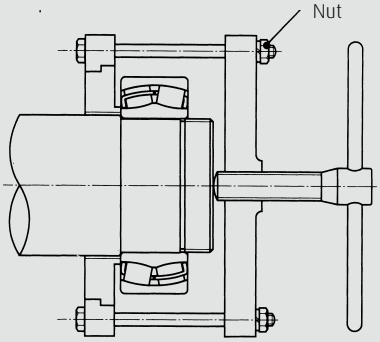

**(b) Mounting frame and split face plates**




**(c) Mount of split face plates**



**(d) Mount of split face plates**




**(e) Mount of main face plate with push-in bolt**

**Fig. 7.2 Special puller method**

### 7.2.1 How to Use the Special Puller (Fig. 7.3)

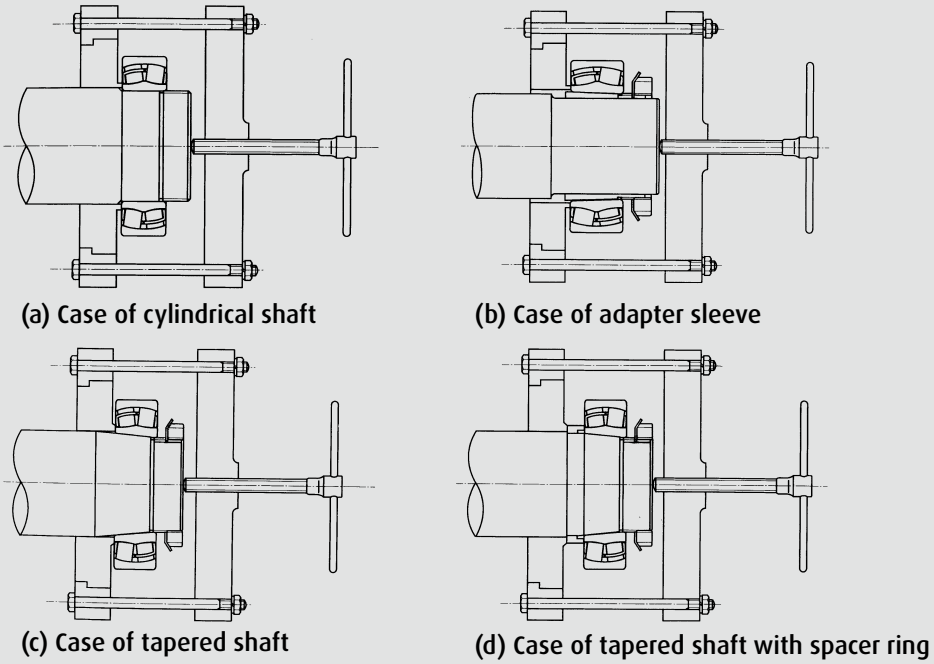
When the bearing mounted condition is as follows, a method using a special puller is adopted.

(a) Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore
(b) Shaft shape: Cylindrical shaft using an adapter sleeve
Bearing inner ring bore shape: Tapered bore
(c) Shaft shape: Tapered shaft
Bearing inner ring bore shape: Tapered bore

In the above cases, start the operation after having removed the turning stopper for the shaft lock nut and adapter sleeve lock nut to allow loosening of the lock nut.

In case of (a)
After removal of the lock nut, mount the special puller, then, turn the push-in bolt to dismount the bearing.
(Remarks: For big bearings, the main plate without a push-in bolt is used. Instead, mount a hydraulic jack between the main face plate and bearing, operate it to dismount the bearing.)

In case of (b) or (c)
After loosening the lock nut of shaft or that of adapter sleeve, return till 1/2 long of thread of shaft or adapter sleeve. (This step is to prevent the bearing falling off from the shaft when it is pulled out by the special puller)
Then, mount the special puller, turn the push-in bolt to separate the bearing inner ring from the adapter sleeve or from the shaft. After complete separation is confirmed, remove the special puller. Remove the lock nut of shaft or that of adapter sleeve, then remove the bearing. The remaining adapter sleeve shall be removed after widening the slit with a screw driver, etc. Also, after cleaning the lock nut, adapter sleeve and shaft, be sure to apply an anticorrosive agent.



(a) Case of cylindrical shaft
(b) Case of adapter sleeve
(c) Case of tapered shaft
(d) Case of tapered shaft with spacer ring

**Fig. 7.3 Method to use special puller**

# 7. Dismounting the Bearing

### 7.2.2 Hammer Method (Fig. 7.4)

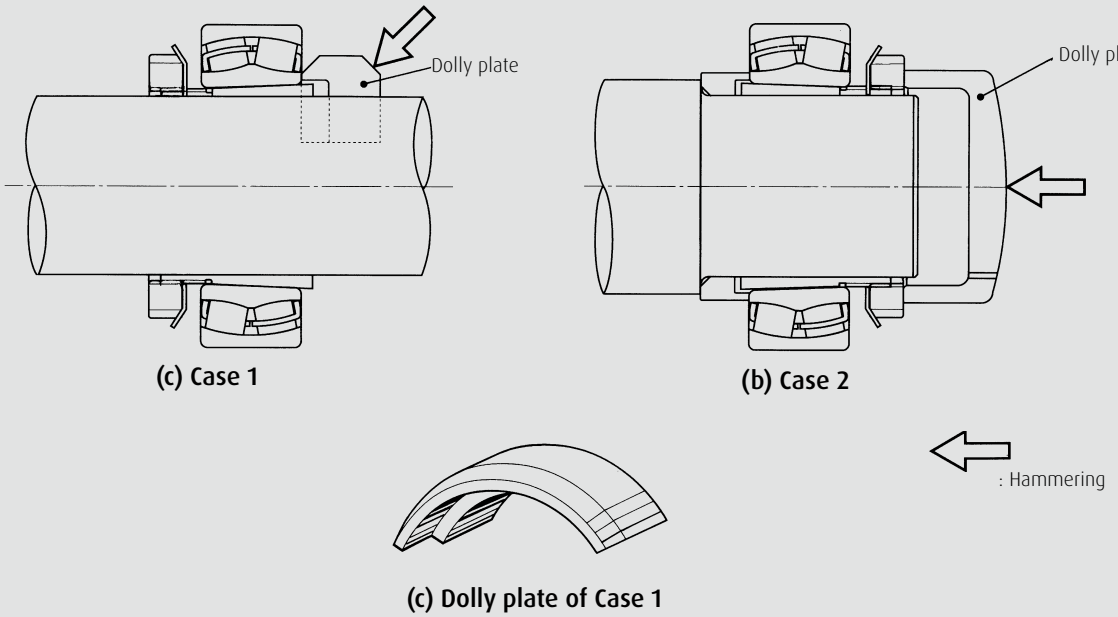
When the bearing mounted condition is as follows, a method that uses a hammer is adopted.

Shaft shape: Cylindrical shaft using adapter sleeve
Bearing inner ring bore shape: Tapered bore

This method applies a guide jig called a "dolly plate" to the end face of the larger bore diameter side of the bearing inner ring. Next, you hammer this dolly plate with a hammer to remove the bearing. This method is used for small bearings which have an inner ring bore that is smaller than 80 mm. It is recommended to use a dolly plate having an appropriate shape and size in the hammering operation. When a dolly plate is used, put it on the side face of the larger bore diameter side of the bearing inner ring, then, hammer it. It is most important that the dolly plate have a shape that ensures a close contact with the bearing side face even when it is hammered.

Procedure (Case 1: In case of straight shaft **Fig. 7.4 (a)**)

1. Remove the turning stopper of adapter sleeve lock nut and loosen once the lock nut till about one half of thread length of adapter sleeve, then, return a little.
2. Put the dolly plate on the end face of the bearing inner ring of the larger bore diameter side so that it is on the outside diameter of the adapter sleeve.
3. Hold the dolly plate by hand and contact it closely to the larger diameter side end face of bearing inner ring, then, hammer the dolly plate.
4. Even when no movement is observed on the bearing, at first hammer the dolly plate along the circumference of bearing inner ring while changing position of the dolly plate.
5. When hammering the circumference of bearing inner ring by one turn, increase hammering force and continue it in the same way.
6. After the displacement of bearing is confirmed, remove the lock nut and remove the bearing completely.




(c) Case 1

(b) Case 2

(c) Dolly plate of Case 1

**Fig. 7.4 Hammer method**

7. Remove the retaining adapter sleeve after widening its slit slightly by inserting a flat-head screw driver or the like.
8. After cleaning the lock nut, adapter sleeve and shaft, apply an anticorrosive agent.

Procedure (Case 2: When spacer ring is used **Fig. 7.4 (b)**)
1. Remove the turning stopper of the adapter sleeve lock nut and loosen the lock nut till about 1/2 of thread length of adapter sleeve, then, back it off a little.
2. Put the dolly plate on the seat face of the lock nut.
3. Hammer the center of the dolly plate to move the lock nut together with the adapter sleeve.
4. When the adapter sleeve starts to move together with the lock nut, hammer the dolly plate until the adapter ring touches the spacer ring.
5. Remove the lock nut and washer, then, remove the bearing.
6. Remove the retaining adapter sleeve after widening the slit slightly by inserting a flat-head screw driver. Finally remove the spacer ring.
7. After cleaning the lock nut, adapter sleeve and shaft, apply an anticorrosive agent.

### 7.2.3 Nut Method (Fig. 7.5)

The nut method is adopted when the bearing to be mounted is as follows:

Shaft shape: Cylindrical shaft using a removable sleeve
Bearing inner ring bore shape: Tapered bore

Procedure
1. Remove the turning stopper from the lock nut and remove the lock nut.
2. Mount the nut on the thread of the removable sleeve and advance it until it touches the bearing inner ring end face.
3. Turn the nut with a special wrench. When the turning torque of the wrench increases, then the movement of the removable sleeve starts. After a while, the turning torque of the wrench decreases. Confirm the separation of the bearing from the removable sleeve.
4. Remove the removable sleeve and remove the bearing.
5. Remove the lock nut, removable sleeve, shaft and nut. Clean them and apply an anticorrosive agent.

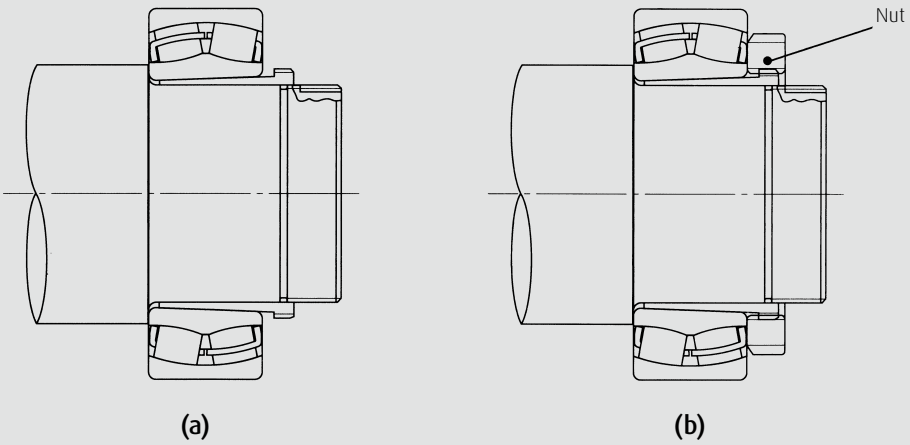



**Fig. 7.5 Nut method**

# 7. Dismounting the Bearing

**7.2.4 Press Method (Fig. 7.6)**

This method uses a press (hydraulic press, mechanical press, etc) instead of a special puller. As an example of a press (hydraulic press), see the photo in Subsection 2.1.1. of Section 2 "Bearing Handling Precautions". The basis of this method is to put a sustainer underneath the lower part of the bearing to sustain it on the table and then press the shaft side with the hydraulic ram in order to remove the bearing. Therefore, the shaft side is in a hung state when the bearing is held by the sustaining jig on the press table. At that time, secure space for the press pushing stroke between the lower side of hung shaft end and the press base.

Cautions when using a press

At first, check the shaft length on which bearing is to be mounted, because the distance between the table and the base of the press determines whether this method is a possible option.

To mount an integrated assembly of shaft with bearing, perform following operations:

(a) Mount correctly the bearing mounted part on the press table. To accomplish it, use an appropriate sustaining jig.
(b) Mount the integrated unit so that the shaft center mates exactly with the ram center.
(c) Make necessary arrangement beforehand to prevent shaft damage by dropping. For example, it could fall off when the bearing is separated from the shaft.

When the bearing mounted condition is as follows, the press method can be adopted.

(a) Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore
(b) Shaft shape: Cylindrical shaft using adapter sleeve
Bearing inner ring bore shape: Tapered bore
(c) Shaft shape: Tapered shaft
Bearing inner ring bore shape: Tapered bore

For case (a)

Procedure

1. Remove the turning stopper from the lock nut and loosen the lock nut, then, set the integrated assembly of shaft and bearing on the hydraulic press table. At that time, arrange so that the upper face of hydraulic press table comes underneath the bearing to be dismounted.
2. Insert the sustaining jig under the bearing.
3. After the integrated assembly of shaft and bearing are set up and hang down from the hydraulic press table onto the sustaining jig, adjust so that the shaft center mates with the ram center of hydraulic press by moving the sustaining jig. Also, secure the space for the press pushing stroke between the hung shaft end and the press base.
4. After confirming that the bearing sustaining jig touches the bearing inner ring end face closely, fix the bearing sustaining jig.
5. After removal of the lock nut, activate the hydraulic ram to push the shaft. After a while, when the shaft starts to move slowly, the shaft separates from the bearing. After removal of the bearing from the shaft, remove the shaft from the press.
6. After cleaning the lock nut and shaft, apply anticorrosion treatment.

Case (b) or (c)

Procedure

1. Remove the turning stopper from the lock nut of shaft or that of adapter sleeve and return it till about one half of thread length of shaft or adapter sleeve.
2. Mount the integrated assembly of shaft and bearing on the hydraulic press table. At that time, arrange so that the upper face of the hydraulic press table comes underneath the bearing to be removed.
3. Insert the sustaining jig under the bearing, when the spacer ring is used, insert the sustaining jig under it.
4. After the integrated assembly of shaft and bearing are set up and hang from the hydraulic press table on the

sustaining jig, adjust so that the shaft center mates with the ram center of hydraulic press by moving the sustaining jig. And secure space for the press pushing stroke betwenn the hung shaft end and the press base.

5. After confirming that the bearing sustaining jig touches the bearing inner ring end face closely, fix the bearing sustaining jig.
6. Activate the hydraulic ram to push the shaft. After a while, the shaft starts to move slowly, the shaft separates from the bearing. At that time when the shaft falls down as the lock nut is loosened, never touch the shaft or bearing while the press is working.
7. Remove the lock nut of shaft or that of adapter sleeve, then, remove the bearing from the shaft.
8. Remove the shaft from the press.
9. Remove the retaining sleeve after widening its slit slightly with a flat-head screw driver. If a spacer ring is used, remove it.
10. After cleaning the lock nut, adapter sleeve, spacer ring and shaft, apply an anticorrosive agent.

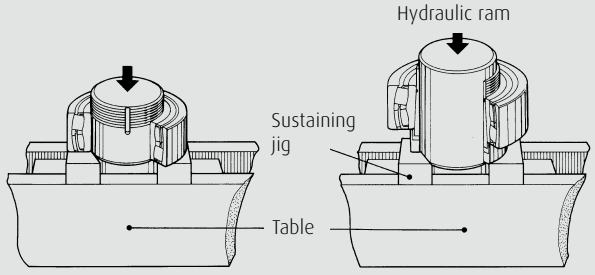
**7.2.5 Hydraulic Nut Method (Fig. 7.7)**

When the bearing mounted condition is as follows, the method to use hydraulic nut is adopted

Shaft shape: Cylindrical shaft using removable sleeve
Bearing inner ring bore shape: Tapered bore

Procedure

1. Remove the turning stopper from the lock nut and remove the lock nut.
2. Mount a hydraulic nut having a matching size with the thread of removable sleeve. At that time, confirm that the piston of hydraulic nut is at the position just prior to action. Mount it in with the piston side facing the bearing side, then, adjust the position so that the hydraulic nut piston end face touches the bearing inner ring end face.
3. Connect the hose of the oil injection pump to the hydraulic nut.
4. Start the oil injection pump. The piston end face of hydraulic nut starts to protrude to push the bearing inner ring end face. Then, a pop sound is produced when the bearing is separated from the removable sleeve.
5. After confirming that the bearing is separated from the removable sleeve, remove the injection oil pump hose and remove the hydraulic nut.
6. Remove the removable sleeve and remove the bearing.
7. After cleaning the lock nut, removable sleeve and shaft, apply an anticorrosive agent.




**(a) In case of cylindrical shaft** **(b) In case of adapter (with spacer)**

**Fig. 7.6 Method to use press**

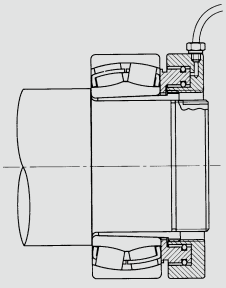


**Fig. 7.7 Method to use hydraulic nut**

# 7. Dismounting the Bearing

**7.2.6 Oil Injection Method (Fig. 7.8)**

When the bearing mounted condition is as follows, the method that uses an oil injection pump can be adopted.

(1) When the oil hole (oil duct) is provided on the shaft

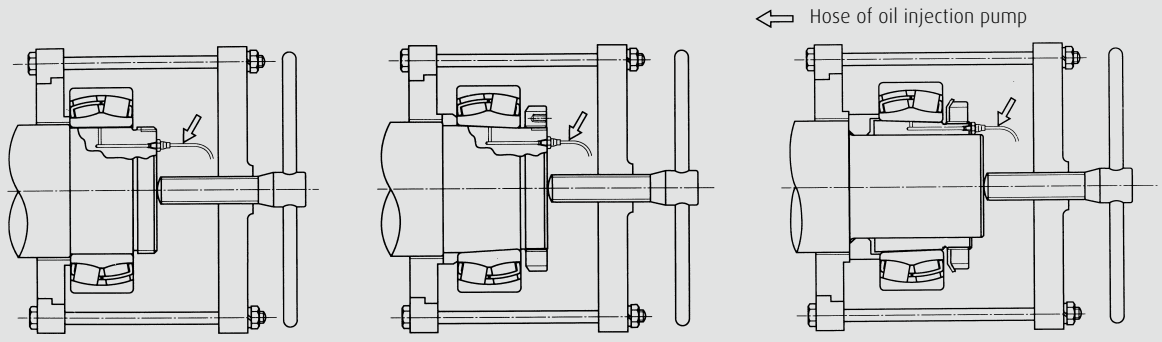
(a) Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Cylindrical bore

(b) Shaft shape: Tapered shaft
Bearing inner ring bore shape: Tapered bore

Procedure

1. Remove the turning stopper from the lock nut and remove the lock nut in case of the cylindrical shaft. (**Fig. 7.8 (a)**) In case of the tapered shaft (**Fig. 7.8 (b)**), return the nut until about 1/2 of thread length of lock nut mounting thread.
2. Mount the special puller. At that time, secure space around the shaft end to allow connection of oil injection pump hose to the oil hole of shaft.
3. Turn the push-in bolt, continue to turn until its turning torque increases.
4. Connect the hose of oil injection pump to the oil hole of shaft and make ready the pump for action.
5. Turn the push-in bolt until reaching a state where the turning torque constantly increases, then start the oil injection pump. After a while, either a sound is heard or hydraulic oil of pump starts to ooze out from the fitted part of shaft and bearing. When the state becomes such, turn the push-in bolt of the special puller and separate the bearing from the shaft. During this operation, let the pump continue to work. Prepare for the possibility of hydraulic oil oozing out from the fitted part of shaft and bearing, by placing an oil pan underneath to catch any dripping oil. (If hydraulic oil drops directly on the floor, it may create a safety hazard.)
6. In case of the cylindrical shaft, after removal of the hose of oil injection pump and special puller, remove the bearing. In case of the tapered shaft, after removal of the oil injection pump hose and special puller, remove the lock nut, then, remove the bearing.
7. After cleaning the lock nut and shaft, apply an anticorrosion treatment.

(2) When the oil hole (oil duct) is provided on the adapter sleeve




(a) Cylindrical shaft (with oil hole) (c) Tapered shaft (with oil hole) (c) Adapter sleeve (with oil hole)

**Fig. 7.8 Oil injection method**

Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

In the case of an adapter sleeve (**Fig. 7.8 (c)**), a special puller can be used jointly. Basically, perform the procedure of Section 7.2.1. "Special puller method" but with the only differences being the connection and action of the oil injection pump. The operation shall be performed by turning the push-in bolt of the special puller while letting the pump run.

Procedure
1. After removal of the turning stopper from lock nut, back it off about 1/2 of the lock nut thread length.
   (This is to prevent dropping of the bearing when it is pulled out by a special puller from the shaft.)
2. Then, mount the special puller and turn the push-in bolt until an increase in the turning torque is felt.
3. Connect the oil injection pump hose to the oil hole of the adapter sleeve, and prepare the pump for action.
4. Turn the push-in bolt until reaching a state where the turning torque constantly increases, then start the oil injection pump. After a while, either a sound is heard or the hydraulic oil of the pump starts to ooze out from the fitted part of shaft and bearing. When the state becomes such, turn the push-in bolt of the special puller and separate the bearing from the shaft. During this operation, let the pump continue to run. Since hydraulic oil might ooze out from the fitted part of shaft and bearing, place an oil pan to catch any dripping oil. (If hydraulic oil drops directly on the floor, it creates a safety hazard.)
5. When the bearing becomes movable, confirm that the bearing inner ring is completely separated from the adapter sleeve.
6. Remove the hose of the oil injection pump and remove the special puller.
7. After removal of the lock nut and bearing, remove the adapter sleeve.
8. After cleaning the lock nut, adapter sleeve and shaft, apply anticorrosive agent.

(3) When the oil hole (oil duct) is provided on the removable sleeve.

Shaft shape: Cylindrical shaft
Bearing inner ring bore shape: Tapered bore

Mount a nut on the removable sleeve to remove the bearing. Basically, perform the procedure of Section 7.2.3. "Nut method", with the only difference being the connection of the oil injection pump hose to the sleeve. When performing this operation, turn the nut mounted on the removable sleeve while letting the pump run.

Procedure
1. After removal of the mounting bolts, remove the end cap or end plate.
2. Mount the nut to the removable sleeve and turn the nut until its turning torque increases.
3. Connect the oil injection pump hose to the oil hole of the adapter sleeve, and make ready the pump for action.
4. Turn the nut and when the turning torque increases, start the oil injection pump. After a while, either a sound is heard or hydraulic oil of the pump starts to ooze out from the fitted section between the shaft and bearing. When such a state is achieved, turn the nut and separate the bearing from the shaft. During this operation, let the pump continue to work. When the hydraulic oil oozes out from the fitted section between the shaft and bearing, place an oil pan to catch any dripping oil. (If hydraulic oil drips directly on the floor, it creates a safety hazard.)
5. When the bearing becomes movable, confirm that the bearing inner ring is completely separated from the removable sleeve.
6. Remove the oil injection pump hose, then, remove the nut and removable sleeve.
7. Remove the bearing. When the spacer ring is used, remove it.
8. Clean the nut, removable sleeve, spacer ring, shaft and end cap or end plate and its mounting bolts.

Next, apply an anticorrosive agent.

# 8. Checking of Shaft and Housing

## 8.1 Checking of Shaft

### 8.1.1 Cylindrical Shaft

(1) Dimensional check of shaft

Measure the shaft size at the place where the bearing will be mounted to confirm that the bearing size is correct. The measurement positions are shown in **Fig. 8.1.** Use an outside micrometer.

(2) Observation of the shaft outside surface

Observe the surface of shaft where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

› When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.

› When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface.

› When there is stepped wearing
After the dimensional measurement of the shaft, decide whether correction is possible.

(3) Anticorrosive agent

After completion of check, apply an anticorrosive agent.

### 8.1.2 Tapered Shaft

(1) Check of shaft shape

Measure the shape of shaft where the bearing will be mounted to confirm that its shape is correct. The measurement positions are shown in **Fig. 8.2.** As for the measurement instrument, use a taper gauge (sine bar system). (**Fig. 2.2 and Fig. 8.2**)

(2) Observation of the shaft outside surface

Observe the shaft surface where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

› When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.

› When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface. (In this case if the zone to be corrected is wide, it is necessary to inspect the shape of the tapered part by using a taper gauge. The inspection method is: apply a thin coat of bluing over the entire surface of taper gauge bore face, insert it slowly after adjusting the taper gauge to the shaft center tapered

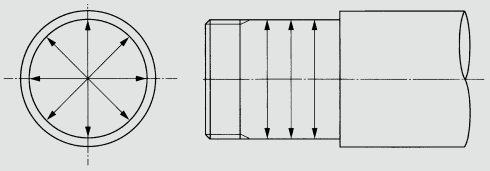
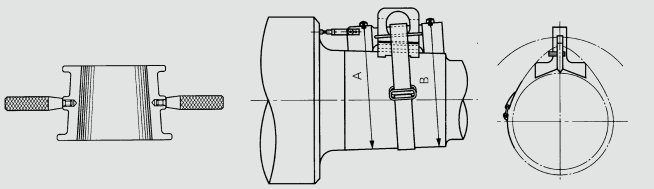


**Fig. 8.1 Cylindrical shaft**




Tapered gauage

Tapered gauage (sine-bar type)

A, B; Measurement positions

**Fig. 8.2 tapered shaft**

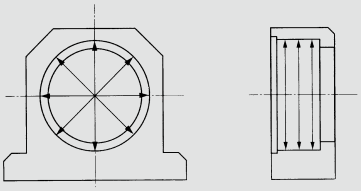


**Fig. 8.3 Integrated housing**


shaft, then, do a run-in by moving back-and-forth. Then, pull the taper gauge out slowly when adjusting to the shaft center. Observe where blue dye is attached to the surface of tapered shaft.
If the blue ares is bigger than 80%, the shaft may be reused. When using a taper gauge (sine-bar type), follow the instructions given in the Operation Manual issued by the manufacturer).

› When there is stepped wearing
After the dimensional measurement of the shaft, decide whether correction is possible.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.

## 8.2 Checking of Housing

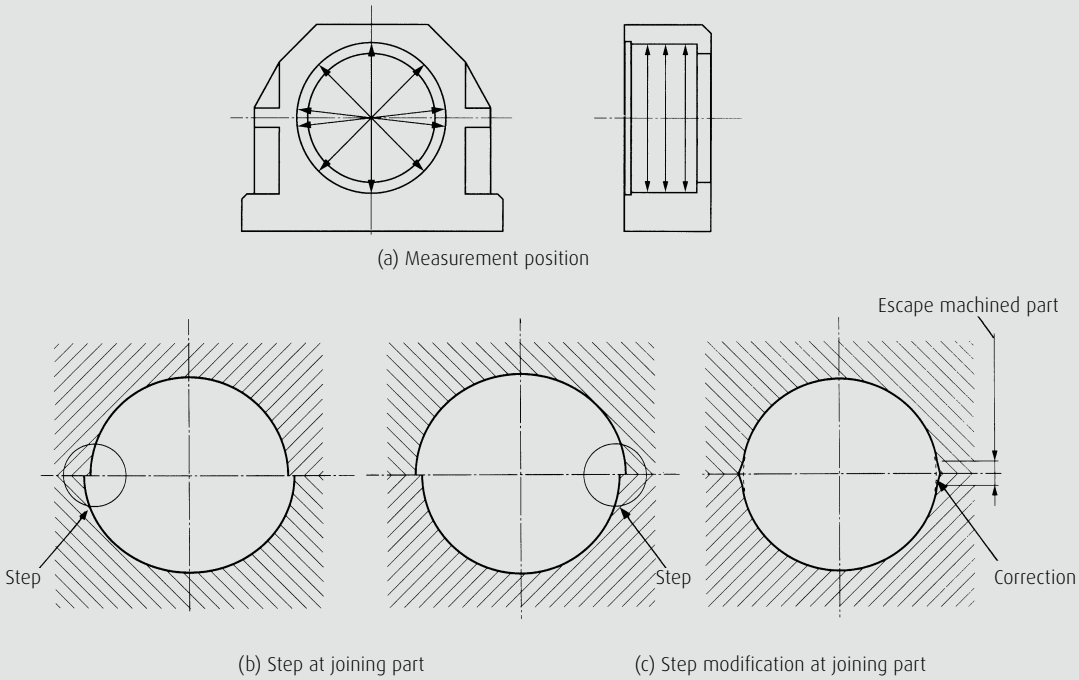
### 8.2.1 Integrated Type Housing

(1) Check of bore size of housing
Measure the housing bore size where the bearing will be mounted to confirm that the size is correct. The measurement position is shown in **Fig. 8.3.** As for the measurement instrument, use an inside micrometer.

(2) Observation of housing bore face
Observe the surface of the housing bore where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

› When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.

› When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface.




(a) Measurement position

(b) Step at joining part

(c) Step modification at joining part

**Fig. 8.4 Split housing**

# 8. Checking of Shaft and Housing

› When there is stepped wearing (**Fig. 8.5**)
After the dimensional measurement of the housing bore, decide whether correction and reuse is possible. In this case, if the measured value of the housing bore is within its tolerance, remove the stepped worn part with oil stone and/or sand paper, etc. and smoothen the surface, then, reuse. If the stepped wearing is severe, either plate or apply thermal spraying to reconstitute to the correct housing size before reusing.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.

### 8.2.2 Split Housing

(1) Check of the housing bore size
In case of a split housing, assemble correctly the housing without bearing, and measure its bore dimension at the place where the bearing will be mounted to confirm that the dimension is correct.
The measurement position is shown in **Fig. 8.4 (a)**. As for the measurement instrument, an inside micro-meter shall be used.

(2) Observation of housing bore face
Observe the surface of the housing bore where the bearing was mounted to check whether there are scratches, dents, rust or stepped wearing.

› When there are scratches, dents
Round edge with oil stone and/or sand paper to smoothen the surface.

› When there is rust
Remove rust with oil stone and/or sand paper to smoothen the surface.

› When there is stepped wearing (**Fig. 8.5**)
After the dimensional measurement of the housing bore, decide whether correction is possible. In this case, if the measured value of housing bore is within its tolerance, remove the stepped worn portion with oil stone and/or sand paper, etc. and smoothen the surface, then, reuse.

› When the stepped wearing is severe
If the stepped wearing is severe, either plate or apply thermal spraying to reconstitute to the correct housing size and reuse.

› When there is a step
As step may occur at the joining part of the split halves housing, confirm whether there is a step. If a step is found, correct it in the way as shown in **Fig. 8.4 (c)**.

(3) Anticorrosive agent
After completion of check, apply an anticorrosive agent.

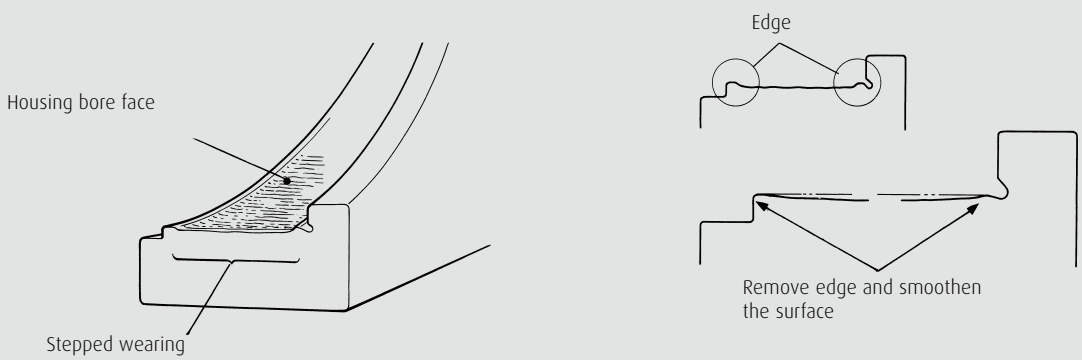



**Fig. 8.5 Correction of stepped wearing on housing bore face**

# 9. Check of Adapter, Removable Sleeve, Nut, Lock-washer and Lock plate

## 9.1 Check of Adapter and Removable Sleeve

After removal of adapter or removable sleeve, check the appearance as follows:

- Check whether there are crushed thread ridges or rust in thread vallies.
- Check whether there are scratches, dents, rust or uneven wearing on bore and outside surface.
- Check whether there are deformation or chips in the slit.

(1) Thread

If crushed thread ridges or rust in thread vallies are found, do not reuse.

(2) Bore and outside surface

- When there are scratches

  If scratches are found, round the edge with oil stone and/or sand paper etc. and smoothen the surface, then, reuse.
- When there are dents

  If the dents are severe, do not reuse. If dents are slight, round edge with oil stone and/or sand paper etc. and make it smooth, then, reuse.
- When rust is found

  Remove rust with oil stone and/or sand paper etc. and smoothen the surface, then, reuse.
- When uneven wearing is found

  If uneven wearing is found, do not reuse.

(3) Slit

If deformation or chips are found in slit, do not reuse.

(4) Anticorrosive agent

After completion of check, apply an anticorrosive agent.

## 9.2 Check of Nut

After removal of lock nut and nut, check the appearance as follows.

- Check whether there are crushed thread ridges or rust in thread vallies.
- Check whether there are scratches, dents, rust or uneven wearing on end face.
- Check whether there is deformation at the cutout of the outside.

(1) Nut threads

If crushed thread ridges or rust in thread vallies are found, do not reuse.

(2) Nut end face

- When scratches are found

  If scratches are found, round edge with oil stone and/or sand paper etc. in order to smoothen the surface, then, reuse.
- When dents are found

  If dents are severe, do not reuse. If dents are slight, round edge with oil stone and/or sand paper etc. to smoothen the surface, then, reuse.
- When rust is found

  When rusting is severe, do not reuse. But if rust is slight, remove rust with oil stone and/or sand paper etc. and smoothen the surface, then, reuse.
- When uneven wearing is found

  If uneven wearing is found, do not reuse.

(3) Cutout of nut outside

If deformation is found on cutout, do not reuse.

(4) Anticorrosive agent

After completion of check, apply an anticorrosive agent.

## 9.3 Check of Lock-washer and lock plate

Check lock-washer or lock plate, when chips or severe deformation is found, discard them and use new ones.

# 10. Check of Damaged Bearing

### 10.1 Investigation of Damaged Bearings

If a damaged bearing is found, investigate its cause by examination of records and phenomena observed during operation, condition of residual lubricant when bearing was dismounted, appearance photo or sketch, check results of shaft and housing, that of sleeve (adapter, removable sleeve) to find out the cause of damage and record it, and take countermeasures to prevent reoccurrence.
When investigating the cause of damage, refer to the "New Bearing Doctor" issued by NSK.

### 10.2 Results of Damage Investigation

If the results of damage investigation reveal that the shaft, housing, sleeve and nut mounted on the bearing are normal, mount a new spare bearing. Repair the faulty part as determined by the damage investigation to prevent any reoccurrence.

# 11. Precautions When Assembling the Machine

As precautions when mounting bearings into a machine, the following items shall be followed.

## 11.1 Confirmation of Sustaining by Bearing

In general, a shaft is sustained by two bearings which are mounted in the housing. When the bearing rotates, temperature difference is caused between the shaft and housing and the shaft expands. By this reason, it is designed that among two bearings one is fixed to the housing (fix side) and another is movable (free side) as the shaft elongates. (**Fig. 1.16 and Fig. 1.17**)
When mounting the bearing in the housing on the free side, confirm that there is a mounting clearance in the axial direction relative to the bearing width dimension.

## 11.2 Lubrication and Piping for Lubrication

Follow the instructions given by the machine manufacturer regarding the kind and amount of lubricant.

- When the lubricant is oil
  Apply lubricant to surface of all the rollers of the bearing. For oil bath lubrication or drip oil lubrication, secure the required oil level. The oil level shall be set so that half of the bearing's lowest roller is immersed in the oil.
- When the lubricant is grease
  Pack the bearing with enough grease. Then, apply grease evenly to housing walls. Pack grease in the free space surrounding the rollers as follows according to operating speed of application as follows:
  - For bearings in applications operating at less than 50% of the bearing limiting speed, pack grease from one half to two-thirds of the free space.
  - For bearings in applications operating at more than 50% of the bearing limiting speed, pack grease from one-third to one half of the free space.

The housing space volume excludes the shaft and bearing. (Note: For the limiting speed, refer to the NSK General Catalog: "Rolling Bearings".)

Oil Lubrication Piping (Tubing):
Confirm that there are no metallic wear particles or debris (dust, contaminants, etc.) within the piping. Inspect the piping to ensure that portions or sections of the pipe have not become clogged, crushed, or damaged.

## 11.3 Mount of Seal

When handling the seal to be mounted in the housing, pay attention not to damage the seal lip. And when mounting it to the housing, pay attention to the seal direction and avoid deforming it.

# 12. Operation Check

After mounting the bearing, in order to confirm that its mounting is correct, check it by running the machine. As the machine running method, for a small machine, turn shaft by hand and confirm that the shaft turns smoothly and that there is no abnormality.

Check if the bearing gets caught during turning, has uneven roration torque or produces an abnormal running noise.

- Caught during turn occurs often when there are scratches or dents on bearing or foreign matter. This problem may also be caused by faulty mounting.
- Faulty mounting may cause uneven torque. The cause may be too small of a bearing clearance, mounting error, friction of seal, etc.
- If abnormal noise is heard while running, its cause may be contact between an object and a rotational part. Other possible causes include caught foreign matter or improper lubricant or not enough lubricant.

If any of the above listed states are observed, determine the cause and remedy it. If the operation of the machine continues without confirming the cause of abnormality, a serious accident related to the bearing may happen. Therefore, when any abnormality is found, be sure to investigate the cause even if it requires dismounting the machine again to remove the cause.

If no abnormality is found by a running test by manual turning then, perform an operation test by turning with its motive force. The power operation may be done for the unit alone or after mounting in the machine. In both cases, start the operation with no load at a low speed, and if no abnormality is observed, then increase the speed gradually and confirm at each step that there is no abnormality.

Power operation test check items:

(1) Whether there is abnormal noise or vibration while running.

(2) Measurement of bearing temperature to detect abnormal temperature rise while running.

The abnormal noise while running shall be checked using a stethoscope or an electronic bearing monitor. The bearing temperature is generally measured on the outside face of the housing. For oil lubrication, the bearing outer ring temperature may be directly measured through the oil hole of the oil supplying system.

The bearing temperature starts to rise gradually from the start of operation and usually reaches a stabilized state after 1 to 3 hours of operation. If the bearing clearance is too small, then mounting is wrong or sealing device has excessive friction. If there is too much or too little lubricant, the bearing temperature suddenly rises and results in an abnormal high temperature. If an abnormal temperature rise is found during operation, stop the operation immediately and inspect the machine. If required, dismount and check the bearing.


As long as abnormal temperature rise or abnormal noise or vibration are not observed, increase the speed gradually till the rated speed is reached. If abnormal noise, vibration of rotating part and abnormal temperature rise of bearing are not observed, then the operation test is OK.

For large machines, a running test by manual turning is not possible, so the test is done by power operation. In this case, perform on a stand-alone unit or with the unit mounted in a machine. It is recommended to test the unit alone, since it is easy to make an emergency stop if any abnormality occurs.

As for the operation, start with no load at low speed. After starting, turn the power OFF immediately and let it coast by inertia. During running by inertia, check for abnormal noise using a stethoscope or an electronic bearing monitor. For the power operation test, similarly to that of small machine, check for abnormal noise or vibration of rotating part, or abnormal temperature rise of the bearing. The bearing temperature is generally measured on the outer face of the housing. As the power operation method, at first start with no load at low speed. At that time when running by inertia, as long as no abnormal sound or vibration is observed, increase gradually till reaching the specified speed. As for the bearing temperature, in case of oil lubrication, check for leaks or foul smells, discoloration of lubricant. If there is no abnormal noise or vibration of rotating part, and the bearing temperature measurement does not show abnormal temperature rise, the operation test is OK.

In case of high speed, if the rotating sound of the bearing is heard through the stethoscope, then an abnormality such as high metallic tone, specific sound or irregular sound may be heard. The cause may be poor accuracy of shaft or housing, entry of foreign matter, damage of bearing, etc. and improper selection of lubrication method, thus, review of lubrication method may become necessary especially when the machine specification is modified to enable high speed operation.

# 13. Maintenance Check

## 13.1 Maintenance Check and Remedies for Abnormalities

In order to keep the performance of bearing in a good state, periodic maintenance and checks are indispensable. Regular maintenance and inspection of bearings allow trouble prevention, more reliable operation, increased productivity and better economical performance. The maintenance shall be systematically executed in accordance with a maintenance schedule appropriate to the actual machine operating conditions. Proper maintenance shall be executed after establishing the maintenance schedule or procedure for monitoring the operating conditions, check and change of lubricant, periodic inspection of the machine after dismounting, necessary working days, method, etc. As for inspection items during operation, be sure to check running sound, vibration, temperature of bearing while operating and state of lubricant. If any abnormality is found during operating, determine its cause by referring to **Table 13.1** and take measure. If needed, dismount the bearing to investigate. For the dismounting procedure, refer to the previous Section 7 "Bearing dismounting method".

## 13.2 NSK Bearing Monitor

(Bearing failure detecting device)

It is very important to predict abnormality of bearing. The NSK Bearing Monitor features an indicator of the running bearing condition. It generates an alarm and/or stops the machine automatically when any abnormality is detected. This function serves to prevent accidents and streamline the maintenance. (See Section 14 "Presentation of Products".)

**Table 13.1 Causes of and measures for operating irregularities**

| Irregularities | | Possible Causes | Measures |
|---|---|---|---|
| Noise | Loud Metallic Sound | Abnormal load | Improve the fit, internal clearance, preload, position of housing shoulder, etc. |
| | | Incorrect mounting | Improve the machining accuracy and alignment of shaft and housing, accuracy of mounting method. |
| | | Insufficient or improper lubricant | Replenish the lubricant or select another lubricant. |
| | | Contact of rotating parts | Modify the labyrinth seal, etc. |
| | Loud Regular Sound | Flaws, corrosion, or scratches on raceways | Replace or clean the bearing, improve the seals, and use clean lubricant. |
| | | Brinelling | Replace the bearing and use care when handling bearings. |
| | | Flaking on raceway | Replace the bearings. |
| | Irregular Sound | Excessive clearance | Improve the fit, clearance and preload. |
| | | Penetration of foreign particles | Replace or clean the bearing, improve the seals, and use clean lubricant. |
| | | Flaws or flaking on roller | Replace the bearing. |
| Abnormal Temperature Rise | | Excessive amount of lubricant | Reduce amount of lubricant, select stiffer grease. |
| | | Insufficient or improper lubricant | Replenish lubricant or select a better one. |
| | | Abnormal load | Improve the fit, internal clearance, preload, position of housing shoulder. |
| | | Incorrect mounting | Improve the machining accuracy and alignment of shaft and housing, accuracy of mounting, or mounting method. |
| | | Creep on fitted surface, excessive seal friction | Correct the seals, replace the bearing, correct the fitting or mounting. |
| Vibration (Axial runout) | | Brinelling | Replace the bearing and use care when handling bearings. |
| | | Flaking | Replace the bearing. |
| | | Incorrect mounting | Correct the squareness between the shaft and housing shoulder or side of spacer. |
| | | Penetration of foreign particles | Replace or clean the bearing, improve the seals. |
| Leakage or Discoloration of Lubricant | | Too much lubricant. Penetration by foreign matter or abrasion chips | Reduce the amount of lubricant, select a stiffer grease. Replace the bearing or lubricant. Clean the housing and adjacent parts. |

## 13.3 Damage of Bearing and Measures

In general, when the bearing is correctly handled, it can be used until its fatigue life but occasionally it may break prematurely. Such premature damage is called failure or accident to distinguish it from the fatigue life. Premature damage is often caused by insufficient consideration given to fundamentals such as mounting, handling, lubrication, entry of foreign matter from outside, insufficient examination of thermal influence of shaft, housing.

Examples of damaged bearings include scoring on race ring of spherical roller bearing, shortage, improper lubricant, defective oil supply/discharge system, entry of foreign matter, error in bearing mounting or excessive bend of shaft, etc. And several of these factors may jointly contribute to the bearing trouble. Therefore, it may be difficult to determine the real cause of the trouble merely by investigating the damaged bearing. It is often possible to prevent a reoccurrence of similar trouble by gaining a complete knowledge of the machine on which the bearing was used, operating conditions, the structure surrounding the bearing, the situation before and after the trouble occurred. (See **Table 13.2**).

**Table 13.2 Causes and measures for bearing failures**

| | Type of Failure | Probable Causes | Measures |
|---|---|---|---|
| **Flaking** | Flaking of one-side of the raceway of radial bearings. | Abnormal axial load. | A loose fit should be used when mounting the outer ring of free-end bearings to allow axial expansion of the shaft. |
| | Flaking of the raceway in symmetrical pattern. | Out-of-roundness of the housing bore. | Correct the faulty housing. |
| | Flaking near the edge of the raceway and rolling surfaces. | Improper mounting, deflection of shaft, inadequate tolerances for shaft and housing. | Use care in mounting and centering, select a bearing with a large clearance, and correct the shaft and housing housing shoulder. |
| | Flaking of raceway with same spacing as rolling elements. | Large shock load during mounting, rusting while bearing is out of operation for prolonged period. | Use care in mounting and apply a rust preventive when machine operation is suspended for a long time. |
| | Premature flaking of raceway and rolling elements. | Insufficient clearance, excessive load, improper lubrication, rust, etc. | Select proper fit, bearing clearance, and lubricant. |
| | Premature flaking of duplex bearings. | Excessive preload. | Adjust the preload. |
| **Scoring** | Scoring or smearing between raceway and rolling surfaces. | Inadequate initial lubrication, excessively hard grease and high acceleration when starting. | Use a softer grease and avoid rapid acceleration. |
| | Scoring or smearing between the end face of the rollers and guide rib. | Inadequate lubrication, incorrect mounting and large axial load. | Select proper lubricant and modify the mounting. |
| **Cracks** | Crack in outer or inner ring. | Excessive shock load, excessive interference in fitting, poor surface cylindricality, improper sleeve taper, large fillet radius, development of thermal cracks and advancement of flaking. | Examine the loading conditions, modify the fit of bearing and sleeve. The fillet radius must be smaller than the bearing chamfer. |
| | Crack in rolling element. Broken rib. | Advancement of flaking, shock applied to the rib during mounting or dropped during handling. | Be careful in handling and mounting. |
| | Fractured cage. | Abnormal loading of cage due to incorrect mounting and improper lubrication. | Reduce the mounting error and review the lubricating method and lubricant. |
| **Indentations** | Indentations in raceway in same pattern as rolling elements. | Shock load during mounting or excessive load when not rotating. | Use care in handling. |
| | Indentations in raceway and rolling elements. | Foreign matter such as metallic chips or sand. | Clean the housing, improve the seals, and use a clean lubricant. |
| **Abnormal Wear** | False brinelling (phenomenon similar to brinelling) | Vibration of the bearing without rotation during shipment or rocking motion of small amplitude. | Secure the shaft and housing, use oil as a lubricant and reduce vibration by applying a preload. |
| | Fretting | Slight wear of the fitting surface. | Increase interference and apply oil. |
| | Wearing of raceway, rolling elements, rib, and clearance. | Penetration by foreign matter, incorrect lubrication, and rust. | Improve the seals, clean the housing, and use a clean lubricant. |
| | Creep | Insufficient interference or insufficient tightening of sleeve. | Modify the fit or tighten the sleeve. |
| **Seizure** | Discoloration and melting of raceway, rolling elements, and ribs. | Insufficient clearance, incorrect lubrication, or improper mounting. | Review the internal clearance and bear-ing fit, supply an adequate amount of the proper lubricant and improve the mount-ing method and related parts. |
| **Electric Burns** | Fluting or corrugations | Melting due to electric arcing. | Install a ground wire to stop the flow of electricity or insulate the bearing. |
| **Corrosion & Rust** | Rust and corrosion of fitting surfaces and bearing interior | Condensation of water from the air, or fretting.Penetration by corrosive substance (especially varnish-gas, etc). | Use care in storing and avoid high temperature and high humidity, treatment for rust prevention is necessary when operation is stopped for long time. Selection of varnish and grease. |

# 14. Presentation of Products

Here we introduce some NSK products to be used when handling bearings.

## Bearing Heater

A bearing heater is used in the shrink fitting and mounting operations.

› Fast, uniform heating
Induction heating reduces bearing mounting time and cost.

› No oil tanks required
Since no oil is necessary, it is free from spills and other messes, and environmentally-friendly. Bearings prelubricated with grease can be heated cleanly and simply.

› Safety
It is in conformity with CE Standard and UL Standards.

› Safe operation
Since there are no flames, there is no fire hazard, and an internal circuit breaker guards against electrical short.

› Compact and light
Most NSK Bearing Heaters are light enough to be carried easily and used any where.

› Automatic temperature control
A thermostat control can be set at any temperature up to 250°C. When the desired level is reached, a buzzer sounds and constant temperature is maintained.

› Automatic demagnetizing
When the heating is finished, the bearing is quickly and automatically demagnetized.

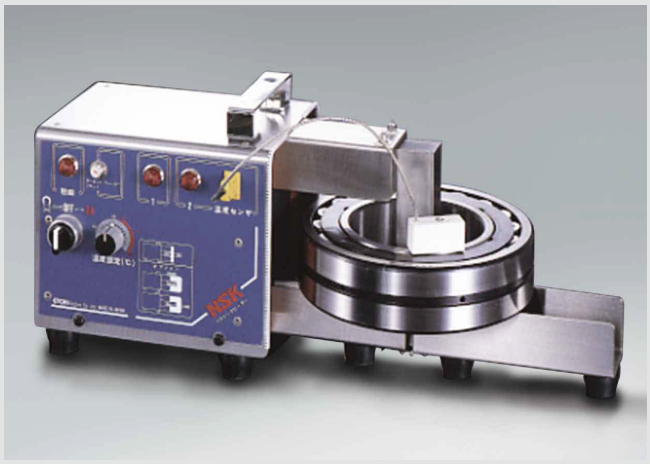
› Horizontal guide
After heating, the bearing can be taken out easily by sliding along the guide.

› Versatility
Besides bearings, other metallic rings such as inner ring spacers can also be heated for shrink fitting or for other purposes.

| Model No. | | IHE0110 | IHE0120 | IHE0320 | IHE0340 | IHE0620 | IHE0640 | IHE1120 | IHE1140 | IHE2320 | IHE2340 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Heating Capacity (kVA) | | 1 | | 3.3 | | 6.6 | | 11.8 | | 23 | |
| Applicable Bearing Size | Minimum bore diameter (mm) | 20 | | 35 | | 35 | | 50 | | 50 | |
| | Maximum outside diameter (mm) | 200 | | 300 | | 400 | | 600 | | 800 | |
| | Thickness (mm) | 70 | | 110 | | 200 | | 300 | | 400 | |
| | Weight (kg) | 12 | | 40 | | 80 | | 300 | | 600 | |
| Heating Bearing type | Seal type bearing | Yes | | | | | | | | | |
| | Open type bearing | Yes | | | | | | | | | |
| Power Supply Characteristics | No. of phases | Single | | Three | | | | | | | |
| | Voltage (V) | 100-120 | 200-240 | 200-240 | 380-440 | 200-230 | 380-440 | 200-230 | 380-440 | 200-220/50Hz<br>200-230/60Hz | 380-440 |
| | Frequency (Hz) | 50/60 | | | | | | | | | |
| | Input rated (Maximum) Current (A) | 7.2 | 4.0 | 5.3 | 2.7 | 8.1 | 4.0 | 13.2 | 6.6 | 27 | 13.5 |
| Dimensions of body | Height (mm) | 347 | | 565 | | 745 | | 1200.0 | | 1440 | |
| | Width (mm) | 175 | | 295 | | 380 | | 600 | | 850 | |
| | Length (mm) | 470 | | 755 | | 975 | | 1250.0 | | 1600 | |
| | Body weight (kg) | 4 | | 43 | | 81 | | 241 | | 335 | |

Precautions
1. Do not heat bearings to 120°C or above.
2. Handle heated bearings or works with care. Do not touch then directly, or get your fingers burned.

Special catalog "Inverter Motor Drive NSK Bearing Heater™" CAT. No. 1275 is available.



### Composition of Bearing Heater Model Numbers

**Model type (example)**

IHE 01 10

a b

Inverter Motor Drive
NSK Bearing Heater

| a Capacity | b Voltage |
|---|---|
| 01: 1.0kVA | 10: 100V class |
| 03: 3.3kVA | 20: 200V class |
| 06: 6.6kVA | 40: 400V class |
| 11: 11.8kVA | |
| 23: 23 kVA | |

## Bearing Monitor

NSK Bearing Monitor measures and analyzes the vibration acceleration of a bearing and generates early warning of trouble to allow streamlining of maintenance.

Features

- Detection of diverse abnormalities
- Reading is in units of g (1g = 9.8 m/sec$^2$)
- Highly sophisticated analysis is possible thanks to several output circuits.
- NB-4 is pocket size thanks to the use of microelectronics. It can be used not only for checking bearings but also for measurement of vibrations in other devices.

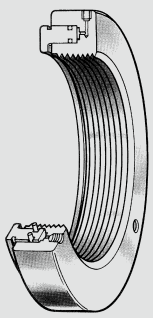
NB-4

## Hydraulic Nut

This is used to mount and dismount bearings.
This is used with high pressure oil after connection of the oil injection pump hose to mount the bearing having a tapered bore to the tapered shaft or adapter sleeve or to dismount the bearing mounted to a removable sleeve.

Features

- Since the ring type piston is driven by the high pressure hydraulic oil, a big piston force can be generated.
- A wide variety of hydraulic nut bore threads are available. They can be mated with the shaft threads. Both adapter sleeve and removable sleeve types are available.



# Notes

MOTION & CONTROL™

NSK

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